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Impact of electromobility development on tax revenues: A case study on Norway

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Abstract

The manuscript deals with the development of electromobility in Norway and its impact on tax revenues. The detailed focus of the paper is on registration and road taxes directly related to the acquisition and operation of a road motor vehicle. The paper aims to verify whether a growing share of electric cars in Norway's fleet impacts the decrease in tax collection, namely road and registration tax. Norway was chosen because it is the country with the highest share of electric cars in the vehicle fleet in the world. Impacts on road and registration tax are investigated, focusing on 1998–2021. Our results suggest that the introduction of electromobility has a negative effect on the collection of road and registration tax, with the addition that this impact is statistically significant only in the case of registration tax. In other words, our research assumption was only confirmed in the case of the registration tax.

Keywords: *road tax, registration tax, electric car, tax revenue, Norway.*

1. Introduction

Road transport is a source of pollution that manifests itself on two levels. Local pollution is caused by emissions of nitrogen oxides (NOx), carbon monoxide (CO) and hydrocarbons (HC). It manifests itself primarily in a negative effect on human health. The other level refers to global pollution by greenhouse gas emissions, the excessive concentration of which in the atmosphere causes global climate change (Andrlík and Zborovská, 2019).

Reducing greenhouse gas emissions from the transport sector is essential in mitigating climate change's impact (Ciccone, 2018). There are currently several ways to achieve this reduction. At the European Union level, these are mandatory standards for CO_2 emissions produced by new passenger cars (e.g., Regulation No. 443/2009 of the European Parliament and the Council). Individual countries are also making efforts to reduce the

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emissions produced. Between 2005 and 2010, the number of European Union countries benefiting from a CO_2 regressive tax increased from 9 to 14 (Yan and Eskeland, 2018). For more details on road tax across EU countries, see Ptak (2011).

Current research in the field of electromobility focuses mainly on environmental aspects in connection with their operation or on incentives from state authorities (Ciccone and Soldani, 2021; Clinton and Steinberg, 2019; Deuten, Gómez Vilchez and Thiel, 2020; Figenbaum and Kolbenstvedt, 2013; Liu, Zhao and Lu, 2022; Ryghaug and Toftaker, 2016; Yan and Eskeland, 2018). However, much less attention is paid to the impact on state or public budgets (Fearnley *et al.*, 2015), although the purchase and operation of electric cars are supported by lower taxation or exemption from paying for them. The reduction of income to state budgets is thus an accompanying phenomenon that has not been sufficiently described and measured.

One of these countries is the Kingdom of Norway, to which the paper will be devoted. The Kingdom of Norway is often seen as a leader in environmental protection for its actions in climate protection. The reason for choosing Norway was, together with Norway's position in climate protection, its long-term support for the sale of electric vehicles. Thanks to this support, electric vehicles acquired nearly 14% of the local vehicle fleet in 2021 (Statistics Norway, 2022b). Norway has the highest share of electric vehicles globally in the vehicle fleet (International Energy Agency, 2020). Therefore, in the case of Norway, it is proposed to verify whether the growing number of electric cars, thanks to the applied benefits in the tax system, will lead to a decrease in tax collection of road and registration taxes, as already addressed by International Energy Agency (2019), especially according to Ingeborgrud and Ryghaug (2019) in the sector of private owners.

The paper aims to verify whether the growing share of electric cars in Norway's fleet impacts the decrease in tax collection resulting from registration and road taxes. These impacts are directly analyzed on the data of the acquisition and operation of a road motor vehicle registered in Norway.

2. Literature Review

In Norway, vehicle acquisition and subsequent operation are associated with a registration tax, a road tax, a mineral oil tax, and charges for using the toll road network (Figenbaum and Kolbenstvedt, 2015). Through a selective level of taxation, these taxes can act as a tool to promote the sale of electric vehicles (Fearnley *et al*., 2015). Historically, sales promotion has been important for alternative propulsion vehicles that are relatively new and may appear risky, unknown, and expensive for consumers (Bandhold *et al*., 2009).

The sales promotion scheme for electric vehicles began in Norway as early as 1990 when it was intended only for electric vehicles (Aasness and Odeck, 2015). The first step in this area was exempting electric vehicles from import and registration taxes in 1990 (Deuten *et al*., 2020). In the following years, the conditions and duration of individual forms of support changed, which in 2013 were extended to hybrid vehicles (Figenbaum and Kolbenstvedt, 2013). At present, electric cars are exempt from VAT at the national level, with a tax rate of 25% in Norway. Owners of electric vehicles are further exempt from the obligation to pay road tax, and the exemption from registration tax is also still valid (Fridstrøm, 2019; Figenbaum, 2022). Sales of electric vehicles are also supported at the local level (Bjerkan *et al*., 2021). These include the unrestricted use of otherwise tolled roads, the possibility to use lanes primarily intended for public transport, free parking, or lower rates for ferry transport (Ciccone and Soldani, 2021; Figenbaum *et al.*, 2014). Expansion of electromobility aims at reduction of emissions.

The forms mentioned above of sales promotion for electric vehicles are the reason why Norway is considered a world leader in the sale of electric vehicles (Aasness and Odeck, 2015; Figenbaum and Kolbenstvedt, 2015). Of the newly registered vehicles, 242,796 (45.9%) were electric vehicles in 2019, and the number of registered hybrid vehicles was 105,535 (14.6%; European Alternative Fuels Observatory, 2022). Table 1 presents the development of the fleet structure between 2012 and 2021 according to the fuel type. The left part of the table shows the absolute number of registered vehicles, and the right part shows the percentage share of individual fuel types in the total vehicle fleet. For clarity, groups of fuels represented only in small amounts (i.e., paraffin 0.001% and natural gas 0.05%) were omitted.

Table 1: The structure of the Norwegian fleet from 2012 to 2021

Year	*Number*				*Share [%]*			
	Electric vehicles	*Hybrid vehicles*	*Petrol*	*Diesel*	*Electric vehicles*	*Hybrid vehicles*	*Petrol*	*Diesel*
2012	8202	513	1463854	1529210	0	0	49	51
2013	18293	2242	1418073	1624786	1	0	46	53
2014	39731	1180	1372665	1707008	1	0	44	55
2015	70952	1193	1335196	1770867	2	0	42	56
2016	100103	91231	1231680	1812579	3	3	38	56
2017	142477	144829	1171902	1837247	4	4	36	56
2018	200705	189946	1104330	1835380	6	6	33	55
2019	268206	227241	1056270	1766502	8	7	32	53
2020	350216	272692	973552	1736959	10	8	29	52.
2021	476413	324966	914086	1699839	14	9	26.	49

Source: Statistics Norway (2022b).

The development of average produced emissions of newly sold passenger cars is in line with the intended goals of the National Transport Plan 2018 – 2029 (Norwegian Ministry of Transport and Communications, 2017). Ciccone (2018) states that the reason for lower emissions is the 2007 registration tax reform. This reform introduced an element in the tax design that considers CO_2 emissions. In the run-up to the reform, the tax was based on vehicle weight, power, and engine displacement (Yan and Eskeland, 2018).

However, while maintaining the current set-up of the tax system, this increase in sales of alternative propulsion vehicles in the fleet may have a negative impact on tax revenues from vehicle taxation (i.e., registration tax or road tax) and fuels (mineral oil tax) (International Energy Agency, 2019).

This assumption, therefore, becomes the subject of scientific research. Therefore, scientific papers aim to examine the impact of the increased number of electric cars on public finances. For example, Aasness and Odeck (2015) looked at whether supporting the sale of electric cars has side effects. They primarily focused on the possibility of electric cars using lanes for public transport and the possibility of free operation of electric cars on tolled sections of roads. The case study focused mainly on tolls in the capital city of Oslo. According to the authors, these losses occur due to the exemption of electric cars from the obligation to pay tolls will be from 6 million NOK (2013) to 95 million NOK (2020). In conclusion, the authors state that support for the sale of electric cars, in addition to financial losses on tolls, also causes an increase in traffic intensity in lanes for public transport, which is reflected in an increase in time spent on the road in these lanes. The study by Liu, Zhao and Lu (2022) addresses the deterioration of road safety in Norway. The authors proved that from 2011 to 2019, the accident rate of electric cars increased from zero to 3.11%, and they state that the negative impact of electric cars is mainly the noiselessness of their operation.

The estimated impacts on individual road taxes are described by Fearnley *et al*. (2015). These authors use four scenarios representing different developments in the fleet structure, together with different lengths of sales support for electric vehicles. Their work focuses on Norway and Austria, and in the case of Norway, they speak of a slight increase in the total number of cars in the country's fleet. However, they emphasize the change in the structure of the vehicle fleet. In particular, they predict an increasing number of electric vehicles at the expense of conventional vehicles. In all four scenarios, there is a declining trend in state budget revenues resulting from the taxation of the transport sector. Revenues are to be reduced by 2045; for different scenarios, the level of their decline varies, but in any case, according to the authors' prediction, there should be a reduction.

According to the authors, the state budget revenues will be reduced without the country having to support the sale of electric vehicles further. The decrease in tax collection is due to CO_2 emissions, which is part of Norway's road and registration tax. They explain this development on the example of a basic scenario, which is based on the current development of the vehicle fleet and includes sales support, including their currently planned changes. The authors quantified the average state budget revenues from various sources in the first and last ten years of the analyzed period, as can be seen in Table 2. The main effects of reducing tax revenues can be seen in the case of registration tax, VAT, fuel tax and parking charges. On the contrary, road charges are expected to fall only slightly (2%), and road tax collection is expected to increase by 7% due to the planned abolition of the road tax exemption for electric cars. Based on the partial changes in tax and fee income listed in Table 2, the authors assume an overall decrease in tax and fee income of 17%. Certain information limits of Table 2 are associated with the fact that the values presented are rounded to billions. As a result, the absolute value of the road tax and toll revenue appears to be the same, but the line expressing the percentage change shows this is not the case.

Table 2: Estimated impact on road tax revenues (rounded - NOK billions)

	VAT	*Registration tax*	*Fuel tax*	*Annual tax*	*Road charges*	*Parking charges*	*Total*
Average 2005 - 2014	6	15	16	7	5	5	53
Average 2036 - 2045	5	9	14	7	5	4	44
Change	-16%	-36%	-15%	7%	-2%	-13%	-17%

Source: Fearnley *et al*. (2015, p. 62).

Another view is offered by Fridstrøm (2019), who, in his work, calculates the cost of supporting the sale of electric cars and tax collection consisting of registration, road and excise taxes paid for all types of propulsion. Its analysis was performed on the data of the electric car market in 2017, considering the financial and non-financial forms of sales support. According to his calculations, the tax collection composed of the above taxes was approximately EUR 1,000 per capita in 2018. However, the total costs associated with supporting the sale of electric cars, including the possibility of using a lane intended for public transport, amount to approximately EUR 7,300 per electric vehicle.

3. Research Methodology

The researched topic is the development of electric cars and its connection to the amount of road and registration tax collection in the Kingdom of Norway. As the essential instrument, regression analysis of time series is performed using the econometric software Stata with a focus on the period from 1998 to 2021.

The central part of this paper is the analysis of the change in the structure of the vehicle fleet. These changes can be examined by vehicles sold or registered. This paper prefers to work with registered vehicles, which take better account of changes in the size and structure of the vehicle fleet for collection of road and registration taxes. Specifically, registered vehicles are those for which motor third-party liability insurance is paid. From the database of the Norwegian Statistical Office (Statistics Norway, 2020b), two categories of fleet breakdown were worked with according to vehicle type and fuel type. In order to be able to analyze the whole monitored period (1998 to 2021), a single timeline was created by merging these categories. When merging the two statistics, emphasis was placed on the same level of data granularity, so the resulting timeline is consistent. Using the number of registered vehicles instead of data on vehicles sold is also empirically justified; for more details, see Clinton and Steinberg (2019).

The paper uses two dependent variables: the amount of road tax collection (*Road tax*) and the amount of registration tax collection (*Registration tax*). The data on both taxes were obtained from the website of the Norwegian Statistical Office (Statistics Norway, 2022a). Both taxes are stated in millions of Norwegian kroner with the logarithmic functional form used in the regression analysis.

The collection of road tax includes the collection paid by households and companies. Its size depends on the number of insured cars that are taxable and the number of exempt cars. The subject of the road tax in Norway is vehicles that have valid motor third-party liability insurance and do not weigh more than 7,500 kg (Norwegian Tax Administration, 2022). At the end of 2022, out of 4,193,941 vehicles, only 27,170 were uninsured, representing 0.65% of all registered vehicles (Norwegian Motor Insurers' Bureau, 2022). The tax liability for road tax arises when the motor liability insurance arises. Vehicles insured as vehicles under the Norwegian Investment Bank, NATO-bound vehicles and vehicles using electric power, including vehicles where electricity is produced in fuel cells, are exempt from the road tax (Norwegian Tax Administration, 2022).

The collection of registration tax depends on the number of vehicles registered for the first time. The subject of the tax is a vehicle registered for the first time in the Central Vehicle Register (Det sentrale motorvognregisteret). The tax liability arises for the vehicle's owner on the first registration day in this register. However, there are conditions under which vehicles can be exempted from registration tax. The exemption is possible in the case of electric vehicles or vehicles registered as hearses, ambulances, motorcycles, especially equipped motor vehicles of the fire brigade, taxi vehicles, buses subject to particular conditions, etc. (Lovdata, 2022).

The impact of introducing electric cars on road tax collection is tested through a share of electric vehicles in the vehicle fleet (*Share of BEV*). This group of vehicles is exempt from the tax; therefore, it is assumed that with its increasing size and thus its increasing share, there will be a decrease in tax collection.

A total of six control proxies are employed in the regression models for each tax. Namely, the share of petrol cars, the share of diesel cars, the share of vehicles with traditional petroleum fuels (petrol and diesel), the share of hybrid vehicles, GDP per capita, the number of newly issued driving licenses and the number of newly registered cars. The first five variables are common to both models (road and registration tax). At the same time, the last two indicators are used separately: newly issued driving licenses in the road tax model and newly registered cars in the registration tax model.

The first four variables, the share of petrol cars (*Share of petrol*), the share of diesel cars (*Share of diesel*), the share of vehicles with traditional petroleum fuels (*Share of petrol and diesel*), the share of hybrid vehicles (*Share of hybrid*), represent the share of individual vehicle types in the Norwegian fleet. The share of individual types allows better monitoring of changes than in the case of absolute values. This group of vehicles is subject to tax, so we assume that their larger share will lead to higher tax collection. Data were drawn from Statistics Norway (2022b). These variables mentioned above are tested separately because they have a strong correlation so that joint use would lead to multicollinearity. This procedure also ensures the robustness of the results.

The fifth control variable, *GDP per capita*, represents changes in tax collection caused by cyclical economic development. For this variable, a positive effect on the dependent variable is expected (for more details, see Castro and Camarillo, 2014). This variable was obtained from the World Development Indicators (World Bank Group, 2022). This indicator is measured in constant 2015 $ and is expressed in a logarithmic function form.

The regression models for road tax collection contain one specific proxy, the number of newly issued driving licenses (*DL issued*). This variable is seen in the road tax collection model as a factor potentially affecting the vehicle fleet size. The vehicle fleet represents the basis for the collection of road tax. Accordingly, a positive dependence is expected between the number of newly issued driving licenses and the growth of road tax collection. Information on the number of newly issued driving licenses is recorded in several units. Obtaining this data was preceded by e-mail correspondence with the Norwegian Public Roads Administration (2022) that provided the data. This variable is expressed in a logarithmic function form.

The regression models for registration tax collection consist of one specific proxy, newly registered vehicles (*Newly registered vehicles*). The purpose of this variable is to reduce the possible distortion associated with a group of exempt vehicles that cannot be identified and subsequently removed from the data. The number of vehicles registered for the first time was obtained from the Norwegian Statistical Office (Statistics Norway, 2022b). The source provided data on the number of registered vehicles every month. For further use in the model, data on the number of registrations were aggregated to the year level. This variable is expressed in a logarithmic function form. To summarise, descriptive statistics for each proxy (two dependent, one explanatory and seven control variables) are presented in Table 3. Specifically, this table presents the number of available values, their average level, standard deviation, and minimum and maximum values.

Table 3: Descriptive statistics

Variable	*Obs.*	*Mean*	*Std. dev.*	*Min.*	*Max.*
log Road tax (millions of NOK)	24	8.95	0.28	8.35	9.26
log Registration tax (millions of NOK)	24	9.60	0.32	8.99	9.96
Share of battery electric vehicles (%)	24	2.13	3.81	0.01	13.94
Share of petrol cars (%)	24	56.74	18.86	26.75	82.08
Share of diesel cars (%)	24	39.53	14.44	17.91	55.98
Share of petrol and diesel cars (%)	24	96.27	6.78	76.50	99.99
Share of hybrid cars (%)	24	1.57	2.99	0.00	9.51
log GDP per capita (constant 2015 $)	24	11.19	0.05	11.08	11.26
log newly issued driving licenses (number)	24	11.03	0.11	10.83	11.19
log Newly registered vehicles (number)	24	11.93	0.15	11.70	12.17

Notes: Obs. means number of observations; Mean denotes arithmetic mean; Std. dev. means standard deviation; Min. and Max. means minimum and maximum value. Source: own calculations based on Lovdata (2022); Norwegian Public Roads Administration (2022); Norwegian Tax Administration (2022); Statistics Norway (2022a); Statistics Norway (2022b); World Bank Group (2022)

The regression analysis uses the ordinary least squares (OLS) method. Econometric verification is verified by testing the cointegration of nonstationary time series (Augmented Dickey-Fuller unit-root test), homoscedasticity (Breusch-Pagan/Cook-Weisberg test) and no serial autocorrelation (Durbin's alternative test). The following regression equations can summarize the above description:

$$Road\ tax_t = \beta_0 + \beta_1 Share\ of\ petrol_t + +\beta_2 logGDPpc_t + \beta_3 logDL\ issued_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (1)$$

$$Road\ tax_t = \beta_0 + \beta_1 Share\ of\ diesel_t + \beta_2 logGDPpc_t + \beta_3 logDL\ issued_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (2)$$

$$Road\ tax_t = \beta_0 + \beta_1 Share\ of\ petrol\ and\ diesel_t + \beta_2 logGDPpc_t + \beta_3 logDL\ issued_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (3)$$

$$Road\ tax_t = \beta_0 + \beta_1 Share\ of\ hybrid_t + \beta_2 logGDPpc_t + \beta_3 logDL\ issued_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (4)$$

$$Registration\ tax\ _t = \beta_0 + \beta_1 Share\ of\ petrol_t + \beta_2 logGDPpc_t + \beta_3 log\ newly\ registererd_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (5)$$

$$Registration\ tax\ _t = \beta_0 + \beta_1 Share\ of\ diesel_t + \beta_2 logGDPpc_t + \beta_3 log\ newly\ registererd_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (6)$$

$$Registration\ tax\ _t = \beta_0 + \beta_1 Share\ of\ petrol\ and\ diesel_t + \beta_2 logGDPpc_t + \beta_3 log\ newly\ registererd_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (7)$$

$$Registration\ tax\ _t = \beta_0 + \beta_1 Share\ of\ hybrid_t + \beta_2 logGDPpc_t + \beta_3 log\ newly\ registererd_t + \beta_4 Share\ of\ BEV_t + \varepsilon_t \quad (8)$$

4. Results and discussion

The introduction to this chapter presents trends reflected in the composition of the Norwegian fleet. The data on registered cars between 1998 and 2021 (Statistics Norway, 2022b) describes these trends in Table 1. The second part of this chapter presents the outputs of the regression analysis.

From the point of view of the registered vehicles forming the Norwegian vehicle fleet, it is evident that there are significant changes in its structure in the monitored period according to the fuel type.

At the beginning of the monitoring, the vehicle fleet consisted mainly of petrol-powered vehicles. Part of the vehicle fleet was already comprised of diesel vehicles, mainly light commercial vehicles. Diesel-powered vehicles significantly increased their share of the vehicle fleet during the period under review, from 18% in 1998 to 49% in 2021. In the observed period, the share of diesel cars probably increased at the expense of the share of cars with a petrol engine, which in 1998 accounted for 82% of the vehicle fleet and in 2021 for 27% of the vehicle fleet (Statistics Norway, 2022b). Since 2011, there has been a significant increase in the number of electric vehicles sold (Yan and Eskeland, 2018), but in 2011, electric vehicles accounted for only 0.14% of the total registered vehicles. In the following years, sales of conventionally powered vehicles (petrol and diesel) began to decline sharply (Aarstad and Kvitastein, 2020). These trends had the effect that the structure of the vehicle fleet gradually changed, and in 2021, electric cars accounted for 14% of the vehicle fleet (Statistics Norway, 2022b).

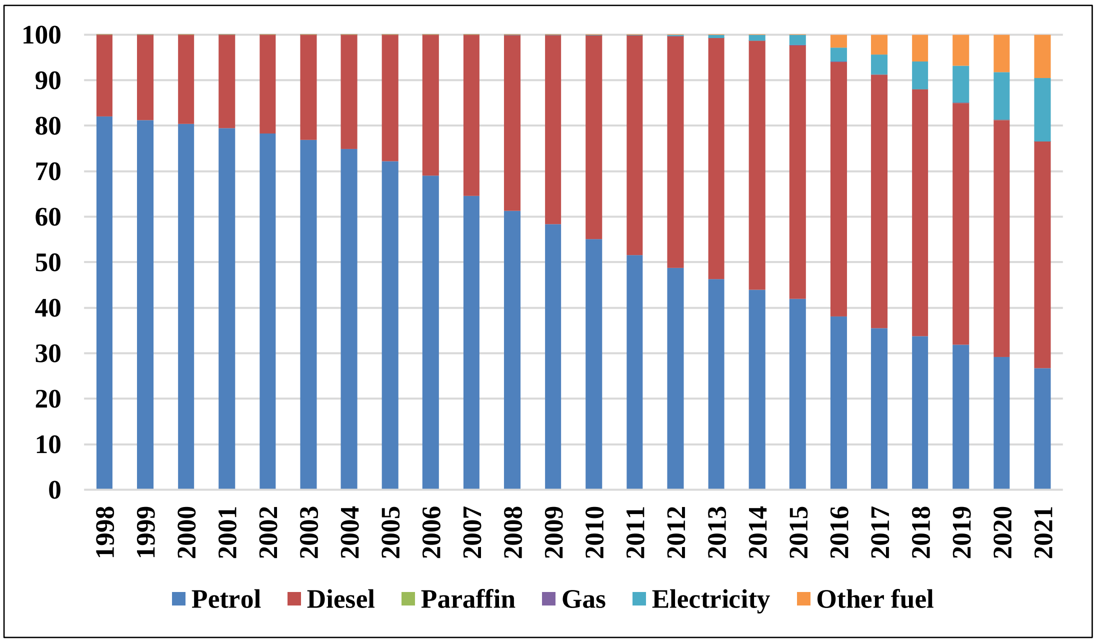

Figure 1: Fleet composition by type of drive (share of vehicles in %)
Source: own calculations based on Statistics Norway (2022b).

At the beginning of the regression analysis, let us mention that time series are cointegrated (Augmented Dickey-Fuller unit-root test), the error term has the same variance (Breusch-Pagan/Cook-Weisberg test), and there is no occurrence of serial autocorrelation (Durbin's alternative test). The results of the VIFs test indicate that it is necessary to test the significance of the individual vehicle types separately to avoid multicollinearity. The outputs of individual tests are presented in Table 4.

Table 4: Results of econometric verification

	Road tax				*Registration tax*			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
ADF	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
test	(-3.31)	(-3.31)	(-3.28)	(-3.27)	(-3.87)	(-3.87)	(-4.23)	(-4.24)
BP test	0.41	0.58	0.23	0.23	0.57	0.54	0.69	0.67
	(0.67)	(0.31)	(1.41)	(1.42)	(0.33)	(0.37)	(0.16)	(0.16)
Durbin	0.14	0.15	0.73	0.73	0.05	0.05	0.11	0.11
test	(2.21)	(2.12)	(0.11)	(0.12)	(4.01)	(3.85)	(2.62)	(2.6)
VIFs	4.97	3.69	74.69	15.67	4.53	3.43	67.61	14.38

Notes: ADF test means Augmented Dickey-Fuller unit-root test, p-value (t-statistics); BP test means Breusch-Pagan /Cook-Weisberg test for heteroskedasticity, p-value (Chi-square); Durbin test means Durbin's alternative test for serial correlation, p-value (Chi-square); VIFs means variance inflation factors, mean VIF. Source: own calculations

The regression analysis is summarized in Table 5. First of all, we focus on control variables.

The effect of the change in the structure of the vehicle fleet on the road and registration tax seems to be statistically insignificant in the case of vehicles with a standard type of fuel (petrol or/and diesel); this may be because the increase in diesel vehicles offsets the long-term decline in petrol vehicles. In other words, owners of cars with internal combustion engines are subject to a non-zero annual fee. This actuality can best be observed in the regression coefficients of road tax.

The positive and statistically significant regression coefficient for *GDP per capita* is in accordance with our assumption that there is an increase in tax collection in the expansionary part of the economic cycle. Specifically, an increase of a percentage will lead to a higher tax collection by 3 to 5%

The specific control variable for road tax (*DL issued*) is statistically inconclusive. The reason may be the number of cars in Norwegian households since 42% of Norwegian households own two or more vehicles (Figenbaum and Kolbenstvedt, 2013). This phenomenon weakens our supposed bond. Drivers who have obtained a new driving license do not have to contribute to the vehicle fleet's expansion, so their growing number does not affect the growth of road tax collection.

Regarding registration tax, the specific proxy (*Newly registered cars*) is statistically significant with an expected positive impact. An increase in the number of newly registered vehicles by one per cent should lead to an increase in the collection of registration tax by 0.5% to 0.7%. A coefficient of less than one is given because only some newly registered cars are subject to this tax (e.g., BEVs are exempt).

Suppose we focus on the influence of electric cars. In that case, our results suggest that the introduction of electromobility has a negative effect on the collection of road and registration tax, with the addition that this impact is statistically significant only in the case of registration tax. In other words, our research assumption was only confirmed in the case of the registration tax.

Several ways can explain the statistical ambiguity in the case of road tax. The sale of electric cars on the Norwegian market has been supported in various forms since 1990 (Ryghaug and Toftaker, 2016; Figenbaum, 2017). Considering the type of cars the road tax applies, electric vehicles accounted for only 13.9% of the vehicle fleet in 2021, significantly less than the paying car group, comprising 86.1% of the vehicle fleet (Statistics Norway, 2022b). In addition to the low share of electric cars in the vehicle fleet, another factor mentioned by Figenbaum and Kolbenstvedt (2013) may also play a role. According to these authors, in up to 90% of cases, electric cars are owned by households that own more than one vehicle. For this reason, cars with internal combustion engines are not replaced by electric cars, but electric cars are just another household car.

Table 5: The impact of the introduction of electromobility on the collection of road and registration tax

	Road tax				*Registration tax*			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Constant	-29.49***	-29.01***	-51.26***	-52.06***	-51.09***	-51.57***	-55.74***	-57.44***
	(-5.48)	(-5.69)	(-8.72)	(-10.70)	(-7.33)	(-7.54)	(-9.45)	(-11.49)
Share of petrol	-0.01***				-0.00			
	(-5.18)				(-1.30)			
Share of diesel		0.01***				0.00		
		(5.59)				(1.25)		
Share of petrol and diesel			-0.01				-0.02	
			(-0.26)				(-0.60)	
Share of hybrid vehicles				0.01				0.02
				(0.22)				(0.59)
log GDP per capita	3.16***	3.11***	4.41***	4.42***	4.88***	4.90***	5.22***	5.22***
	(7.80)	(7.98)	(8.68)	(8.69)	(8.31)	(8.32)	(9.78)	(9.78)
log DL issued	0.33*	0.26	1.05***	1.05***				
	(1.78)	(1.38)	(4.96)	(4.92)				
log Newly registered cars					0.54**	0.54**	0.74***	0.74***
					(2.53)	(2.49)	(4.40)	(4.40)
Share of BEV	-0.03***	-0.01***	-0.02	-0.02	-0.09***	-0.09***	-0.12**	-0.10***
	(-5.80)	(-3.74)	(-0.45)	(-0.64)	(-13.96)	(-17.08)	(-2.37)	(-4.53)
R^2	0.97	0.97	0.92	0.92	0.94	0.94	0.93	0.93
No.	24	24	24	24	24	24	24	24

Notes: (.) denotes t-statistic, */**/*** means a significance level at 10 %/5 %/1 %; R^2 means an adjusted R-squared; No. means a number of observations. Source: own calculation

5. Conclusions

The paper paid attention to the current topic, namely the growing share of electric vehicles in Norway's fleet and its possible impact on the amount of road and registration tax collection. The reason for the increase in the number of electric vehicles registered in Norway is undoubtedly the group of tools supporting their sale. As mentioned, various sales promotion forms have been evolving since 1990. However, a significant increase in registrations of electric vehicles did not occur until 2011, which is considered a turning point. The main reason for introducing sales support for electric vehicles is the pressure to reduce CO_2 emissions through the change in the structure of the vehicle fleet in terms of the type of propulsion, which is very significant in the case of Norway. The significant change in the structure of the vehicle fleet, in the form of an increase in the number of electric vehicles, was the impetus for performing a regression analysis verifying the assumption of whether this increase could affect the collection of road and registration taxes. Indeed, there is a theoretical presumption that the tax collection of registration and road taxes may be directly affected by changes and the composition of the vehicle fleet in the country since support for the sale of electric vehicles involves the exemption of those vehicles from those taxes.

In order to verify this theoretical assumption, two groups of regression models were compiled within the paper; the first group of models was devoted to the collection of road tax, and the second to the collection of registration tax. According to the outputs of the road tax models, it has yet to be confirmed that the current increase in the number of electric vehicles in the case of Norway will be reflected in a reduction in the collection of this tax. Short timelines can be considered the main limitation of this paper. Changes in the vehicle fleet took place only in recent years (after 2011), impacting the limited input data. Therefore, the topicality of the topic only allows a partial assessment of the impacts of introducing electric cars, which offers opportunities for further research. Fearnley *et al*. (2015) estimate the impacts in 2036 at the earliest. This finding is consistent with road tax results since the increase in electric vehicles on the lower collection of these taxes has not been proven, but this does not contradict its decrease in future years. From this point of view, the authors agree with the results, expecting a decline in collections from 2036, obviously in the case of road tax. The limited impact may also be due to the growth of the vehicle fleet during the period under review, both vehicles with internal combustion engines (taxpayers) and BEVs (tax exemptions).

If we focus on the registration tax, we can see a negative effect because a growing proportion of newly registered cars are exempt from this tax. It is also essential to add that one limitation makes this finding not demonstrable.

In the period under review (1998–2021), several reforms were carried out, which significantly affected the structure of the registration tax. Thus, an element that considers the amount of CO_2 emissions produced enters the calculation of the tax liability. Ciccone (2018) points to the side effect of this reform, which only considers CO_2 emissions, which has been reflected in an increase in the share of diesel vehicles in the vehicle fleet. Having placed that side effect of the registration tax reform in the context of this paper, it follows that the acquisition of a diesel vehicle has become relatively cheaper under the registration tax than the acquisition of a petrol vehicle. As a result, the number of taxable vehicles increased, but diesel vehicles generated lower tax collections due to lower CO_2 emissions (Ciccone, 2018). The side effect of the registration tax reform described by the author thus potentially weakens the effect of the increase in electric vehicles on tax collection (obviously in the case of road tax), which may represent a limitation for future research.

It is clear from the setting of the registration tax in Norway that it favours the purchase of electric vehicles. Other accompanying measures related to this policy include exemption from road tolls in 1997 or exemption from parking fees on municipal-owned parking facilities in 1999 (see Ciccone and Soldani, 2021). However, these supports do not have a tax character and are revenue of the municipalities, so they do not affect the revenue side of the state budget.

This is, therefore, further support for this type of emission-free vehicle, which, albeit indirectly, positively affects the registration of new vehicles and lower volumes of registration tax collection. The indisputable benefit of the contribution is demonstrating the positive effect of setting up the tax system on increasing the number of emission-free vehicles.

The Norwegian experience is undoubtedly repeatable in other countries. At the same time, the Norwegian example can be a model for others who want to increase the number of electric cars in their fleets. This Norwegian experiment brought both positive and negative sides. The results showed that the setting of the tax policy has a definite effect on the support for the purchase of emission-free vehicles. On the other hand, as part of the research, we identified a definite decrease in registration tax collection. The question for tax policymakers is whether positive environmental benefits sufficiently compensate for the reduction in state budget income.

However, in the long term, the support for electromobility will reach a tipping point when the meaning of the current support in the tax regulations will significantly increase the number of this type of vehicle. Subsequently, there will undoubtedly be changes in the setting of tax policy parameters that will tax the ownership or operation of electric vehicles. For further research, it will be interesting to follow the development of the number of electric cars in countries other than Norway. Moreover, above all, how changes in the setting of tax policies will affect the revenues of the state budget in the short and long term. The idea will be to find a budget-neutral solution to support electromobility.

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