How effective has Irish Government policy been in reducing consumption of non-electric cars and incentivising the usage of electric cars; what happens next and what can the government do?

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Introduction

Introduction :

Aims:

- The SDG’S
- Define what is an electric car and what isn't
- Why we chose this project
- Why we are interested in it

Context: What is the problem?

Climate change means “a significant change in the measures of climate, such as temperature, rainfall, or wind, lasting for an extended period – decades or longer. The Earth's climate has changed many times during the planet's history, with events ranging from ice ages to long periods of warmth. What’s different about this period of the earth’s history is that human activities are significantly contributing to natural climate change through our emissions of greenhouse gases” (Environmental Protection Agency).

Greenhouse gas emissions are created by humans in many different forms and to save the planet, actions must be taken to reduce the harmful effects of them.

Context: why we choose this project

It is clear that the environmental crisis needs more attention. The United Nations states that achiveing the SDGs by their target date of 2030 may not be possible, due to a $2.3 trillion gap in annual funding. (Mohammed, 2019)

As economics students, this compelled us to research what can be done to close this gap. We wondered if there was anything the Irish government could do to reduce this problem, especially considering how badly Ireland preforms in regard to C02 emissions. (European Environmental Agency, 2011)

This prompted us to research the historical approaches taken by the government, and try and predict how consumption patterns will change in the future.

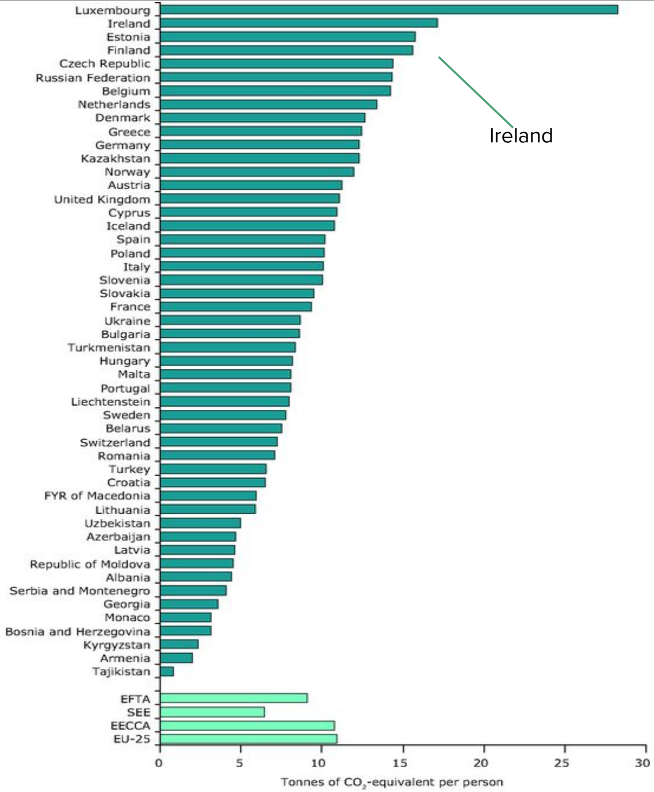


Photo source : European Environmental Agency

Why choose cars?

There are a few reasons why we choose to look at cars specifically:

1. There are more eco friendly options, such as electric cars that are a good alternative
2. They are easy to compare before and after, through looking at data patterns.
3. The transport sector contributes to 23% of Ireland's total emissions. It is second only to agriculture.

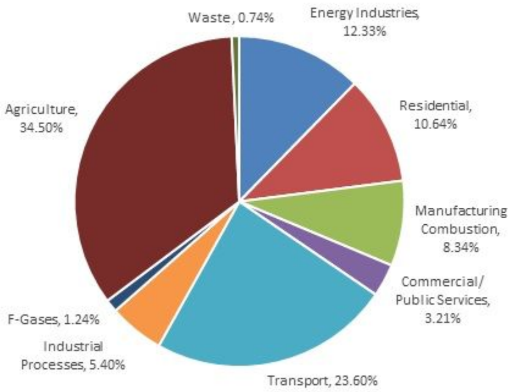
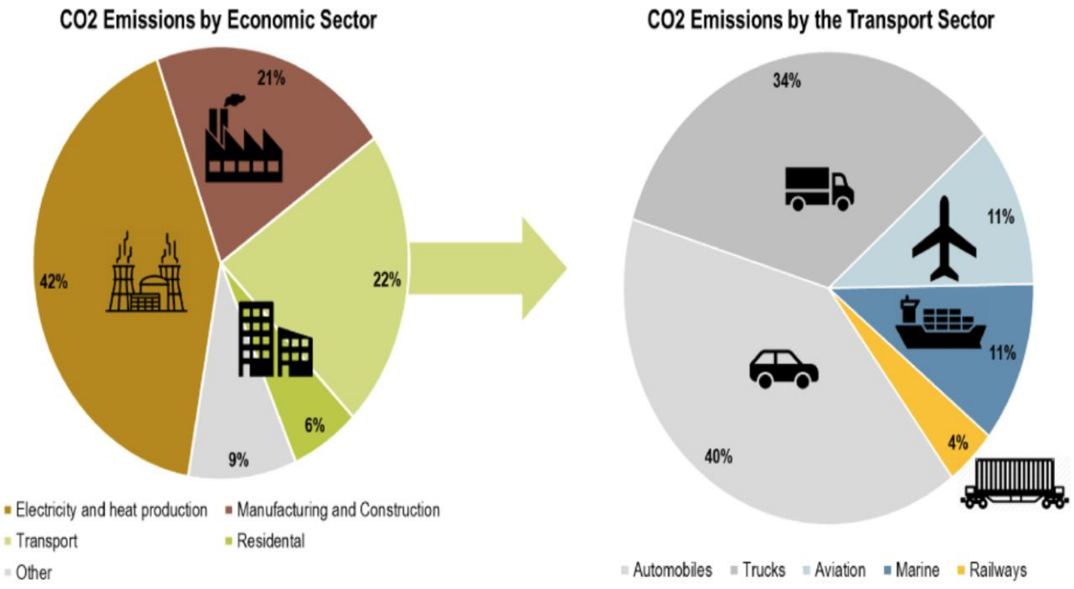


Photo from: Irish environmental protection agency, Jun 06 2019
(Environmental Protection Agency, 2020)

Context

As can be seen by the graph opposite, cars are a leading emitter of C02 gases. (Transport Geography, 2015)

Overuse of cars create large quantities of greenhouse gases and go against Sustainable Development Goals 11, 12 and 15.



Global Greenhouse Gas Emissions by the Transportation Sector

Context: definitions and assumptions

The type of vehicle we are analysing is passenger cars.

According to The Organisation for Economic Co-operation and Development, OECD (2013), a passenger car can be defined as:

“a road motor vehicle, other than a motorcycle, intended for the carriage of passengers and designed to seat no more than nine persons (including the driver)”

We will look at both electric, hybrid and non-electric or traditional engine cars(petrol and diesel). How we classified the different engines will be outlined in slide 27.

We also assume that the number of cars registered in a year equals the number of cars purchased in that year, although this may not necessarily reflect the true quantity demanded.

SDG 12-responsible production

Aim: promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all (United Nations).

How it relates to our project: it entails the responsible production of sustainable transport (i.e. electric cars) that are more energy efficient, sustainable and offer a better quality of life for all

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

SDG 11 sustainable cities

Aim: to make cities and human settlements safe, resilient and sustainable (United Nations).

How it relates to our project: One of the goals included under SDG 11 is sustainable transport, this would include the move to more sustainable cars and engines, as well as public transport.

SDG 15 life on land

Aim: To protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity (United Nations).

How it relates to our project: According to the Environmental Protection Agency, (EPA) transport accounted for 20.3% of Irish emissions in 2019. The move to more sustainable transport would help to reduce total emissions, positively affecting animal habitats and nature.

Historical analysis

What has the Irish government done?

Historical analysis

Ireland’s attempts to combat the harmful effects of non-electric cars have been ongoing since the Government agreed in the *Programme for Government 2007-2012* that ‘appropriate fiscal instruments, including a carbon levy, will be phased in on a revenue-neutral basis over the lifetime of this Government’ (Government of Ireland, 2007).

These financial instruments took two different approaches:

1. The disincentivization of using non-electric cars
2. The incentivisation of using electric cars.

We will analyse them both.

Disincentivization

In their Programme for Government, the coalition set out to:

‘[...]in the context of maintaining a strong economy, investigate fiscal measures to protect and enhance the environment including the introduction of a carbon tax.’ (Government of Ireland, 2007)

In 2010 they did so. In the 2010 Budget, a levy was placed on non-solid fuels of €15 per tonne. This includes all carbon-based fuels (coal, peat, kerosene and gas) This was then increased to €20 a tonne in the 2012 Budget, a 66% increase. The Carbon Tax was then introduced to solid fuels in May 2013 at a rate of €10 per tonne. In 2014 it rose to fall in line with other fuels (Money Guide Ireland, 2020)

Recent disincentivization

On May 1st 2020, the carbon tax on all fuels was increased to €26, a 30% increase. However, at this point the Climate Change Advisory Council recommended that the Carbon Tax should be increased to €35 per tonne in 2020. This shows how much increased taxation is required to internalise the negative externality of consumption created by carbon emissions.

Finally in Budget 2021, the Carbon Tax was increased by €7.50 a tonne to the current tax of €33.50 a tonne. The Government plans to increase the tax to €100 per tonne by 2030. It is worth remembering that throughout this process VAT continued to be charged as well as the Carbon Tax.

History of government policy timeline

Carbon Tax created at €15 per tonne
2010 Budget

Carbon tax increased to €20 per tonne on non-solid fuels
2012 Budget

All fuel, liquid and non liquid taxed at €20 a tonne
May 1st 2020

Carbon tax increased to €33.50 a tonne
Budget 2021

Incentivisation of the usage of electric vehicles

The aforementioned programme for government also laid out its intention to

- ‘[...]introduce measures to further weight VRT and motor tax in favour of cars with lower emissions.
- Continue to use the taxation system to encourage good environmental behaviour and discourage poor practice: for example, through rebalancing the VRT and Motor Tax system to reward the purchase of greener cars.’

These approaches show the Government attempting to make electric vehicles more popular by making them comparatively cheaper.

Further policies

Further policies that have been enacted include:

- Reduced motor tax for a battery electric vehicle of €120 per annum and typically €170 per annum for a Plug-in Hybrid Electric Vehicle;
- Accelerated Capital Allowance (ACA) Scheme for business purchases of electric vehicles and charging infrastructure where costs can be written down in the year of purchase rather than the standard eight-year period (under the Tax Consolidation Act);
- a grant of up to €12,500 to stimulate take-up of electric vehicles in the taxi /hackney/limousine sector (administered by the National Transport Authority);
- and Benefit-in-Kind rate of 0% which applies to staff provided with electric vehicles by their employers (under the Tax Consolidation Act).

In some local authorities parking has become free of charge for electric vehicles from 2019 on.

All these policies can be read about on the European Alternative Fuels Observatory (2019) website.

Irish incentivising policies

- In 2009, the Sustainable Energy Authority of Ireland (SEAI) offered grants of up to €5,000 for a Battery Electric Vehicle (BEV) or a Plug-in Hybrid Electric Vehicle (PHEV) purchased
- In 2016, the ESB began instillation of home charge points, public charge points and fast charge points throughout the country.
- In 2017, the Government introduced a wide range of policies to support and encourage the purchasing of electric vehicles (EVs). These included:
    - Electric Vehicle Home Charger Grant of up to €600 to support installation of home charger points for buyers of new and second-hand electric vehicles (administered by SEAI);
    - Electric Vehicle Public Charge Point Grant - local authorities can apply for funding to install charge points on public street or public car parks which provide overnight parking for local residents;
    - Relief on Vehicle Registration Tax (VRT) of up to €5,000 for new battery electric vehicles and up to €2,500 for plug-in hybrid electric vehicles (under the Tax Consolidation Act);

Evaluation

The joint effect of these policies were to discourage the usage of non-electric cars and at the same time, to encourage the usage of electric cars.

In the next part of our project we will researched data that will allow us to investigate whether or not these policies worked.

We will do this by analysing consumption patterns for both types of engine (electric and non-electric), and conclude which policies are most effective.

What effect do subsidies have:

While subsidies increase producer revenue, make certain goods affordable to more consumers, encourage production of a particular good and support growing industries, especially those that the government views as desirable for consumers there are also negative aspects.

It is a heavy burden sometimes on the Government's budget and can potentially result in opportunity cost and it can cause international disputes in circumstances where it upsets other countries' balance of trade (though this is not relevant in this example). (Tragakes, 2012)

What effect does taxation have:

Taxation is a source of government revenue and discourage the consumption of goods that the government views as having negative results for the society as a whole. This is clear in this example here, furthermore it improves the allocation of resources within the economy by correcting negative externalities.

It is controversial however as it further raises the cost of living for citizens of a country, and can worsen the distribution of income in a country if it is not a progressive tax. (Tragakes, 2011).

Data and Data collection

Table 1: All data 2007-2020

The table below contains all the number of cars, and their engine type registered in Ireland between 2007 and 2020. We decided to record data between these years as:

1. The data is current and relevant, without being inaccurate
2. The data takes into account what sales were like before the tax could have an impact (3 years before)
3. The data included statistics from before the economic crash of 2008.

The data can be found on the SIMI Motorstats website in the bibliography

Table 1: All data 2007-2020

Car type	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Diesel	38233	54556	68367	85662	102748	88813	70751	53944	59045	64025	56506	32679	52406	52432
Petrol	32600	47569	48405	40289	40642	33903	24252	19787	18562	23944	28120	23703	95216	132213
Petrol-electric	10474	10193	6927	4434	2566	1406	1001	581	634	552	736	292	1221	1067
Petrol electric hybrid	4013	3444	1233	622	392	466	221	49	138	46	18	5	6	0
Electric	2459	1343	729	323	286	116	35	0	0	0	0	0	0	0
Diesel-electric	512	1	0	1	4	93	0	1	1	1	0	0	0	0
Diesel electric hybrid	33	3	10	3	12	1	0	0	0	0	0	0	0	0
Other	0	3	0	0	0	9	24	2	1194	1350	3066	707	2760	0

What are the different engine types?

Diesel and petrol engine:

- Cars that run off diesel and petrol fuel alone.
- Considered the worst cars for the environment
- Most popular and accessible engines

Images from https://www.carkeys.co.uk/news/what-s-the-problem-with-diesel-engines and https://en.wikipedia.org/wiki/Toyota_Prius

Diesel-electric and petrol-electric

- Combination between traditional petrol or diesel engines, and electric batterie engines.
- They are “self charging”, in other words, they don't need to be plugged in like other electric vehicles.
- They consume less fuel and produce less co2 than a purely petrol or diesel engine. (Honest John)

What are the different engine types?

Diesel -electric hybrid and Petrol-electric hybrid

- Plug in hybrids
- Combination of electric and traditional engine
- They have a bigger battery, compared to the diesel-electric/petrol electric

https://www.topgear.com/car-reviews/kia/niro

Electric

- Cars that run solely on electricity, and have no exhaust or emissions.
- They are powered by an electric engine, that uses batteries.

https://www.irishtimes.com/life-and-style/motors/new-bmw-i3-the-best-electric-car-this-side-of-a-tesla-1.3002558

Table 2: Total electric vs non-electric car sales and electric car sales as a percent of total sales

The next table shows the total number of non-electric (pure petrol and diesel engines), electric or partially electric cars and the number of electric or partially electric cars as a percentage of total cars registered.

We decided to include all car engines that were “partially electric” (cars with an engine type that is fully electric, or a variation of a hybrid engine) together, as although they are not all fully electric they all work towards being cleaner alternatives to fully petrol and diesel cars. Throughout the project these are referred to as “electric”, for simplicity.

The non-electric (other cars) are made up of petrol and diesel cars. We again used SIMI as our source

Table 2: Total electric vs non-electric car sales and electric car sales as a percent of total sales

Car type:	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Total non-electric	70833	102128	116772	125951	143390	122725	95027	73733	78801	89319	87692	57089	150408	184645
Total electric/partially electric	17419	14984	8899	3260	2974	2082	1257	631	773	599	754	297	1227	1067
Total	88324	117109	125671	131334	146650	124807	96284	74363	79574	89918	88446	57466	151609	186546
Total electric as % of total	19.72%	12.79%	7.08%	2.48%	2.02%	1.66%	1.30%	0.84%	0.97%	0.66%	0.85%	0.51%	0.80%	0.57%

Please note: total electric refers to all hybrid cars + electric cars

Evaluation of source: table 1 and 2

We collected our data from SIMI (the Society of the Irish Motor Industry) motorstats.

They have a motor statistics database, created in conjunction with their used car website, beepbeep.ie. (https://stats.beepbeep.ie)

This database has all car registrations between 2007 and 2021, including make, model, engine type and energy efficiency.

Evaluation of source limitations: table 1 and 2

Although this source was very useful in providing us with the relevant information, it does have some limitations that must be outlined before our calculations:

1. We only have data going back to 2007, it would of been ideal to have more data as it would give us more accurate statistics, that are completely unaffected by the 2008 economic crisis
2. It gave the figures based on cars registered, this is not necessarily the cars sold, or the amount of cars on the road in the year though these are very similar statistics.
3. They do not specifically define what kind of vehicle is included in their statistics, this could mean that we are including small trucks in our calculations. This could skew our results, as larger vans are more likely to be non-electric in comparison to a passenger car.

Table 3: average price, in euros of electric and non-electric cars 2013-2020

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Non-electric	26844	26567	25651	23448	23669	24654	24750	25242	25646	26854	27786	28299	28975	33287
Electric	N/A	N/A	N/A	N/A	N/A	N/A	N/A	30595	23215	23215	26261	40540	33471	30890

Please note that there was no “partially electric” or hybrid figure for price, so only the price of fully electric cars is included

Source:

1. Non-electric figures and electric figures for 2019, 2018, 2017: “new car market profiling and RV/Hybrid predictions for 2020”, by john, published 24.4.19, accessed 15.2.20
2. Electric 2020, 2014,2015, 2016: SIMI price guide

Data collection: table 3

They method we used to collect data on electric cars was:

1. Try and find a source that has an average price figure
   a. This relates to years 2017, 2018, 2019.
2. For years that didn't have an average price figure, use the average price of the most popular electric car. In Ireland this is the nissan leaf, which is the most popular electric car of all time in Ireland (Money Guide Ireland, 2020). The table in the next slide highlights this
   a. This relates to figures in 2014, 2015, 2016, 2020.
3. The reason we used two different sources in our data collection was to ensure that the highest quality (an average price of electric cars in the year), was used for as many years as possible. Where this was not possible, we looked at the next best thing, the average price of the most popular model of electric car, to try and estimate an average value.

Table 3: data limitations/collection of data

Unfortunately, there is limited data available for electric cars. This is because:

- Electric cars were not very popular before 2014 as shown by the above data.
- The harmonised system (HS) code for electric cars was first used in 2017, so there were no import statistics separating car imports by engine type before then available from the Central Statistics Office.
- The Nissan Leaf (statistic for years 2014, 2015 and 2016) was first sold in Ireland in 2011, so there was no data from before this point.

Table 4: Average Income 2008-2020

Year	2020 (projection)	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
Average income (€)	41868	40283	38871	37646	36919	36519	35768	35830	36079	35906	36117	34184	33622

Please note no data was available in 2007

Source: https://www.cso.ie/en/statistics/earnings/earningsandlabourcosts/

Table 4: source limitations and data collection

The source we used for data on average incomes was the CSO.

They published the average income for the years 2010 to 2019. However, they had not yet published data for 2020 or 2007 to 2009, so we had to email them asking for this information.

To estimate an income figure for 2020 we:

1. Collected weekly earnings for the first three quarters
    a. This was the only available data
2. Added them together, and divided by 3 to find the average weekly earnings
3. Multiplied this figure by 52 to estimate yearly earnings

Income in Ireland from 2007 to 2020

The figures for the first two years were provided to us very kindly by the Central Statistics Office who also said that all information was not available for 2020, so the below figure is a calculated projection based off average *weekly* earnings for the first 3 quarters of 2020.

This graph shows that our estimate was relatively accurate, as it follows the natural curve of the graph.It is interesting to see that the 2020 figure was actually higher than the 2019 figure, or that there was an increase in average earnings in 2020.

However, we believe this was due to the majority of job losses being in more low skilled sectors and thus they were workers on lower incomes.

Market equilibrium of electric and non-electric cars

Why look at market equilibrium?

To show how well the disincentivization policies worked we will look at the market equilibrium for non-electric cars. We will analyses how the demand curve has shifted between 3 years before and 3 years after the policies were introduced.

To show how well the incentive policies have worked we will look at the market equilibrium for electric cars. We will analyse how the demand curve has shifted between 3 years before and 3 years after the policies were introduced.

How we represented the change in market equilibrium

To show the shift in demand for electric or partially electric cars, we used our data and applied it to graphs.

The graphs show a visual representation of the shift in demand in reaction to the nessures introduced by the government. However, they are not drawn to scale, and are only meant to be a loose visual representation of the change in demand.

We graphed this by analysing our data patterns, and applying them to the general market equilibrium graph. We also added a supply curve, to show the change in equilibrium position. However, this is also not drawn to scale, and does not accurately reflect the actual supply curve.

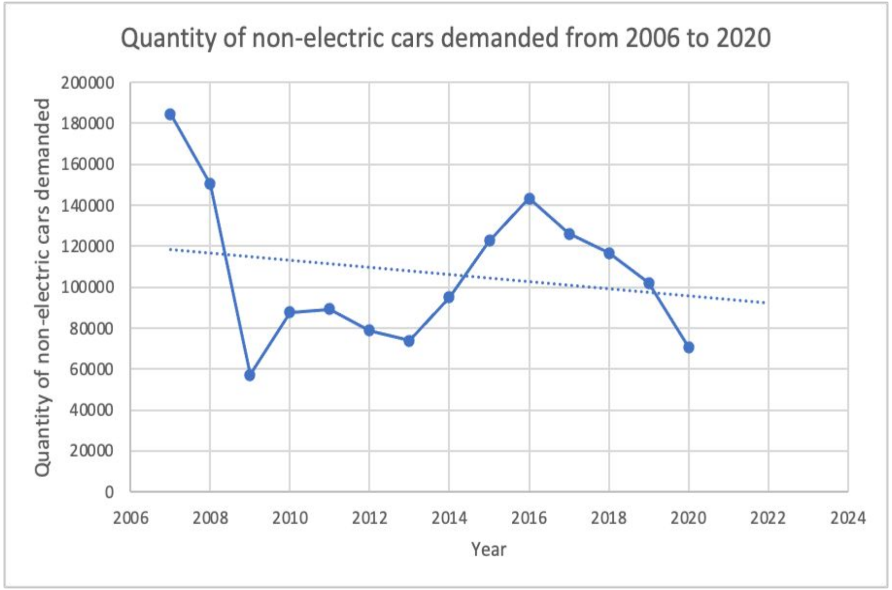
Quantity demanded of non-electric cars 2006-2020

Explanation of graph

This graph clearly shows that the demand for non-electric cars is falling.

Specifically, it dips in the years following the introduction of various government policies. For example, from 2016 to 2020 the demand is falling sharply.

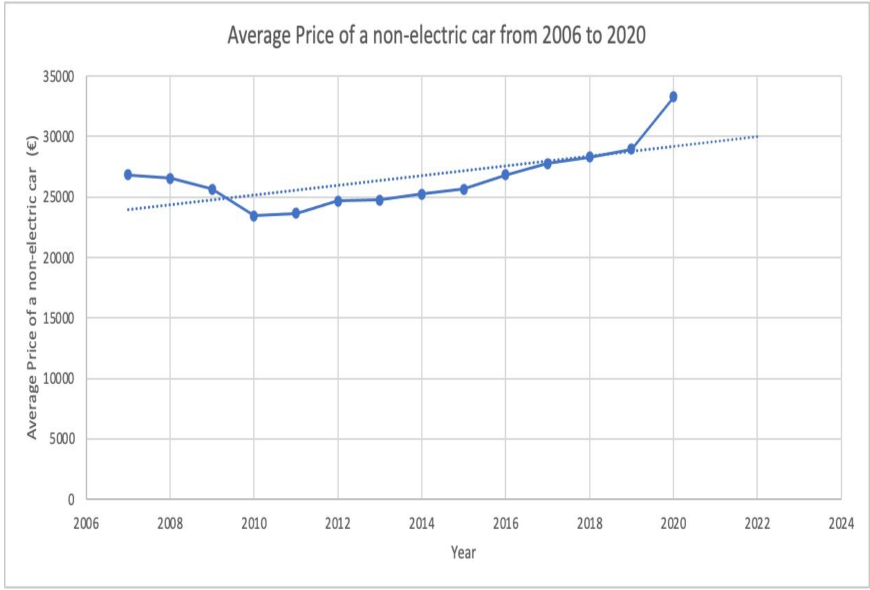
An interesting point to note is the change in demand in reaction to Ireland's general economic performance. For example from 2008 to 2009 the demand for non-electric cars fell dramatically. This can also be seen, although to a lesser extent, in 2020, with the demand falling more sharply than the previous years. This could be due to the economic uncertainty of the Covid-19 pandemic, or the various policies introduced by the government or both.



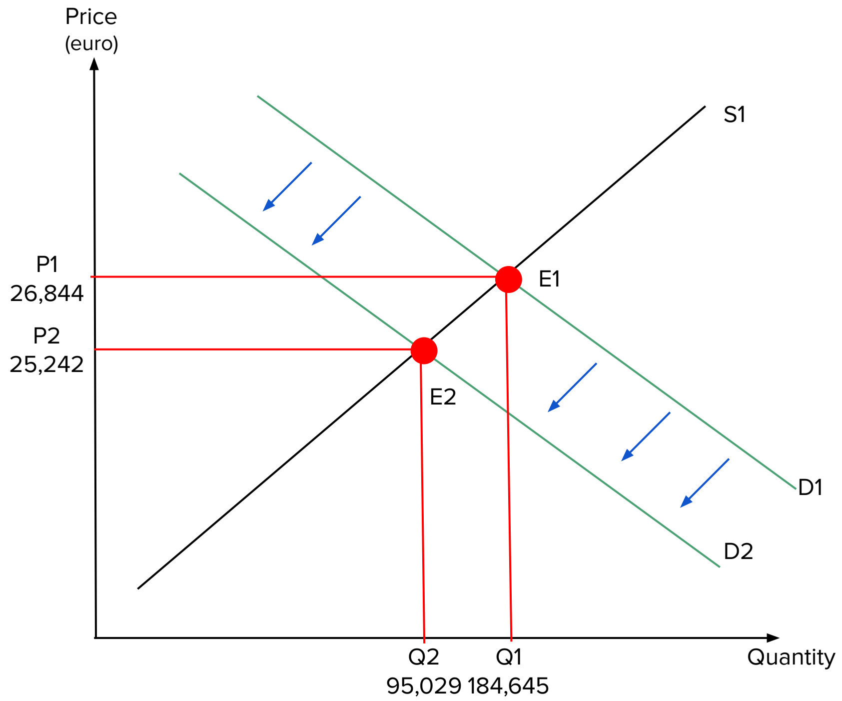
Non-electric cars trends: price

Explanation of graph

This graph show that the average price of a non-electric car is increasing. However, it is increasing, generally at a very slow rate. This can be seen through the dotted forecast line. Interestingly, the price fell from 2008, and only reached the same price again in 2015. This could indicate that the price fell in reaction to the environmental policies implemented in 2010. However, it could also be a result of the 2008 financial crash, or a combination of both.



Market equilibrium of non-electric cars 2007-2014



The graph shows that the demand curve for non-electric cars has shifted left, in reaction to the disincentive policies introduced by the government in 2010.

The amount of non-electric cars bought in 2014 is nearly half the amount bought in 2007.

This indicates that the disincentive policies worked, and less people bought non-electric cars.

Please note: graphs are not drawn to scale, and the supply curve and graph are for representation purposes only.

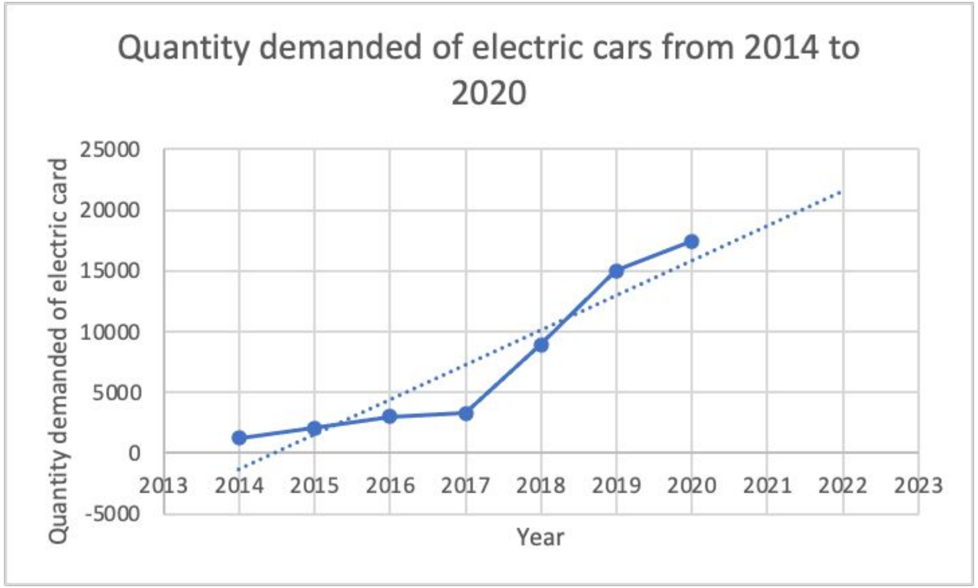
Quantity of electric cars demanded 2014-2020

Explanation:

This graph clearly shows the increase in quantity demanded for electric cars.

The forecast line also shows that the demand will continue to increase.

This graph indicates there has been a shift right in the demand curve for electric cars. This may be due to government regulations and incentive policies.



Average price in euros of an electric car 2014-2020

Explanation of graph:

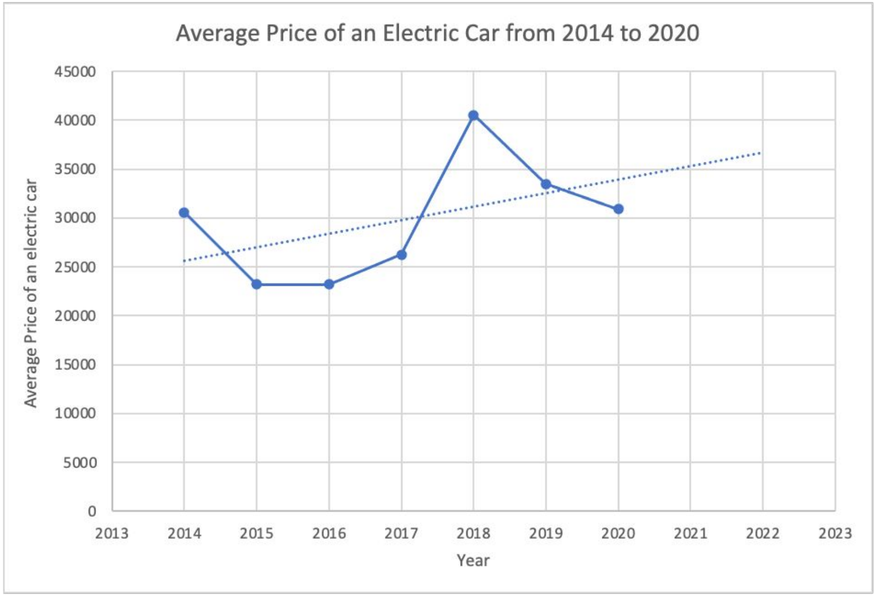
This graph shows the change in price of electric cars over the years.

In 2014 the average price began to decrease. This may be due to firms benefiting from economies of scale, as the demand increases, due to government insensitive isolation policies.

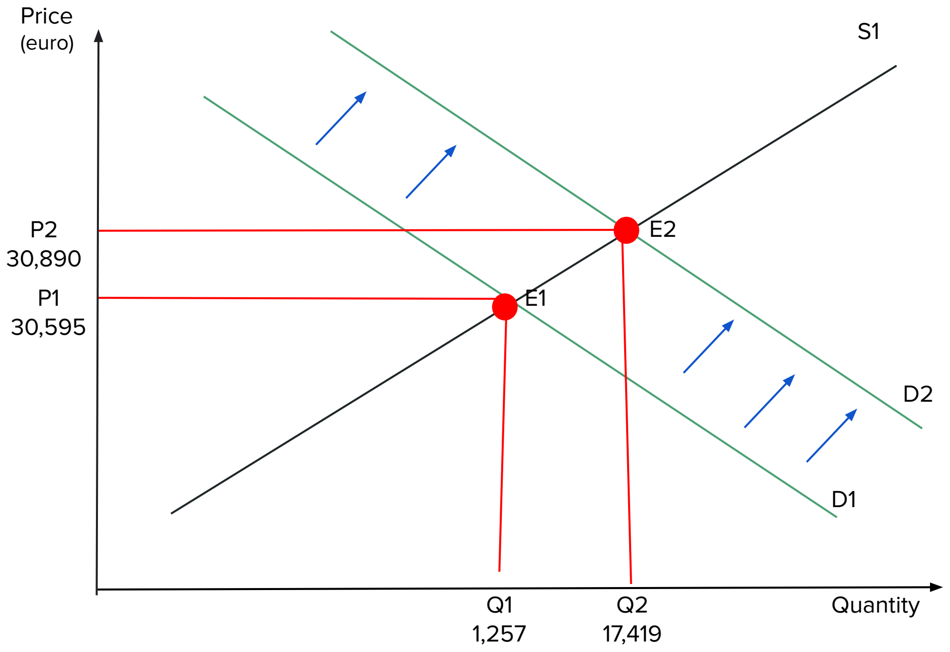
In 2018 there was a large increase in price. We hypothesize this is due to the addition of Tesla, a luxury brand electric car which would push up the electric car. However, it may also be due to limitations of our data.

This is important as it indicates the general upward trend in prices for electric car, as indicated by the forecast line (dotted line) created by Microsoft Excel.

It also shows that an increase in demand for electric cars causes an increase in price.



Graph of the shift in market equilibrium for electric cars 2014-2020



The diagram shows that between 2014 and 2020 there has been a shift right in the demand curve for electric cars.

The demand curve shifted right, moving the equilibrium position up to E2.

This indicates that the incentives introduced in 2017 caused an increase in demand for electric cars.

Please note: graphs are not drawn to scale, and the supply curve and graph are for representation purposes only.

Analysis

Both the incentive and disincentive policies implemented by the government achieved their aims.

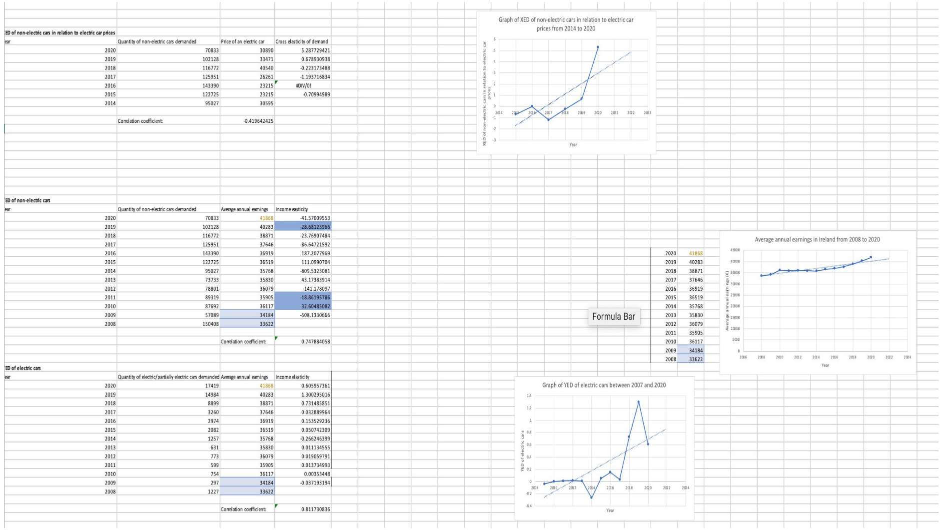
The disincentive policies caused the demand curve for non-electric cars to shift left, or lower the amount of consumption for them. The incentive policies caused the demand curve for electric cars to shift right, or increased consumption for them.

However, we want to know more about how these policies have affected consumption patterns. To do this we will analyse the elasticities of both types of car.

Elasticities of electric vs non-electric cars

Note on statistics

All data used in our spreadsheets, the graphs associated created by them and all formulae used to calculate our statistics can be found in the also attached Excel document entitled ‘yeoty numbers refined’.



ED of non-electric cars in relation to electric car prices

ear	Quantity of non-electric cars demanded	Price of an electric car	Cross elasticity of demand
2020	70833	30890	5.287729421
2019	102128	33471	0.678930938
2018	116772	40540	-0.223173488
2017	125951	26261	-1.193716834
2016	143390	23215	#DIV/0!
2015	122725	23215	-0.70994989
2014	95027	30595	
	Correlation coefficient:	-0.419642425	

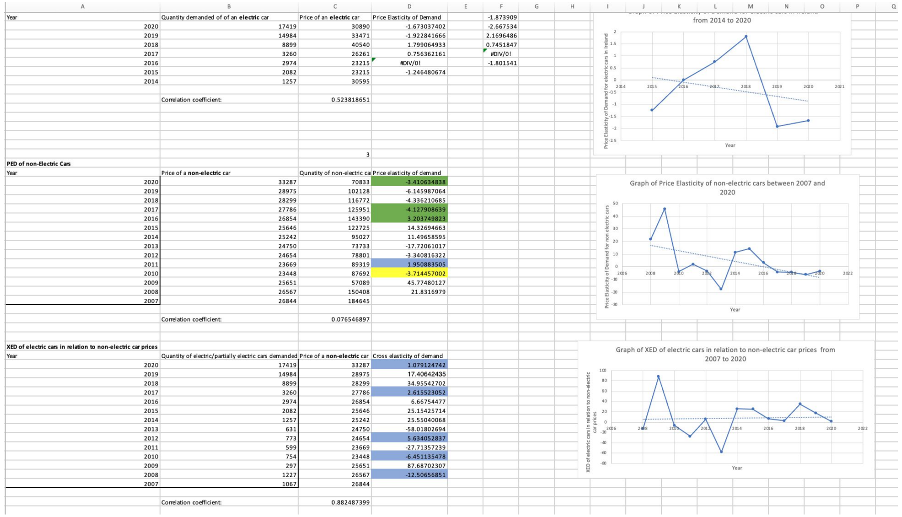
ED of non-electric cars

ear	Quantity of non-electric cars demanded	Average annual earnings	Income easticity
2020	70833	41868	-41.57009553
2019	102128	40283	-28.68123966
2018	116772	38871	-23.76907484
2017	125951	37646	-86.64721592
2016	143390	36919	187.2077969
2015	122725	36519	111.0990704
2014	95027	35768	-809.5323081
2013	73733	35830	43.17383914
2012	78801	36079	-141.178097
2011	89319	35905	-18.86195786
2010	87692	36117	32.60485082
2009	57089	34184	-508.1330666
2008	150408	33622	
		Correlation coefficient:	0.747884058

ED of electric cars

ear	Quantity of electric/partially electric cars demanded	Average annual earnings	Income elasticity
2020	17419	41868	0.605957361
2019	14984	40283	1.300295016
2018	8899	38871	0.731485851
2017	3260	37646	0.032889964
2016	2974	36919	0.153529236
2015	2082	36519	0.050742309
2014	1257	35768	-0.266246399
2013	631	35830	0.011134555
2012	773	36079	0.019059791
2011	599	35905	0.013734993
2010	754	36117	0.00353448
2009	297	34184	-0.037193194
2008	1227	33622	
		Correlation coefficient:	0.811730836

2020	41868
2019	40283
2018	38871
2017	37646
2016	36919
2015	36519
2014	35768
2013	35830
2012	36079
2011	35905
2010	36117
2009	34184
2008	33622



Year	Quantity demanded of of an **electric** car	Price of an **electric** car	Price Elasticity of Demand		
					-1.873909
2020	17419	30890	-1.673037402		-2.667534
2019	14984	33471	-1.922841666		2.1696486
2018	8899	40540	1.799064933		0.7451847
2017	3260	26261	0.756362161		#DIV/0!
2016	2974	23215	#DIV/0!		-1.801541
2015	2082	23215	-1.246480674		
2014	1257	30595			
	Correlation coefficient:	0.523818651			
		3			

PED of non-Electric Cars

Year	Price of a **non-electric** car	Qunatity of non-electric ca	Price elasticity of demand
2020	33287	70833	-3.410634838
2019	28975	102128	-6.145987064
2018	28299	116772	-4.336210685
2017	27786	125951	-4.127908639
2016	26854	143390	3.203749823
2015	25646	122725	14.32694663
2014	25242	95027	11.49658595
2013	24750	73733	-17.72061017
2012	24654	78801	-3.340816322
2011	23669	89319	1.950883505
2010	23448	87692	-3.714457002
2009	25651	57089	45.77480127
2008	26567	150408	21.8316979
2007	26844	184645	
	Correlation coefficient:	0.076546897	

XED of electric cars in relation to non-electric car prices

Year	Quantity of electric/partially electric cars demanded	Price of a **non-electric** car	Cross elasticity of demand
2020	17419	33287	1.079124742
2019	14984	28975	17.40642435
2018	8899	28299	34.95542702
2017	3260	27786	2.615523052
2016	2974	26854	6.66754477
2015	2082	25646	25.15425714
2014	1257	25242	25.55040068
2013	631	24750	-58.01802694
2012	773	24654	5.634052837
2011	599	23669	-27.71357239
2010	754	23448	-6.451135478
2009	297	25651	87.68702307
2008	1227	26567	-12.50656851
2007	1067	26844	
	Correlation coefficient:	0.882487399	

Why we look at elasticity:

In order to understand the intricacies of the change in consumption patterns we decided to look at three types of elasticity, and compare if and how the values have changed:

1. Price elasticity of demand
   a. We looked at PED to see if the price of the car type mattered and to determine what kind of good each engine type is.
2. Income elasticity of demand
   a. We look at YED to determine if income affects the consumption levels for different engine types.
3. Cross elasticity of demand
   a. We look at XED to see if the price of different types of car affect each other, in other words, if an increase in the cost of owning a non-electric car impacts the consumption of electric cars

The three elasticities will inform us on the change in consumption patterns in reaction to different policies, and help us predict what may happen in the future. We also hope to use our calculations to make recommendations to the government, regarding which policies work most effectively.

Why we only analyse certain years:

Throughout this section we choose to only analyses the elasticities of specific years. We did this for the following reasons:

1. To target the reaction of consumption patterns in response to specific policies implemented by the government
2. To allow for in depth analysis, this would of been impossible to do for every year, given the time we had to complete the project
3. To use the most accurate figures possible, or the ones we felt were not affected to badly by inaccuracies in our data.

How we calculated elasticities:

Due to the large amount of calculations needed, we used excel to calculate elasticity and graph the changes. The steps to do this were:

1. We collected all data on paper from different sources before inputting it into spreadsheets such as this one.
2. We put the columns adjacent
3. We calculated the following excel formula in order to replicate the economic formula we were using.
4. In this table for example, the formula to calculate PED, was the following: =(((B3:B8-B4:B9)/B3:B8)*100)/(((C3:C8-C4:C9)/C3:C8)*100)

PED of Electric Cars		
Year	Quantity demanded of of an **electric** car	Price of an **electric** car
2020	17419	30890
2019	14984	33471
2018	8899	40540
2017	3260	26261
2016	2974	23215
2015	2082	23215
2014	1257	30595

Correlation coefficients:

Throughout our analysis of Elasticities we also discussed the figures' Pearson's correlation coefficient results. Pearson's correlation coefficient, according to Laerd Statistics is a measure of the strength and direction of association that exists between two variables measured on at least an interval scale.

This would make it very useful to our investigation as it would be possible now to see how strong the correlation between two variables were and to see how much they impacted each other. The formula for a correlation coefficient is:

$$r = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{[\Sigma(x-\bar{x})^2(y-\bar{y})^2]}}$$

(Laerd Statistics, 2018)

However on Excel we were able to simply use the pre-written Excel function =PEARSON(array1,array2)

Correlation Coefficients:

Regardless of the nature of the relationship between income and demand for electric cars, be it positive or negative, the two goods are heavily linked from a statistical perspective. Pearson's correlation coefficient measures how strong the correlation and relationship between two variables are. As Heavelick and Peterson determined in their analysis: "the Pearson *r* is insensitive to rather extreme violations of the basic assumptions of normality" (Havlicek, 1976)making it very useful to this investigation.

Diana Mindrila, Ph.D, (2017) states that Pearson correlation coefficient results fall into the following categories:

$r < 0.3$ =None or very weak

$0.3 < r < 0.5$ = Weak

$0.5 < r < 0.7$ = Moderate

$r > 0.7$ = Strong

R-Squared Values

In addition to the correlation between variables, we will also analyse the R-Squared figures. As Jim Frost of Data Science Central (2017) writes:

“R-squared is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination, or the coefficient of multiple determination for multiple regression.

The definition of R-squared is fairly straight-forward; it is the percentage of the response variable variation that is explained by a linear model. Or:

R-squared = Explained variation / Total variation

R-squared is always between 0 and 100%:

- 0% indicates that the model explains none of the variability of the response data around its mean.
- 100% indicates that the model explains all the variability of the response data around its mean.

In general, the higher the R-squared, the better the model fits your data.”

Both easy to calculate, and useful for analysis, any time we calculate R, we will also calculate R-Squared.

How we graphed the elasticities:

In order to gain a deeper appreciation of the change in elasticities, we decided to graph the demand curves. This allowed us to visually see the change.

To graph PED we used the formula, $\frac{\Delta P}{\Delta Q}$,from coreecon.org to calculate the slope (M) of the line (Core Econ).

We then applied this slope to the general equation of the line: (Y-Y1)=M(X-X1)

Then using desmos graphing calculator (desmos.com), we graphed the demand curve for the various different elasticities.

For the other elasticities we altered the formula for the slope of the PED demand curve. We then followed the other steps to finding the equation of a line, and created the following formulas to find the slope: YED= $\frac{\Delta Y}{\Delta Q}$ XED= $\frac{\Delta PB}{\Delta QA}$

Price Elasticity of Demand (PED):

Aims:

- Background
- Calculations
- Analysis
- Graphs

Definition and formula

Definition: the percentage or proportionate change in demand caused by a change in price.

Formula: the percentage change in quantity divided by the percentage change in price

$$\frac{\%\ \Delta\ Q}{\%\ \Delta\ P}$$

Price elasticity of demand: background

- When PED is negative, it indicates that the good can be seen as a normal good, or a good that follows the law of demand. For this type of good, a percentage change in price causes a larger percentage change in demand.
- When PED is positive, it indicates that it is a veblen good, or a good that does not follow the law of demand. For this type of good, an increase in price will cause an increase in demand.
- When the PED has an absolute value greater than 1, it is considered elastic.
- When the PED has an absolute value less than 1, it is considered inelastic.

Calculations: non-electric

Year	Calculation	Result
2019/2020	$\frac{102128 - 70833}{70833} \Big/ \frac{28975 - 33287}{33287}$	-3.41
2016/2017	$\frac{143390 - 125951}{125951} \Big/ \frac{26854 - 27786}{27786}$	-4.13
2009/2010	$\frac{87692 - 57089}{57089} \Big/ \frac{23448 - 25651}{25651}$	-3.71

Analysis: non-electric

In 2009/2010 (before the introduction of the carbon tax) non-electric cars were highly elastic, and very sensitive to price change. They had a PED with an absolute value greater than one, and a negative PED. This means they were a normal good. A one percent increase in price causes a 3.41% decrease in demand. After the incentives made in 2017 the PED became even more elastic for non-electric cars. This suggests the incentives are working, as the price sensitivity is increasing.

In 2019/2020 the PED changed again. It is now slightly lower PED, but still very elastic. This may be due to the profit maximisation of inelastic goods, that will be discussed in the next slide.

The high PED may be due to the following factors:

1. They are considered luxury goods
2. People spend a high proportion of income on them
3. They very durable.

Year	Results:
2019/2020	-3.41
2016/2017	-4.13
2009/2010	-3.71

Graph of Non-electric cars PED for the years 2019/2020, 2016/2017, 2009/2010

2019/2020(red)

- PED= -3.41
- Equation: y-33287=-0.14(x-70833)

2016/2017 (blue)

- PED= -4.13
- Equation: y-125951=-0.05(x-27786)

2009/2010(green)

- PED=-3.71
- Equation: y-25651=-0.071=(x-57089)

Please note that the slope has been multiplied by 10 to show the change more clearly

Calculations of PED: electric

Years	Equation	Result
2019/2020	$\frac{14984 - 17419}{17419} \Big/ \frac{33471 - 30890}{30890}$	-1.67
2016/2017	$\frac{3260 - 2974}{2974} \Big/ \frac{26261 - 23215}{23215}$	0.76

Analysis: electric

In 2016/2017 (when the government introduced a number of incentivisation policies), the PED for electric cars was a positive value greater than one. This means that it was an inelastic good, that does not follow the law of demand, and as price increases so does demand. This suggests that the policies implemented by the government worked, and consumers were less price sensitive with electric cars. However, inelastic goods profit is maximised by an increase in price. In 2019/2020, the PED of electric cars has changed. It is now a normal good that follows the law of demand. This may be due to the general rise in price for electric cars, in response to it being an inelastic good in 2016/2017. This can be seen as a negative side effect of the government incentives.

Years	Results:
2019/2020	-1.67
2016/2017	0.76

Graph of electric cars PED for the years 2019/2020 and 2016/2017

2019/2020 (red line)

- PED = -1.67
- Equation:Y-30890=-1.05(X-17419)

2016/2017 (blue line)

- PED = 0.75
- Equation:Y-23215=10.7(X-3260)

Analysis: overall

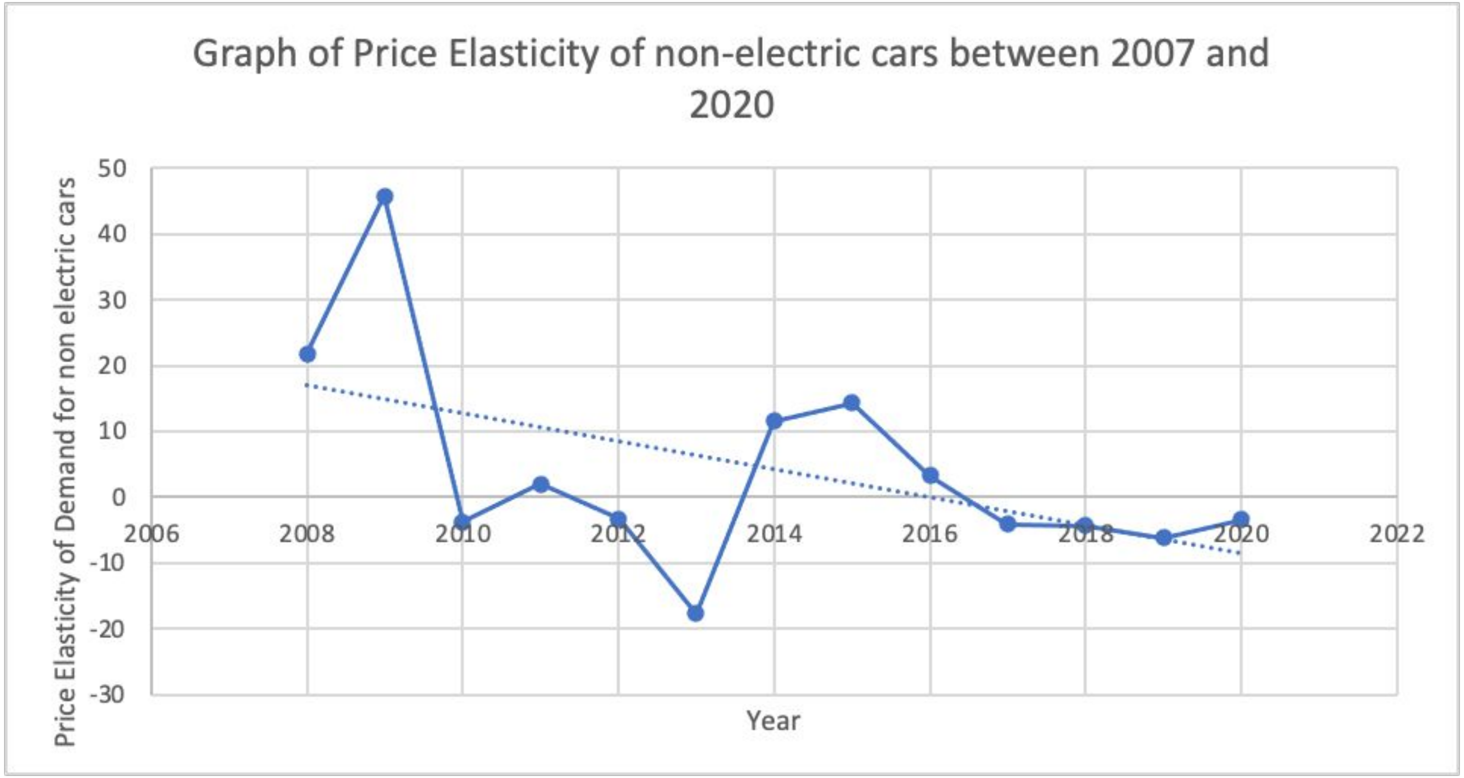
The PED results indicate that people are moving away from non-electric cars. A small price change is causing a larger change in demand for non-electric cars in comparison to electric cars.

This is especially true in 2017, when the demand for electric cars actually increases with price change, and non-electric cars were highly elastic and price sensitive.

This suggests that in incentivisation policies implemented worked.

Electric cars were less price sensitive than non-electric cars. This indicates that consumers were willing to buy electric cars even if the price increased, and they were less willing to buy non-electric cars that had a price increase.

Graph of PED: non-electric cars

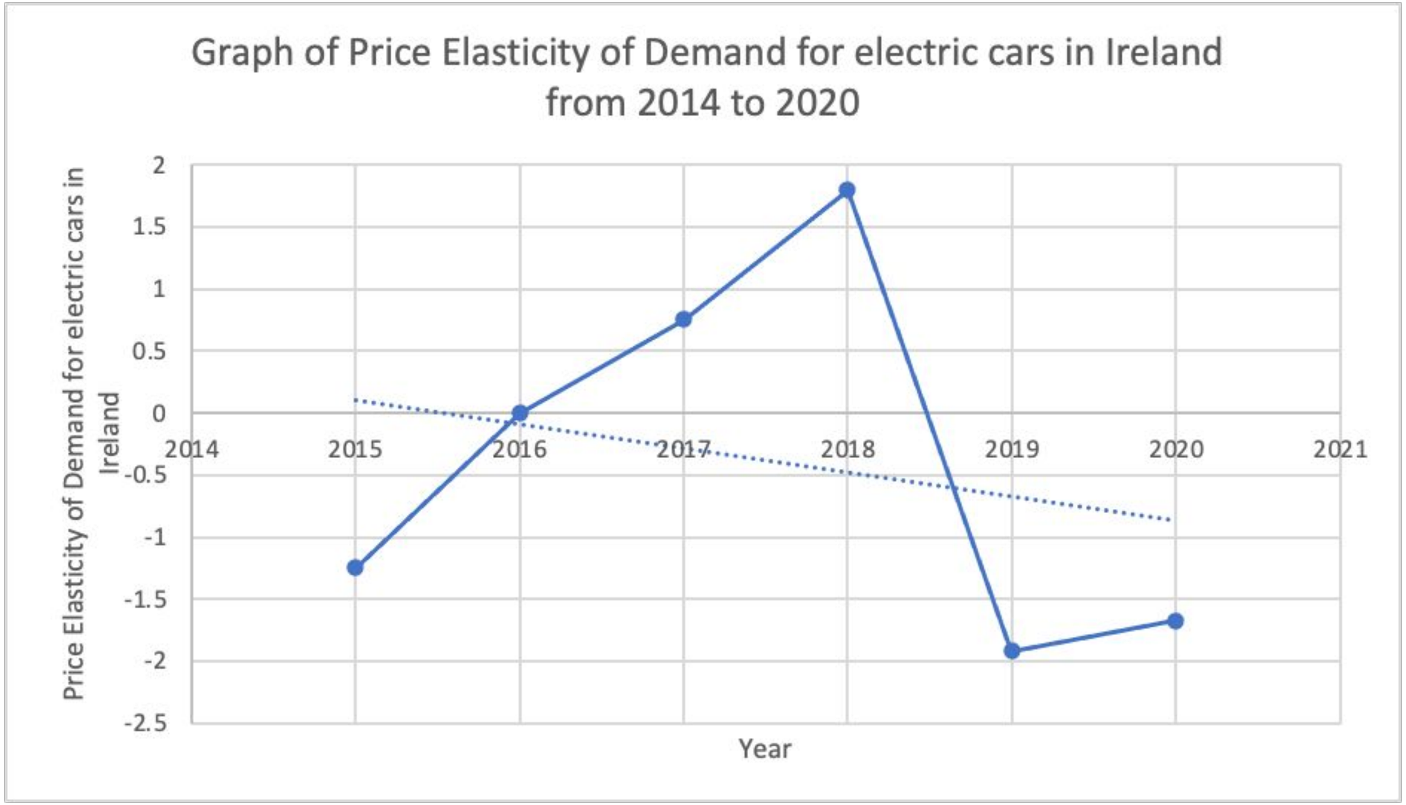


Analysis of graph

Although it has many fluctuations, the PED for non-electric cars has a general negative trend, with the line of best fit showing the PED to continue becoming more elastic. This shows that people are becoming more price sensitive in relation to non-electric cars as time goes on.

This suggests that the government policies introduced are working as the percentage change in demand caused by a change in price continues to increase.

Graph of PED : electric cars



Analysis of graph

The PED for electric cars is constantly decreasing. It is becoming more elastic. This can be seen with the line of best fit (dotted line) sloping down, in a general negative trend.

However, there was a sharp drop in elasticity in 2018. This was shortly after the introduction of a variety of incentivisation measures implemented by the government. This suggests that these incentives caused electric cars to become normal goods, that are bought by the general population.

The forecast line (dotted line) suggests the PED will continue to decrease.

Correlation coefficients of quantities demanded and price

Quantity demanded of non-electric cars and price:

R=0.076546897

R^2 = 0.00585942744

The correlation between price and demand for non-electric cars is very weak. This is potentially due to the movements in both variables taking place at different points for different reasons.

Quantity demanded of electric cars and price:

R=0.523818651

R^2= 0.27438598

The correlation between price and demand for electric cars is moderate. This means that they are relatively closely linked, and the price of an electric car matters to consumers. 27% of the variance in the quantity demanded was due to variance in price.

Income elasticity of demand(YED):

- Background
- Calculations
- Analysis
- Graphs

Definition and formula

Definition: the percentage or proportionate change in demand caused by a change in income

Formula:

$$\frac{\% \, \Delta \, Q}{\% \, \Delta \, Y}$$

Where Q refers to the quantity demanded and Y refers to income

Income elasticity of demand: background

- When YED is negative, it indicates that the good can be seen as an inferior good, and when people’s incomes increase they are likely to buy goods that are seen as superior.
- When YED is positive, it indicates that it is a normal good and demand for the good moves in the same direction as income
- If YED has an absolute value less than one it is income inelastic
- If YED has an absolute value greater than one it is income elastic

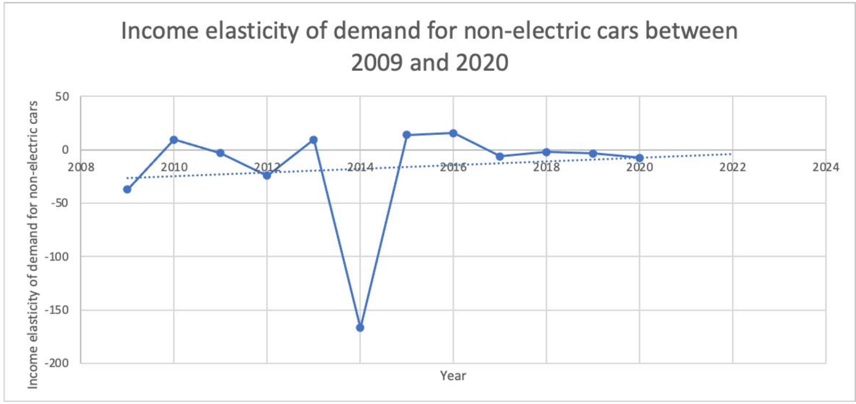
Why and how we removed the outlier:

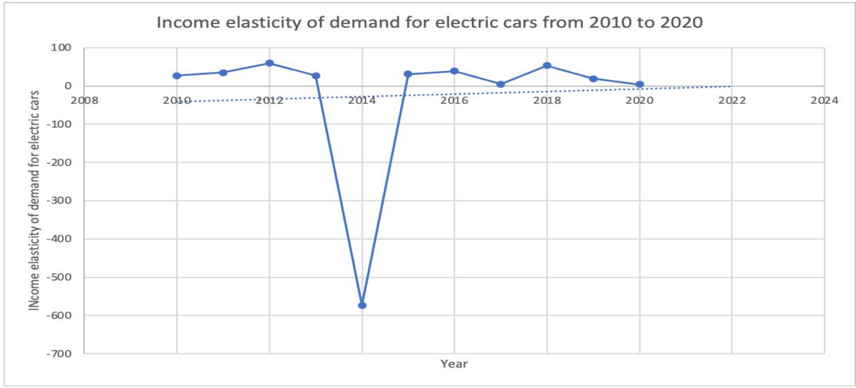
Something to note in this section is the outlier, 2014. As it was such a significant outlier, we ran Grubbs' statistical test which is used to determine if a figure is an outlier and should thus be removed (Glen, 2016).

It requires 4 steps.

1. Find the G test statistic.
2. Find the G Critical Value.
3. Compare the test statistic to the G critical value.
4. Reject the point as an outlier if the test statistic is greater than the critical value.

We used Excel to do this.





Grubbs' test

1). Finding the G test statistic is done with the following formula (Engineering Statistics Handbook):

$$G = \frac{Y_{max} - \bar{Y}}{S}$$

Where G is the G test statistic

Ymax is the number we suspect to be an outlier

$\bar{Y}$ is the average from the data set (in this case the range of income elasticities)

S is the standard deviation of the data set (again the range of income elasticities)

Grubbs' test

For non-electric YED the figure we suspected was an outlier was for 2014: -166.9

Thus we ran the figure through Excel with the equation laid out in steps. (Note that the absolute figure was required as the numerator).

$G = \frac{Y_{max} - \bar{Y}}{s}$	mean of the set found by using the '=average()' formula =
	-16.92318915
-166.8977431 - mean of the data set	
standard deviation of the data set	
	standard deviation of the data set found by using the '=stdev()' formula =
-166.8977431 - -16.92318915	49.65134562
standard deviation of the data set	
G = -166.8977431 - -16.92318915	
49.65134562	
G = 3.020553663	

Grubbs' test

2). Finding the G critical value

This is done by using an existing table with data regarding what the G critical value is with 95% confidence based off the amount of data in a data set. It can be found by the link http://www.sediment.uni-goettingen.de/staff/dunkl/software/pep-grubbs.pdf or can be done by hand using the equation:

$$\frac{(N-1)}{\sqrt{N}}\sqrt{\frac{\left(t_{al(2N),N-2}\right)^2}{N-2+\left(t_{al(2N),N-2}\right)^2}}$$

With the 12 data points we found it using the table.

Grubbs' test

N	0.1	0.075	0.05	0.025	0.01
3	1.15	1.15	1.15	1.15	1.15
4	1.42	1.44	1.46	1.48	1.49
5	1.6	1.64	1.67	1.71	1.75
6	1.73	1.77	1.82	1.89	1.94
7	1.83	1.88	1.94	2.02	2.1
8	1.91	1.96	2.03	2.13	2.22
9	1.98	2.04	2.11	2.21	2.32
10	2.03	2.1	2.18	2.29	2.41
11	2.09	2.14	2.23	2.36	2.48
12	2.13	2.2	2.29	2.41	2.55
13	2.17	2.24	2.33	2.46	2.61
14	2.21	2.28	2.37	2.51	2.66
15	2.25	2.32	2.41	2.55	2.71
16	2.28	2.35	2.44	2.59	2.75
17	2.31	2.38	2.47	2.62	2.79
18	2.34	2.41	2.5	2.65	2.82
19	2.36	2.44	2.53	2.68	2.85
20	2.38	2.46	2.56	2.71	2.88

G critical value can be found on the table

When there are 12 observations and 95% confidence

G critical value = 2.29

Grubbs' test

3). Compare the test statistic to the G critical value.

4). Reject the point as an outlier if the test statistic is greater than the critical value.

We compared the two and as the G test statistic = 3.020553663

And as the G critical value = 2.29

Because 3.02 > 2.29

The figure -166.8977431 for income elasticity of demand between 2013 and 2014 can be rejected and removed.

Grubbs' test

The same process was completed for the figure of -573.3239609 for YED between 2013 and 2014 for electric vehicles.

And as 3.29 > 2.29 that figure was also removed. All calculations can be found at the bottom of the attached Excel document.

With the statistical skew avoided, we created new graphs and analysed the revised data with added confidence.

Calculations: YED of non-electric cars

Years	calculation	result
2019/2020	$\frac{70833-102128}{102128} \Big/ \frac{41868-40283}{40283}$	-7.78
2016/2017	$\frac{125951-143390}{143390} \Big/ \frac{37646-36919}{36919}$	-6.17
2009/2010	$\frac{87692-57089}{57089} \Big/ \frac{36117-34184}{34184}$	9.47

Analysis of YED: non-electric cars

Before the introduction of the carbon tax, in 2010, eclectic cars had a YED of 9.47. This indicates that it was considered a normal good, with income and quantity demanded moving in the same direction. It also had an absolute value greater than one, showing that it was income elastic.

In 2016/ 2017, non-electric cars had a negative YED. this indicates they were considered inferior goods, and as income rose, demand for non-electric cars decreased. They also had a YED with an absolute value greater than one, showing the were income elastic. This trend continued in 2019/2020, with non-electric cars becoming increasingly income elastic, and remaining inferior goods.

Therefore it is possible to conclude that the policies introduced from 2010 onward are working to make non-electric cars less desirable.

A visual representation of this change can be seen on the next slide:

Year	Result
2019/2020	-7.78
2016/2017	-6.17
2009/2010	9.47

Graphs of YED non-electric cars for the years: 2019/2020, 2016/2017,2009/2010, 2008/2009

2019/2020: red line

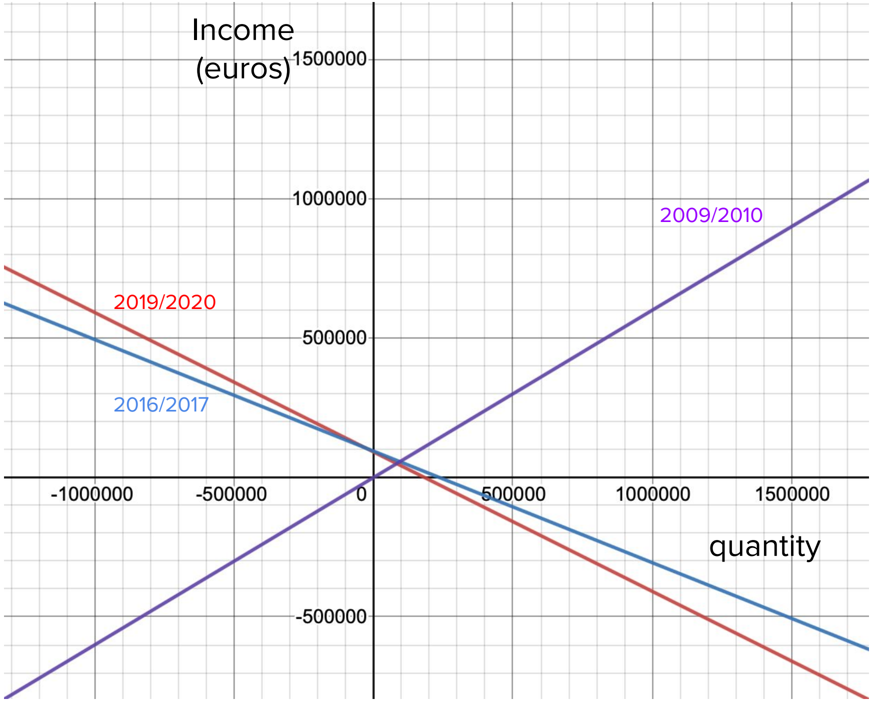
- YED: -7.78
- Equation: y-40283=-0.5(x-102128)

2016/2017: blue line

- YED: -6.17
- Equation: y-36919=-0.4(x-143390)

2009/2010: purple line

- YED: 9.47
- Equation: y-34184=0.6(x-57089)



Please note that the slope has been multiplied by 10 to show the change more clearly

Calculations: YED of electric cars

years	Calculation	Results
2019/2020	$\frac{17419-14984}{14984} / \frac{41868-40283}{40283}$	4.13
2016/2017	$\frac{3260-2974}{2974} / \frac{37646-36919}{36919}$	4.88
2009/2010	$\frac{754-279}{279} / \frac{36117-34184}{34184}$	27.21
2008/2009	$\frac{297-1227}{1227} / \frac{34184-33622}{33622}$	-45.34

Analysis of YED: electric cars

Before any policies were introduced electric cars had a negative YED with an absolute value greater than 1. This shows that demand for them moved in the opposite direction to income, they were income elastic and highly sensitive to changes in income and that they were considered inferior goods.

This has changed with the introduction of several government policies, this has changed.

This change can be seen in 2009/2010, when the YED changed to a positive value, indicating it is no longer an inferior good. During these years they were highly sensitive to changes in income. Electric cars have continued to remain normal goods, however, their YED is decreasing.

A visual representation of this change can be seen on the next slide

Years	Result
2019/2020	4.13
2016/2017	4.88
2009/2010	27.21
2008/2009	-45.34

Graph of YED electric cars for the years: 2019/2020, 2016/2017,2009/2010, 2008/2009

2019/2020 Red line

- YED: 4.13
- Equation:Y-40283=0.65(X-1498)

2016/2017: Blue line

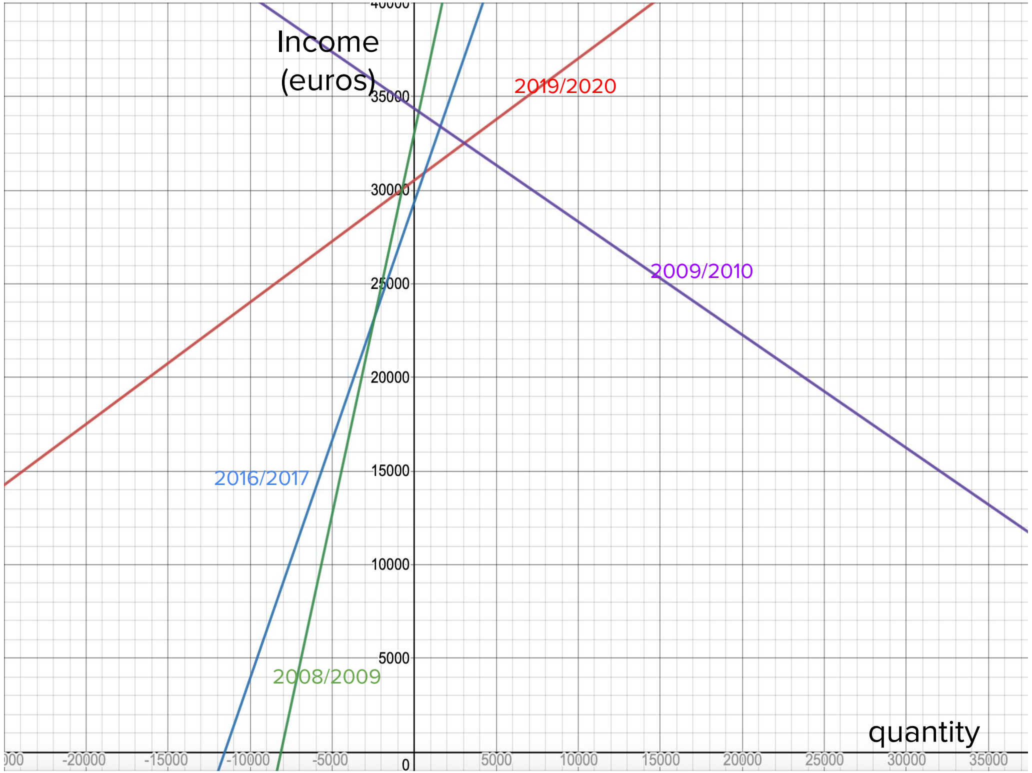
- YED: 4.88
- Equation Y-36919=2.54(X-2974)

2009/2010:Green line

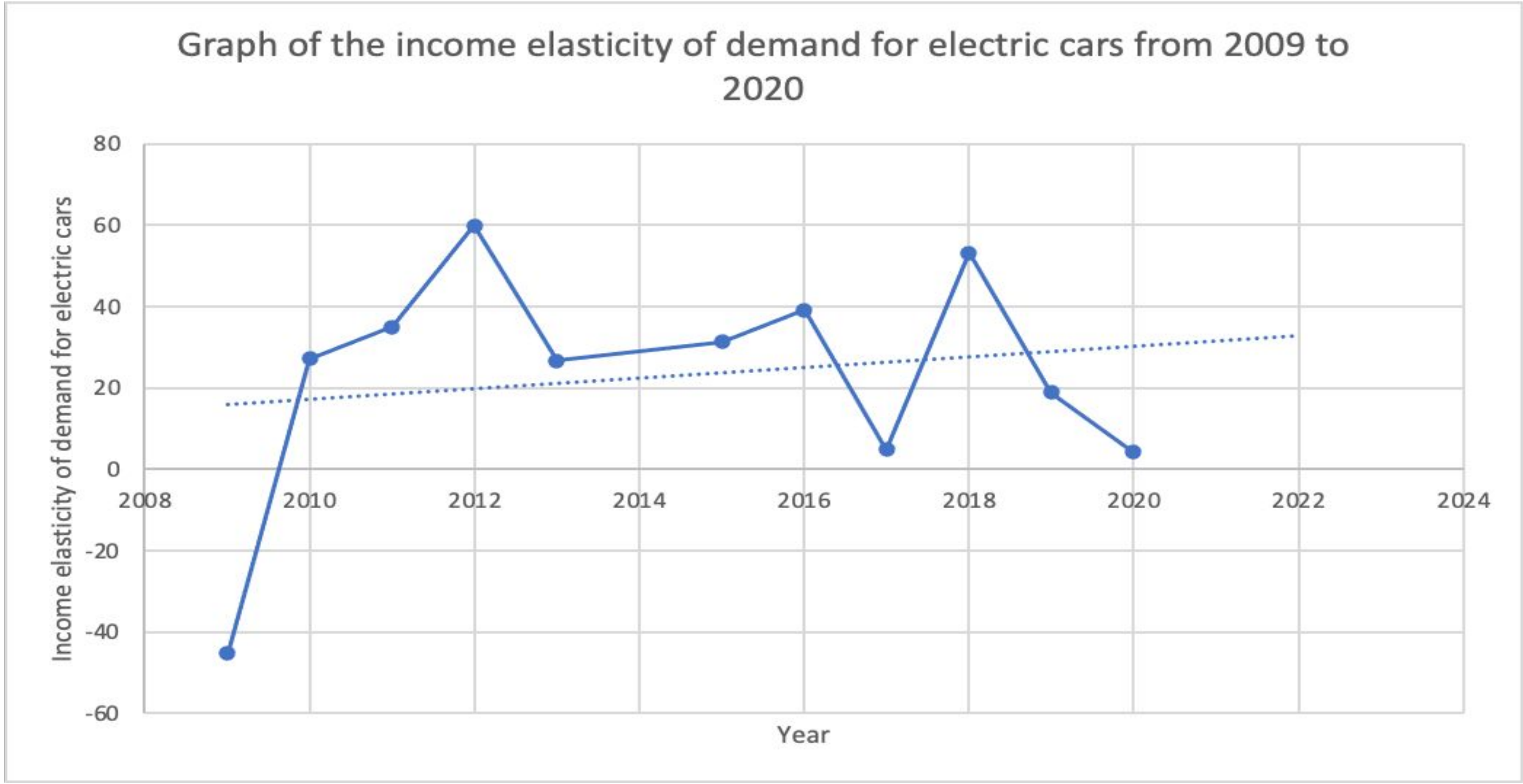
- YED: 27.21
- Equation: Y-34184=4.07(X-279)

2008/2009: Purple line

- YED: -45.34
- Equation: Y-33622=-0.6(X-1227)



Revised Graph of electric cars YED overtime



Analysis of Graph of electric cars YED overtime

As you can see form the graph in the previous slide, the YED has changed dramatically over the last number of years.

Before the government began introducing policies, electric cars were seen as inferior goods. However, as soon as they began encouraging people to buy them, they have become normal goods. This shows that the government policies are working.

Further, the dotted forecast line shows that electric cars will continue to remain normal goods, that are sensitive to income increases.

It may also indicate that in order to increase consumption of electric cars the government should introduce policies that increase consumers income, such as grants.

Correlation

Quantity of electric cars and income:

R= 0.926605865

R^2 = 0.8585984291

There is a very strong correlation of 0.92. This indicates that there is a 'very strong' relationship between annual earnings and the quantity demanded of non-electric cars and that 85% of the variance in the quantity of electric cars being bought is due to the variance in come.

This definitely of note and is the highest of the figures we calculated. With purchases of electric cars being so linked to income the government can design policy around this fact to encourage the buying of more

Quantity of non-electric cars and income:

R=0.747884058
R^2 = 0.5593305642

There is a very strong relationship between annual earnings and quantity of electric cars demanded, with 55% of the variance in Qd of non-electric cars being due to variance in income.

Electric cars have a stronger correlation with income than non-electric cars, suggesting that higher incomes lead to increased consumption for electric cars and confirming the effect of non-electric cars owning a larger market share than electric cars, making them less responsive to other factors.

Cross Elasticity of Demand (XED):

Aims:

- Background
- Calculations
- Analysis
- Graphs

Definition and formula

Definition : the percentage or proportionate change in demand caused by the percentage or proportionate change in demand for another good

Formula:

$$\frac{\%\ \Delta\ Qa}{\%\ \Delta\ Pb}$$

Where Qa is the quantity demanded of one good, and Pb is the price of the second good.

Why we chose to analyse XED

As it displays to what extent movements in the price of one good can impact the other, the goal of increased usage of electric cars will rely to some extent on how much the price of a non-electric car grows. A weakness of our data is that it displays the average price of a non-electric car, but legislation put in place mainly relates to that of *running* the car i.e. through fuel taxes.

Regardless, the XED data will show us the direct impact of the average price of a non-electric motor.

Background

When the calculated figure for XED is positive the goods can be described as substitutes, the higher the figure, the closer they are as substitutes. When it is negative the goods can be regarded as complementary goods, that tend to be bought together.

Thus, it would be in the government’s interest then to have the non-electric cars especially be substitute goods, as they are looking for decreased consumption of non-electric cars and this can be achieved through the switching out of

Calculations: XED of electric motors in relation to non-electric motors

Years	Calculation	Result
2019/2020	$\frac{17419 - 14984}{14984} \Big/ \frac{33287 - 28975}{28975}$	1.08
2013/2014	$\frac{1257 - 631}{631} \Big/ \frac{25242 - 24750}{24750}$	25.55
2008/2009	$\frac{297 - 1227}{1227} \Big/ \frac{25651 - 26567}{26567}$	87.69

Analysis: XED of electric motors in relation to the price of non-electric motors

As can be seen in the figures we calculated and in the graph of XED over time on the next slide, the figures were often erratic and frequently fell out of a normal range of figures for XED. This is potentially due to the limited sample of data regarding the quantity of electric cars that were bought before the large increase in 2017.

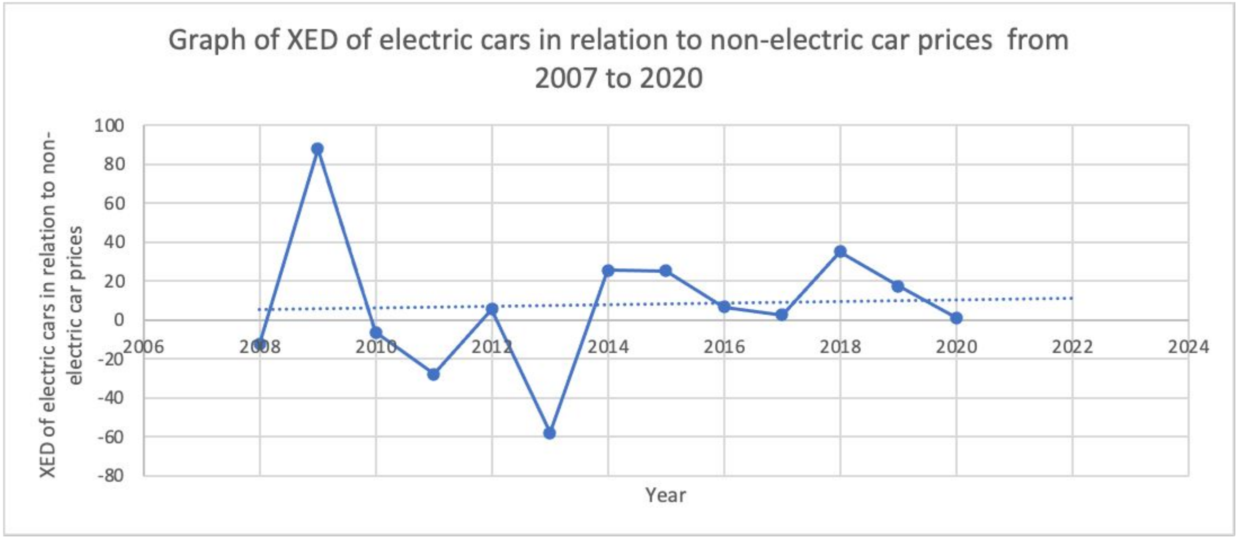
However it is still possible to come to some conclusions. While the figures make it difficult to say whether or not increasing the price of non-electric motors with a carbon tax was effective in 2010, XED has on the whole began to attain more normal figures after the tax was increased and at the same time demand for electric cars grew. The 2008/2009 figure displays how difficult it is to come to a reasonable conclusion with these figures.

The figure of 1.08 for 2020 however is a good sign that the tax is working as planned on non-electric motors and the figure 1.08 indicates that the two goods are now more likely to be seen as substitutes, a view the government wants to encourage to increase their usage by the public.

The next XED analysing electric motors will tell us whether the subsidy policy has done a better job of creating a substitution effect than non-electric motors if it has an XED figure above 1.08

Year	Result
2019/2020	1.08
2013/2014	25.55
2008/2009	87.69

Graph of XED over time



As can be seen, it is difficult to come to a conclusion when faced with data as sporadic as this, though for the most part they have remained substitute goods and the Microsoft Excel-generated forecast suggests that this will increase over time good news for the government, though 1.08 is a moderate XED rating.

Graph of the XED of electric cars in relation to the price of non-electric cars, for the years:2019/2020, 2013/2014, 2008/2009

2019/2020: red

- XED: 1.08
- Equation: y-28975=1.7(x-14984)

2013/2014: blue

- XED: 25.55
- Equation:y-24750=0.78(x-631)

2008/2009: green

- XED: 87.69
- Equation: y-26567=0.98(x-1227)

Calculations - XED of non-electric cars in relation to electric car prices

Year	Calculation	Result
2019/2020	$\frac{70833 - 102128}{102128} \Big/ \frac{30890 - 33471}{33471}$	5.29
2018/2019	$\frac{102128 - 116772}{116772} \Big/ \frac{33471 - 40540}{40540}$	0.68
2017/2018	$\frac{116772 - 125951}{125951} \Big/ \frac{40540 - 26261}{26261}$	-0.22

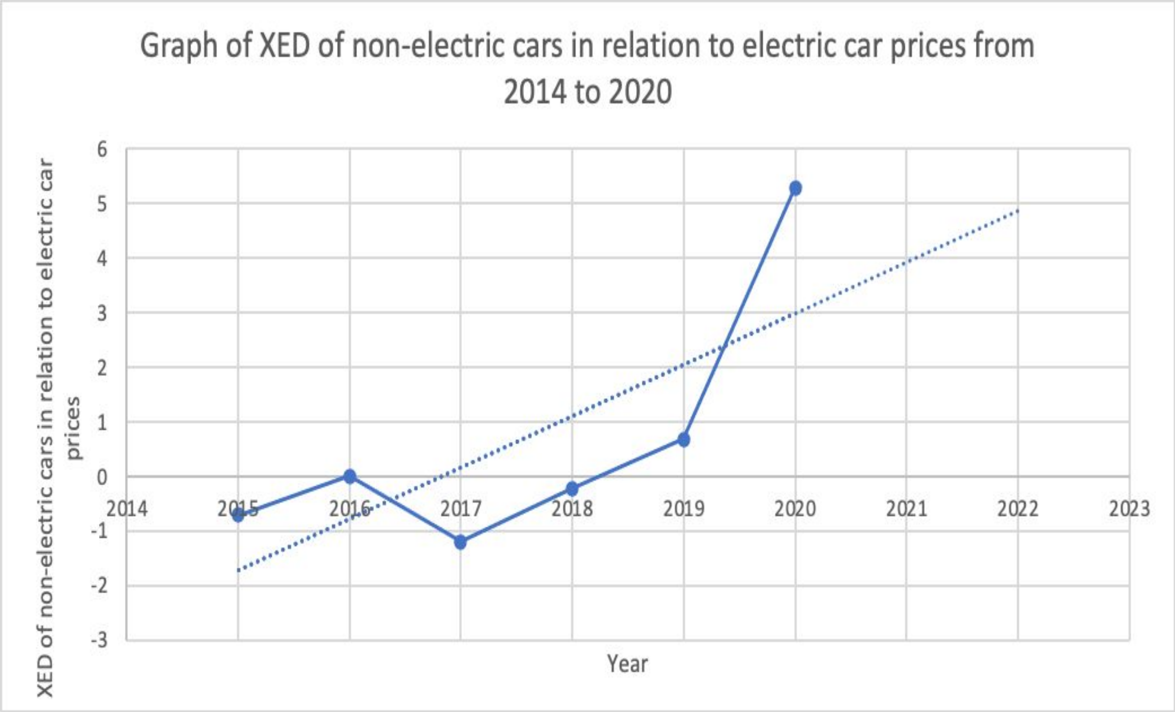
Analysis: XED of non-electric motors in relation to the price of electric motors

As the three most recent years display and the graph of XED over time will attest to, there has been a consistent exponential increase of XED over the last few years. This is very good news to the government who will look to capitalise on this. As XED is very high, a slight decrease in the price of electric motors will lead to a disproportionately higher decrease in the purchasing of non-electric motors, a goal of the government. The decrease of the price of electric motors is being done, clearly to great effect by the subsidies. Given this a continuation of this policy could lead to increase of figures such as 5.3 to even higher levels.

Given the subsidies came in to place in 2017 is clear and obvious the effect these subsidies have had.

Year	Result
2019/2020	5.29
2018/2019	0.68
2017/2018	-0.22

Graph of XED of non-electric motors in relation to the price of electric motors



While the number varied prior to 2017, potentially due to the statistical skew from the small sample, after 2017, XED moves solidly in an upwards direction.

The Excel-generated forecast line suggests that this will continue in to the future as well.

Graph of the XED of non-electric cars in relation to the price of electric cars, for the years:2019/2020, 2013/2014, 2008/2009

2019/2020: red

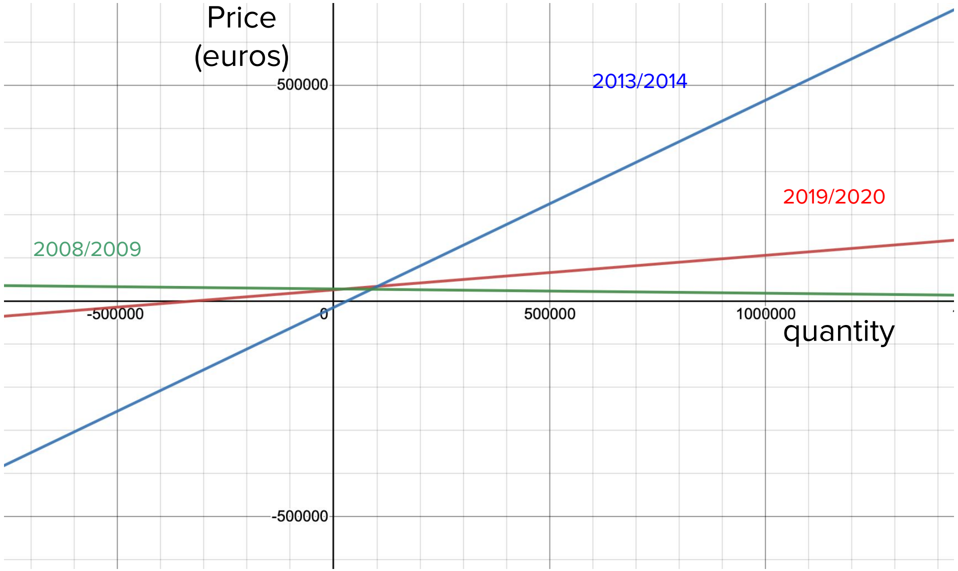
- XED: 5.29
- Equation: y-33471=0.08(x-102128)

2013/2014: blue

- XED: 0.68
- Equation:y-40540=0.48(x-116772)

2008/2009: green

- XED: -0.22
- Equation: y-26261=-0.01(x-125951)



Correlation coefficient - XED

Correlation between quantity demanded of non-electric cars and the price of electric cars

R = - 0.419642425
R^2= 0.1760997649

This indicates that there is a weak relationship between the two variables and that 17.6% of the variance in Qd of non-electric cars was due to the price of electric cars, explainable as non-electric cars are still far more popular and would have stronger market influence. However, the fact that the relationship is negative and thus inverse suggests that fewer non electric cars will be purchased if the price of electric cars continues to decrease, thus confirming the work of the government.

Correlation between quantity demanded of electric cars and the price of non electric cars:

R = 0.882487399
R^2 = 0.778784009

This indicates that there is a very strong relationship between the quantity demanded of electric cars and the price of non-electric cars. 77% of variance in QD of electric cars was due to the price of non-electric cars With this in mind, if the government knows that they are goods heavily linked to each other, they can better design policy to take on the issue.

Other things to consider:

Other things to consider:

- Coronavirus impact
- Market structure of cars (oligopoly)
- Irish economy
- Change in mindset

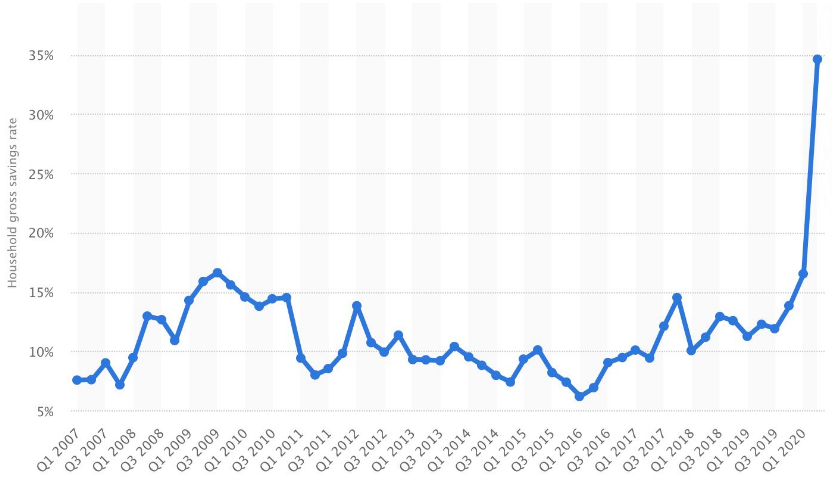
The COVID-19 pandemic

The covid 19 pandemic has caused saving rates to increase, and overall consumption to decrease.

As cars are a large purchase, people are less likely to buy them during times of economic uncertainty, such as the pandemic.

Also, many people have lost or partially lost their jobs, due to the pandemic.

This is something to consider throughout this project, as it may have impacted our 2020 income and demand figures.

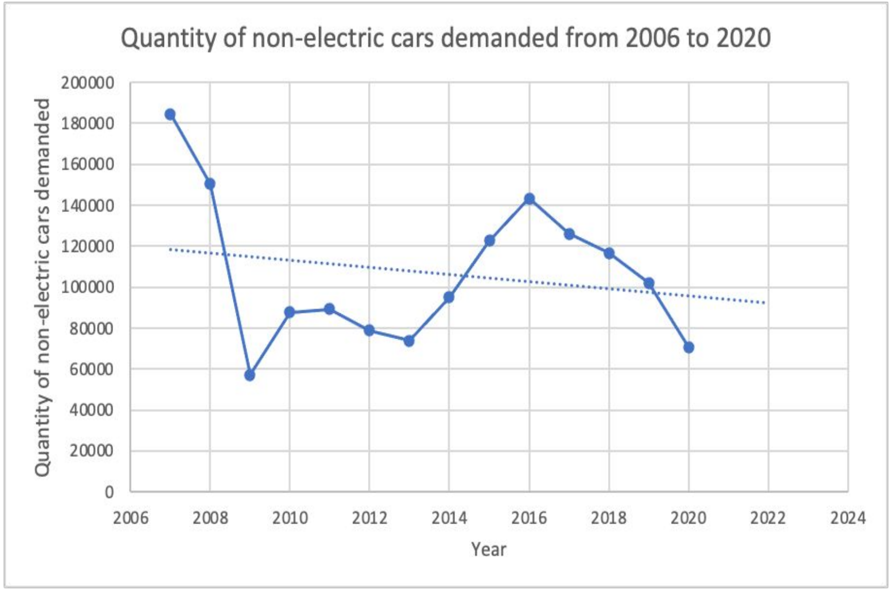


[graph showing Household gross savings as a share of disposable income in Ireland from 1st quarter 2007 to 2nd quarter 2020]
https://www.statista.com/statistics/1076741/household-gross-savings-rate-ireland/

Irish economic performance

The irish economy has gone through many different cycles of economic growth. As our project takes into consideration such a wide range of time, this is something we have to consider. For example, this can be seen very clearly in the change in demand for non-electric cars in 2008.

This sharp fall in demand was caused by the 2008 “great recession”, and highlights the effect of poor economic performance on consumption patterns. This may skew some of our results, as we are trying to see the change in consumption patterns due to government action, not economic performance.



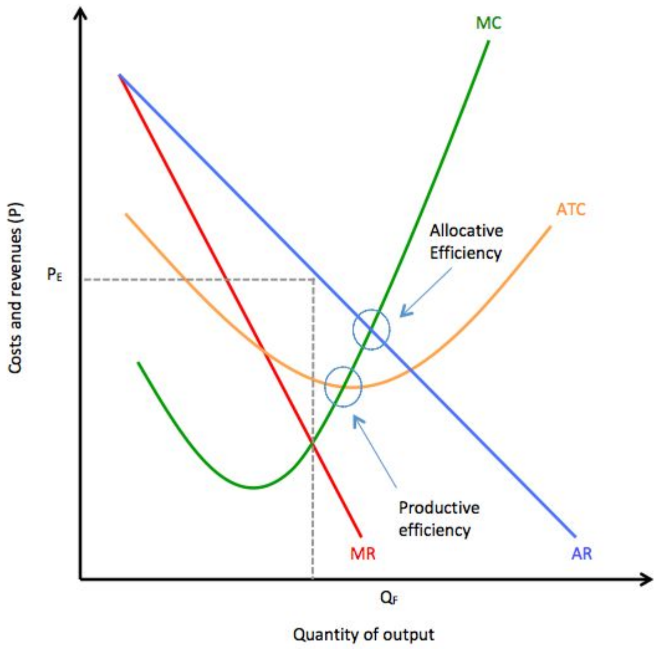
Market structure of cars: efficiency

Cars are in an oligopoly market structure.

A firm in oligopoly will not produce at the point where they are productively efficient (where MC=ATC), as they do not need to take into consideration minimising costs; the additional cost can be easily transferred to the consumer as they are price makers and have a large share of the total market.

They are also not allocatively efficient as they do not operate at the point where their marginal cost line intersects their marginal revenue line(MC=MR), meaning they produce less than the market desires. This means they don't have allocative efficiency as they restrict output to maximise profits and only produce until marginal cost equals marginal revenue.

This is bad as productive and allocative efficiency facilitates climate action, helping achieve SDGs 11,12 and 15.



Changes in mindset:

With the influence of social media and and increase in global awareness of the climate crisis, consumers are changing their attitude to all environmentally destructive products.

This has caused a shift towards eco-friendly products, such as reusable shopping bags. However, this could impact our project, as we are trying to analyse the effect of government policies, not the change in consumer mindset due to other factors.

Conclusion:

Conclusion

- PED
- YED
- XED
- Overall

Have the policies worked?

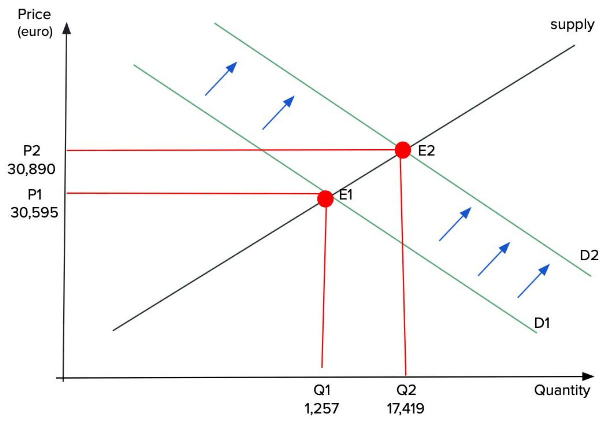
From our analysis of market equilibrium, we can see that the policies have achieved their aims.

The taxation policies introduced from 2010 onwards have caused the quantity of non-electric cars to decrease, achieving its aim of reducing the demand for non-electric cars.

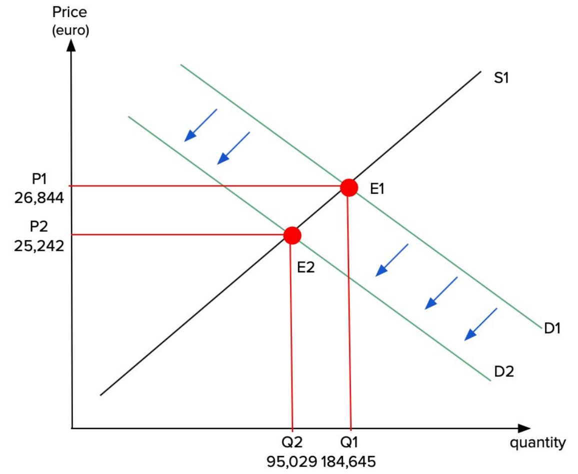
We can also see that the quantity of electric cars has shifted right after the introduction of the subsidies in 2017, achieving its aim of increasing the demand for electric cars.

However, we wanted to see how well these policies worked. In the following slides we draw conclusions from our elasticity calculations on how effective the policies were, and which worked better.

market equilibrium for electric cars 2014-2020



Market equilibrium of non-electric cars 2007-2014



PED:

Non-electric cars:

Our calculations showed that the PED of non-electric cars is negative, and will continue to become more negative, and elastic. They are becoming more price sensitive, indicating that the taxes and disincentivization policies (carbon taxes), are working.

We believe that this should be capitalized on, and policies that increase the price of noon-electric cars should be introduced, and continued.

(Increase price to decrease quantity demanded)

Electric cars:

Our calculations show that the PED of electric cars is negative, and becoming increasingly elastic. They have also moved from being luxury goods to normal goods, indicating that the incentivisation policies are working, as they now follow the law of demand.

Our forecast line also shows that this trend will continue. Therefore, the incentivisation policies should be continued, as they will be highly effective.

(decrease price to increase quantity demanded)

YED

Our calculations showed that both electric and non-electric cars were income elastic, and sensitive to changes in income. However, non-electric cars had a negative YED, whereas electric cars had a positive YED. This shows that an increase in income will not only increase the quantity demanded of electric cars, but it will also decrease the quantity demanded of non-electric cars.

Thus, we believe that the subsidisation policies are working, and will continue to be highly effective, as increasing incomes will encourage people to switch to electric cars.

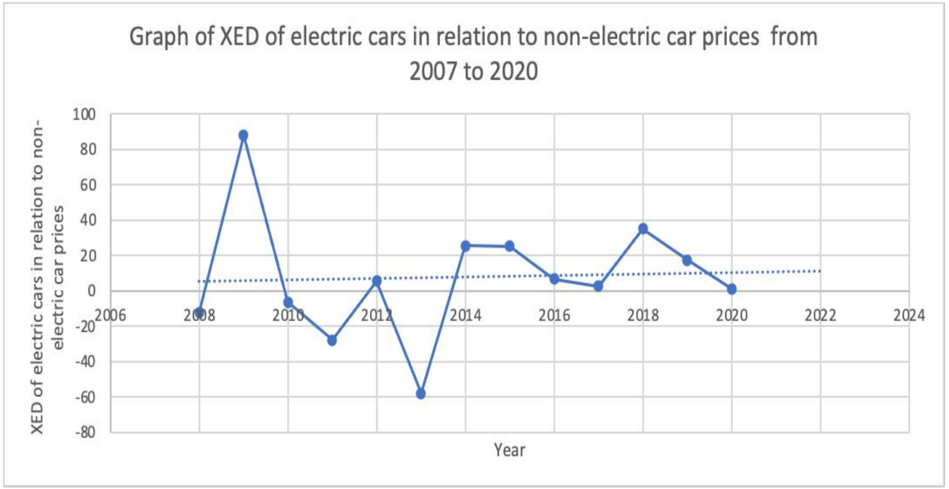
As a decrease in income doesn’t cause a shift to electric, this could indicate that subsidisation policies work better. In order to confirm his we will look at XED in the next slide.

XED of electric: how effective were taxation policies?

From our calculations we were able to see that a change in price of non-electric cars has had an effect on the quantity demanded of electric cars.

We can therefore conclude that the taxation policies are working, as they are more likely to be seen as substitutes now, than before the taxes were introduced.

However, as the graph of XED overtime is so sporadic, it is difficult to tell exactly how effective the taxation policies have been. We would encourage the taxation policies to continue, as they do work, although it is slightly unclear how effectively.

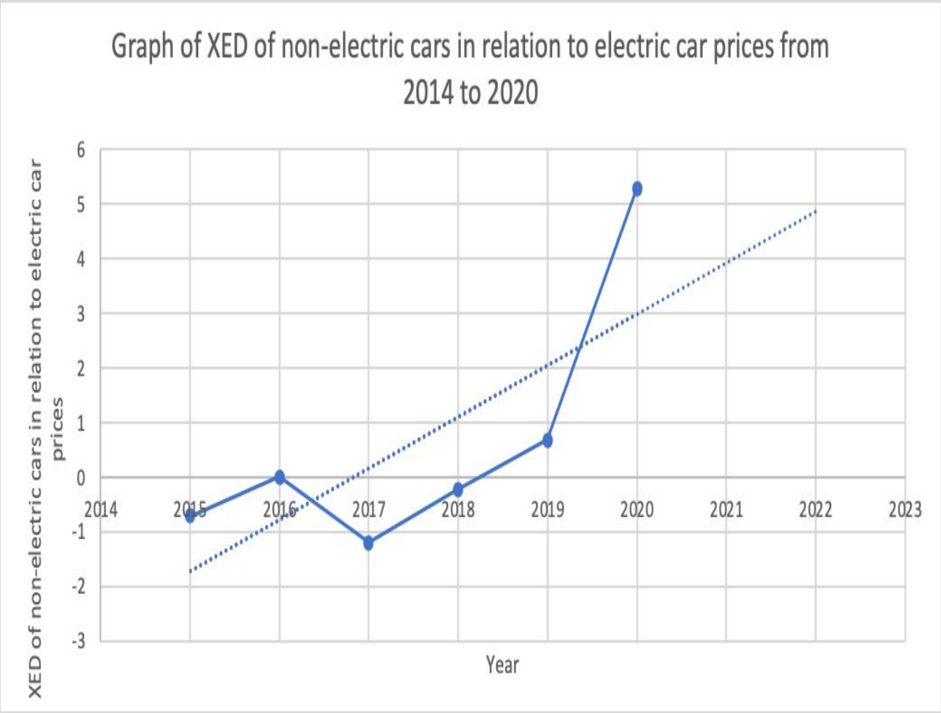


XED: How effective have subsidisation policies been

From our calculations we were able to see that a change in price of electric cars had a clear effect on the quantity demanded of non-electric cars.

Before the subsidies were introduced in 2017 the XED fluctuated, and it was relatively unclear how much the price of electric cars affected the demand for non-electric cars. However, it is very clear after 2017 that the price has a large effect on the quantity demanded of non electric cars, with the XED currently at 5.3%.

This clearly shows that the subsidisation policies are highly effective, and that they are potentially better than the taxation policies or at least more clearly evident.



Overall

Taking into consideration all aspects of our project, we can conclude that the policies introduced by the government are working.

The forcast lines used in the various elasticity also indicate that the policies will continue to work.

Finally, through our analysis of YED and XED we can see that the subsidisation policies are the more effective policies.

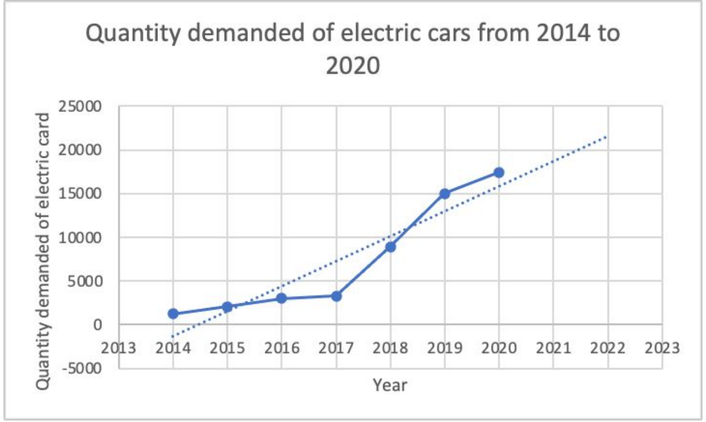
Based on these concluding points, we will make recommendations to various different government bodies in the next section.

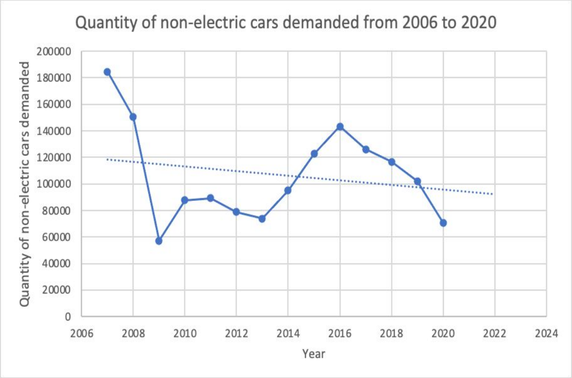
Recommendations:

Irish government

Based off our analysis we can conclude that both taxes and subsidies are working and should be increased. However, there should be a special focus on subsidies as they can be seen to be more effective and efficient.

For example, the increased number of electric cars bought after the introduction of subsidies in 2017 out weights the decrease in non-electric cars seen after the introduction of the taxation policies, that began after 2010. This can be seen through the line of best fit, which is far steeper for electric cars.





An intersectional approach:

We would also urge the government to continue its intersectional approach when introducing these further policies. This includes cross-communication between the Department of Finance and the Department of the Environment, Climate and Communication. We would also encourage them to work alongside IGEES, who can provide economic advise in order to limit any potential negative aspects of increases subsidies, as we describe in slide 22.

An Roinn Airgeadais
Department of Finance

IGEES
Irish Government Economic and Evaluation Service

An Roinn Comhshaoil, Aeráide agus Cumarsáide
Department of the Environment, Climate and Communications

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