Fatal Policy or Market Adaptation?

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ABSTRACT

This thesis investigates the effects of the implementation of a new policy requiring petrol stations in Sweden to include an alternative fuel in their product range. We extend the research to investigate the negative consumer effects following the law, namely effects on fuel price and fuel sales volume. Using data from a unique computed dataset we conduct a standard Poisson regression as well as an OLS, using a difference-in-difference approach, we find that there has been a decrease in the number of stations in the years following the law's introduction that is not attributable to changes in market's demographic parameters. However find no negative consumer effects that follow the decrease in number of stations.

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1. Introduction

1.1 Topic introduction

During the past ten years, the local accessibility of petrol stations in Sweden has had a negative trend and stations are closing down by the hundreds every year even though there has been a steady increasing demand for fuel[i] since the 1940's. Many are hasty and jump to the conclusion that this a result of the industry wide structural rationalization due to diminishing profits and ownership shifting, further explained in the background. However, The Act on The Obligation to Provide Renewable Fuels[ii] was sequentially introduced through the years 2006-2010 and has been questioned and suspected to be a contributing factor. The law has in short forced single stations to invest a relatively large amount in a pump system in order to be able to offer an alternative fuel.

Intuition would suggest that with fewer numbers of stations in a market, i.e. less competition, the fuel prices for the end consumer would increase. The discussions around fuel price seldom stray far from arguments relating to high taxes on fuels or the ever-rising oil price. Seldom is light shed on the how the competition on the local petrol station market affects the fuel price. It might be because it only has a minor influence in the larger picture, however, when scaling the minor effects one can observe huge nominal effects. Essentially these effects transfers value from the consumer to the oil companies due to inefficient markets, i.e. not perfect competition.

Following the increase in fuel price, relating to supply and demand theory, the fuel sales volume would decrease, ceteris paribus. Like for the fuel price increase, the consumer looses the utility value of the decreased fuel consumption.

Little to no previous research has been done focusing on local Swedish petrol station markets and the conditions under which they compete. We find neither previous statistical proof for if the new law has affected the market negatively in the sense described above nor if the effects are so widespread to have affected the fuel price and fuel sales volume.

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[i] Hereafter when we say fuel we mean the liquid propellants
[ii] Hereafter also referred to as *The Pump Law.*

1.2 Aim

Our ambition is to contribute to the current discussions on the topic by providing statistical evidence. We investigate the indirect effects of The Pump Law. We not only look at the effects on number of stations but also the effects on the fuel price and fuel sales volumes.

1.3 Research Questions

The 3 questions we aim to answer in this thesis are:

- Did the implementation of The Pump Law have a negative effect on the number of petrol stations in Sweden?
- Has the reduction in the number of petrol stations affected the competition conditions in the local markets to the extent that it has resulted in a fuel price increase?
- Has the increase in the fuel price affected the fuel sales volume in the local markets?

1.4 Target Audience

The results gained from this thesis are not only intended to contribute to academia and/or industry specific usage. We think that our conclusions will be interesting and useful for the common man. We aim to present our results and conclusions in an easy and understandable way so that no specific background or education is needed to benefit from them. We hope that many will share our opinion that our results will be of interest to the common man, as the consumption of fuel has become a dependent factor for functioning living for many. So to gain knowledge about the effects governmental policies can have on local markets, e.g. competition conditions, prices and quantities would not only enrich the government and the industry but also the common man.

2. Background

2.1 The Industry

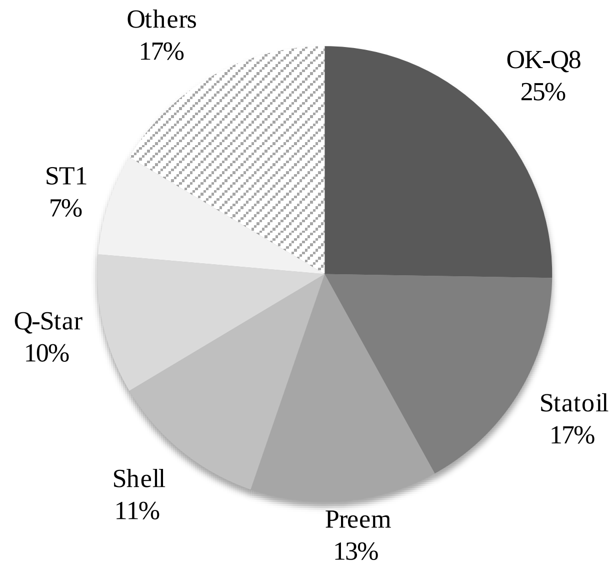
The industry of interest for this thesis is the retail automotive fuel industry in Sweden, in other words the Swedish petrol station industry. Companies in the industry focus on retail automotive fuel such as petrol, diesel and alternative fuels. Many petrol stations also offer other services on top of forecourt fuel service such as, car wash services, garage services, and many also operate a convenience store. [1] This is also consistent with the definition by The Cambridge Dictionary – "a place where fuel is sold for road vehicles, often with a small shop and public toilets"[2]. An important addition to the definition that we make is that petrol stations sell directly to final consumers *and* the stations must be accessible by the public. Therefore stations that do not serve the public, which for example only serve trucking companies, are excluded from our definition. Also note that a significant proportion of heavy goods vehicles, buses, and coaches obtain fuel directly from wholesalers, why these sales are excluded from the industry figures we use.[iii]

In Sweden petrol stations are run both by the larger oil companies and by single independent companies under franchise contracts. There are 6 larger brands (>150 stations each) under which both franchise companies and the larger oil companies operate petrol stations. In addition to this, there are approximately 6 brands where each operates between 50 – 150 stations.[3] As seen below in the figure (1) the two largest brands control 42% of the total market measured in number of stations. However there is co-ownership between some of the smaller brands for example between ST1 and Shell, which would make their collected stations count the second largest. Due to measurement issues there are approximately 200 – 300 additional stations that are not observed, of which the majority are very small local stations located in the countryside.

[iii] This definition is used throughout this paper when referring to petrol stations.

Figure 1 - Market Share

Number of stations by brand 2012

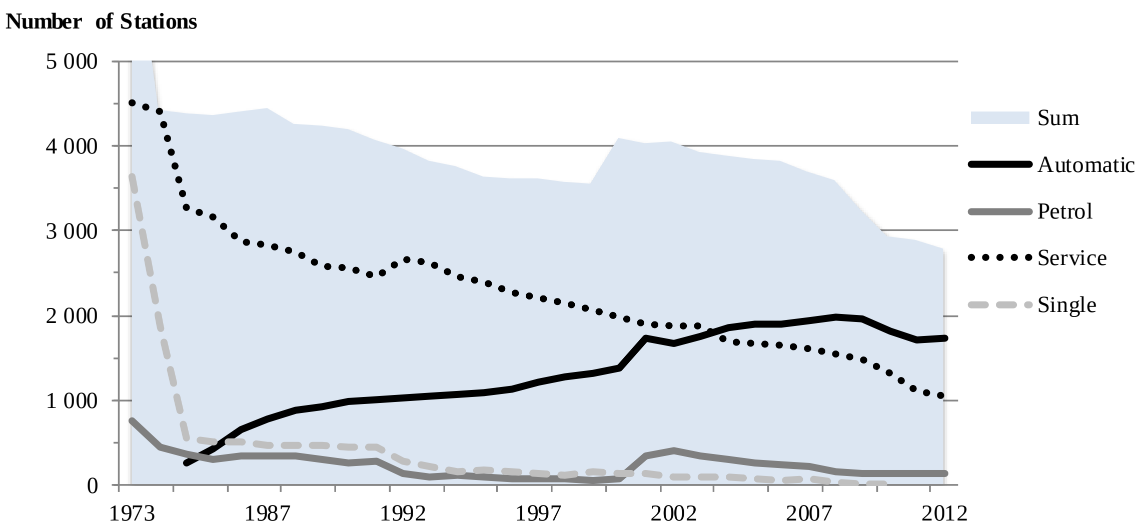


Others include:
- Jet
- Din-X
- Bilia
- Billisten
- Pump/Gulf
- Dalvik Oil

Souce: SPBI

Figure 2 - Petrol Stations

Number of stations per type for years 1973 - 2012



Souce: SPBI

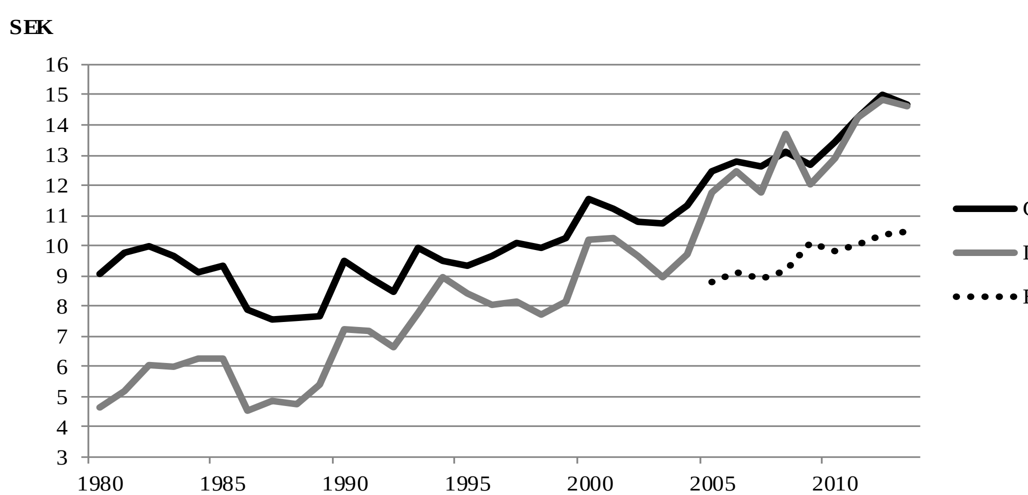
Definitions:
Automatic - Station without staff. No store, garage or equivalence.
Petrol - Station with multiple pumps and convenience store. No garage or car service.
Serice - Larger station with convenience store *and* garage or car service.
Single - Single pump in adjecent to other business such as garage, car service or equivalence.

According to SPBI (The Swedish Institute for Petrol and Renewable Fuel) the number of petrol stations in Sweden has had a stable declining trend since the 1960's. In fact, between 1968 and 2012 there have only been 4 years when the observed number of petrol stations increased compared to the previous year as seen in Figure 2. The relatively large increase year 1999 is due to 4 new companies entered the Swedish market establishing a total of 600 new petrol stations. When SPBI first started to register the number of petrol stations in 1968 they observed a count of 8927 stations. This figure is today only 2786. During the few years in the new millennium there has been a decline of 1303 stations, where around half of which closed down during 2009 and 2010.[4] These two years are also the years when the final stages of The Pump Law were implemented.

The price development in the industry has, much like the number of petrol stations, had a somewhat consistent trend throughout the observed period. In Figure 3 we display fuel prices to the final consumer. The numbers are adjusted for inflation during the period with a starting value of 9.06 SEK for gasoline (lead-free, 95 octane) and 4.66 SEK for diesel. Since 1980, the gasoline price has increased by 62% and now (May 2013) retails at 14.69 SEK while the price for diesel has increased by a staggering 213% retailing at 14.60 SEK. Ethanol (E85) was first introduced in 2005 on the Swedish market why we observe an incomplete curve. The Price for ethanol was at first and still is, although not to the same extend, tax deducted to encourage sales of the environmentally friendly fuel.[5]

Figure 3 - Fuel Prices

Prices per type of fuel for years 1980 - 2013 (inflation adjusted)



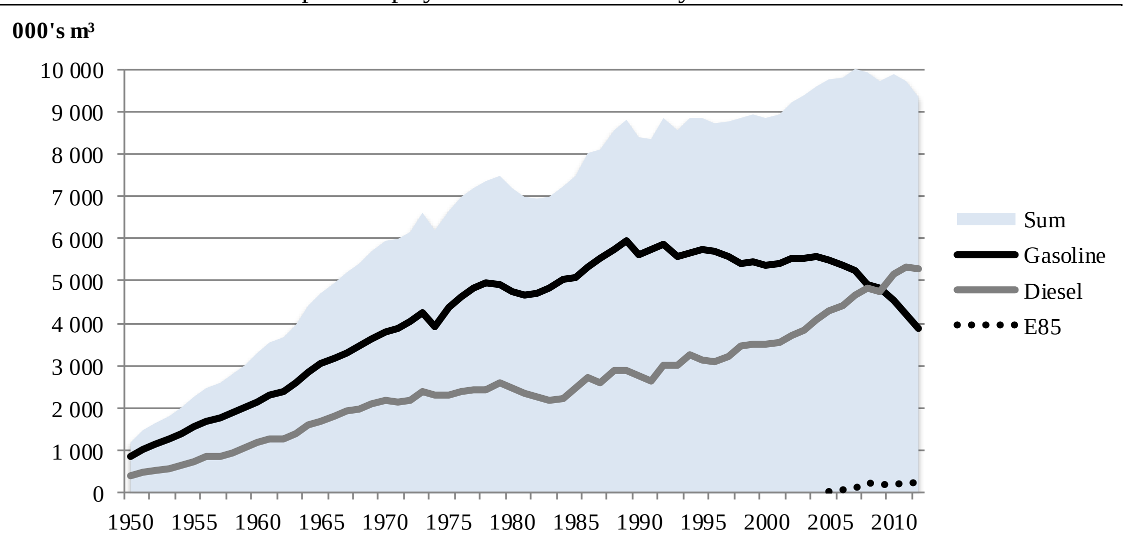
Souce: SPBI

We will not go into detail describing the major drivers that affects the price to the final consumer. Though, in short there is a strong correlation with the global oil price as well as a direct dependence on political decisions regarding taxation. However, what is interesting to this thesis is if the declining number of petrol stations has affected the fuel price, i.e. has the competition conditions in a given market changed to the extent that it has affected the fuel price. Especially interesting is the steep decline during the years 2006 – 2010 when The Pump Law was sequentially implemented.

Up to recent years the aggregated fuel consumption/sales volume has steadily increased since the 1940's. However, during the past 5 years we have observed an inconsistency in the historical trend and aggregated volumes have declined each consecutive year since 2007. Historically there has been a strong correlation between the number of newly registered cars and fuel sales however since 2007 the correlation has weakened. We still see a strong increase in cars but, as seen in Figure 4, the fuel consumption has declined. Experts agree that the increased fuel efficiency of modern combustion engines has played a large role when explaining this change.[6] However, comparing the recent decline in volume to the historical growth, it can be viewed as only a minor dent in the long-term trend. Similar cases have been observed a couple of times before without having disrupting the long-term trend.

Figure 4 - Fuel Consumption

Consumption displayed in thousands m³ for years 1950 - 2013



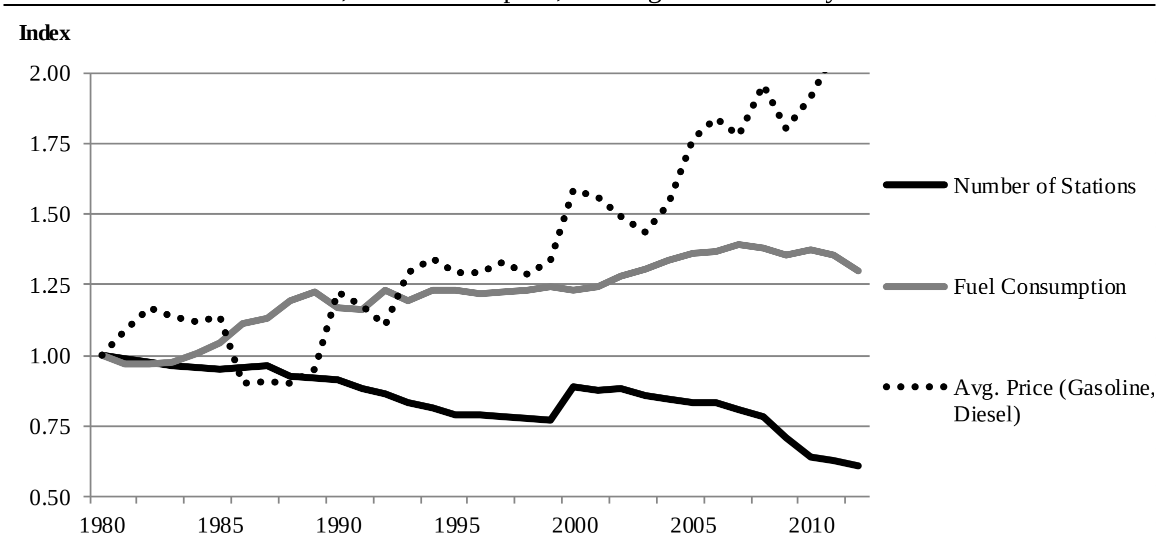
Souce: SPBI

Looking at Figure 4, focusing on the recent years, we also observe a shift in the type of fuel consumed. There has been a major decline in gasoline volumes while diesel and ethanol volumes are still increasing. This is mainly due to technological advances of diesel-powered engines making them relatively more fuel-efficient, thus increasing demand for diesel-powered cars and thereof the fuel. Also recent environmental related reasons explained in section 2.2 have had an effect on the increased demand for so called alternative fuels.[7,8]

If we relate supply and demand theory to the industry developments presented above, one can argue that there are some inconsistencies, which we have tried to display in Figure 5. The price increase as well as the increase in fuel consumption should attract new entry, as market size has grown and more suppliers would be able to compete at the higher price. However, keeping in mind that the margins in the industry on which the firms compete is not entirely dependent on the retail price, the increase in market size would still suggest that there is more room for additional competition. Taking a look at the industry margins (Figure 6) we can see that from the year 1989 the industry has suffered decreasing margins. However, from 2008 and onwards the industry has drastically increased its margins which leads us back to our initial reasoning presented in the introduction. The less competition has raised the industry margins and transferred value from the consumer to the operating firms.

Figure 5 - Index Comparison

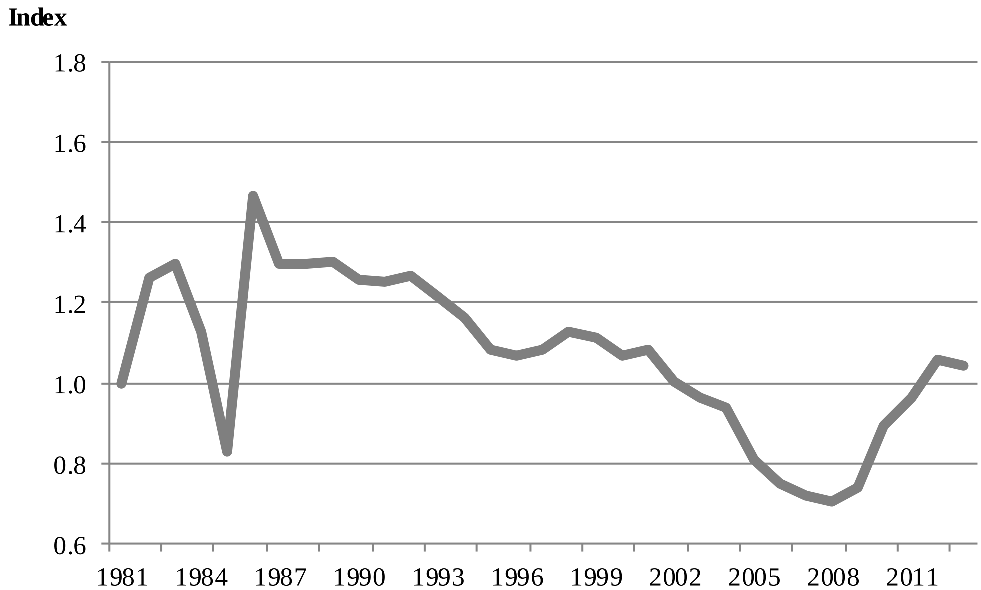
Number of Staions, Fuel Comsumption, and Avg. Fuel Price for years 1980 - 2012



Souce: Constructed based on data from SPBI

Figure 6 - Net Margin Index

Index for the net margin denoted in SEK on fuel sales between 1981 - 2013



Souce: SPBI

2.2 Environmental Focus

Recent years' focus on society's effect on the environment has forced governments to take further responsibility and increase the efforts to protect the environment. As a result organizations have introduced international environmental agreements and long-term emission goals. The Kyoto protocol, which entered into force in February 2005 as part of the United Nations Framework on climate change, is an example of this.[9]

Of the total carbon dioxide emissions in Sweden 30% is related to road transportation and is due to the combustion of fuels. Even though modern combustion engines have become much more efficient, the total emission volume from road transportations has increased by 10% since 1990. More still if you include construction vehicles such as dumpers, loaders and excavators.[10] Therefore is it crucial to reduce the emission from road vehicles as they contribute to such a large share of society's total emission volumes.

According to the Swedish Department of Motor Vehicles there are 3 main factors that affect the total vehicle emission:

1. Total usage, i.e. aggregated kilometers driven,
2. Energy consumption per kilometer, i.e. the fuel efficiency of the engine as well as the drivers way of driving,
3. Share of fossil fuels, i.e. the amount of gasoline and diesel consumed relative to alternative fuels such as ethanol, biogas and other non-fossil fuels.

Regarding the total usage of road vehicles the government has different tools when trying to influence this. High taxation on fuels, road tolls and the expansion of the public transportation sector are examples of this that are used frequently.[11] For the second factor we also see high governmental involvement to increase fuel efficiency. Not only is the government focused on affecting car manufactures to produce more fuel-efficient vehicles, but also towards the consumer to adapt a more fuel-efficient way of driving. C. Huse and C. Lucinda (2013)[12] show evidence that governmental discounts on low emission vehicles[iv] has indeed increased the demand for low emission vehicles as well as affected car manufacture's supply of such vehicles. Also The European Union has agreed upon new emission goals for newly produced cars within the EU which enters into force in 2015, limiting the allowed emission to 130g CO^2/km.[13]

The last factor listed by the Swedish Department of Motor Vehicles is the one we see as most interesting to this thesis. Especially the real effects of the governmental efforts to increase the share of renewable fuels used. The tax discount for low emission vehicles is, again, an example of such efforts as vehicles running on renewable fuels have by nature lower volume of CO^2-emission per liter of fuel consumed than cars using fossil fuels. Shown by C. Huse and C. Lucinda as above, the demand for the low emission vehicles specifically compatible with renewable fuels have increase as well. So the overall effects of the discount have been beneficial for increasing the number of cars compatible with renewable fuels, which brings us to our main focus: The Pump Law, i.e. the government's effort to increase the supply of renewable fuels. Following the reasoning of K. S. Corts[14], C. Huse and A. Salvo[15], and in accordance with governmental

[iv] Cars emitting less than 120 gCO^2/km regardless of fuel type.

follow-up reports[16], The Pump Law has been necessary to avoid the hindering of the adoption of the new technology. In other words, when influencing the demand for vehicles running on alternative fuels, a sufficient infrastructure for the supply of such fuels is a highly causal factor.

2.3 The Act on The Obligation to Provide Renewable Fuels – "The Pump Law"

In 2003 the Swedish government began to investigate the possibility of forcing petrol stations by law to provide renewable fuels.[v] The background for this was as stated above that the demand for renewable fuels would not increase in desired pace if not there was a developed infrastructure to supply the fuel. This followed the EU agreement that member countries should have reached a consumption share for renewable fuels of 5,75% by 2010.[17] The investigation resulted in a proposition to the parliament in 2005, which was after some time, accepted by in the parliament by the red-green majority[vi].

The law, which is still unchanged today, requires petrol stations that have yearly fuel sales volumes for above a certain level to offer a renewable fuel in addition to their fossil based alternatives. The law was sequentially introduced, meaning that the specified sales volume for when a petrol station is compelled by the law was gradually lowered. The first step included all stations with total fuel sales above 3000m^3 during 2004, forcing them to offer a renewable fuel alternative by the 1st of April 2006. The volume was lowered to 2500m^3 for sales during 2005 and 2000m^3 during 2006 to finally include all stations selling more that 1000m^3 during 2008 and onwards forcing them to have introduced the alternative fuel within two years. So by the 1st of January 2010 the law had been fully implemented.[18]

The law is technically independent, meaning that there is no paragraph controlling what type of renewable fuel the station is obligated to offer, with an exception for electricity which is not found to be satisfactory. In theory there is no restriction, however in practice we observe that the majority of stations included by the law has started to offer ethanol (E85) for cost reasons. Which also brings us onto the subject of why this

[v] European agreement: EUT L 123, 17.5.2003, p. 42, Celex 32003L0030
[vi] The Social Democrats, The Left Wing Party and The Green Party together holding majority votes in the term 2002 – 2006.

law is interesting to our study. To be able to offer a renewable fuel a station needs to install a separate fuel pump that is very costly, especially for the smaller stations that have relatively small sales volumes but still above $1000m^3$. The estimated cost for installing an ethanol (E85) pump is 200.000 SEK – 400.000 SEK. However for a system supporting biogas, the installation cost can be up to 4.000.000 SEK for a single station. [19] This large installation cost, both for the ethanol and biogas pump systems, has been suggested to be a contributing factor to the decline in number of petrol stations as it is argued that smaller stations cannot afford to comply with the law and are forced out of business.[20] Under certain circumstances, the Swedish Transport Agency[vii] is authorized to give exemptions from the law. However, these exemptions are always time-limited, meaning in practice that a given station is only granted a longer time-period to adapt to the new law.

A station can apply for governmental funding for installing a new pump system. These types of subsidies come from and are decided by governmental bodies. One of these is the Swedish Environmental Protection Agency, which has three possible subsidy programs to which a station can apply. All three are oriented around installing biogas pump systems whereof two, Klimp and LIP, are general subsidy programs on reducing CO^2 emission, not specific to petrol stations. The third is a subsidy specifically toward petrol stations that are looking to install a biogas pump system. The reason for this is because of the bias towards stations installing ethanol pumps in favor to biogas systems due to the large cost difference.[21] However the subsidy from the SEPA will only cover up to 30% of the total cost but is often complemented with additional governmental funding. Most commonly is that the government subsidizes the cost for a biogas system so the remaining cost is equal to the cost for an ethanol pump installation. Regarding the installation for ethanol pump systems, these are never subsidized according to a governmental follow-up report.[22]

Concluding, due to the introduction of the Pump Law, petrol stations selling more than $1000m^3$ are obligated to install a new pump system compatible with the renewable fuel of choice. Resulting in a compulsory investment no lesser than 200.000 SEK and up

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[vii] A governmental body that administrates all questions regarding transportation in Sweden.

to 400.000 SEK assuming that one is granted governmental funding for a biogas system. This is argued to be a large capital expenditure for single petrol stations and in some cases suggested to have forced them out of the market. In which case, exits attributable to the law have occurred sometime between when the first compulsion was enforced in 2006 and up until today. However, exits are more likely to have occurred in the later stages of the law, as the smaller stations are then included. This will be another area of focus in the thesis as it will be of interest to determine what stage of the sequential introduction resulted in exits if any.

2.3.1 Governmental Follow-up

Two years after the first introduction of the Pump Law, the Swedish Transportation Agency was instructed to conduct a follow-up report[23] on the effects of the law, which was later published in 2009. The focus of the report is around the law and its effects but the report is also very extensive covering the entire industry and all surrounding developments. We will only highlight the key findings of the report that we deem related to our specific research. Furthermore the report often states that conclusions drawn are not statistically significant due to the qualitative nature of the report. Cecilia Forsberg, co-writer of the report, concurs with our aim for this thesis that it would indeed be interesting and beneficial for the industry to obtain statistical validation for the effects of the law. Due to lack of funding, she was unable to collect sufficient data to conduct a quantitative study.

Overall observed effects of the law have been positive and in coherence with the initial aim of the law. The number of petrol stations offering ethanol as well as biogas has increased since the introduction of the law although there is a clear skew towards ethanol offering. Together with some additional political tools used by the government the law has contributed to increasing the number of Flexi-Fuel Vehicles and thus the demand for the renewable fuel ethanol. However, the report highlights that consumer’s choice of fuel is still very price sensitive and thereby showing the increased importance of the tax subsidy on ethanol relative the ethanol accessibility established by the law.

The report also touches upon the specific topics that are widely discussed in the media and highly relevant to our thesis. It’s namely the effects on the individual stations including the financial burden of the pump installation and the possible consequence of forcing single stations out of the market. Regarding the decrease in number of stations the report points out that many smaller stations in the countryside which closed down after the law's introduction were not covered by the law as their volumes were too low. Also this has not been a unique occurrence for the Swedish market. A similar trend can also be observed in other countries, where there is no law equivalent to the Pump Law. Although the extent of the decrease in Sweden compared to the other countries is not discussed. Instead they refer to the structural rationalization of the industry, mentioning that it is due to the shifting in ownership in current years where oil companies now own and run more of their branded stations. Following the slim industry margins, this has led to the oil companies being more cautious when evaluating the profitability of single stations and resulted in some smaller stations with lesser volumes being considered unprofitable to the franchise as a whole. More often than not, these smaller stations are operating on such thin margins that, for a small owner, continuing the business would be unprofitable as well.

Specifically regarding the financial strain the installation cause single stations to suffer, the Swedish Petrol Trade Organization[viii] have argued that the thin margins of the industry together with the current economy with conservative lending policies have increased the difficulty for obtaining financing for the installation. Though this is mainly observed when the station is run by a small private owner rather than a larger oil company. The report agrees with this and also confirms that the magnitude of the investment has, for some stations, indeed been problematic to cope with. A factor that speaks against the fatal effect on stations is that the government can grant exemptions to certain stations if necessary. The report does not go into depth about this but states that all but 36 of the 650 applicants had been granted an exemption in 2009. It would be interesting to see if there is a general trend of the reason the exemption is granted, be it financial or related to sales volumes, however due to insufficient resources we have not been able to gather this information.

[viii] *Svensk Bensinhandel* – The industry organisation for petrol retail in Sweden.

In the concluding remarks they again state that there is unfortunately insufficient statistical evidence to draw any reliable conclusion. However they firmly say that in some cases the law can have been a contributing factor for the closure of a station. They also do not rule out the possibility of the law becoming a more causal factor in the future, when for example current exemptions given to certain stations expire. Although the report generally determines that the law has not had a wide spread effect on the decreasing number of stations. This statistical uncertainty they always return to in their conclusions increases the importance of a statistical exploration of the subject. There might well be hidden causalities and effects that are hard to detect in a qualitative investigation.

3. Data

When collecting the data needed to conduct this study we have mainly used SCB, Trafa and SPBI, all of which are considered official sources. Meaning that they are frequently used by the Swedish government as well as by industry agencies and other official authorities. Also both Trafa and SCB are organizations that are seen as neutral with no conflict of interest in the statistics they provide. Therefore we conclude the data to be reliable coming from these sources.

The overall data used in this study is specific for Sweden and no international comparisons have been made. This might limit the dimension of our analysis however given the limited recourses this was a tradeoff that was necessary. This has accelerated the process of collecting data, not only when gathering the different data variables but also when evaluating the reliability of our sources. It has also brought certain uniformity amongst our variables, reducing the manipulation needed to compute interoperable variables when regressing the data. The only variable that doesn’t follow this pattern is the Number of Stations, which brings us to our unique computed dataset.

3.1 Unique Dataset

We found no satisfactory secondary set of data constructed including the number of petrol stations and sufficient address and operation details to meet our needs for this study. Even when checking with SCB for acquirable data this did not suffice. This meant we had to construct the dataset ourselves so we started to consider a couple of different methods for doing this. Internet scraping was one of them, which we however had to scrap, as the data did not contain the historical parameter. It finally led us to contacting the different municipalities directly and requesting the specific data parameters we needed. This included a yearly list of the operational petrol stations with street addresses, fuel type offering, organization number and fuel sales volume. However due to privacy restrictions and incomplete data from different municipalities, we could not retrieve all the parameters we initially wanted for all municipalities. So the final dataset we used in our analysis consisted of the number of stations operating per year from 2004 – 2012 for each municipality. This allowed us to determine if there had been stations that had closed down or if new stations had been established from year to year in a given market. In total we contacted 70 municipalities whereof we obtained adequate data from 52[ix]. The 70 municipalities we contacted were randomly chosen from a selection that passed our initial definition of a secluded market explained in the method section.

The data collected from the municipalities included a couple of stations that did not coincide with our definition of a petrol station so some observations had to be excluded. For example all stations branded Såifa were excluded because they only provide truck diesel and are not accessible by the public. Also some specific observations containing stations that are only used by busses inside closed terminals were excluded for the same reason as above.

We also raised the question of reliability when collecting the data. This is because all the information we collected was initially computed by a person employed at the given municipality office. So, the reliability of the data was directly dependent on the thoroughness of the employee. However we believe there is reason to treat the data as reliable as the municipalities are usually relatively small and only have a handful of stations in most cases, which are easy to track. Also when questioning a couple of randomly chosen municipalities about the reliability we could conclude that the data was reliable. There are strict restrictions for the treatment of flammable liquids, why all firms are obligated to apply for a permit that the municipality office provides. Also the format

[ix] *See Appendix for complete table (Table 2)*

of which they held the data in is easily handled so the probability for an error along the way was very little.

3.2 Demographic Characteristics

The demographic characteristics we have used are all based on municipality except for *Person Km per Capita*, which is based on state-level due to limited data availability. Further, our main sources did not supply more detailed data than on a municipality-level, why we had to make do with this level of detail. This somewhat limited the construction of our secluded markets as described in the method section below. However, we do not think these limitations have had any substantial negative effect on the results of this study. Below you find a table (1) of all data variables collected from the various sources including those we have computed from other variables.

Table 1 - Descriptive Statistics

Variable	Use	Source	Year	Computed	Obs	Unit	Max	Mean	Min	Std. Deveation
Population	Regressor	SCB	2004-2012		441	People	140357.00	20953.71	2673.00	25256.85
Population Growth	Regressor	SCB	(2004)-2012	x	441	Decimals	0.02	0.00	-0.03	0.01
Number of Cars	Regressor	Trafa	2005-2012		343	Cars	65391.00	10823.83	1478.00	11986.63
Per Capita Income	Regressor	SCB	2004-2012		441	000's SEK	271.80	197.11	158.90	18.15
Commuters (net)	Regressor	SCB	2004-(2012)	x	441	People	4339.00	-32.43	-2903.00	1069.48
Land Taxation	Regressor	SCB	2004-2012		441	000's SEK	333.17	96.25	3.58	58.63
Land Area	Regressor	SCB	2004-2012		441	Km-squared	19371.12	3682.68	142.33	4172.02
Person Km Per Capita	Regressor	SCB + Trafa	2004-2012	x	441	000's Person Km	1.25	0.61	0.08	0.38
Fuel Sales Volume	Regressor	SCB	2004-2012		401	000's Metres-cubic	195.50	28.27	1.90	33.73
Oil Price	Regressor	Cap. Pro.	2004-2012		441	USD per Barrel	91.48	66.65	37.66	17.69
Sugar Price	Regressor	Ind. Mundi	2004-2012		58	USD, Cent per Pound	33.28	30.64	26.01	2.84
Diesel Price	Regressand	SSE	2007-2009		95	SEK per Liter	14.79	11.47	8.41	1.34
Gasoline Price	Regressand	SSE	2007-2009		125	SEK per Liter	14.22	11.89	9.80	0.72
Ethanol Price	Regressand	SSE	2007-2009		58	SEK per Liter	9.63	8.55	7.44	0.65
Number of Stations	Regrassand	Computed	2004-2012	x	441	Stations	66.00	12.02	2.00	11.67

As seen in the table the majority of our variables that come from SCB have data observations for years 2004 – 2012. Some variables do not have data for the entire period due to limited availability from the source, which is shown under *Year*. The start/end years that we have marked with a parenthesis are constructed from an average from the other years. Theses are explained in further detail below. Also when looking at the number of observations for the different variables we see that a "full" dataset would contain 441 observations. However, we see some deviations from this figure across the variables, which is due to missing observations. In some cases we are missing entire years and in some just specific observations. We will now explain the variables that we suspect can be somewhat unclear for the reader or if we have made some noteworthy adjustments to them.

Population Growth is computed from *Population* and is just the calculated growth each year. As we did not have data for 2003, we could not calculate the growth for 2004, so we have assigned values for 2004, which are the average growth for the three following years. *Number of Cars* is adjusted to only contain the cars registered as "in use" by the authorities as this would be a better approximation of the market size. It was retrieved from Trafa and did not have any data for 2004. This is not a too severe problem and as seen in results later, we have anyhow chosen to drop this variable in our regressions as it caused some issues with multicollinearity. *Commuters (net)* is a computed variable which we have used both when defining our markets as well as in the regressions. It is basically the inflow of the work force minus the outflow of the work force in a given municipality. This means that if you are living in municipality X and work in municipality Y, you are counted as outflow in X and inflow in Y. This allowed us to control our markets for inflow or outflow that would essentially affect the market size[x, 24]. The data available from SCB was only for years up to 2011. Therefore, 2012 is the average for all of the previous years we have data for. When defining our markets we used a ratio constructed from this variable that also accounts for the total population in the municipality. This is further described in the method section.

The Land Taxation is a variable we have used to estimate cost differences between the municipalities. The data is collected from SCB, however it is based on the taxation value set by the Swedish Tax Authority. The Swedish Tax Authority sets a taxation value every 6 years that is supposed to represent 75% of the market price. The value is separated into land value and building value and we have chosen to only look at land value as the building value would differ depending on what type of station it is or how many different fuels they offer[xi]. The value obtained from SCB is the total land value under a specific code referring to the type of property, in this case petrol station. This is then divided with the number of stations that the total is computed with so we end

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[x] We found insperation for this from: *Entry and competition in concentrated markets",* Tmothy F. Bresnahan, Peter C. Reiss

[xi] Costs for different fuel pump alternatives is discussed in the background section.

up with the average taxation value per station. *Land Area* is surprisingly not consistent across our observation period. So to adjust for this we have taken the average km^2 from our observation period, 2004 – 2012.

Our measure for approximating public transportation usage is *Person Km Per Capita*. A "Person kilometer" is one kilometer traveled by one person with public transportation, i.e. if two people sat on the same buss and it drove 1 km, this would aggregate to 2 person kilometers. This measure would essentially describe the distance that a person travels by public transport instead of taking a car and therefore reducing said person's fuel consumption, which relates to the market demand. This variable have been computed from the accumulated so-called person kilometers and then divided by the population to estimate a value comparable between municipalities. The data was retrieved from Trafa who uses first hand data from ticket sales to calculate the accumulated distance traveled in the given region. Worth noting is that Trafa only provides this data on a state-level why some municipalities will have the same data values for this variable.

The Oil Price[25] and *Sugar Price*[26] are both the nominal price denoted in dollars. We have taken the average for each year because we aim to match the observations with our petrol-, diesel-, and ethanol price regressands, explained below, for which we only have a yearly price.

For the regressands in our later regressions we use the yearly average *Gasoline Price*, *Diesel Price* and *Ethanol Price* per municipality. This was collected from a dataset computed for a thesis at SSE in 2011[27], which is why the data was limited to the years 2007 – 2009. The dataset is initially based on data from the website www.bensinpriser.se to which users report prices from individual stations in Sweden. This means however that all data is not entirely reliable, however still suffices to approximate an average per year. However, we did encounter an issue with missing data for some of our municipalities. This resulted in a poor number of observations in some of our regressions, especially when using Ethanol as the regressand.

3.3 Background Data

At first when we decided on our subject we mainly used new articles. This is because they are a great way of detecting interest. If it is written about and if people go to great extent to *tweak* the truth one can conclude that it is indeed an emotional subject that interests a lot of people. However, the source is not good relying facts on when conducting a study. So for the background section we have also mainly used official sources like the ones listed above. However there are a few sources that do not live up to the "official standard" we have tried to maintain throughout our selection of sources.[xii] This is also why we have not based our main reasoning on facts coming from these sources, as we do not what to accidentally misguide the reader.

4. Method

Below we will briefly walk through the theory of the Poisson and OLS regression models, which we intend to use. Although we will focus the theoretical section on the precautions we have taken to make sure that our results are valid and reliable. After we have introduced the theory we will explain our course of action if the reader feels compelled to reproduce parts of our study. We hope that this divided approach will give the reader a more fluent review of our course of action.

We have structured our approach with three main points, two of which are preparations for the main research. The main research can then be divided into three focus areas around which we have structured our regressions. But firstly we start by addressing our sources of inspiration for our method.

4.1 Inspiration

When deciding on a method for how to conduct our research and conclusively answering our research questions we found inspiration from the papers described below. The first paper, written by Bresnahan and Reiss (1991), was our initial inspiration but we ended up not using the method they illustrated. However it was a large part of our research so we will describe the method in short and what problems we encountered, as we would generally recommend the method for future research. The two latter papers both use the same method, however it would not be right to only list one of them as a source because we have indeed found inspiration in both.

[xii] E.g. Egmont Tidskrifter, How Stuff Works, Volvo Group.

4.1.1 Bresnahan & Reiss (1991, JPE)[28]

"This paper proposes an empirical framework for measuring the effects of entry in concentrated markets. Building on models of entry in atomistically competitive markets, we show how the number of producers in an oligopolistic market varies with changes in demand and market competition." The two first sentences in the abstract of the paper summarize the outline of their paper pretty well. In other words the result of their framework enables the user to analyze the competition conditions in a given market. They introduce something they call "entry threshold" indicating the market size for when a new firm is expected to enter, given underlying demographic and microeconomic factors. They also construct a ratio with the different entry thresholds, with which the user can analyze the competition effects of entry. They find that across the 5 industries they study, the effects of entry on the competition conditions are greatest for the 3rd – 4th first entries. After that, there is only a slight marginal effect for each additional entry.

The overall method basically consists of defining the demographic and microeconomic factors that drive the number of companies within an industry, then using Maximum Likelihood Estimation to finally reveal the entry thresholds for the given market. One of the strengths with their method is that under a few assumptions based on basic economic theory one can conduct fairly extensive research on a market despite limited availability of data. This is why we started off exploring the possibility of using this method in our research. Briefly our plan was to utilize the findings from Bresnahan and Reiss and paring it with a before and after comparison to analyze the effects of the law related to our research questions. However, after having constructed our dataset, when running the model we encountered some issues with the maximization process. We found that our number of firms (stations) was too high as we had approximately between 5 – 25 per market while they only explored markets with 0 – 5 firms. We will not go into further detail about this. So even though we ended up not using the framework presented by Bresnahan and Reiss we strongly recommend future studies to do so. Mainly because it enables extensive research based on very limited data.

4.1.2 Adda & Berlinski & Machin (2012, JLE)[29]

This paper analyses the effects on firms of a ban on smoking in public places. They specifically look at the effects on pub sales, prices and firm performance for companies operating pubs. This is interesting for us because if we divert attention from the specifics and generalize their research method, it is very similar to ours. They use a statistical research method when looking at the introduction of a new law and how it has affected sales volumes, price and firm performance. They use a standard OLS regression with a difference-in-difference setup, which we also chose to do as it is commonly used when looking at events. However in their study they have a definite date for the introduction of the law, making the difference-in-difference approach easily applicable. Our timeframe was unfortunately not equally distinct. The law we studied was sequentially introduced over 5 years while the industry also underwent a structural rationalization simultaneously. Still we have chosen to use the difference-in-difference approach with some altercations to make it better suitable for our study.

4.1.3 Erutku & Hildebrand (2010, JLE)[30]

The paper written by Erutku and Hildebrand in 2010 is rather similar to the one above looking at the choice of method. They also use an OLS with a difference-in-difference setup. Although this paper offers more similarities to ours compared to the previous as they specifically investigate the effect of a certain public announcement on the gasoline price. The paper has therefore set guidelines for us in how to interpret our regression results which validates our analysis of the results in the extent that we use their reasoning.

4.2 Theoretical Introduction

4.2.1 Ordinary Least Square

The regression model we have chosen for some of our regressions is the OLS Multiple Linear Regression Model. The model is based on "Ordinary Least Squares" (OLS), which is a method that, in brief, estimates unknown parameters in a linear regression model by minimizing the sum of squared residuals. The model equation is presented below,

$$Y_t = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

where, Y_t is the dependent variable, or the regressand. X_x is the independent variable, or the regressor. β_x is the unknown coefficient, which is estimated in the model that explains the regressor's relation to the regressand. α is the constant for the equation and finally ε is the error, i.e. the variation in the regressand that is not explained by the regressors.

The model is based on a couple of assumptions that must be met for it to produce valid and reliable estimations. However, in some cases, one or more of these assumptions are not fully met, which may result in unreliable estimations. The OLS is a model that is fairly sensitive to deviations from the model assumptions, which might become problematic. Thus we considered the possibility of changing to a more robust regression model[xiii], i.e. a model that is not as sensitive to deviations from the model assumptions. However, we decided on sticking with our initial model and instead making sure to control and compensate for minor deviations from the assumptions. Below we walk through precautionary measures that we have taken to ensure valid and reliable estimates.

The Error Term

There are three main assumptions about the error term in the OLS presented below:

- Nonautocorrelation, i.e. the errors are uncorrelated between observations.
- Homoscedasticity, i.e. the error term has the same variance for every observation.
- Normality, i.e. the errors follow a normal distribution.

The third assumption is not always as strict as the first two. However, if violated all of these essentially cause the same problem with the regression results. They affect the significance levels of the coefficient estimates. Meaning that the coefficient values are unaffected whilst the significance levels become unreliable. This is easily adjusted for using robust standard errors, also known as "Huber/White-" or "Sandwich-" estimates.[31] This basically eases the initial assumption and allows some deviation.[32]

[xiii] Examples of robust regression models are among others are; *M-estimation*, introduced by Huber in 1973, *LTS (Least trimmed square)*, introduced in the 1980's by Rousseeuw and Leroy.

Multicollinearity

The independent variables within a regression are often correlated to one another and do in most cases not cause any problems. However, when they are correlated to a non-trivial degree of accuracy, it can cause problematic multicollinearity. Leading to invalid results and unreliable significance levels for individual predictors. To control for multicollinearity we have used the Variance Inflation Factor test presented below,

$$\text{Tolerance} = 1 - R_j^2, \qquad VIF = \frac{1}{Tolerance}$$

where R_j^2 is the coefficient of determination of the explanatory variable j with respect to other independent variables. According to O'Brien [33] there is a problem with multicollinearity if the VIF-value exceeds 10. The cutoff value for VIF is something that researchers are not always agreed upon, however we will follow O'Brien's suggestion. Final note on multicollinearity, this does not create an issue for dummy variables.[34]

Endogeneity

If an independent variable is correlated with the error term it is so called endogenous and can cause biased and inconsistent OLS estimates. This can happen when for example there is a measurement error or a misspecification of the model, i.e. an omitted variable.[35] To control for endogeniety we have followed Davidson and Mackinnon's[36] suggestion for an augmented regression test, aka. Durbin-Wu-Hausman test. Meaning regressing the suspected endogenous variable against the others, then including the residual from that regression in the original model. If the new coefficient is non-significant one can conclude that there is no endogeneity issue related to the tested variable.

Finally, to ensure that our measures have taken effect and that no deviations from the assumptions remain that might impair the performance of our model we run a couple of regressions with different specifications, i.e. we drop one dependent variable per specification. This will also help us detect some issues that have not been solved with the above precautions. Also, OLS regressions are not robust to outliers, for which we have not conducted any test and can be hard to spot in a descriptive summary of the variables. We can detect possible issues by evaluating inconsistencies in the coefficients suggesting that there is an endogeniety issue or changes in the significance levels of the estimates suggesting that the regressions are not robust. If detected one can run additional specifications while dropping all suspicious variables. The different regression specifications are found in the results section.

4.2.2 Poisson

A Poission regression model is often used instead of a regular OLS is cases when the dependent variable is a count variable. Meaning that it takes on only non-negative integer values (0, 1, 2, …). The model is ultimately a non-linear model that uses Maximum Likelihood Estimation to retrieve the parameter estimations. [37] However described by Wooldrige [38], the model assumes that the dependent variable follows a poisson distribution and that the logarithmic of the dependent variable can be modeled with a linear function as shown below.

$$\log(Y_t) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

Another central assumption with the Poisson regression model is that the mean of the dependent variable is equal to its variance. In reality though, this assumption is often deviated from, which causes some estimation issues. This is called over dispersion meaning that the variance of the dependent variable is greater that its mean and is often caused by omitted variables. When this occurs the regression results are often underestimating the standard errors and overestimating the significance of regression parameters.[39] In some cases this can be avoided by using a negative binomial regression instead. However, it can also been controlled for by simply evaluating the alpha value in the negative binomial regression. In other words, the Poisson regression is considered to be a good fit if one observes a "good" alpha value. Good meaning a value that is not significantly different from zero, in which case the Poisson regression is equivalent to a negative binomial regression. [40]

Like with the OLS model there are deviations to the underlying assumptions can cause estimation errors. These are generally very similar to the ones described above in the OLS theory, except for over dispersion that we explained here. So the same precautionary measures can be applicable to the Poisson regression, e.g. using robust standard errors and running different specifications, checking for variations in the estimates and significance levels.

4.2.3 Difference-in-Difference

This approach is commonly used when measuring the effects of a treatment or an event at a given point in time. The practice behind the Diff-in-Diff approach is that one observes both an unaffected control group and a treatment group and compares the differences before and after the event. It is based on a standard OLS model with some additional dummy variables denoting "treatment" and "post", as seen below, to capture the effects of the event.

$$y = \beta_0 + \delta_0 Post + \beta_1 Treatment + \delta_1 Treatment * Post + Controls + u$$

The estimate of β_0 will show the before value for the control group and $\hat{\delta}_0$ will show the post effect for the control group. $\hat{\beta}_1$ captures the before value of the treatment group while $\hat{\delta}_1$ captures the post effect for the treatment group and is usually the estimate of interest.[41] When running the Diff-in-Diff approach one should be aware of issues that might arise as described above as it is based on an OLS model.

Moving on from the theoretical introduction to our step-by-step walkthrough of our method. We start off by defining our secluded markets of interest following Bresnahan and Reiss (1991) as seen above.

4.3 Defining Secluded Markets

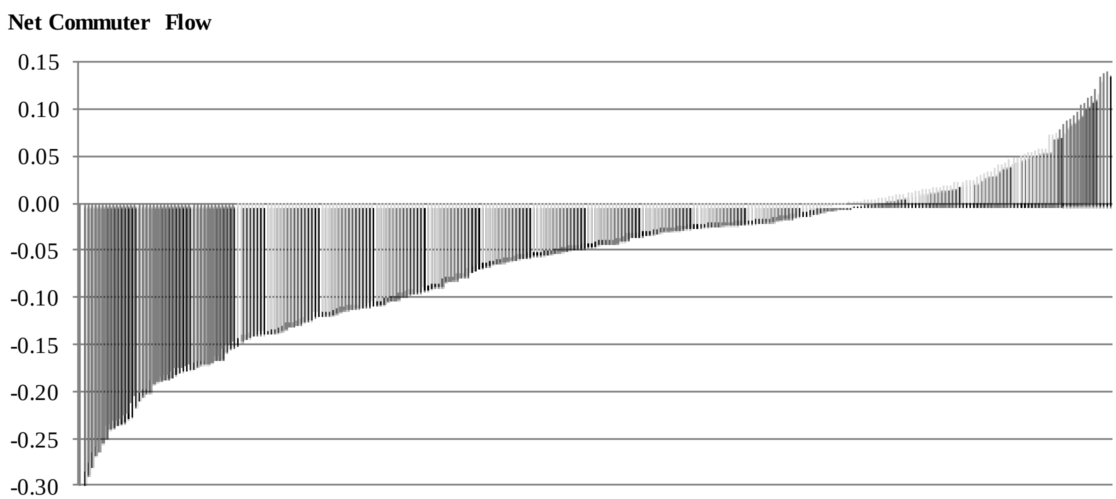
There were two main criteria we looked at when defining our markets. The first was making sure that the markets were secluded against one another. This was crucial for when establishing and using the markets' demographics, i.e. when establishing market size, demand and costs etc. However, it was obvious to us that there would not be any entirely secluded markets. Instead we evaluated the degree of seclusion of the markets.

The second was the measurability of the market demographics. Even though we would find a secluded market, if the demographics weren't measurable, we would not be able to use this observation in the study. So we weighed the measurability of the market to the degree of seclusion in our choice. We soon realized that there was not a lot of wiggle room when looking at the measurability. The demographics were often provided on either state-level or municipality-level. In most cases we also found population data for specific cities and towns, however as we needed more exhaustive demographic data than population the most detailed level we found was per municipality. So, we quickly moved on to looking at what municipalities might be appropriate given our first criteria, making sure the market was secluded.

We started by screening the country map of Sweden to drop apparent non-secluded markets such as the larger cities in Sweden such as Stockholm, Göteborg, Malmö and Uppsala. We also removed the surrounding municipalities, as the high number of daily commuters to and through the cities would cause measurement errors. Secondly we looked at the hub towns in each municipality. We excluded municipalities with hub towns very close to other municipalities as this would most likely result in size and demand measurement errors. We arrived at a selection of municipalities that met our criteria and started calling them to gather our dataset described above. Given the resources we had, we contacted a total of 70 municipalities and retrieved sufficient data from 52 of them. We took one last measure to ensure that the selected markets had an acceptable degree of seclusion. We looked at the commuter statistics we retrieved from Trafa, from which we computed a net flow of commuters per municipality as seen below. The figure[xiv] shows the ratio adjusted for the municipality's population.

Figure 7 - Net Commuter Flow

Average net commuter flow ratio between 2004 - 2012



Souce: Constructed based on data from SCB

[xiv] Stockholm is not visible in the figure as it has 42% net commuter inflow.

We can see that there are a lot of municipalities with very high, absolute, net commuter flow suggesting that the markets are not secluded. To adjust for this we decided upon a cut-off value of +/-0.15. This corrected for two high values in our selection. After correcting for this all of our municipalities fall inside the lighter gray area in the figure. Another manipulation done with our markets is the merge of two municipalities, namely Habo and Jönköping to create “Storjönköping”. This was because Habo lies very close to Jönköping geographically and had a commuter ratio of -0.16, mainly to Jönköping. The two municipalities we dropped above were Hammarö and Forshaga, both of which could have been merged with Karlstad. Unfortunately we did not have sufficient data from Karlstad so the observations were dropped instead. After these modifications we ended up with 49 useable markets.[xv]

4.4 Defining Demographic Characteristics

When choosing our demographic variables, we found inspiration in the paper written by Bresnahan and Reiss that we’ve mentioned earlier. They approach the demographics searching for variables that can approximate the different components in their framework, namely market size, market demand and variances in cost. Although we ended up not using their framework for our study, we still followed their approach because the demographics are still applicable in our method. A summary of the chosen variables can be found in the data section above including a short motivation behind our choices.

To ensure that the demographics we have collected are suitable to use in our study we conduct a series of regressions and tests. Here we used the OLS model using *Number of Stations* as the regressand and our demographic variables as regressors. We used robust standard errors, as explained above, to ensure reliable significances. We also conducted a VIF-test to ensure we did not have any issues with multicollinearity amongst our independent variables. We corrected for multicollinearity by dropping *Number of Cars*. Detailed regression and test results can be found in the appendix. We found the coefficient estimates for *Fuel Sales Volume* and *Population Growth* not to be significant however we still kept the variables as controls in our coming regressions.

[xv] A table with all municipalities can be found in the appendix.

Lastly we ran a DWH-test for *Fuel Sales Volume* as we suspected it to be endogenous. The suspicion was based on the fact the sales volume is essentially the result of a demand function. Thereby, likely to be correlated with an omitted variable captured in the error term, e.g. fuel price. As the estimates are determined simultaneously it might result in the variable being endogenous. The test showed no issues with endogeniety as seen in the results, so we did not have to make any further altercations.

We have now defined the markets and the demographic variables that we will use in the main section of our study related to the research questions posed in the introduction. Starting with the first, did the implementation of The Pump Law have a negative effect on the number of petrol stations in Sweden?

4.5 Policy Effects on Number of Stations

For this part of the study we chose to run a Poisson regression model because our dependent variable, *Number of Stations*, is a count variable.[xvi] Having this set we created nine year dummy variables to capture effects across the years that are not captured in our controls and demographic variables.[42] The dummies are set to 1 if equal to the year they represent and set to 0 for all other years. This means that the estimates would show year specific effects compared to the base year 2004, keeping all else fixed. Seeing that the Pump Law was sequentially introduced starting in year 2006 and implemented the final stage in 2010, the intuition would be that the year dummies would show significant negative estimates for years when the Pump Law has had effect on the number of stations as this is not anything captured in our controls.

In addition to the dummy variables we used the demographic variables defined in the section above. Also we added controls for all 49 municipalities to control for market specific effects that are not observed in the demographic variables. The demographic variables and the controls will essentially make the year dummy estimates cleaner in the sense that effects of market size, demand etc. as well as unobserved market specific effects are captured by the controls.

As we used a Poisson regression model we ran a negative binomial regression and evaluated the alpha value to confirm that Poisson was an appropriate model as

[xvi] Detailed reasoning for this is described in the theoretical introduction.

described in the theory. To further ensure that our results were valid and reliable we used robust standard errors as well as ran a series of different specifications[xvii]. When running the different specifications we observed some variations in the significance levels and coefficient estimate, why we ran an additional specification adjusting for this. Results can be found in the appendix.

4.6 Competition Conditions – Fuel Price and Fuel Sales Volume

When addressing our second and third research questions we used an OLS regression model, as our dependent variables are continuous, with a setup for difference-in-difference analysis. We wanted to investigate if the decrease in number of stations has affected the competition conditions on the markets and thus affecting the fuel price or fuel sales volume. Looking at our data it was apparent that it was not ideal as we only had observations for years 2007-2009. However, it was still sufficient to construct a Diff-in-Diff.

In accordance with the standard Diff-in-Diff approach we need to define a control group and a treatment group as well as defining the post dummy. Assuming that the competition conditions will not have changed drastically if no exits have occurred, we defined our control group as municipalities where there has not been any change in number of stations from one year to the next. Accordingly our definition of the treatment group includes municipalities where the change in number of stations is less than zero. Thereof, our treatment dummy equals to 1 if the observation is included in the treatment definition and equal to 0 otherwise. As we had three years of observations we decided to conduct two separate regressions where in the first we used 2007 and 2008 as pre and post and the second 2008 and 2009 as pre and post. Thereof our post dummy is set equal to 1 if year equal to 2008 in the first regression and if equal to 2009 in the second regression. Given our limited dataset, running two regressions would help us to utilize the observations for all three years. The estimates of interest for these regressions will be the ones for our newly constructed dummy variables, mainly the estimate for the interactive dummy using both treatment and post. Following the framework for Diff-in-Diff, the

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[xvii] See the reasoning behind this in the theoretical introduction in the method section.

estimate should show us the difference in fuel price/volume specific to markets where the number of stations have declined, i.e. the answer to our research question.

Adding some extra dimensions to this examination we expanded our regression count from 2 to 8, running separate regressions with different fuel types as the dependent variable as well as using *Fuel Sales Volume* as the dependent variable following the reasoning in the introduction.[xviii] In other words we used gasoline, diesel, ethanol and fuel sales volume as the dependent variables. Then ran two regressions per regressand given the two examination periods. A crucial step before running these regressions was to add an additional control variable. For gasoline, diesel and volume sales regressions we added the world oil price as a control to extract the influence this has on the retail prices described in the background section. Following the same reasoning, we added the world sugar price as control for ethanol as this is the raw material used to produce ethanol.

As for all of our regressions we ensured our results were reliable and valid by using robust standard errors. As seen in the results we also ran a series of different specifications to conclude our results as reliable and valid.

5. Results

Below we will briefly comment on key observations of our results through a statistical viewpoint. Later in the analysis section we will go in-depth about the implication and meaning of the results related to our research questions. All regression results can be found in the appendix.

5.1 Demographic Characteristics

The results from our first two regressions concern the preparations of our demographic variables that are used in all coming regressions. They are standard OLS regressions and identify the important demographic variables affecting the number of stations in a municipality, i.e. we have used *Number of Stations* as the regressand and the demographics as regressors. In Regression 1 we have 298 observations and all but three

[xviii] "Intuition would suggest that with fewer numbers of stations in a market, i.e. less competition, the fuel prices for the end consumer would increase." "Following the increase in fuel price, relating to supply and demand theory, the fuel sales volume would decrease, ceteris paribus."

explaining variables have significant coefficient estimates. However, seen in the first VIF-test (1), the significance of the *Population* and *Number of Cars* coefficients is not reliable as we observe extremely high VIF-values, 226.13 and 219.68 respectively[xix]. In Regression 2 we see that all but two variables have significant coefficient estimates as *Number of Cars* was dropped. However, looking at the value of adjusted r^2 (0.924) in the first regression compared to the value for the second regression (0.914), we see that we did not loose much explanatory power when dropping the variable. The number of observations has also increase to 401 because *Number of Cars* did not have data for 2004, so additional observations from 2004 are now utilized, which is also why we chose to drop *Number of Cars* and not *Population* when correcting for multicollinearity. The second VIF-test (2) also shows that there is no longer an issue with multicollinearity. The variables *Fuel Sales Volume* and *Population Growth* are still not significant on a 5% level.

Looking at the different signs of the coefficient estimates in Regression 2, *Population* and *Land Area* both have positive estimates, which is in line with intuition as the larger the area and the larger the population, the more stations are needed to support the market. *Per Capita Income* has a negative coefficient estimate and can be explained, with respect to that it might seem far-fetched, by drawing a parallel to the income in rural areas compares to urban areas. Generally the income is higher in more urban areas compared to that of rural areas. Then relating it with distance, as people in the countryside most likely will travel a farther distance every day by car than in urbanized areas, thus using more fuel and increasing the demand. *Land Taxation* follows intuition with a negative coefficient estimate considering that the more expensive it is to establish a station, the less stations there are. The negative estimate of *Commuters (net)* is not in line with the intuition that would suggest that the more people that commute into a given municipality and thereby increasing the market size, this would increase the number of stations. *Person Kilometers* which denotes the aggregated km traveled is also in line with intuition with its negative coefficient suggesting that the more and longer people travel

[xix] See the theory behind the VIF-test in the theoretical introduction in the method section.

by public transport, the less they use their car, i.e. decreasing the demand for fuel and petrol stations.

Lastly, when controlling for our suspicion of *Fuel Sales Volume* being endogenous. The DWH-test we conducted showed non-significant results for the residuals meaning the test showed no indication for endogeniety for the tested variable.

5.2 Policy Effects on Number of Stations

Regression 3, which is a Poisson regression, is the main regression where we hope to show if the law has affected the number of stations. The demographic variables we used in Regression 1 and 2 are now used as control variables together with 49 controls for municipality. The variables of interest in this regression are the year dummies. They will essentially show if there is anything that differs between the years that is not caught by the control variables. First off the dummy for 2004 is omitted due to collinearity, which was expected. The remaining year dummies have overall significant coefficient estimates except for year 2005. Naturally they also have negative signs, which follows intuition and the decreasing trend of number of stations. Looking at the magnitude of the year coefficients we can conclude that it has increased for each year (2006<2007<2008…), meaning that for each year there are lesser number of stations compared with the base year (2004), ceteris paribus. The change from non-significant estimates to significant estimates between years 2005 and 2006 is quite interesting and is to be discussed in the analysis section. We still have 401 observations from the previous regression as no alterations to the regression specifications have been made other than the adding year dummies.

As mentioned in the theoretical introduction we checked for overdispertion and made sure that the Poisson regression was an appropriate model by running a negative binomial regression and evaluated the alpha. As seen in the overdispertion test we observed an alpha that was not significantly different from zero, concluding a good fit. Looking at our different specifications we observe fluctuations in the coefficient values and significance levels of the estimates when dropping *Person Km Per Capita* and *Per Capita Income.* This would suggest issues with endogeniety and non-robust specifications, which makes our results not entirely valid and reliable.

5.3 Competition Conditions – Fuel Price and Fuel Sales Volume

With the coming 8 regressions we aimed to examine the effects of the pump law on the competition conditions on the market by looking at the fuel prices as well as fuel sales volumes. They are all standard OLS regressions using a difference-in-difference setup so the coefficient estimate of interest will essentially be the one corresponding to the Treatment*Post dummy. We still control for 49 municipalities and the various demographic characteristics. As described in the method the regressions are conducted in two time periods, 2007-2008 and 2008-2009. Before looking on the regressions individually we see a common pattern amongst all regressions, the *Oil Price/Sugar Price* variables have been omitted. This is due to the perfectly linear relationship with the Post dummy, as the price variables only have one value each year being the yearly average. This does not however affect the coefficient value for the Treatment*Post parameter or its significance. This is because if *Oil Price/Sugar Price* was dropped this would be captured to the full extent by the Post dummy, i.e. not affecting Treatment*Post. Why we have chosen to still keep the *Oil Price/Sugar Price* variables is because if one were to conduct the same regression with more frequent price observations, one would get a more detailed result. So since it has no effect on our results, we keep it hoping it will contribute to future studies using similar regression specifications with more detailed data.

In Regression 4 and 5 the *Gasoline Price* is used as the dependent variable. The regression utilizes 71 and 75 observations respectively because we only have two observation years for the gasoline price in each regression. In the specifications where we drop *Fuel Sales Volume* we see a slight increase in the observation count as the variable was missing data for some observations, i.e. more observations were now utilized. This is also consistent for Regression 6 – 9. The Treatment*Post dummy has a non-significant coefficient for all specifications we run in these regressions. For Regression 4 we observe a significant estimate for the Post coefficient. However it varies a lot across our specifications, suggesting that there might be an issue with robustness or endogeniety.

For Regression 6 and 7, using the *Diesel Price* as regressand, we have slightly less observations, now 58 and 54 respectively. This is because the data for diesel price was less complete than for the gasoline price. We do not observe any significance in the estimate corresponding to the Treatment*Post dummy except when running specification 3 in the first period where we observe a positive estimate with <5% significance. However as this is only observed in one specification and only on a 5% - level we cannot draw any conclusions from this, as stronger evidence would be needed. The suspicion we had in Regression 4 recurs in Regression 6 as we observe the same fluctuations in the Post dummy.

In Regression 8 and 9 we used Ethanol as the dependent variable. Here we only have 42 and 31 observations respectively. Noteworthy is that we use the *Sugar Price* instead of the *Oil Price* as a control. But as stated above, even this is omitted. An obvious difference compared to Regression 4 – 7 is that the Post dummy is now very significant (<0.1%) in Regression 9, the second observation period. We see consistent coefficient estimate values across all of our specifications and no fluctuations in the significance level as we have seen before. We still observe a non-significant estimate corresponding to the Treatment*Post dummy.

In the last two regressions, Regression 10 and 11, we have left the investigation of price effects and used the *Fuel Sales Volume* as our dependent variable. We have 87 and 84 observations for period one and two respectively. This is because we could gather a complete set of data for all municipalities from SCB. Consistent with the price effect investigation, we do not observe any significant estimates corresponding to the Treatment*Post dummy across all specifications. Neither do we observe any fluctuations across our specifications. As before, *Oil Price* has been omitted for the same reasons as above.

Having presented the most important results to our study and shortly commented on the statistical interpretation, we now move on to our analysis.

6. Analysis

Before we start with our analysis we would like to look back at our research questions:

- Did the implementation of The Pump Law have a negative effect on the number of petrol stations in Sweden?

- Has the reduction in the number of petrol stations affected the competition conditions in the local markets to the extent that it has resulted in a fuel price increase?
- Has the increase in the fuel price affected the fuel sales volume in the local markets?

The analysis will be focused on answering our research questions, referring to facts presented in the background as well as relating to our initial intuition.

6.1 Policy Effects on Number of Stations

Recall our initial reasoning regarding this research questions: The heavy investment requirements following the new law has caused noticeable financial strain on individual stations. Given the already slim industry margins, it is possible that this has forced individual stations out of the market. In Regression 3 we observe significant negative coefficient estimates corresponding to the year dummies starting in year 2006 (2007 for two specifications). This suggests that there has been a decrease in the number of stations starting year 2006 (2007). The decrease is not related to any demand or market size effects, seen as we control for these. So there is evidence that something unobserved has affected the industry that is not related to any control parameters. As mentioned in the results, we observed some indications for the regressions being non-robust, why we will interpret the results as indicative rather than fully trusting the significance levels.

The two years we start to see significance are the two years for when the first and second steps of the Pump Law were implemented which suggests that the Pump Law has had an effect. However, even though we observe the year dummies starting to show significance, we cannot conclude that the effects we see are consequences of the Pump Law. Mainly because the implementation coincides with the structural rationalization of the industry. Trying to distinguish the results of the rationalization from the potential effects of the law is very difficult to do in our rather simple regression setup. We have no observable parameter in our regression that allows us to distinctively capture either effect.

To try to extract the effects of the rationalization one would need an approximation of the industry rationalization or the law. Given our limited resources we have not been able to conduct any tests when including these parameters, yet alone defined and collected good approximation variables. However if we take a second to discuss the possibilities if this was done. A good variable capturing for example the rationalization would extract the explanatory power for the specific parameter that is now picked up in the year dummies. This would mean that it would not interfere with the effects of the law. Keeping in mind that the year dummy coefficients would, besides showing the potential effects of the law, still show noise from other unobserved events in the market. Another way of approaching the question would be to compare the Swedish market to other countries. Recall from the governmental follow-up on the law, there has been similar decreasing trends in the number of stations abroad in absence of any equivalent law. If one were to use a difference-in-difference setup, defining the Swedish market as the Treatment and foreign markets as the controls, one could potentially seclude the effects of the law. However, even though there have been similar trends abroad it can be hard to match the concentrated rationalization occurred in Sweden. There might be similar events but most likely not during the same years, which can be a bit problematic when setting up the Diff-in-Diff.

Complementing the suggested Diff-in-Diff approach would be to just conduct a study in a couple of years. Why this is interesting is because, as mentioned in the background, individual stations are granted time limited exemptions from the law. When these exemptions expire the stations have to conform to the law, why one might observe lagged effects of the law.

Indirect Effects of the Law

As our regression setup has proven not to be optimal for our investigation we will divert attention from our regressions and try to formulate a convincing reasoning around possible indirect effects of the law. Even though we cannot distinguish any direct effects of the law on the number of stations, could the law have had an indirect effect by affecting the industry rationalization? We know that the two events coincide, but is this a coincidence or is there a causal connection between the two? There could be reason to suspect that the Pump Law has accelerated the course of the rationalization. Meaning that the rationalization was not due until a couple of years, however given the new law, the oil companies started to evaluate the profitability early. Even though this would be an effect of the law, it is not in line with our research question, i.e. the law did not cause the actual decrease only accelerated the course of the causal event. Keep in mind that with this reasoning we do not reject the idea of the law still adding to the decrease in number of stations.

6.2 Competition Conditions – Fuel Price and Fuel Sales Volume

Despite the uncertainty about what has caused the decrease in number of stations, the decrease is certain. So let's leave the investigation of if the law has caused the number of stations to decrease and look at the actual effects of the decrease. The analysis will be divided into two parts, one for each of our research questions. First we will look at the price effects and secondly at the effects on fuel sales volume.

We have found support for our interpretations of our regression results in the papers earlier referred to by Erutku and Hildebrand and by Adda, Berlinski & Machin, as they also use a Diff-in-Diff approach in their studies.

6.2.1 Fuel Price Analysis

The intuition for the price effect is that given fewer firms in the market the competition would be less intense therefore allowing a price increase, which would essentially harm the consumer. The results from Regressions 4 through 7 show non-significant coefficient estimates for the Treatment*Post dummy suggesting that there has not been any price increases specific to markets where the number of stations has decreased. In other words, the competition conditions have not been affected to the extent that firms have increased the fuel price. This follows Bresnahan and Reiss' findings when investigating competition conditions, mentioned in section 4.1.1. They conclude that the competition conditions are not affected to a great extent after the 3rd – 4th entry. In other words, not significantly affected by exits when there are approximately 5 – 25 firms like in our case[xx].

However, this might not be the whole truth. Recalling our definition of the treatment group: markets where the change in number of stations was < 0. In the majority

[xx] The average station count in the observed markets is 12

of the observed markets this meant a change of -1 or -2 at most, when there are 15 – 20 stations in total. With negative change of only 5% to 10% it is possible that this does not significantly affect the competition conditions. However, if one were to redefine the treatment group to markets where there has been a decline of roughly 20% to 30% and run the same Diff-in-Diff setup one might see different results. Also a dataset with more frequent price data as well as specific exit dates for petrol stations might help this investigation.

Looking at the coefficient corresponding to the Post dummy, we can see positive significant estimates in Regression 4, 6, and 9. Meaning that there has been an industry wide price increase for gasoline and diesel between 2007 and 2008 and for ethanol between 2008 and 2009. Though as we mentioned in the results, because the oil price/sugar price variables were dropped, they would be captured in the Post coefficient. This is most likely why we see this price increase, keeping in mind that the Post coefficient also will capture other unobserved effects that are not controlled for.

Direct or Indirect?

Leaving our results and looking at the bigger picture one can argue that there have indeed been effects affecting the competition conditions. Looking back at Figure 6 in the background section we can see the industry margins decline until 2008 when they instead start to increase. Interestingly though, the margins are still increasing 2010, 2011 and 2012, reaching the high margins observed back in 1981, yet the number of stations are still decreasing. Economic theory would suggest that there would be new entry if the margins were to increase to a certain level, given all else equal. So can this be evidence of the competition conditions have changed in the sense that the entry barriers for the industry have increased? Meaning that even though there are higher aggregated profits than before, firms will not enter as the industry needs even higher profits to support new entry under the new law.

The framework developed by Bresnahan and Reiss would be perfect to investigate this as it allows one to estimate the industry entry thresholds. According to their framework, if either the fixed costs decrease or the contribution margins increase we would see decreasing entry thresholds. So applying this to our case, we see increasing margins in the industry. Given all else equal we should observe decreasing entry thresholds equivalent to the increasing margins, which is consistent with the reasoning above. However, if the entry thresholds do not decrease with the corresponding magnitude or on the contrary even increases one can conclude that the fixed costs have increased. This is then easily translated into industry entry barriers.

6.2.2 Fuel Sales Volume Analysis

The intuition behind a potential decrease in fuel sales is supported by supply and demand theory. If there is a price increase, ceteris paribus, fewer consumers want to buy a given product at the higher price. The results from Regression 10 and 11 are very consistent across all specifications and show no indication that there is a decrease in fuel sales volume specific for markets where the number of stations has decreased. This is not very surprising as we did not see any strong evidence for a price increase in the markets defined as treatment either. So our observed results are consistent with theory, which is reassuring.

Another potentially viable reasoning for a decrease in sales volume would be that there are fewer outlets for fuel, i.e. less accessible, thus a decrease in sales volume could be argued. For example people would choose alternative ways of transport if the fuel accessibility was too compromised. This might be true for a range of different products; however one must investigate further the demand drivers and consumer price sensitivity etc. to be able to draw any conclusion around this reasoning.

In conclusion, a decrease in fuel sales volume is not observed and naturally following the conclusion of fuel price. However a further investigation in demand drivers and price sensitivity would contribute to the insight of how competition conditions affect the fuel sales volume.

7. Conclusion

In conclusion, we find indicating evidence that a significant decrease in the number of stations started during 2006 – 2007, the first and second year of the Pump Law, and has continued throughout the observed period (2012). The decrease is not due to any changes in the underlying market conditions such as the demographic parameters or effects specific to any of the secluded markets we investigate. Given our regression setup we cannot distinguish if this is an effect of the Pump Law or the industry structural rationalization.

Our results consistently show that the decrease in number of stations has not affected the competition conditions to the extent that we observe negative effects that harm the consumer. This is true for both the fuel price and fuel sales volume for years 2007 – 2009. This is also supported by the findings of Bresnahan and Reiss as they conclude that the competition conditions do not significantly change after the 3rd – 4th entry. Lastly, the industry entry barriers might have increased following our reasoning in "*Direct or Indirect?*". However to be able to draw conclusions about this, it should be tested with the framework developed by Bresnahan and Reiss.

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9. Appendix

Table 1 - Descriptive Statistics

Variable	Use	Source	Year	Computed	Obs	Unit	Max	Mean	Min	Std. Deveation
Population	Regressor	SCB	2004-2012		441	People	140357.00	20953.71	2673.00	25256.85
Population Growth	Regressor	SCB	(2004)-2012	x	441	Decimals	0.02	0.00	-0.03	0.01
Number of Cars	Regressor	Trafa	2005-2012		343	Cars	65391.00	10823.83	1478.00	11986.63
Per Capita Income	Regressor	SCB	2004-2012		441	000's SEK	271.80	197.11	158.90	18.15
Commuters (net)	Regressor	SCB	2004-(2012)	x	441	People	4339.00	-32.43	-2903.00	1069.48
Land Taxation	Regressor	SCB	2004-2012		441	000's SEK	333.17	96.25	3.58	58.63
Land Area	Regressor	SCB	2004-2012		441	Km-squared	19371.12	3682.68	142.33	4172.02
Person Km Per Capita	Regressor	SCB + Trafa	2004-2012	x	441	000's Person Km	1.25	0.61	0.08	0.38
Fuel Sales Volume	Regressor	SCB	2004-2012		401	000's Metres-cubic	195.50	28.27	1.90	33.73
Oil Price	Regressor	Cap. Pro.	2004-2012		441	USD per Barrel	91.48	66.65	37.66	17.69
Sugar Price	Regressor	Ind. Mundi	2004-2012		58	USD, Cent per Pound	33.28	30.64	26.01	2.84
Diesel Price	Regressand	SSE	2007-2009		95	SEK per Liter	14.79	11.47	8.41	1.34
Gasoline Price	Regressand	SSE	2007-2009		125	SEK per Liter	14.22	11.89	9.80	0.72
Ethanol Price	Regressand	SSE	2007-2009		58	SEK per Liter	9.63	8.55	7.44	0.65
Number of Stations	Regrassand	Computed	2004-2012	x	441	Stations	66.00	12.02	2.00	11.67

Table 2 - Municipality Overveiw					
Municipality	**State**	**Comment**	**Municipality**	**State**	**Comment**
Ånge	Västernorrland		Mora	Dalarna	
Arjeplog	Norrbotten		Mullsjö	Jönköping	
Arvidsjaur	Norrbotten		Munkfors	Värmland	
Arvika	Värmland		Orsa	Dalarna	
Berg	Jämtland		Ragunda	Jämtland	
Boden	Norrbotten		Robertsfors	Västerbotten	
Borlänge	Dalarna		Skellefteå	Västerbotten	
Degerfors	Örebro		Sollefteå	Västernorrland	
Eda	Värmland		Sorsele	Västerbotten	
Falun	Dalarna		*Storjönköping*	Jönköping	Computed
Filipstad	Värmland		Storuman	Västerbotten	
Forshaga	Värmland	Dropped	Sundsvall	Västernorrland	
Gotland	Gotland		Sunne	Värmland	
Habo	Jönköping	Merged	Säffle	Värmland	
Hagfors	Värmland		Timrå	Västernorrland	
Hammarö	Värmland	Dropped	Torsby	Värmland	
Hedemora	Dalarna		Tranås	Jönköping	
Härjedalen	Jämtland		Vaggeryd	Jönköping	
Hörnösand	Västernorrland		Vansbro	Dalarna	
Jokkmokk	Norrbotten		Vilhelmina	Västerbotten	
Jönköping	Jönköping	Merged	Vännäs	Västerbotten	
Kalix	Norrbotten		Årjäng	Värmland	
Kiruna	Norrbotten		Älvdalen	Dalarna	
Kramfors	Västernorrland		Älvsbyn	Norrbotten	
Ludvika	Dalarna		Östersund	Jämtland	
Lycksele	Västerbotten		Övertorneå	Norbotten	
Malå	Västerbotten				

Regression 1 - Demographic Check (1)		
Dependent Variable: Number of Stations		
Method: OLS	Robust Std. Err.	
Variable	**Coeficient**	**Std. Err.**
Population	0.0003*	0.0001
Population Growth	-5.482	24.3000
Number of Cars	0.0005	0.0003
Per Capita Income	-0.0845***	0.0124
Commuters (net)	-0.0007**	0.0003
Land Taxation	-0.0060*	0.0025
Land Area	0.0004***	0.0000
Person Km Per Capita	-1.8220**	0.5780
Fuel Sales Volume	-0.0032	0.0090
_cons	18.4300***	2.4650
N. Observations	298	
Adj R-squared	0.924	

Significance : *p<0.05,**p<0.01,***p<0.001

VIF Test 1 - Multicollinearity Test (1)		
Dependent Variable: Number of Stations		
Method: OLS		
Variable	**VIF**	**1/VIF**
Population	226.13	0.0044
Number of Cars	219.68	0.0046
Population Growth	1.50	0.6671
Per Capita Income	1.47	0.6793
Commuters (net)	1.72	0.5804
Land Taxation	1.29	0.7775
Land Area	1.22	0.8207
Person Km Per Capita	1.23	0.8123
Fuel Sales Volume	1.64	0.6102
Mean	50.65	

Regression 2 - Demographic Check (2)		
Dependent Variable: Number of Stations		
Method: OLS	Robust Std. Err.	
Variable	**Coeficient**	**Std. Err.**
Population	0.0005***	0.0000
Population Growth	-24.0900	23.4300
Per Capita Income	-0.0730***	0.0103
Commuters (net)	-0.0007**	0.0002
Land Taxation	-0.0065*	0.0025
Land Area	0.0005***	0.0000
Person Km Per Capita	-2.0160***	0.5030
Fuel Sales Volume	0.0031	0.0077
_cons	16.2100***	1.9780
N. Observations	401	
Adj R-squared	0.914	
Significance : *p<0.05,**p<0.01,***p<0.001		

VIF Test 2 - Multicollinearity Test (2)		
Dependent Variable: Number of Stations		
Method: OLS		
	VIF	**1/VIF**
Population	2.88	0.3470
Population Growth	1.52	0.6592
Per Capita Income	1.41	0.7113
Commuters (net)	1.68	0.5947
Land Taxation	1.22	0.8167
Land Area	1.18	0.8508
Person Km Per Capita	1.17	0.8549
Fuel Sales Volume	1.65	0.6051
Mean	1.59	

DWH Test - Fuel Sales Volume		
Dependent Variable: Number of Stations		
Method: OLS	Robust Std. Err.	
Variable	**Coeficient**	**Std. Err.**
Fuel Sales Volume	0.0729	0.0727
Fuel Sales Volume_Res	**-0.0736**	**0.0730**
Population	0.0002	0.0001
Number of Cars	0.0005	0.0003
Per Capita Income	-0.0756***	0.0159
Commuters (net)	-0.0006	0.0003
Land Taxation	-0.0005	0.0064
Land Area	0.0005***	0.0001
Person Km Per Capita	-1.7940**	0.6320
_cons	15.2300***	4.3820
N. Observations		311
Adj R-squared		0.9190
F-test: Fuel Sales Volume Residual		0.3145

Significance : *p<0.05,**p<0.01,***p<0.001

Regression 3 - Year Control For The Decrease in Number of Stations										
Dependent Variable: Number of Stations										
Method: Poisson	Robust Std. Err.									
Variables	**Specifications**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Population	Coefficient	0.0000*	0.0000*	0.0000**	0.0000*	0.0000*	0.0000*	0.0001**	0.0000*	dropped
	Std. Err.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	dropped
Population Growth	Coefficient	0.1630	0.1200	-0.4930	0.1630	0.1610	0.2030	0.3420	dropped	0.0590
	Std. Err.	1.1240	1.0570	1.0870	1.1240	1.1230	1.1250	1.1510	dropped	1.1120
Per Capita Income	Coefficient	0.0049**	0.0047**	0.0013	0.0049**	0.0049**	0.0050**	dropped	0.0050**	0.0058**
	Std. Err.	0.0017	0.0016	0.0015	0.0017	0.0017	0.0018	dropped	0.0017	0.0019
Commuters (net)	Coefficient	0.0000	0.0000	-0.0001	0.0000	0.0000	dropped	0.0000	0.0000	0.0000
	Std. Err.	0.0000	0.0000	0.0000	0.0000	0.0000	dropped	0.0000	0.0000	0.0000
Land Taxation	Coefficient	0.0000	0.0000	0.0001	0.0000	dropped	0.0000	0.0001	0.0000	0.0000
	Std. Err.	0.0002	0.0002	0.0002	0.0002	dropped	0.0002	0.0002	0.0002	0.0002
Land Area	Coefficient	0.0001***	0.0001***	0.0001***	dropped	0.0001***	0.0001***	0.0001***	0.0001***	0.0001***
	Std. Err.	0.0000	0.0000	0.0000	dropped	0.0000	0.0000	0.0000	0.0000	0.0000
Person Km Per Capita	Coefficient	0.2840***	0.2830***	dropped	0.2840***	0.2840***	0.2920***	0.2010***	0.2830***	0.3010***
	Std. Err.	0.0597	0.0574	dropped	0.0597	0.0572	0.0624	0.0497	0.0581	0.0614
Fuel Sales Volume	Coefficient	-0.0002	dropped	-0.0001	-0.0002	-0.0002	-0.0002	-0.0003	-0.0002	-0.0002
	Std. Err.	0.0004	dropped	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004
Year Dummy 2005	Coefficient	-0.0261	-0.0250	-0.0082	-0.0261	-0.0260	-0.0264	-0.0042	-0.0263	-0.0295
	Std. Err.	0.0186	0.0180	0.0199	0.0186	0.0187	0.0185	0.0193	0.0184	0.0185
Year Dummy 2006	Coefficient	-0.0739***	-0.0743***	-0.0290	-0.0739***	-0.0737***	-0.0726***	-0.0265	-0.0738***	-0.0792***
	Std. Err.	0.0204	0.0195	0.0201	0.0204	0.0201	0.0203	0.0175	0.0204	0.0211
Year Dummy 2007	Coefficient	-0.1160***	-0.1160***	-0.0538*	-0.1160***	-0.1150***	-0.1150***	-0.0450*	-0.1160***	-0.1240***
	Std. Err.	0.0265	0.0252	0.0243	0.0265	0.0261	0.0268	0.0183	0.0265	0.0279
Year Dummy 2008	Coefficient	-0.1850***	-0.1820***	-0.0876**	-0.1850***	-0.1850***	-0.1860***	-0.0764***	-0.1850***	-0.2000***
	Std. Err.	0.0379	0.0357	0.0326	0.0379	0.0374	0.0389	0.0179	0.0380	0.0406
Year Dummy 2009	Coefficient	-0.2500***	-0.2450***	-0.1260**	-0.2500***	-0.2500***	-0.2520***	-0.1050***	-0.2500***	-0.2700***
	Std. Err.	0.0495	0.0469	0.0422	0.0495	0.0489	0.0514	0.0193	0.0496	0.0534
Year Dummy 2010	Coefficient	-0.2910***	-0.2890***	-0.1550***	-0.2910***	-0.2910***	-0.2940***	-0.1300***	-0.2910***	-0.3130***
	Std. Err.	0.0539	0.0510	0.0460	0.0539	0.0535	0.0563	0.0215	0.0541	0.0583
Year Dummy 2011	Coefficient	-0.3200***	-0.3120***	-0.1750***	-0.3200***	-0.3200***	-0.3240***	-0.1460***	-0.3210***	-0.3450***
	Std. Err.	0.0586	0.0554	0.0501	0.0586	0.0583	0.0610	0.0218	0.0589	0.0632
Year Dummy 2012	Coefficient	-0.3720***	-0.3630***	-0.2030**	-0.3720***	-0.3720***	-0.3780***	-0.1660***	-0.3730***	-0.4020***
	Std. Err.	0.0743	0.0696	0.0627	0.0743	0.0739	0.0768	0.0269	0.0745	0.0788
_cons	Coefficient	0.4190	0.4550	1.2150***	0.4300	0.4210	0.4540	1.3570***	0.4170	0.3240
	Std. Err.	0.3570	0.3430	0.2930	0.3580	0.3460	0.3550	0.0697	0.3590	0.3820
N. Observations		401	441	401	401	401	401	401	401	401
Pseud R-squared		0.681	0.670	0.681	0.681	0.681	0.681	0.681	0.681	0.681

Significance *p<0.05,**p<0.01,***p<0.001
49 controls were used for municipality id

Regression 4 - Gas Price Difference in Difference (2007 - 2008)

Dependent Variable: Gasoline Price

Method: OLS — Robust Std. Err.

Variables	Specifications	1	2	3	4	5	6	7	8	9
Treatment*Post	Coefficient	-0.1710	-0.4130	-0.0874	-0.1710	-0.3670	-0.2090	-0.1570	-0.1680	-0.2150
	Std. Err.	0.5050	0.4840	0.4850	0.5050	0.5150	0.5390	0.5080	0.4800	0.4970
Post	Coefficient	2.2170**	2.0350*	1.7860*	2.2170**	2.0180*	2.0200**	1.0280***	1.6690	2.5320**
	Std. Err.	0.7420	0.7510	0.7640	0.7420	0.7480	0.5590	0.2420	0.8570	0.7200
Treatment	Coefficient	0.2900	0.5750	0.2380	0.2900	0.3630	0.3440	0.3210	0.2760	0.2190
	Std. Err.	0.4770	0.4760	0.4730	0.4770	0.4840	0.5560	0.5090	0.4660	0.4510
Population	Coefficient	-0.0005	-0.000823*	-0.0005	-0.0005	-0.0005	-0.0006	-0.0007	-0.0005	dropped
	Std. Err.	0.0004	0.0003	0.0004	0.0004	0.0003	0.0004	0.0003	0.0003	dropped
Population Growth	Coefficient	35.9500	37.6600	33.5600	35.9500	28.5000	34.6300	22.6200	dropped	35.9800
	Std. Err.	22.7100	22.1700	23.8600	22.7100	23.7900	21.9800	21.8500	dropped	22.9300
Per Capita Income	Coefficient	-0.1750	-0.1480	-0.1270	-0.1750	-0.1170	-0.1460	dropped	-0.0915	-0.2190*
	Std. Err.	0.0980	0.1090	0.1020	0.0980	0.1020	0.0720	dropped	0.1190	0.0945
Commuters (net)	Coefficient	-0.0009	0.0004	-0.0007	-0.0009	-0.0007	dropped	-0.0004	-0.0008	-0.0014
	Std. Err.	0.0015	0.0015	0.0014	0.0015	0.0015	dropped	0.0014	0.0015	0.0014
Land Taxation	Coefficient	0.0235	0.0247	0.0230	0.0235	dropped	0.0224	0.0186	0.0196	0.0232
	Std. Err.	0.0177	0.0168	0.0177	0.0177	dropped	0.0172	0.0177	0.0182	0.0174
Land Area	Coefficient	0.0004	0.0006	0.0004	dropped	0.0005	0.0005	0.0004	0.0003	0.0001
	Std. Err.	0.0003	0.0003	0.0003	dropped	0.0003	0.0003	0.0003	0.0003	0.0002
Person Km Per Capita	Coefficient	-1.6920	-1.4310	dropped	-1.6920	-1.5680	-1.4650	-0.5320	-1.3340	-1.9560
	Std. Err.	2.4090	2.0510	dropped	2.4090	2.2330	2.1450	2.3290	2.6090	2.4250
Fuel Sales Volume	Coefficient	-0.0264	dropped	-0.0231	-0.0264	-0.0324	-0.0232	-0.0271	-0.0293	-0.0301*
	Std. Err.	0.0179	dropped	0.0165	0.0179	0.0196	0.0170	0.0190	0.0187	0.0144
Oil Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	50.1000*	47.9200*	40.0700*	50.1900*	38.5700	45.9600**	16.6900***	33.4500	55.2500**
	Std. Err.	18.5500	20.8000	19.2400	18.5800	18.9800	14.8500	2.8500	22.5800	18.5300
N. Observations		71	80	71	71	71	71	71	71	71
Adj R-squared		0.5990	0.5150	0.6040	0.5990	0.5600	0.6090	0.5820	0.5720	0.6000

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

Regression 5 - Gas Price Difference in Difference (2008 - 2009)										
Dependent Variable: Gasoline Price										
Method: OLS		Robust Std. Err.								
Variables	**Specifications**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Treatment*Post	Coefficient	0.1050	0.3100	0.1360	0.1050	0.1560	0.1170	0.2630	0.1090	0.3010
	Std. Err.	0.4080	0.4000	0.4150	0.4080	0.3940	0.4010	0.3760	0.4110	0.3800
Post	Coefficient	1.3190	0.9730	0.0071	1.3190	1.2370	0.0916	-0.5290*	1.3020	0.8380
	Std. Err.	-1.5080	-1.0980	-1.3210	-1.5080	-1.4590	-1.3030	-0.2450	-1.5100	-1.3960
Treatment	Coefficient	0.1300	0.0965	0.2450	0.1300	0.0695	0.0504	-0.0097	0.1240	-0.0229
	Std. Err.	0.3580	0.3510	0.3960	0.3580	0.3450	0.3420	0.3110	0.3600	0.3170
Population	Coefficient	0.0006	0.0007	0.0005	0.0006	0.0005	0.0002	0.0003	0.0006	dropped
	Std. Err.	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004	-0.0003	-0.0004	dropped
Population Growth	Coefficient	-4.5230	-2.9840	6.4030	-4.5230	-5.6520	-3.2430	-0.0158	dropped	-1.0520
	Std. Err.	29.4800	28.4300	33.3500	29.4800	26.8500	33.1000	35.1500	dropped	29.7000
Per Capita Income	Coefficient	0.2440	0.2190	0.0673	0.2440	0.2410	0.0897	dropped	0.2410	0.1870
	Std. Err.	-0.1890	-0.1460	-0.1600	-0.1890	-0.1870	-0.1670	dropped	-0.1910	-0.1780
Commuters (net)	Coefficient	-0.0037	-0.00384*	-0.0026	-0.0037	-0.0035	dropped	-0.0025	-0.0037	-0.0032
	Std. Err.	0.0019	0.0017	0.0019	0.0019	0.0018	dropped	0.0012	0.0018	0.0017
Land Taxation	Coefficient	0.0076	0.0071	0.0118	0.0076	dropped	0.0003	0.0068	0.0078	0.0041
	Std. Err.	-0.0125	-0.0103	-0.0134	-0.0125	dropped	-0.0135	-0.0125	-0.0115	-0.0130
Land Area	Coefficient	0.0001	0.0001	-0.0001	dropped	0.0001	-0.0002	-0.0001	0.0001	0.0005
	Std. Err.	0.0004	0.0004	0.0004	dropped	0.0004	0.0004	0.0003	0.0004	0.0004
Person Km Per Capita	Coefficient	-8.2220*	-6.1330*	dropped	-8.2220*	-8.4920*	5.4330	-4.7520*	-8.080*	-7.9840*
	Std. Err.	-3.1430	-2.8120	dropped	-3.1430	-3.3000	-3.0570	-2.0850	-3.4640	-3.1150
Fuel Sales Volume	Coefficient	0.1230***	dropped	0.09410***	0.1230***	0.1270***	0.1270***	0.1040***	).1210***	0.1230***
	Std. Err.	0.0167	dropped	0.0228	0.0167	0.0162	0.0185	0.0193	0.0200	0.0171
Oil Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	59.2300	53.2700	19.4600	59.2600	59.4800	31.6200	10.1200**	58.6500	52.0000
	Std. Err.	38.2400	29.9500	30.9000	38.3000	38.1300	34.7400	2.9470	38.5900	37.1100
N. Observations		75	82	75	75	75	75	75	75	75
Adj R-squared		0.6110	0.5340	0.5240	0.6110	0.6220	0.5140	0.5680	0.6270	0.6010

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

Regression 6 - Diesel Price Difference in Difference (2007 - 2008)

Dependent Variable: Diesel Price

Method: OLS | Robust Std. Err.

Variables	Specifications	1	2	3	4	5	6	7	8	9
Treatment*Post	Coefficient	1.1420	0.9400	1.378*	1.1420	1.1830	1.1390	1.1500	0.9060	1.2200
	Std. Err.	0.6470	0.6650	0.6440	0.6470	0.5560	0.6480	0.6280	0.6110	0.6140
Post	Coefficient	3.2020*	2.7170*	2.0990	3.2020*	3.2790**	3.4230**	2.7400***	3.5240**	2.9600**
	Std. Err.	1.1490	1.0570	1.1030	1.1490	0.9400	1.1430	0.3370	1.0210	0.9070
Treatment	Coefficient	-0.3960	-0.2700	-0.4990	-0.3960	-0.4160	-0.4360	-0.3810	-0.3210	-0.3770
	Std. Err.	0.2880	0.2620	0.3050	0.2880	0.2380	0.2810	0.2430	0.2830	0.2530
Population	Coefficient	0.0003	0.0001	0.0001	0.0003	0.0003	0.0004	0.0002	0.0004	dropped
	Std. Err.	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0002	0.0003	dropped
Population Growth	Coefficient	44.8500	42.7900	60.9200	44.8500	45.4100	44.1200	46.3900	dropped	48.5100
	Std. Err.	35.6700	32.5100	35.2000	35.6700	35.4800	36.5500	33.3100	dropped	33.7100
Per Capita Income	Coefficient	-0.0652	0.0194	0.0582	-0.0652	-0.0820	-0.0978	dropped	-0.0900	-0.0331
	Std. Err.	0.1860	0.1670	0.1920	0.1860	0.1390	0.1850	dropped	0.1590	0.1510
Commuters (net)	Coefficient	0.0008	0.0014	0.0011	0.0008	0.0008	dropped	0.0010	0.0008	0.0011
	Std. Err.	0.0011	0.0013	0.0011	0.0011	0.0011	dropped	0.0011	0.0012	0.0010
Land Taxation	Coefficient	-0.0045	-0.0104	-0.0047	-0.0045	dropped	-0.0027	-0.0069	-0.0058	-0.0050
	Std. Err.	0.0167	0.0155	0.0173	0.0167	dropped	0.0169	0.0119	0.0164	0.0158
Land Area	Coefficient	-0.0003	-0.0001	-0.0001	dropped	-0.0004	-0.0003	-0.0002	-0.0004	-0.0002
	Std. Err.	0.0004	0.0004	0.0004	dropped	0.0003	0.0004	0.0001	0.0004	0.0003
Person Km Per Capita	Coefficient	-3.4400*	-2.5080	dropped	-3.4400*	-3.4450*	-3.6390*	-2.9130	-4.5450*	-3.1670*
	Std. Err.	1.4850	1.7170	dropped	1.4850	1.3910	1.5430	1.5820	1.6450	1.3550
Fuel Sales Volume	Coefficient	-0.0061	dropped	0.0018	-0.0061	-0.0050	-0.0090	-0.0054	-0.0127	-0.0036
	Std. Err.	0.0144	dropped	0.0130	0.0144	0.0110	0.0142	0.0147	0.0161	0.0149
Oil Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	24.8200	9.0650	0.4360	24.7600	28.0700	29.7100	12.2300***	29.2900	20.3500
	Std. Err.	-35.2400	-31.6800	-36.0000	-35.1500	-25.9600	-35.2300	-2.2050	-30.4100	-30.6900
N. Observations		58	64	58	58	58	58	58	58	58
Adj R-squared		0.9340	0.9050	0.9250	0.9340	0.9380	0.9360	0.9370	0.9260	0.9370

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

Regression 7 - Diesel Price Difference in Difference (2008 - 2009)

Dependent Variable: Diesel Price

Method: OLS — Robust Std. Err.

Variables	Specifications	1	2	3	4	5	6	7	8	9
Treatment*Post	Coefficient	0.2300	1.1500	-0.9590	0.2300	0.5070	-0.1350	0.6690	-0.4140	-0.9520
	Std. Err.	1.0940	1.8750	1.1860	1.0940	1.0210	1.0270	1.5390	1.0630	0.8670
Post	Coefficient	1.7930	-0.8470	1.8050	1.7930	1.5840	1.2610	-0.6710	1.6740	3.0780
	Std. Err.	3.0880	3.3970	3.9040	3.0880	3.2280	2.9930	0.6860	4.7050	3.2560
Treatment	Coefficient	-1.3240	-1.8220	0.2900	-1.3240	-1.6240	-1.0720	-1.6610	0.3660	-0.1530
	Std. Err.	1.4360	1.9600	1.0680	1.4360	1.3500	1.3540	1.8530	1.0430	1.0900
Population	Coefficient	-0.0015	-0.0022	-0.0005	-0.0015	-0.0016	-0.0014	-0.0021	-0.0006	dropped
	Std. Err.	0.0011	0.0015	0.0010	0.0011	0.0010	0.0010	0.0014	0.0010	dropped
Population Growth	Coefficient	170.2000	129.6000	100.0000	170.2000	167.2000	161.1000	173.3000	dropped	134.2000
	Std. Err.	140.7000	158.0000	114.9000	140.7000	156.2000	150.8000	159.3000	dropped	140.5000
Per Capita Income	Coefficient	-0.3270	-0.0489	-0.3080	-0.3270	-0.3470	-0.2650	dropped	-0.3460	-0.4780
	Std. Err.	0.3990	0.4130	0.4630	0.3990	0.4180	0.4000	dropped	0.5860	0.4130
Commuters (net)	Coefficient	-0.0034	-0.0014	-0.0020	-0.0034	-0.0024	dropped	-0.0025	-0.0026	-0.0034
	Std. Err.	0.0046	0.0044	0.0038	0.0046	0.0036	dropped	0.0042	0.0051	0.0043
Land Taxation	Coefficient	-0.0273	-0.0068	-0.0339	-0.0273	dropped	-0.0189	-0.0298	-0.0251	-0.0320
	Std. Err.	0.0356	0.0337	0.0342	0.0356	dropped	0.0324	0.0311	0.0292	0.0337
Land Area	Coefficient	0.0000	-0.0001	-0.0001	dropped	-0.0002	-0.0002	0.0001	-0.0002	0.0000
	Std. Err.	0.0003	0.0003	0.0002	dropped	0.0002	0.0002	0.0003	0.0002	0.0002
Person Km Per Capita	Coefficient	-20.5900	-21.9000	dropped	-20.5900	-22.6900	-16.6000	-19.8000	-4.1150	-11.7400
	Std. Err.	17.9200	20.6900	dropped	17.9200	17.3600	18.5300	20.0800	10.7900	14.9000
Fuel Sales Volume	Coefficient	-0.1190*	dropped	-0.1070*	-0.1190*	-0.1130	-0.1080*	-0.1400*	-0.0733	-0.1060*
	Std. Err.	0.0491	dropped	0.0424	0.0491	0.0512	0.0469	0.0589	0.0484	0.0440
Oil Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	54.0000	60.0000	54.0000	54.0000	54.0000	54.0000	54.0000	54.0000	54.0000
	Std. Err.	0.5760	0.3410	0.5040	0.5760	0.5730	0.5690	0.5480	0.3920	0.5430
N. Observations		54	60	54	54	54	54	54	54	54
Adj R-squared		0.5760	0.3410	0.5040	0.5760	0.5730	0.5690	0.5480	0.3920	0.5430

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

Regression 8 - Ethanol Price Difference in Difference (2007 - 2008)

Dependent Variable: Ethanol Price

Method: OLS — Robust Std. Err.

Variables	Specifications	1	2	3	4	5	6	7	8	9
Treatment*Post	Coefficient	0.1680	-0.2270	0.1470	0.1680	0.0573	0.1600	0.1840	0.1890	0.2070
	Std. Err.	0.4830	0.5350	0.4060	0.4830	0.4090	0.4010	0.3960	0.4140	0.4220
Post	Coefficient	1.0670	0.9220	0.9560	1.0670	0.9160	1.0530	0.5390*	1.0500	1.0750
	Std. Err.	1.1040	1.3320	0.8410	1.1040	0.9460	0.9220	0.1420	0.9290	0.9530
Treatment	Coefficient	-0.1140	-0.1450	-0.1270	-0.1140	-0.1380	-0.1260	-0.1460	-0.1130	-0.0976
	Std. Err.	0.1480	0.2670	0.1690	0.1480	0.1610	0.1550	0.1830	0.1340	0.1430
Population	Coefficient	0.0002	0.0014	0.0003	0.0002	0.0007	0.0003	0.0004	0.0001	dropped
	Std. Err.	0.0006	0.0015	0.0007	0.0006	0.0007	0.0003	0.0005	0.0008	dropped
Population Growth	Coefficient	-3.0460	-36.3800	-4.0650	-3.0460	-15.9800	-4.3430	-1.3110	dropped	1.9210
	Std. Err.	39.0900	61.3600	35.8400	39.0900	40.8600	37.1700	35.0000	dropped	33.5200
Per Capita Income	Coefficient	-0.0815	-0.0079	-0.0653	-0.0815	-0.0405	-0.0780	dropped	-0.0807	-0.0869
	Std. Err.	0.1940	0.1910	0.1500	0.1940	0.1380	0.1550	dropped	0.1710	0.1660
Commuters (net)	Coefficient	0.0001	-0.0015	0.0000	0.0001	-0.0004	dropped	-0.0002	0.0002	0.0003
	Std. Err.	0.0010	0.0019	0.0010	0.0010	0.0009	dropped	0.0007	0.0012	0.0005
Land Taxation	Coefficient	0.0116	-0.0108	0.0103	0.0116	dropped	0.0108	0.0060	0.0124	0.0140
	Std. Err.	0.0186	0.0218	0.0150	0.0186	dropped	0.0129	0.0064	0.0167	0.0141
Land Area	Coefficient	0.0000	-0.0001	0.0000	dropped	-0.0001	0.0000	-0.0003	0.0000	0.0002
	Std. Err.	0.0002	0.0002	0.0008	dropped	0.0001	0.0004	0.0004	0.0002	0.0003
Person Km Per Capita	Coefficient	-0.4170	0.1100	dropped	-0.4170	0.0113	-0.3510	0.3090	-0.4370	-0.5650
	Std. Err.	1.7910	2.0950	dropped	1.7910	1.6790	1.5340	1.6840	1.6410	1.6690
Fuel Sales Volume	Coefficient	0.0274	dropped	0.0269	0.0274	0.0212*	0.0267*	0.0246*	0.0280	0.0288
	Std. Err.	0.0144	dropped	0.0118	0.0144	0.0047	0.0096	0.0055	0.0121	0.0108
Sugar Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	19.3400	-17.6700	14.3700	20.7800	1.8550	17.0200	3.4100	20.4200	21.1100
	Std. Err.	44.0300	43.4300	24.3100	35.3000	24.2900	23.6600	3.3350	43.1800	30.7200
N. Observations		42	43	42	42	42	42	42	42	42
Adj R-squared		0.8010	0.6030	0.8470	0.8010	0.8220	0.8500	0.8240	0.8500	0.8480

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

Regression 9 - Ethanol Price Difference in Difference (2008 - 2009)

Dependent Variable: Ethanol Price

Method: OLS — Robust Std. Err.

Variables	Specifications	1	2	3	4	5	6	7	8	9
Treatment*Post	Coefficient	0.1220	0.1450	0.1440	0.1460	0.1210	0.1520	0.2210	-0.0392	0.1400
	Std. Err.	0.3620	0.3270	0.3390	0.3500	0.3520	0.2600	0.3360	0.2570	0.3440
Post	Coefficient	0.7270***	0.7190***	0.7220***	0.7360***	0.7270***	0.7250***	0.8050***	0.7780***	0.7250***
	Std. Err.	0.1350	0.1210	0.1230	0.1170	0.1280	0.1300	0.1330	0.1120	0.1340
Treatment	Coefficient	-0.0756	-0.0988	-0.0898	-0.1020	-0.0738	-0.0940	-0.2340	-0.0333	-0.0892
	Std. Err.	0.2130	0.1800	0.2040	0.2030	0.2020	0.1640	0.1990	0.1810	0.1930
Population	Coefficient	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	dropped
	Std. Err.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	dropped
Population Growth	Coefficient	-22.9600	-19.6300	-21.3600	-22.8600	-22.8700	-24.6400	-10.6200	dropped	-24.2400
	Std. Err.	22.0700	20.4500	21.3400	21.8000	20.9200	15.7200	23.4800	dropped	20.4000
Per Capita Income	Coefficient	0.0137*	0.0123*	0.0127*	0.0128**	0.0137**	0.0135*	dropped	0.0087	0.0134**
	Std. Err.	0.0049	0.0057	0.0059	0.0041	0.0048	0.0048	dropped	0.0080	0.0046
Commuters (net)	Coefficient	0.0000	-0.0001	0.0000	0.0000	0.0000	dropped	0.0000	-0.0001	0.0000
	Std. Err.	0.0001	0.0001	0.0001	0.0001	0.0001	dropped	0.0001	0.0000	0.0001
Land Taxation	Coefficient	0.0000	-0.0004	0.0002	-0.0001	dropped	0.0000	0.0001	0.0003	-0.0002
	Std. Err.	0.0014	0.0012	0.0012	0.0013	dropped	0.0014	0.0016	0.0014	0.0011
Land Area	Coefficient	0.0000	0.0000	0.0000	dropped	0.0000	0.0000	0.0000	0.0000	0.0000
	Std. Err.	0.0000	0.0000	0.0000	dropped	0.0000	0.0000	0.0000	0.0000	0.0000
Person Km Per Capita	Coefficient	0.0850	0.1330	dropped	0.0830	0.0827	0.0626	-0.0350	0.0054	0.1210
	Std. Err.	0.2500	0.2370	dropped	0.2470	0.2180	0.2460	0.2710	0.2570	0.1660
Fuel Sales Volume	Coefficient	0.0036*	dropped	0.0038*	0.0036*	0.0036*	0.0039	0.0029	0.0029	0.0031
	Std. Err.	0.0016	dropped	0.0016	0.0015	0.0014	0.0020	0.0022	0.0022	0.0017
Sugar Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	5.6760***	5.9950***	5.9430***	5.8410***	5.6760***	5.7120***	8.5560***	6.8630***	5.6880***
	Std. Err.	0.9150	1.1100	1.1130	0.8610	0.8950	0.8810	0.3660	1.7220	0.8730
N. Observations		31	33	31	31	31	31	31	31	31
Adj R-squared		0.5750	0.6130	0.5930	0.5950	0.5960	0.5950	0.5330	0.5540	0.5940

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

Regression 10 - Fuel Sales Volume Difference in Difference (2007 - 2008)

Dependent Variable: Fuel Sales Volume

Method: OLS — Robust Std. Err.

Variables	Specifications	1	2	3	4	5	6	7	8
Treatment*Post	Coefficient	-2.8710	-2.2660	-2.8710	-2.1800	-3.2080	-2.9160	-3.3640	-2.1600
	Std. Err.	4.4700	4.3780	4.4700	3.6670	4.7580	4.4360	4.6110	4.6140
Post	Coefficient	3.1120	-0.1690	3.1120	3.2280	1.7940	3.6590	4.2150	0.5960
	Std. Err.	3.3010	2.6760	3.3010	3.3150	3.2390	2.5880	3.6880	4.1850
Treatment	Coefficient	-0.7420	-1.4300	-0.7420	-1.0540	0.0133	-0.7360	0.2880	0.0283
	Std. Err.	3.5070	3.4030	3.5070	3.0350	3.8230	3.4540	3.5180	3.4660
Population	Coefficient	0.0072	0.0072	0.0072	0.0070	0.0050	0.0073	0.0065	dropped
	Std. Err.	0.0043	0.0043	0.0043	0.0046	0.0054	0.0042	0.0048	dropped
Population Growth	Coefficient	-149.6000	-147.3000	-149.6000	-131.1000	-147.4000	-146.5000	dropped	-115.8000
	Std. Err.	126.5000	124.2000	126.5000	113.4000	131.5000	120.1000	dropped	126.5000
Per Capita Income	Coefficient	0.0795	0.4250	0.0795	-0.0189	0.3210	dropped	-0.1120	0.4350
	Std. Err.	0.4650	0.5180	0.4650	0.4290	0.6190	dropped	0.4520	0.6160
Commuters (net)	Coefficient	-0.0162	-0.0156	-0.0162	-0.0175	dropped	-0.0164	-0.0161	-0.0101
	Std. Err.	0.0182	0.0184	0.0182	0.0190	dropped	0.0186	0.0184	0.0187
Land Taxation	Coefficient	-0.0937	-0.1010	-0.0937	dropped	-0.1190	-0.0918	-0.0727	-0.0855
	Std. Err.	0.1340	0.1340	0.1340	dropped	0.1560	0.1290	0.1230	0.1330
Land Area	Coefficient	-0.0037	-0.0043	dropped	-0.0042	-0.0032	-0.0037	-0.0031	0.0013
	Std. Err.	0.0043	0.0041	dropped	0.0041	0.0048	0.0042	0.0048	0.0022
Person Km Per Capita	Coefficient	-18.8600	dropped	-18.8600	-19.4100	-18.0000	-19.3500	-18.6500	-19.0100
	Std. Err.	11.8500	dropped	11.8500	12.6900	10.3300	12.3000	11.3700	11.3300
Oil Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	-61.6000	-141.0000	-62.3400	-41.6800	-81.5100	-46.4400	-18.6300	-77.7500
	Std. Err.	101.0000	110.6000	101.0000	95.0000	108.7000	34.8500	95.0300	126.3000
N. Observations		87	87	87	87	87	87	87	87
Adj R-squared		0.9760	0.9760	0.9760	0.9770	0.9760	0.9770	0.9760	0.9750

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

Regression 11 - Fuel Sales Volume Difference in Difference (2008 - 2009)									
Dependent Variable: Fuel Sales Volume									
Method: OLS		Robust Std. Err.							
Variables	**Specifications**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Treatment*Post	Coefficient	0.6340	0.7130	0.6340	0.7760	0.5690	0.6280	0.6840	0.7810
	Std. Err.	0.7290	0.8060	0.7290	0.8780	0.6560	0.7110	0.7720	0.8660
Post	Coefficient	-0.9660	-0.1670	-0.9660	-0.9790	-1.5270	-0.2950	-1.4680	-1.2450
	Std. Err.	1.3270	0.5940	1.3270	1.3910	1.7880	0.3400	1.7410	1.5370
Treatment	Coefficient	-0.1370	-0.2470	-0.1370	-0.3110	-0.1340	-0.1120	-0.1440	-0.2410
	Std. Err.	0.2720	0.3390	0.2720	0.3970	0.2580	0.2430	0.2530	0.3240
Population	Coefficient	0.0006	0.0005	0.0006	0.0004	0.0004	0.0007	0.0006	dropped
	Std. Err.	0.0008	0.0007	0.0008	0.0005	0.0006	0.0008	0.0008	dropped
Population Growth	Coefficient	26.9000	32.2200	26.9000	20.8500	22.1300	31.8000	dropped	26.4200
	Std. Err.	35.1300	38.7400	35.1300	32.0400	32.6800	39.3100	dropped	35.1500
Per Capita Income	Coefficient	0.0930	-0.0163	0.0930	0.0644	0.1650	dropped	0.1510	0.1250
	Std. Err.	0.1480	0.0785	0.1480	0.1400	0.2000	dropped	0.1890	0.1690
Commuters (net)	Coefficient	-0.0025	-0.0032	-0.0025	-0.0018	dropped	-0.0029	-0.0021	-0.0021
	Std. Err.	0.0031	0.0037	0.0031	0.0023	dropped	0.0034	0.0027	0.0026
Land Taxation	Coefficient	-0.0323	-0.0292	-0.0323	dropped	-0.0283	-0.0313	-0.0297	-0.0297
	Std. Err.	0.0401	0.0362	0.0401	dropped	0.0359	0.0385	0.0367	0.0366
Land Area	Coefficient	0.0002	0.0004	dropped	0.0001	0.0000	0.0003	0.0001	0.0006
	Std. Err.	0.0004	0.0003	dropped	0.0004	0.0005	0.0004	0.0005	0.0004
Person Km Per Capita	Coefficient	4.9670	dropped	4.9670	4.0430	6.2220	3.7920	5.6470	4.8170
	Std. Err.	5.9650	dropped	5.9650	4.9650	7.0170	4.5250	6.4820	5.7500
Oil Price	Coefficient	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
	Std. Err.	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
_cons	Coefficient	-21.1700	4.0770	-21.1300	-12.5200	-33.2300	-2.2590	-33.1900	-23.2400
	Std. Err.	37.7700	14.9500	37.8100	32.6600	47.7800	10.9600	47.8000	39.4100
N. Observations		84	84	84	84	84	84	84	84
Adj R-squared		0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980

Significance *p<0.05,**p<0.01,***p<0.001

49 controls were used for municipality id

End notes in Order of Appearance (End Notes)

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