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The council going electric

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Abstract

Local governments in the Netherlands have a significant influence on the dissemination of electric cars, on top of the national government policies. Many local governments also have instruments to stimulate electric vehicles. The effectiveness of the instruments to simulate EV's in their municipalities was determined in a previous quantitative study in 2012 and presented successfully on EVS 27. However, the number of EV's in the Netherlands increased tenfold since mid-2012 until mid-2014. Also the awareness of EV's and local instruments to stimulate EV's changed a lot during this period. We repeated the study on the effectiveness of policy instruments. The following policy measures have a significant effect on the number of electric vehicles: charging infrastructure in the public space and the subsidy for and the purchase of an electric vehicle. Compared to 2012, the effect of the municipality as launching customer has declined.

Keywords: effectiveness local instruments, EV dissemination, stimulate EV's, policies local governments, amount of FEV's and PHEV's.

1 Introduction

The increase of electric vehicles in the Netherlands can mainly be attributed to governmental policy that provides many fiscal advantages. Research on the effectiveness of the EV policy of councils in 2012 shows that the EV policy of a council has an influence on the number of electric vehicles [1]. The number of electric vehicles increased tenfold to around 40,000 vehicles in mid-2014 in the Netherlands [2]. During this period the policy of councils also developed. It is therefore interesting to repeat the research on effectiveness of the EV policy of councils. In this research is shown how the effectiveness of different policy measures changes during the growth of electric vehicles.

In this paper the results of the study are presented on the effectiveness of councils' EV policy on the proportion and increase of electric vehicles. This research is performed by APPM, Decisio and the province of 'Noord-Holland'.

2 Method

2.1 Regression model

Based on a regression model, a qualitative study is performed that analyses the relation between EV policy and the proportion and increase in the number of electric vehicles in a municipality. The following steps are made:

1. Collection of the necessary data;
2. Analysis of data in the regression model;
3. Analysis of the results;
4. Interpretation of the results in order to reach conclusions and recommendations.

The regression model analyses the relation between independent variables and a dependent variable. By using the data from as many councils

as possible, the most reliable insight can be gained from the regression model on the influence of the EV policy and control variables (as independent variables) on the proportion or increase of electric vehicles in the fleet of cars (dependent variables).

Based on the available data we performed the following six analyses using the regression model:

1. The influence of the EV policy and the control variables on *the proportion* of FEVs (Full Electric Vehicles) in a municipality;
2. The influence of the EV policy and the control variables on *the proportion* of PHEVs (Plug-in Hybrid Electric Vehicles) in a municipality;
3. The influence of the EV policy and the control variables on *the proportion* of FEVs and PHEVs in a municipality;
4. The influence of the EV policy and the control variables on *the increase* in the proportion of FEVs in a municipality;
5. The influence of the EV policy and the control variables on *the increase* in the proportion of PHEVs in the municipality;
6. The influence of the EV policy and the control variables on *the increase* in the proportion of FEVs and PHEVs in a municipality.

Within this analysis we perform iterations in order to achieve a regression model in which the explanatory variance (R^2) is as high as possible. The iterations consist of the specific inclusion of policy measures in the regression model. The result is a regression model that includes those policy measures that are most explanatory for the proportion and increase in the number of electric vehicles in a municipality.

2.2 Data collection

The following data is collected:

1. The number of electric vehicles compared to conventional vehicles per municipality;
2. Information about EV policy, including councils' policy measures;
3. Control variables with specific characteristics of municipalities.

2.2.1 Number of electric vehicles

In order to draw up an inventory of the number of FEVs, PHEVs and conventional vehicles per municipality, the Climate Monitor of the Department of Transport is used [3]. The Climate Monitor provides an overview of the number of vehicles in the Netherlands. The Climate Monitor is continually updated. In this study the number of vehicles registered on the reference date August 1, 2014 is used, compared to the number that was registered at December 31, 2012.

2.2.2 Policy measures used by councils

A questionnaire is used to gather insights on EV policy of councils. Civil servants who are familiar with EV policy were asked to fill in this questionnaire. The study focuses on municipalities in the Province of Noord-Holland. In addition to this, we approached councils in other provinces that have EV contacts we know, to gain extra data in order to increase the reliability of the results.

The following policy measures are studied:

1. *The promotion of EV:* this involves specific local activities to bring EV to the attention of inhabitants and businesses of a municipality (e.g. EV roadshows, information meetings);
2. *The provision of parking benefits for EV:* this policy measure includes free parking for electric vehicles, the exemption of electric vehicles from (the costs of) a parking permit and non-financial benefits (e.g. park for an unlimited amount of time in case of a time limit);
3. *The council as launching customer:* this implies that the council has electric vehicles in its own fleet by which they increase the visibility and presence of EV;
4. *The provision of a subsidy for the purchase of an electric vehicle:* the council provides a subsidy for inhabitants and/or businesses that purchase an electric vehicle (both FEVs and PHEVs);.
5. *The number of charging stations in public spaces in the municipality*: when a council installs charging stations, it means that they have at least issued permits to do so which implies that they also drafted or thought about EV policy;
6. *The authorization of private charging facilities in public spaces:* the council allows EV drivers to use their 'own' charging possibilities such as laying out cables on public roads from a house or business to the vehicle and/or allowing an extension of a house connection;
7. *Providing information about charging stations:* the council provides information

about the possibilities of charging an electric vehicle within and outside public spaces (e.g. communication on the council's policy with regard to this subject, referrals to suppliers of charging stations for private property);

8. *EV in local media:* the council (possibly together with other local parties) ensures that there is attention for EV in the local media;
9. *Providing a special EV contact:* an EV expert at the council offices can help inhabitants, businesses and other parties with their EV questions (e.g. about EV policy, subsidies and charging infrastructure);
10. *Informing about EV in general:* the council provides information about EV in general and the council's EV policy (e.g. information on a webpage, information meetings for businesses and inhabitants);
11. *Subsidies for charging stations on private property:* a subsidy from the council for the realisation of charging stations on private property (e.g. a charging station situated at houses or local businesses (either accessible to the public or not).

2.2.3 Control variables

Control variables are used to analyse the effectiveness of the EV policy. Control variables concern the specific characteristics of municipalities. Without using control variables, 'composition effects' could emerge. In the case of subsidy regulations the number of electric vehicles appears to be partly defined by the average income in a municipality. Without the control variable average income the results could be biased. The following control variables are included in the regression model:

1. Presence of one or more car leasing company in a municipality, source VNA (Association of Dutch leasing companies) top 10 leasing companies 2011;
2. Average wage per inhabitant, source CBS StatLine (Statistics Netherlands) for the year 2012;
3. Absolute number of inhabitants on reference date 1 January 2014, source CBS StatLine;
4. The population density expressed in the surrounding address density in 2012, source CBS StatLine.

3 Results

3.1 Characteristics participating municipalities

We approached several municipalities we approached for the questionnaire. Every municipality in Noord-Holland and several municipalities from other Dutch provinces. These othere municipalities were selected because we knew that they had an employee with knowledge of the local EV policy. A total of 159 municipalities were approached with a response of 85 (53%). These municipalities are located in the provinces Noord-Holland, Utrecht, Flevoland, Noord-Brabant and Zeeland. In the case of Noord-Holland, the response amounted to 33 of the 53 municipalities (62%). The Netherlands consists of 403 municipalities. The research is thus performed with data of 21% of the Dutch municipalities. Table 1 shows a number of relevant characteristics of these 85 municipalities.

Table 1: Characteristics of municipalities based on the control variables

Control variables	Average participating municipalities	Average the Netherlands per municipality
1. Income	25,412	25,327
2. Number of inhabitants	42,751	43,969
3. Surrounding address density	1,132	992

The municipalities that were taken into account in the study are a typical representation with regard to the average income and population. In general, the participating municipalities are more densely populated than the average Dutch municipality.

3.2 Effectiveness of policy measures

The regression model provides insight in the extent to which a policy measure has an effect on the proportion or increase in the number of electric vehicles in a municipality. The results of the six analyses, following iteration and selection of policy measures, (see explanation in section 2.1) is presented in tables 2 and 3. Subsequently, an

Table 2. Analysis of the effectiveness of EV policy measures on the proportion of FEV, PHEV and FEV and PHEV. The green shading indicates the correlations found with a significant effect.

Proportion FEV, PHEV and FEV and PHEV (n=85)	FEV R2 = 0.345		PHEV R2 = 0.744		FEV and PHEV R2 = 0.768	
	Beta	Signifi-cance (p)	Beta	Signifi-cance (p)	Beta	Signifi-cance (p)
Policy measures						
1. The promotion of electric transport	-0.075	0.476	-0.054	0.412	-0.086	0.171
2. Parking benefits for electric vehicles	0.002	0.983	0.027	0.672	-0.001	0.984
3. The council as launching customer	0.024	0.820	0.024	0.715	0.014	0.828
4. Subsidy for the purchase of an electric vehicle	0.152	0.182	0.136	0.060	0.148	0.031
5. Number of charging stations in public spaces	0.525	0.014	0.338	0.011	0.421	0.001
6. Other charging possibilities public spaces	0.177	0.086	-0.009	0.892	0.031	0.611
Control variables						
1. Leasing company present	0.207	0.089	0.749	0.000	0.704	0.000
2. Population density	-0.196	0.154	0.124	0.150	0.055	0.498
3. Population	-0.199	0.451	-0.251	0.132	-0.232	0.143
4. Income	0.296	0.008	0.201	0.004	0.251	0.000

Table 3. Analysis of the effectiveness of EV policy measures on the increase in the number of FEV, PHEV and FEV and PHEV. The green shading indicates the correlations found with a significant effect.

Increase in number of FEV, PHEV and FEV and PHEV (n=85)	FEV $R^2 = 0.308$		PHEV $R^2 = 0.680$		FEV and PHEV $R^2 = 0.696$	
	Beta	Signifi-cance (p)	Beta	Signifi-cance (p)	Beta	Signifi-cance (p)
Policy measures						
1. The promotion of electric transport	-0.071	0.511	-0.061	0.407	0.071	0.323
2. Parking benefits for electric vehicles	0.008	0.939	0.021	0.765	0.019	0.759
3. The council as launching customer	-0.054	0.618	0.018	0.805	0.004	0.948
4. Subsidy for the purchase of an electric vehicle	0.165	0.159	0.133	0.095	0.156	0.046
5. Number of charging stations in public spaces	0.436	0.045	0.333	0.025	0.397	0.006
6. Other charging possibilities in public spaces	0.214	0.044	-0.029	0.688	0.019	0.783
Control variables						
1. Leasing company present	0.143	0.251	0.677	0.000	0.648	0.000
2. Population density	-0.198	0.160	0.111	0.244	0.059	0.525
3. Population	-0.122	0.653	-0.193	0.297	-0.202	0.263
4. Income	0.302	0.008	0.228	0.004	0.269	0.001

explanation and analysis of the results for each of the policy measures and control variables is provided.

The interpretation of the results is as follows:

- The coefficient of determination (R2) represents the validity of the regression model used. That is, the extent to which the independent variables from the model explain the number of electric vehicles in a municipality.
- An important part of the interpretation is the extent to which the effect of a measure is significant. That is, the extent to which the effect found (Beta) is based on coincidence. We maintain a maximum of 10% for this. This means that we consider a statistical significance of 0.1 or less as 'not being a coincidence'.

For variables with a significant effect, the Beta expresses the size and direction of the effect of an independent variable on the dependent variables. By interpreting the Beta, it is possible to reach a conclusion on the effectiveness of a policy and whether there is a positive or negative correlation. A positive and negative value of the Beta indicate a positive and negative effect of the variable, respectively. A higher Beta generally means that the policy measure has a strong influence or control variables on, for example, the proportion of FEVs.

3.3 Comparison results study 2012

A study into the effectiveness of EV policy measures was also conducted in 2012. The

various results between 2012 and 2014 compared on policy measures and control variables. A change in the effectiveness of the following policy measures between 2012 and 2014 has been established: the municipality as launching customer, population (control variable) and income (control variable).

3.3.1 Launching customer (policy measure)

The council as launching customer shifts from a positive significant relation in 2012 to a policy measure without a significant effect in 2014. This change can possibly be explained by the fact that in 2012, the electric vehicle was still very low profile in the street scene. However, in 2014 there are many more electric vehicles on the roads and in addition to this, advertising for EV has also increased. Therefore, in 2012 an electric vehicle owned by the council contributed to the prominence of electric vehicles among the inhabitants of a municipality and thus also to the awareness of the possibility to drive an EV there. Setting a good example as a municipality no longer seems to have a significantly large effect. However, this does imply that it has no effect at all.

3.3.2 Population (control variable)

In 2012, the population of a municipality appeared to have a significant negative effect on the proportion of electric vehicles in a municipality. In other words, the larger the municipality, the smaller the proportion of electric vehicles. In 2014, there is no longer a significant effect of the number of inhabitants in a municipality and the proportion or increase in the number of electric vehicles there. It is possible that this difference can be attributed to the fact that the councils' fleet of cars carried more weight in 2012 than it does in 2014. Because, in 2012, a relatively large number of councils had electric vehicles in their fleet of cars, it gave the impression that the proportion of electric vehicles was larger in smaller municipalities. This is no longer the case in 2014, because the proportion of electric vehicles owned or used by a council is now relatively small compared to the total number of electric vehicles in a municipality.

3.3.3 Income (control variable)

In 2012, there was not a significant relation between the average income of a municipality and the proportion of electric vehicles. However, this does seems to be the case in 2014. This could be explained by the same reason as with population and number of electric vehicles, more electric vehicles are owned and used by the public. Thus, an effect of income on the proportion and increase in the number of electric vehicles in a municipality is found.

4 Conclusion

The regression model leads to a significant effect for a number of policy measures and control variables. On the basis of the analysis of the results (as explained in Chapter 3), we draw the following conclusions.

The possibility to charge in public spaces is the most determining factor for the proportion and increase in the number of (full) electric vehicles in a municipality: The number of charging stations in a municipality has an exceptionally significant effect on the proportion of electric vehicles there. The more charging stations, the more electric vehicles there are in a municipality. It has also been found that it is essential for full electric vehicles to be able to charge, because the permission for other possibilities than charging at a charging station has a significant positive effect on the proportion and increase in the number of FEVs. Examples of other possibilities include the extended house connection or the permission to place a charging cable on a public road.

The effect of the number of charging stations is also significantly larger than the effect of other policy measures. As a result we can conclude that the possibility to charge is the most defining factor for the proportion and increase in the number of electric vehicles in a municipality. In this study the number of electric vehicles was defined as a variable. This implies that it is necessary for municipalities to extend the network of public charging infrastructure to ensure the continued increase in the number of electric vehicles.

The difference between FEVs and PHEVs provides opportunities for municipalities: The results from the regression model show that various policy measures have a significant effect on the proportion and increase in the numbers of FEVs or PHEVs in a municipality. The subsidy for purchase has, for example, a significant effect on PHEVs but not on FEVs. The possibility to charge in public spaces (not through public charging stations) has a significant effect for

FEVs and not for PHEVs. This leads to two conclusions.

Firstly, based on these results councils are able to make a distinction in their policy focusing on FEVs and/or PHEVs. For example, paying more attention to charging possibilities in public spaces (such as an extended house connection) has a positive effect on the proportion of FEVs and/or PHEVs. Secondly, it is of lesser importance for PHEV drivers to charge, thus it is evident that with specific policies the council can positively influence the charging behaviour of PHEV drivers and as a result, improve the local air quality very effectively.

The effectiveness of the policy measures changes with the increase in the number of electric vehicles in the Netherlands: The comparison of the study results from 2012 and 2014 shows a shift in policy measures and control variables that have a significant effect on the proportion and increase in the number of electric vehicles in a municipality. It is found that the council as launching customer does not have a positive significant effect in 2014, whereas in 2012 it did. We can also see a development in the distinction between policy measures that contribute to FEVs and PHEVs.

Concerning the control variables, we notice that in 2014, the number of inhabitants does not have a significant effect on the proportion of electric vehicles. The average income level did not appear to have an effect in 2012, but does have a significant positive effect in 2014. Based on this information, we can conclude that the effectiveness of policy measures change according to the increase of electric vehicles. Councils can take this into account in the development of their policy. The same applies to the influence of local characteristics that are included in the control variables.

The EV policy of councils included in this study is effective: The policy measures of most municipalities contains to a large extent policy measures with a significant positive effect on the proportion of electric vehicles. An important example is the presence of public charging places in most municipalities (88% of the municipalities in this research). This indicates that in most municipalities the current EV policy is effective and stimulates the growth of the number of electric vehicles.

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