Congestion tolls effect on car consumption

Wilmer Hareskog

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Wilmer Hareskog

Supervisor:	**Pedro Guimares Naso, Swedish University of Agricultural Sciences, SLU, Department of Economics**
Examiner:	Robert Hart, Swedish University of Agricultural Sciences, SLU, Department of Economics

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Swedish University of Agricultural Sciences

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Abstract

This thesis investigates the relationship between the sales of new cars and the introduction of congestion tolls in Sweden, estimating their correlation. This was done by conducting three different linear regression models. The thesis result points towards a negative correlation between the introduction of tolls in a region and the consumption of cars in that region with statistical significance. According to the result, an introduction of tolls in a region would result in a consumption decrease of 3491 newly produced cars with a standard deviation of 1869. This result confirms the study’s hypothesis. This knowledge can help predict future car consumption in Swedish regions where congestion toll will be introduced.

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1. Introduction

Traffic congestion has been a problem for a long time all over the world. This problem occurs in big cities for the most part, based on the large amount of people traveling within them. The two biggest cities in Sweden are Stockholm and Gothenburg. They both have a problem with congestion and are looking for ways to reduce it. A solution that is implemented in these regions is the introduction of congestion tolls. These tolls are supposed to lower the incentives to travel in and through the densest parts of the city by car. A congestion toll is supposed to make it more expensive to travel past the tolls and thereby redirect people to travel in an alternative way, for example by train or travel around the toll instead of through it. The price of driving through one of these tolls ranges from 0 to 45 Swedish krona in Sweden. This price depends on the time of the day, region and season (Skatteverket. n.d.). The expense may appear minimal, although for individuals driving past multiple times a week, the cumulative expense might become significant. A reduced incentive to drive a car would then end up lowering the incentives to buy a new car.

The objective of this thesis is to empirically investigate the effects of introducing congestion tolls on the consumption of new cars. This will be done by using yearly data from every of the 290 regions in Sweden. The amount of newly sold cars will be measured by looking at the amount of newly registered cars in the regions. This will add to the existing literature by widening the knowledge of the effects of congestion tolls, which will help the understanding of their implementation.

Some side effects of the congestion tolls are time reduction for traveling, reduced CO_2 pollution and tax revenue (Börjesson et al. 2012). This thesis will however only see if there is an effect on the consumption of new passenger cars and thereby not investigate other effects.

The result points towards a negative correlation between the introduction of tolls in a region and the consumption of cars in that region with statistical significance. However, using only one simple linear regression without control variables can not show this correlation. Therefore multiple linear regressions were conducted. An introduction of tolls according to the results would mean a decrease of 3491 newly produced cars in that region with a standard deviation of 1869.

The significance of this thesis is underscored by the potential impact that a shift in the car market could have. These shifts could potentially lead to substantial effects (Shahabuddin 2009). The car market is a big industry that affect a lot of people. There are 306181 newly registered cars from Jun 23 – May 24 and the numbers are steadily growing (Car info n.d.). In addition to the car industries direct effect on the economy, it also has a large spillover effect on other parts of the economy. (Shahabuddin 2009). This means that the consumption of cars does not only leave an impact on the car dealership but a whole production line and other industries that are dependent on the consumption of cars. Understanding the car market better will thereby help the new car dealerships to adjust in advanced to changes in a consumption pattern. Production lines and other affected industries will then be better prepared.

2. Literature review

Congestion is a large problem worldwide and it often correlates with the density of the area. Solutions for this have been searched for a long time and have been dealt with in many ways. This is a big reason why the interest of the effects of congestion tolls in Stockholm has been so well covered in today's literature. These outcomes will have a big chance of affecting congestion toll use around the world. Today's literature is however weaker when it comes to discussing the effects of the surroundings of the congestion tolls.

Börjesson et al. (2012) shows an overview over the effects that the tolls had during their first five years of implementation in Stockholm, January 3 – July 31, 2006. This was done by investigating multiple works completed during this period where multiple methods were used. According to their article the effect on traffic was statistically significant. The reduction of cars on the roads were around 21% after removing several factors and the everyday driver could easily feel the difference. They could also map out a shift in transport method. The congestion tax made the use of public transport go up 6%. The article also shows that the change in the amount of traffic was not only limited to the area with the tolls but a large area that is not just close to the zone limit. The article is mainly focused on the congestion change and does not bring up the change in consumption of newly produced cars. They do however bring up the change in consumption of “clean” vehicles. The article discusses multiple results of the congestion tolls and therefore the importance of a better understanding of the subject.

Shahabuddin (2009) looks at forecasting automobile sales. This paper's purpose is to understand the behaviour of the automotive industry, which is of importance to avoid economic disruptions. The paper discusses the importance of sales forecasting, the understanding of where to put prices and the understanding of the market's demand. This helps the automotive industry to have an optimum inventory level and to maximize efficiency. The paper argues that succeeding with this will not only be done by planning and forecasting but also by coordinating all activities that affect a consumer's behaviour in this industry. Understanding this was done by using multiple regression models. The models that were used included twelve independent variables. The study concluded that the USA is heavily affected by changes in automobile sales and a part of the reason is because of its large production within the country. More related to this research was that the imported car sales were largely correlated with economic variables. This was more related because of the somewhat large car production that Sweden has.

Metz (2018) article tracks the traffic congestion that has been experienced in London, Stockholm and Singapore. They investigate the congestion problem before and after the implementation of tolls. This was done by looking at the travel times over time which then indicate changes in congestion. The article concluded that the congestions decreased drastically in London after its implementation but increased to similar levels a few years later, despite an increase in prices over that time. Stockholm had a similar result where the congestion decreased drastically in the beginning but increased later on. Singapore has a different charging system where they charge more when the traffic runs slower. This seemed to have worked by reducing the traffic with 10-15% steady over time. The article covers the congestion effects that the tolls had. It does not however bring up any other effects that could have been caused by the congestion tolls. Metz's article is of interest based on that it includes the effect from different countries where congestion tolls has been implemented.

Islam et al. (2016) investigated the factors that affect the number of car sales in Malaysia. This was done by using a multiple regression model. According to Islam's research, the GDP had a positive correlation with a 1% significance, the inflation has a negative correlation with a 1% significance and the interest rates inflation has a negative correlation with 1% significance. The unemployment rate was positively correlated with sales of cars. This article does not include any tax effects that could have led to a change in the consumption of cars. The article does however give important knowledge of variables affecting car consumption which some could be implemented in this research.

Fantazzini & Toktamysova (2015) research embraces the subject of forecasting German car sales with Google data. This is done by looking at historical numbers from Google search data with multivariate models. According to the paper, this method statistically outperformed the competing models for most of the car brands and forecast horizons after several robust checks. The article looks at car sales at a national scale and not regional. This article is still interesting because of its arguments for the importance of the forecasting of the industry.

Eliasson (2009) paper presents the cost-benefits of the congestion tolls in Stockholm. This is done by the observed data that has been collected after the implementation and not by a model that forecast the effects. The conclusion of the article is that it is well socially beneficial. The price of introducing congestion tolls is paid off in 4 years in regard to social benefit calculations which includes not only tax revenue but the value of social benefit. The article is of interest based on its reasoning of the congestion toll side-effect, the cost. They assume that the government spending will not be affected. They do however not specify what would happen to the new car sales. This research may help this paper to locate a specific welfare cost of the introduction of congestion tolls.

This study will contribute to the existing literature by enlighten another part of congestion tolls that has not been well covered. A lot of focus has been on the congestion effect but not as much on surrounding effects, including car consumption.

3. Conceptual framework

In this section, the conceptual framework of the research will be presented. This will describe the effect that congestion tolls will have on the consumption of new cars within an economy. When introducing congestion tolls to a region, the price of using a motor vehicle increases. This cost increase will affect drivers in four multiple ways:

A price increase can lead costumers to substitutes. The concept of substitutes is of importance. An increase in cost for a product will increase the consumption of substitutes. This is because the increase in price will make customers look elsewhere for similar products providing similar utilisation. Price increases will therefore lead to fewer costumers of that product as a result of substitutes providing similar utilisation (Bucklin et al. 1998). The concept of substitutes is of importance based on that the price of using a car increases with an implementation of tolls. This can thereby make customers buy substitutes like bus tickets and bikes instead.

A price increase can affect drivers by lowering the incentives for a specific route. A toll increases the price for one road which means that a different route that's cheaper might be a better choice for a traveller. The travellers who would reroute could be the ones who are cost-sensitive but not time-sensitive. This means that they are happy with increasing the loss of time for decreasing cost. This is similar to the substitutional concept. The difference is that the driver change route instead of product completely. It's possible to think of different routes as substitutes to each other, they are giving similar utilisation but the cost is different.

A price increase can simply make drivers choose to travel less. The increase in expenses for traveling could make price-sensitive travellers not willing to pay for the trip. The utility gained from the travel might not be worth it because of the increase in price. This does not necessarily mean that they will choose a substitute instead. They might just find some other sort of product that will give them more utility. The difference is that instead of changing to a similar product they change category completely to save for future utility or other products providing utility.

A price increase could potentially affect drivers' attitude towards traveling with a motor vehicle. The tolls are meant to incentivise public transport and reduce air pollution surrounding the area within. According to Bowles & Polania-Reyes (2012), there are social preferences. These preferences represent altruism, people find value in just not helping themselves but to help others. Having this increased cost might get people to think that they are doing something good when choosing other ways of travel and therefor decrease their traveling with car.

These factors will ultimately affect the consumption of cars. The decision to purchase a vehicle involves the following factors:

- Utility gained from using a vehicle.
- Expense of buying a vehicle.
- Expense of operating a vehicle.
- Expense of alternatives to owning a vehicle.
- Utility gained from the alternatives.

Congestion tolls will affect these factors of the decision based on the following.

Utility gained from using a vehicle will likely increase with an introduction of tolls. Decreased travel time (Börjesson et al. 2012) will make traveling with a vehicle more convenient and thereby increase the utility. Environmental awareness will affect the utility gained from owning a vehicle as well. Tolls will possibly enlighten drivers to be more aware of the negative effects coming from car usage, which is why the tolls were introduced. A common reason for the introduction of congestion tolls is to get cleaner air within its areas (Bowles & Polania-Reyes, 2012). This awareness could lower the driver's utility because of altruism. The negative effects might not affect them but affect other people in the trafficked area. New incentive, according to Bowles & Polania-Reyes, (2012) does often have a slow effect and can therefore be viewed as a process.

The cost of buying a vehicle will most likely not change because of an introduction of tolls. It could be argued in some circumstances that the change in demand for cars would change the price because of principles of supply and demand. The consumption change in one region, because of an introduction of congestion tolls, would most likely not make a noticeable change in demand for the whole market. If there would be changes it would be shown locally to the region. However, most brands sell cars for the same price through a whole country which means that the effect most likely would not be noticeable even in that case.

The expense of operating a vehicle would increase if tolls were introduced, based on that using a vehicle when tolls are introduced forces you to pay a toll or travel a longer alternative route which leads to higher fuel costs.

The expense of alternatives to owning a vehicle will probably not increase. Generally, when a product changes in price, the substitute follows. The substitute in this case is public transport which is owned for the most part by the Swedish government. This means that the goal for the substitute in this case is not to act for profit, resulting with the price for substitute not changing.

The utility gained from the alternatives might go down with an introduction of congestion tolls. According to Börjesson et al. (2012), the introduction of congestion tolls shifts people to public transport, which could make it more crowded, resulting in lower the comfort affecting the utility negatively. Increased number of travellers could lead to an increase of utility based on that an increase of travellers often leads to added routes and higher frequency for the public transport.

3.1 Hypothesis

The conceptual framework delineates the primary mechanisms where various variables could influence automobile sales. The following is the testable hypothesis from this discussion: According to theory the introduction of tolls in a region will lead to a reduced consumption of cars in that region in the short run. Given that automobiles are a durable good, the impact of a toll will perhaps manifest over a longer time span. However, in this thesis I'm interested in the short term effect.

I will test this hypothesis in my empirical analysis using a linear regression models with data for Sweden.

4. Data

The data type used for this research is panel data. This data combines cross-sectional data, multiple variables observed at a single time point and time-series data, involves observations of a subject across multiple time points. This allows for complex analyses showing variables influence on a dependent variable. Data used for this research is collected from the Swedish statistical authority (SCB)[1].

4.1 Description of variables

Table no.1 shows the variables used for the study along with a description, the mean, standard deviation, and min and max value of the variable. There are 5 variables, and the observations are from all 290 regions in Sweden. The observations are from every year from 2006 to 2022. This totals of 4930 observations per variable. These observations were collected during the same periods which ensured the compatibility for this study.

Table 1. Description of variables

VARIABLE	DESCRIPTION	MEAN	STD.DEV	MIN	MAX
Newly registered cars	The number of newly registered cars in the region	1115.962	3458.203	7	65668
Tolls	If the region has congestion tolls or not	0.005477	0.0738091	0	1
Educated	Number highly of educated in the region	4902.002	15683.45	134	272686
Average income	Average income in the region	256.3621	48.49858	169.5	639.3
Population	Population in the region	33761.9	68872.97	2375	984685

[1] https://www.scb.se/

Newly registered cars show a min value of 7 which means that a region during a year had 7 registered cars. With this the assumption is made that there have been 7 cars bought in one region for one year and that this is the smallest value recorded during the research. The max value is on the other hand 65668 which means that there is a big span of different values in this variable.

The tolls variable shows a min and max value 0 and 1 which means that a region can either have tolls or not. The average value is small because of the low number of regions that have introduced tolls.

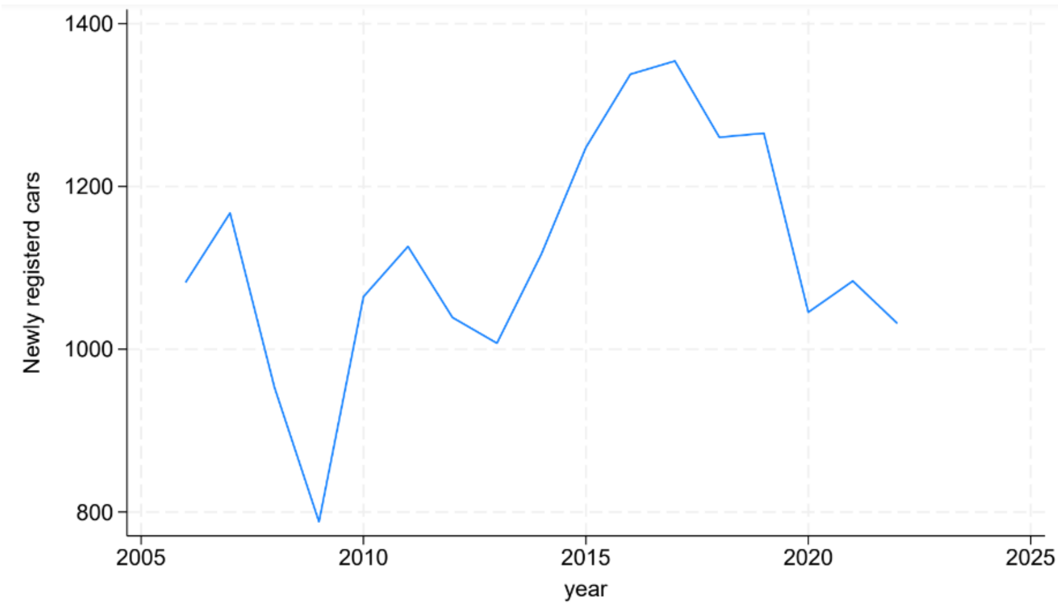
The variable Educated shows the results from all the number of educated people in regions during different years. The smallest amount is 134 people in one region for one year and the highest amount is 272686. The standard deviation is 15683,45 which is a relatively high number. This could be because of different population amounts in combination with differences in availability and importance of education in different regions.

The average income value shows the average income in a region for one year in SEK thousands. The lowest average income for a year is 169,5 and the highest is 639,3. The average number is 256,3621. The standard deviation of 48,49858 is small compared to the difference of the numbers. The mean is much closer to the lower value which indicates that there are a few regions that have a very high average income. The low standard deviations indicate that most of the regions have a fairly similar average income rate.

The population variable shows the amount of people for a specific year. The lowest population in a region during a year is 2375 and the highest is 984685. The average number is 33761,9 and the standard deviation is 68872,97. The mean is closer to the lowest number which indicates that there are a few regions that have a very large number of people. The standard deviation is compared to the min and max which indicates that regions differ a lot in population sizes.

4.2 Dependent variable

The dependent variable for this study is Newly registered cars. The amount of newly sold cars in a region could not be found for this study. However, a new car that someone buys in Sweden will get registered at their home address. This will therefore give a representation of the amount of newly consumed cars per region. Graph 1 shows the amount of newly registered cars per region in Sweden. The data for the variable is collected from the Swedish government statistical website (SCB 2024), which shows new registrations of passenger cars by region and type of fuel month 2006M01-2024M03. This data limited the study because of the few amounts of years it covered. If there had been data from earlier years, we would have had data from Stockholm before the implementation of tolls and thereby getting a more accurate result. The data for this variable was sorted by month and by what category of fuel they used. This compelled a calculation that implied a summation of the total number of newly registered cars total over a year for each year. The table below shows the average newly registered cars over time for regions in Sweden. As shown in the graph, the amount is changing frequently and does not show a sign of trend over time, therefore it is difficult to predict future values.



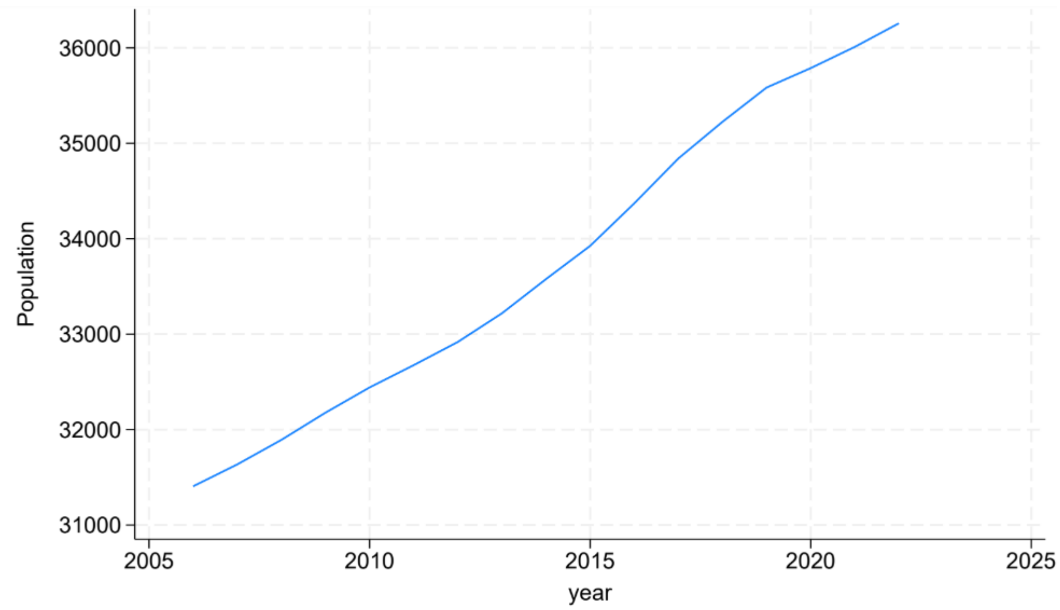
Graph 1. Mean of newly registered cars over time.

4.3 Explanatory variables

The explanatory variables in the model are tolls, education, average income and population. These variables are supposed to in a degree predict the dependent variable. These variables where chosen based on that they differ from region to region and have relations to the consumption of cars. Something that can change the consumption of cars for example is fuel prices. However, this does not differ significantly or at all from region to region and is therefore not used in this model. The chosen variables are viewed as important factors when predicting car consumption and consumption behaviour, combined with that they differ from region to region, they are chosen for these models.

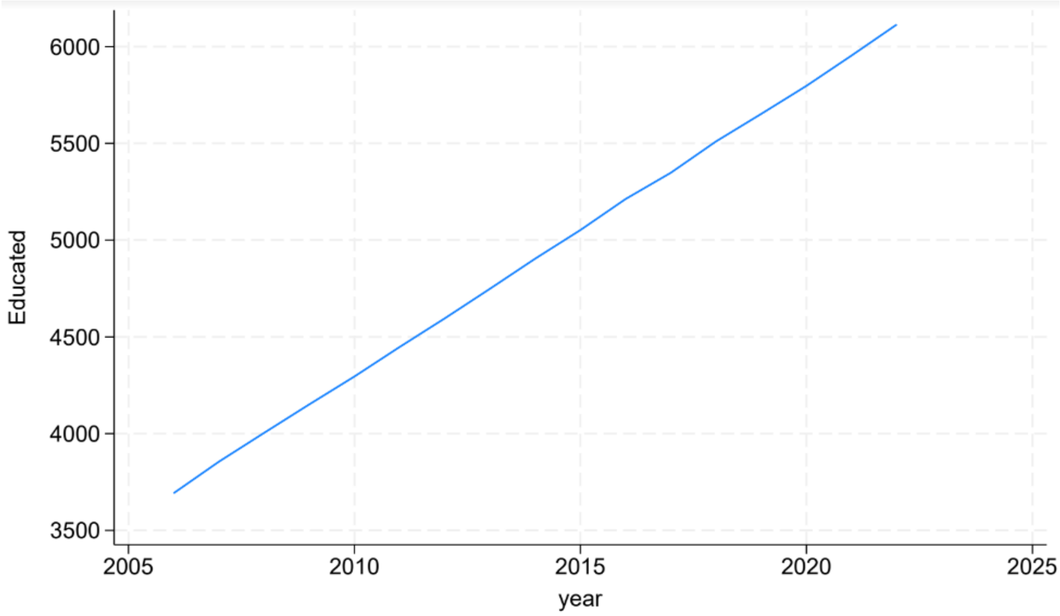
The population variable shows the amount of people in a region. Graph 2 shows the average population over time in a region. The variables data is collected from (SCB

2023). The graph shows a relatively steady increase over time. This could for example explain a steady change in the dependent variable. Shahabuddin (2009) explains that the population is a factor that can affect the amount of car sales, therefore it's also used as an impact factor in these models.



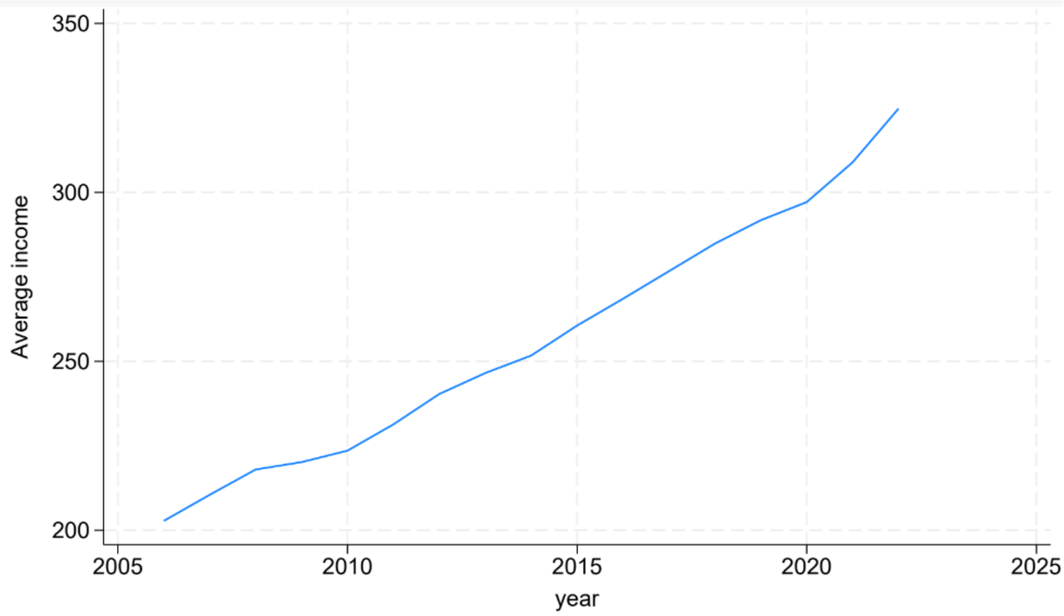
Graph 2. Mean of population over time.

The education variable shows the amount of highly educated people in the region. The definition for a highly educated person in this case is a person that has a three year or more university education. This variable is of importance based on that the level of education effects big parts of personal decisions. Areas with different amount of education might act and behave differently according to Michael, R. (1975) which makes this variable suitable for this study. The variables data is collected from (SCB 2023). Graph 3 shows the mean of educated per region over time.



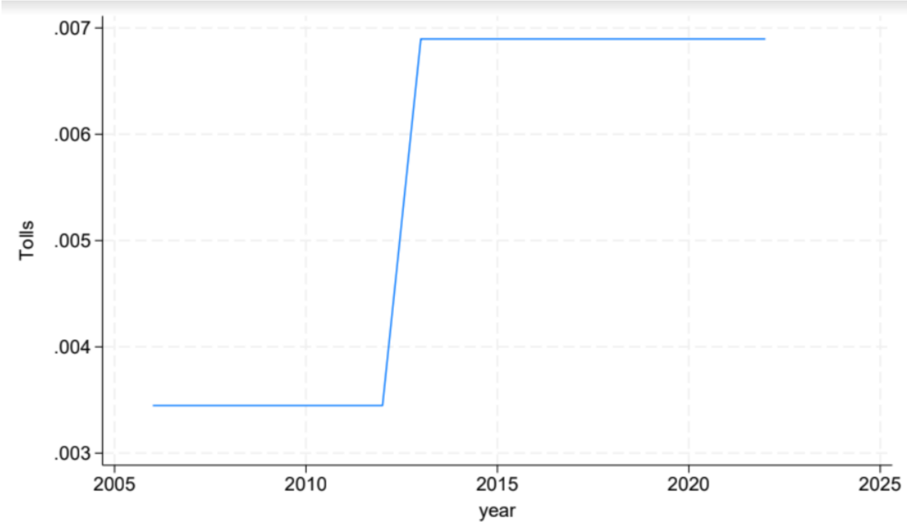
Graph 3. Mean of educated over time.

The average income variable shows the average income for every region. This variable is representing the effect of consumption power. This effect could potentially exist in this market based on that general consumption is highly affected by income. The wealth of a population could also change the effectiveness of congestion tolls within a region. A wealthier population could potentially lead to a bigger dampening effect, discussed in the theory. The variables data is collected from (SCB 2022). Graph 4 shows the mean of the average income overtime for the regions.



Graph 4. Mean of the average income over time.

The Tolls variable shows if a region has introduced congestion tolls. Tolls variable is a dummy variable. This means that if a region has introduced tolls, it will have the value 1 and if a region has not introduced tolls it will have the value 0. This value is supposed to make it possible to see the change congestion tolls have on car consumption in a region. Graph 5 shows how big part of the regions that has implemented tolls over time. Stockholm initially implemented tolls in 2006 as a trial. The tolls were later permanently established in 2007. The tolls were in effect during 6 months of 2006. This is a significant time so this study will include 2006 as a year Stockholm had congestion tolls. The big change in the curve 2013 is when Gothenburg introduced tolls. This sums up to two regions (Skatteverket, n.d.).



Graph 5. Part of the regions that has implemented tolls over time.

5. Empirical analysis

5.1 Method

This study seeks to test the following hypothesis: The introduction of tolls in a region will lead to a reduced consumption of cars in that region in the short run.

The observations are yearly for the period 2006 - 2022. The explanatory variable of interest is the dummy variable Tolls and the dependable variable Newly registered cars. The variable Newly registered cars had to be calculated from the data gathered from its source. The data were first sorted monthly and divided into multiple categories which necessitated a summation of the categories and the month during a year.

STATA was used to perform the linear regressions. Three regressions were conducted. One simple linear regression, one multiple linear regression and one multiple linear regression with robust standard error.

This methods will be able to test if there is a correlation between the main variable Newly registered cars and the explanatory variable Tolls. The methods also shows how trustworthy the correlation is based on the data provided, and it will also remove variables that could affect the outcome differently by adding multiple explanatory variables.

The simple variable linear regression is preformed to have a baseline regression that can demonstrate the basic dynamics between the two variables of interest. The multiple variables linear regression is preformed to see the impact of multiple variables that are affecting the outcome. The multiple variables linear regression with robust standard errors is to ensure that the result is reliable and valid by estimating the standard errors even when there is heteroscedasticity.

Using multiple regression with different complexity allows for a layered understanding. Every regression builds on the earlier one which leads to a deeper analysis.

The methods will however not test if there is a causality between the dependent variable Newly registered cars and the explanatory variable Tolls. The methods merely include the synchronization of the variable’s changes. An indication of causality would require us to estimate a cause-effect relationship, which is done by exogenously changing the cause and observing the effect. A correlation would for example not address the direction of causality. Since it’s not possible to control every confounding effect, the chosen method only estimates the correlating effect.

5.1.1 Regression equations

Presented below are the equations for the regressions performed. Y is the dependent variable, Newly registered cars. β_0 is a coefficient corresponding to the constant. $\beta_1, \dots, \beta_4$ are coefficients for the independent variables. $x_1, \dots, x_4$ represents the independent variables and ϵ is the error term for the equation.

Simple variable linear regression.

$$Y = \beta_0 + \beta_1 x + \epsilon$$

Multiple variable linear regression and Multiple variable linear regression with robust standard error.

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \epsilon$$

Independent variables

x_1 = Tolls

x_2 = Educated

x_3 = Average income

x_4 = Population

5.2 Result

Table 2 presents the results of the simple variable linear regression, multiple variable linear regression and multiple variable linear regression with robust standard error.

Table 2. Linear Regressions

VARIABLE	Single Variable Linear Regression	Multiple Variables Linear Regression	Multiple Variables Linear Regression with Robust Standard Errors
Tolls	37542.31***	-4435.858***	-3490.944 *
	(399.3222)	(1144.654)	(1869.193)
Educated		0.2119471***	0.2176566 ***
		(0.211661)	(0.0299814)
Average income		-9.919017 ***	-2.833906 ***
		(3.61472)	(0.4274322)
Population		0.2119471***	0.0027453
		(0.211661)	(0.0050209)
_cons		1819.897	701.9467 ***
		(1113.185)	(127.5245)
R-squared	0.642038338	0.9434	0.9436
Observations	4930	4930	4930

* is p values <10%, ** p value <5% and *** p-value <1%

The significance differed over the regressions and variables. The variables Educated and Average income was significant with a degree of 99% for all the regressions. The variable population was, according to the regressions, only significant in the multiple variables linear regression that did not include robust standard errors, 99% degree of significance. The constant does only have a significance in the multiple variable linear regression with robust standard errors, 99% degree of significance. The variable Tolls, which are the explanatory variable of most interest for this research, has a significance in every regression. The degree of significance is 99% for the simple variable linear regression and the multiple linear regression. The significance did however drop 90% in the multiple variable linear regression with robust standard error. This does not mean that it is not valid based on that there is still significance.

The regression that will be mostly considered when arguing the result is the multiple variables linear regression with robust standard error. This is based on that it will give the conclusion more robustness taking into account heteroskedasticity. When looking at the variable Tolls we can see that an implementation of tolls would lead to an increase in consumption of cars by 37542.31 cars according to the simple linear regression. The multiple variables linear regression shows a decrease of 4435.858 cars and the multiple variables linear regression with robust standard errors a decrease with 3490.944 cars. These changes are predictions based on the different methods when the Tolls variable goes from 0 to 1. The possible reasons for the big difference from the simple variable regression to the multiple variable's regressions will be discussed in the discussion section.

The result confirms the hypothesis by showing a negative correlation between the variable Tolls and the variable Consumption of cars. This means that an introduction of tolls in a region is followed with a decrease of the consumption of cars according to correlation.

The variable Educated had a similar result in the two multiple linear regressions. The confessions were 0.2119471 and 0.2176566. This means that an increase of one unit in Educated will result in an increase in cars with around 0.215 car units according to the regressions. The R-squared value was 0.6429 for the simple linear regression, 0.9434 for the multiple variable's linear regression and 0.9436 for the multiple variable's linear regression with robust standard error. The high number for the multiple linear regressions indicates that they are well suited and explains the dependent variable well.

6. Discussion

Following the execution of the regression analyses, it becomes evident that a few variables are significant and some lack relevance for the dependent variable.

The Tolls variable stayed significant through all the regressions but the coefficient changes a lot from the simple linear regression to the multiple linear regressions. This could be because of the big effect that other variables might have on the dependent variable. The result of the simple linear regression goes against the hypothesis that is based on the theory where it predicts that tolls have a negative effect on the car sales.

The variable Educated have significance in the multiple variable linear regressions and the coefficient are relatively similar. A positive correlation could be due to more people in larger cities are usually more often educated. This means that if the variable shows a large amount educated people it implies that it's probably a larger city which means that it's a chance that there is a larger consumption of cars. Due to this correlation, it is not possible to assume that the amount of education is the sole cause.

The variable Average income showed a high significance as well through both of the multiple variable linear regressions. The coefficients are however not similar but aims toward a negative correlation. This correlation at a first glance looks unreasonable based on that higher income usually leads to higher consumption. There is however a correlation that indicates that the salaries are usually larger in big cities which means that the result could be distorted. Big cities usually have better public transport which means that the need for a car in bigger cities are smaller in a lot of cases compared with small cities which would explain a negative correlation.

The variable Population has a correlation in the multiple linear regression model without robust standard errors but not in the one with robust standard error. This could be because the robust standard error removes heteroscedasticity. There is also a chance that there is an overlap with the Educated variable related to that the amount of educated also indicates in a way how large the cites are.

The R squared results increased from the simple variable linear regression to the multiple variables linear regressions. A likely factor for this is that there are more variables that can explain the dependent variable together. The multiple regression can also account for combined effects of different regressions which means that the regression would be more well suited for the dependent variable. The simple linear regression could with other words be too simple to capture the actual relationship with the variables.

There are certain points that could be discussed regarding the validity of the study’s results.

The regions that have congestion tolls implemented would get a dummy variable 1. This means that the regions that do not have an implementation will have a dummy variable 0. There are cases where regions that do not implement tolls would be affected by a region nearby that introduced tolls. These regions would still get the variable 0, which means that the variable will not be fully accurate. An example of this could be that people in regions near a region with tolls travel into the region with tolls for work. This would mean that the people perhaps would be affected by a toll even though it’s not implemented in the region where they register their cars.

There is also the fact that some people might travel for vacation to the cities with tolls which means that multiple regions could be affected differently by the tolls without being in the range of traveling for work. This effect is probably not to be taken too much of in consideration based on what’s discussed earlier, the expense of the tolls will be mostly noticeable if you have consistent traveling through the tolls.

The Result may be skewed, given that the cities with tolls are located in Sweden’s two largest regions, which are also home to Sweden’s most populous cities. The variables used in the research are supposed to counteract this effect, there of the result could still be of interest.

Another potential factor that could question the validity of this research could be that there are other road tolls implemented around Sweden that exist because of different reasons. For example, financing a large infrastructure project. Even though it’s not implemented for the same reasons it could perhaps have a similar effect. This is probably because these infrastructures are usually made to make a travel route faster which means that people still can travel their old route without an extra cost. This means that there would not be any incentives to go from traveling with car in that aspect. The new route with a fee could however make the public road network faster which means that there would be an incentive to go from car to public transport, the buses might take this new route that have a toll fee for example.

According to the result, an introduction of tolls in a region would decrease the number of cars sold. The result shows a decrease of 3490.944 cars if the dummy variable goes from 0 to 1, which means that a region goes from no congestion tolls to implementing congestion tolls. The standard deviation of 1869.193, indicates that the impact of an implementation can vary significantly depending on which region the tolls are implemented. The span of potential changes goes from -7155.396 to 173 with a conf. Interval of 95%. These values are rare results. A positive number according to the conf. Interval would thereby be unlikely. This big of a variance could be explained by a big change in populations over regions. Larger regions tend to have more traffic and small regions would thereby have a smaller change in terms of numbers of cars sold. It could also be explained through that the multiple variable regression model with robust standard error is not good enough for prediction.

The understanding of an introduction of congestion tolls could lead to a better prediction of a decrease in future car sales. This could help car dealerships to better predict sales in the region and thereby be able to hold a smaller stock within that region. The importance of this knowledge could be argued based on that some new car sales are orders from the factory directly.

Future research would certainly benefit if more cities introduced tolls. Being able to use more examples of cities with tolls would increase robustness and increase the generalizability. Malmö might introduce congestion tolls in the future which means that there will be data on another region with tolls soon. Therefore, this research should be done again in the future if a more precise result is of interest.

The methods used in this research do not predict the effects looking at different timestamps. Based on that a car is a good that is utilized during a long time, this would be interesting and might give different results over time. Metz (2018) showed that the congestion tolls had different changes over time in Stockholm and London. This indicated that it might be the same for the car consumption.

It would also be interesting to see what happens with the consumption of cars after an introduction of tolls in different time spans. The future will also open up for this opportunity based on that more sites will have had tolls for a longer time. This knowledge would also consolidate with the result in this article and widen the knowledge of congestion tolls.

7. Conclusion

The result shows a correlation between the introduction of tolls in a region and the consumption of cars in that region. These results can help new-car dealerships to predict potential decreases in the consumption of cars that are correlated with the introduction of congestion tolls. This result can also be considered in the future when discussing effects the of introduction of tolls. The findings do not prove a causality in the relation between the introduction of tolls and the consumption of cars, which means that it is yet to be proven by further research. The regressions should also be considered to be redone with inclusion of newer data when available to increase robustness. This result could possibly be counteracted with policies. Moreover, it is worth considering whether this result should be counteracted at all. This points towards the necessity for further research that discusses pros and cons of the result, and evaluates the overall welfare effect.

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