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Tax Implications of the Electromobility Development in the Czech Republic 2015–2023 Within the Context of EU Policies

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Abstract: This paper aims to identify tax externalities of an increased number of electric vehicles in the Czech Republic using a unique approach based on authors´ calculations and estimation based on accessible historical data. The study is focused mainly on decreased revenues of VAT and excise taxes applied to fossil fuels and road charges as cars with internal combustion engines are being replaced by electric vehicles. The obtained results show that the Czech Republic is in initial phase of electromobility development. There were 32,253 electric vehicles registered as of 31.12. 2022, which represent only 0.38% of all vehicles in the Czech Republic. However, the year-on-year increase recognized in recent years is significant up to 61%. Although current tax implications connected with the low share of electric vehicles can be treated as negligible to the total fiscal balance, the results show a multiple difference between the tax revenue connected with the operation of electric vehicles and tax loss relating to the fossil fuel vehicles being replaced (approximately 7 times higher). Therefore, despite other possible positive externalities, the electromobility development can represent significant issue for the future fiscal balance of the Czech Republic if the tax system is not adequately adjusted.

Keywords: electromobility; tax effect; fiscal policy; state budget; VAT; excise taxes

JEL Classification: H23; H30; H68

1. Introduction

The European Union (EU) defined a climate target plan for minimal decrease of greenhouse gas emissions by at least 55% below 1990 levels by 2030 and to get a carbon neutrality by 2050. As a result, the EU banned the sale of new passenger cars with combustion engines since 2035. Thus, the vehicle owners, passengers, and the whole automotive industry are highly motivated to zero-emission mobility represented mostly by electric vehicles (hereinafter referred as “EV”). However, decades of using combustion engines vehicles have influenced the fundamental setup of the tax system, especially amount of taxes annually expected in the state budget from the consumption of fossil fuels.

Friant et al. (2021) and Laroche et al. (2022) mentioned that electromobility can eliminate negative environmental impact of transportation and Hartley et al. (2020) and Punzo et al. (2022) support the idea that the electromobility is sustainable transportation alternative. Furthermore, Patola and Szpytko (2021) prefer wider implementation of autonomous driving

in electric cars which can represent reduction of human errors and, therefore, lead to lower electricity consumption.

Despite a strong motivation arising from EU regulations or general ecological or political philosophy (e.g., lower CO2 emissions, cleaner air, lower energy addiction on fossil fuel producers), the electromobility development can have significant impact on tax revenues and subsequently fiscal balance of state.

Government incentives and support as well as restrictions can represent important aspect in the electromobility development as mentioned by Bauer (2018) or Bjerkan et al. (2016). It mainly depends on country's fiscal and budget strategy, value and prices of electricity production and also the general attitude towards electromobility. Nevertheless, the connection between state incentives and electromobility development is analyzed in another part of authors' research.

This paper is focused solely on the impact on the tax collection in 2015–2022 arising from the electromobility development regardless the reason (state support or restrictions) of such development. This research verifies the hypothesis, that under the current Czech tax system the electromobility expansion has negative impact on the fiscal balance of the Czech Republic.

2. Methodology

Bonzi Teixeira et al. (2022) as well as Mitteregger et al. (2019) refer the main tax impact of the electromobility development on decrease of tax revenues relating to fuel consumption, especially excise tax on mineral oils, value added tax (further "VAT"), import duties, carbon taxes or other environmental fees. In addition to these taxes related to fuel consumption, other tax revenues relating to ownership and usage of vehicle may be impacted, e.g. road tax and toll. On the other hand, the tax revenue relating to electricity consumption may increase, in the Czech Republic especially tax on electricity or VAT.

Bonzi Teixeira et al. (2022) describes a complexity of measurement of tax revenue connected with the fuel consumption as countries do not typically present disaggregated data, especially data relating to the electricity consumed by electric vehicles. Furthermore, Bonzi Teixeira et al. (2022) analyses the net impact of fuel revenues and fuel subsidies which is not applicable in CZ (no subsidies on fuel consumption). As the tax system significantly varies in different countries, the research team considered a methodology of Bonzi Teixeira et al. (2022) or Leurent and Windisch (2012) as inappropriate for the application in the Czech environment. Moreover, the short data period available for 2015–2022 (affected by Covid-19 period 2020–2021) and initial phase of the electromobility development with low number of electric vehicles registered in the Czech Republic unable application of standard statistic methods. Non-validity of the statistical model applied on such narrow data set was also experienced by Filla et al. (2020).

Therefore, the research team implemented a unique approach based on the average fuel or electricity consumption and amount of particular type of vehicle registered in respective period, in particular:

1. Quantitative analysis of vehicles recorded in Central register of vehicles in the Czech Republic during the period 2015–2022.
2. Quantitative analysis of total fuel consumption end electricity consumed by electric vehicles (EV) in the Czech Republic during the period 2015–2022.
3. Quantification of the impact of EV registered in the Czech Republic on the tax revenues during the period 2015–2022.

The research team used a primary detailed disaggregated data from the Czech register of vehicles directly provided by a public research institution of the Czech Ministry of transportation and focused specifically on the category of passenger's cars (M1), light commercial vehicles (N1), buses (M2 and M3) and trucks (N2 and N3). From the fuel type perspective, the research focused on battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV) and fuel cell electric vehicles (FCEV). Total fossil fuel consumption and prices data were sourced in Czech national statistical office.

3. Results

3.1. Electromobility Development

The road transportation of the Czech Republic is primarily based on the vehicles using fossil fuel as petrol, diesel or alternatively liquified petroleum gas (LPG). Vehicles using other than fossil fuel represented by BEV, PHEV, FCEV, partly hybrid electric vehicles (HEV) or liquefied natural gas (LNG) and compressed natural gas (CNG) did not amount even 1% of all vehicles registered in the Czech Republic in 2022. Table 1 shows in detail the summary of vehicles registered in the Czech Republic in 2015–2022 classified by the type of fuel consumed.

Table 1. Summary of vehicles classified by the fuel consumed (in pc). (Centrum dopravního výzkumu, v.v.i. (2023))

	2015	2016	2017	2018	2019	2020	2021	2022
BEV	2,475	2,904	3,742	5,024	7,621	12,807	17,384	23,801
PHEV	-	-	-	-	-	2,535	5,229	8,440
HEV	313	536	847	1,948	4,641	4,851	7,178	9,335
FCEV	-	-	-	-	-	1	9	12
petrol	4,559,812	4,498,310	4,593,762	4,571,083	4,787,482	4,861,088	4,959,712	5,009,233
diesel	2,517,687	2,638,941	2,795,085	2,804,420	3,008,234	3,092,162	3,184,691	3,237,754
CNG	12,780	16,486	20,932	22,416	26,957	28,838	30,177	30,579
LNG	-	-	-	2	4	7	33	84
LPG	112,413	115,807	118,812	106,254	112,786	112,941	111,604	112,267
Other	884	858	851	4 619	832	812	787	766
Grand total	*7,206,364*	*7,273,842*	*7,534,031*	*7,515,766*	*7,948,557*	*8,116,042*	*8,316,804*	*8,432,271*

The total number of electric vehicles in category BEV, PHEV and FCEV was 32,253 as of 31. 12. 2022 which represent only 0.38% of all vehicles registered in the Czech Republic. However, significant increase in the number of electric cars in recent years 2020–2022 can indicate the start of electromobility adoption in the Czech Republic. While number of petrol and diesel vehicles increased year-on-year by 1.3% in 2022, the year-on-year increase of BEV was 37% and PHEV even 61% in 2022.

The electromobility development has been significantly evident since 2020 in the segment of passenger's cars (M1) and light commercial vehicles (N1) as shows Figure 1 and Figure 2. The segment of cargo trucks (N2 and N3) has not yet been influenced by the electromobility – only 11 BEV has been recorded in the Czech Republic as of 31. 12. 2022.

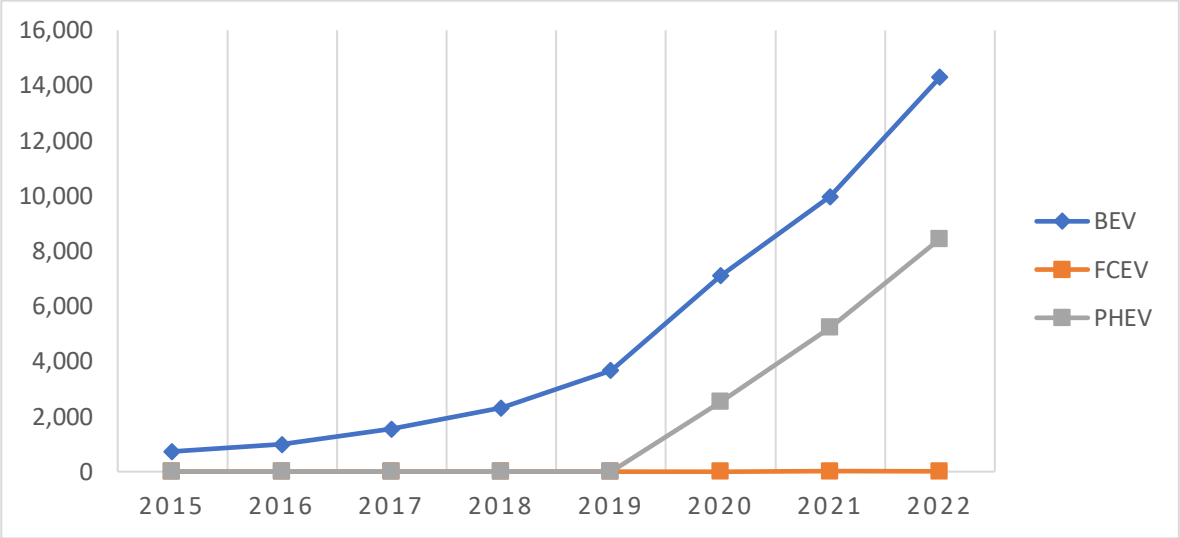

Figure 1. Electromobility development in passenger's car category (in pc) (Centrum dopravního výzkumu, v.v.i. (2023))

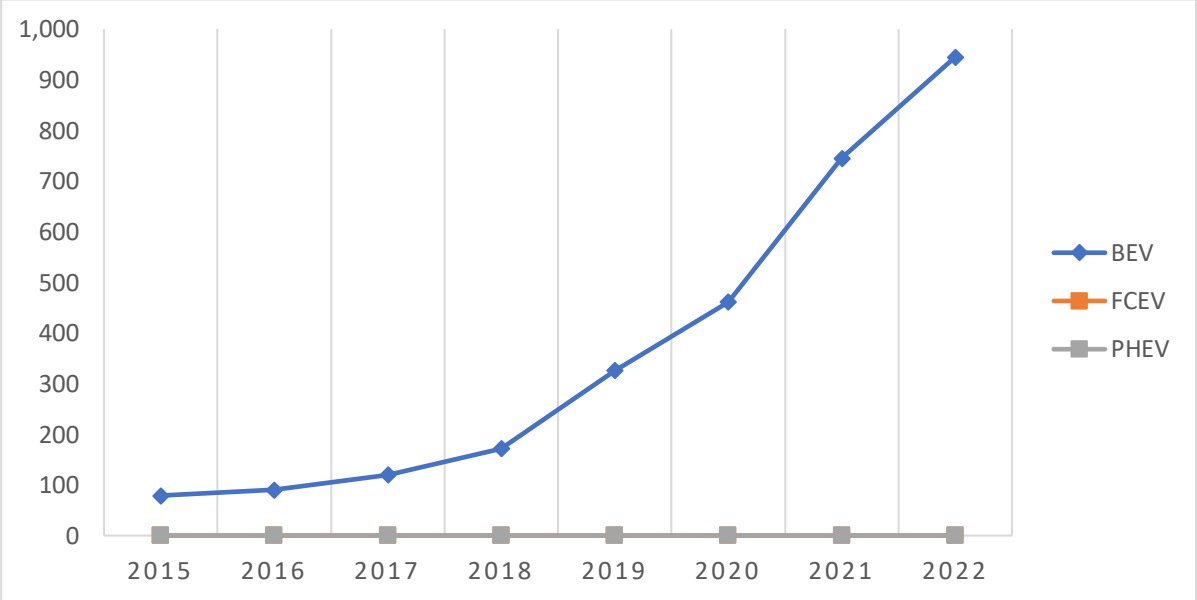

Figure 2. Electromobility development in LUV category (in pc) (Centrum dopravního výzkumu, v.v.i. (2023))

Although the period of 2015–2022 is too short to statistically prove a trend, the preliminary data of 2023 are consistent with such idea. Moreover, recent government support program of almost 2 billion CZK for acquisition of a new EV or new charging station construction can probably even accelerate the electromobility development in the Czech Republic.

The research team also analyzed the development of the public charging points especially in relation to the number of EV (Figure 3).

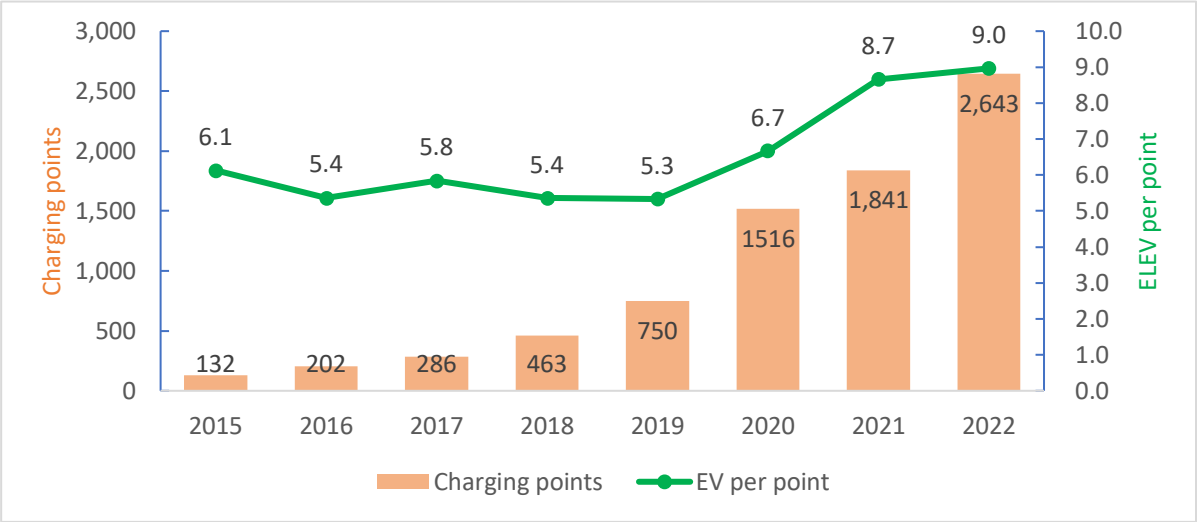

Figure 3. Development of public charging points in relation to EV in category M1, N1, N2, N3 (Centrum dopravního výzkumu, v.v.i. (2021), Ministry of industry and trade (2023), own calculation)

The number of public charging points increased from 132 in 2015 to 2,643 in 2022, however, the growth rate of EV was even higher. Therefore, 5 electric vehicles per one public charging point was recognized in 2019, while the proportion got worse in 2022 to 9 EV per one public charging point. The BUS category was excluded from the calculation based on the assumption of primary usage for city public transportation and, therefore, consuming electricity in non-public charging stations.

3.2. Consumption of Fossil Fuel and Electricity in Electric Vehicles

The major tax implications of transportation are closely connected with the consumption of fuel – fossil or alternatively electricity. The total consumption of fossil fuel (petrol and diesel) is regularly reported by the statistical office. However, the electricity consumed by EV is statistically monitored by the Ministry of Industry and Trade only in respect of public charging stations. The electricity supplied by non-public charging points has not yet been officially monitored in the Czech Republic. Therefore, the research team calculated the total amount of electricity consumed by EV based on number of registered EV, average annual mileage and average consumption of electricity per vehicle (Equation 1):

$$C = \sum_{i=1}^{n} x_i * m_i * c_i \quad (1)$$

where i = type of vehicle (M1-N3), x = number of vehicles of particular type, m = coefficient of average annual mileage, c = coefficient of average fuel (fossil or electricity) consumption per 100 km.

Coefficients m, c applied for the situation in the Czech Republic are summarized in Table 2 below. However, it may be different for other state based on specific socioeconomics situation (population density, average distance between municipalities, public transport development, etc.).

The consumption of fossil fuel and electricity consumed in EV are showed in following Figure 4 and Figure 5.

Table 2. Coefficients *m*, *c* applied for the Czech Republic (Diviš (2018), Sdružení dopravních podniků ČR (2022), Euroenergy (2021), Beck (2021), Peichl (2009), Bandivadekar et al. (2020))

Category of vehicle	**Passenger car**	**BUS**	**Light commercial vehicle**	**Cargo truck**
	M1	M2 + M3	N1	N2 + N3
Average annual mileage (in km)	8,053	39,182	19,100	124,800
Average electricity consumption (in kWh/100 km)	17	130	25	145
Average fuel consumption (in l/100 km)	7.13	41	7.2	24

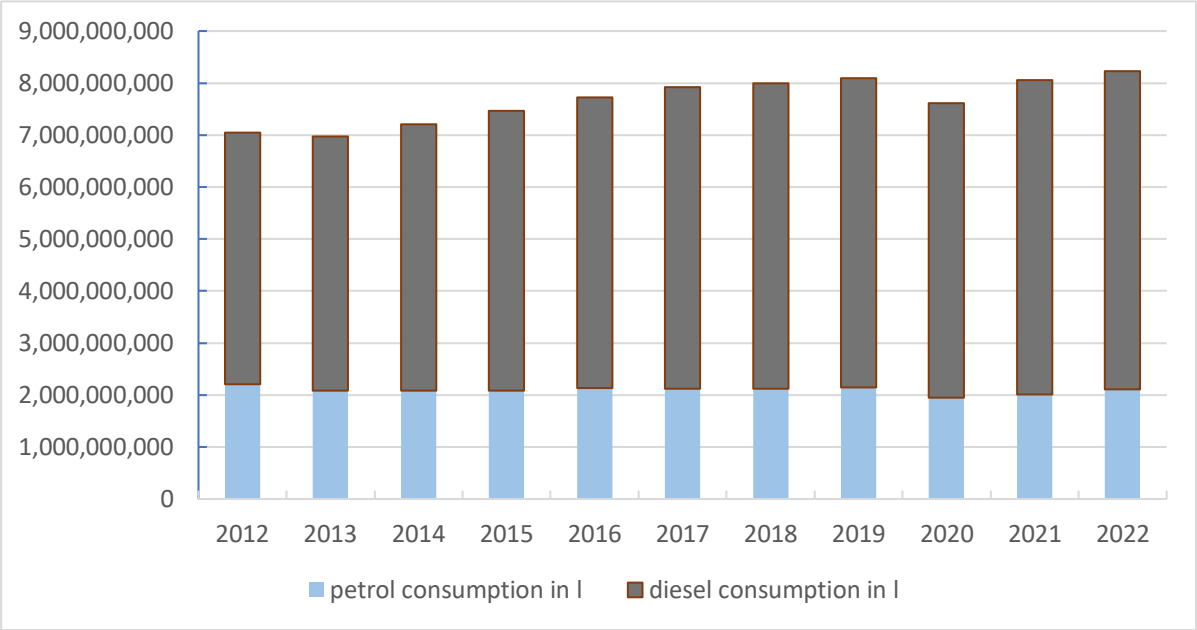

Figure 4. Consumption of fossil fuel (Czech statistical office (2017), Czech statistical office (2018), Czech statistical office (2022), Czech statistical office (2023b)

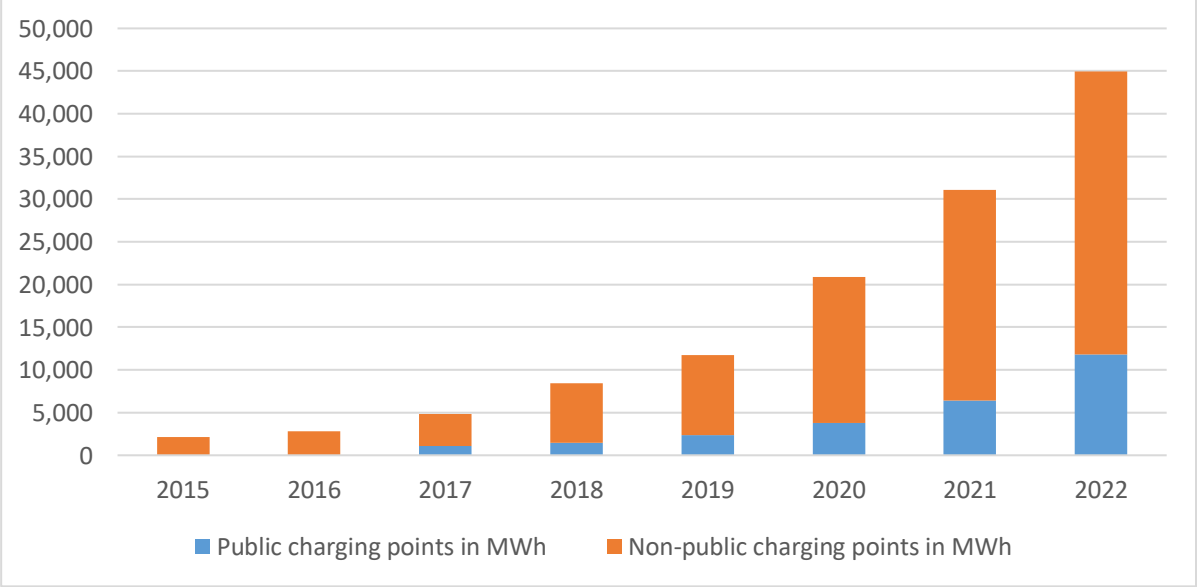

Figure 5. Consumption of electricity from public and non-public charging points (Ministry of industry and trade (2023) and own calculation)

The state administration has started with publishing data about electricity consumption in public charging points since 2017. Therefore, authors fully classified the electricity consumed in EV in 2015–2016 as consumption in non-public charging points. Based on the calculations, most of the electricity consumption has been realized in non-public charging stations so far which is also consistent with conclusions of Anderson et al. (2022).

3.3. Tax Implications of Electromobility Development

The usage of vehicles has various tax implications in the Czech Republic. Authors ignored those with minority or only time shifted impact on the fiscal balance, especially shortening the tax depreciation period of charging stations ("wallbox") from ten to five years, lower employee's taxation of EV provided by an employer to an employee for private purposes or free parking for EV as it is applied in a few Czech cities only.

The research focused on taxes applicable on electricity, petrol and diesel consumption, relating VAT and payments for road usage (road tax, toll and highway vignettes). Collection of excise tax from fossil fuel, road tax, toll and highway vignettes are reported by the state administration. However, VAT relating to fossil fuel consumption and the tax on electricity and VAT collected from the electricity consumed by EV must be specifically quantified (Table 3).

The authors based their calculation of the tax on electricity on the total electricity consumed by EV (chapter 3.2.) and the applicable tax rate of 28,30 CZK per MWh. VAT collected from electricity or from the fossil fuel consumed was calculated as follows:

$$VAT = C * \frac{p}{100\% + t} * t \quad (2)$$

where C = consumption of particular type of fuel (petrol, diesel, electricity), p = average annual price including VAT reported by the Czech statistical office, t = VAT rate applicable.

Table 3. Tax revenue relating to the use of vehicles (in mil. CZK) (Ministry of finance (2023), Ředitelství silnic a dálnic (2022), Státní fond dopravní infrastruktury (2024) and own calculation)

	2015	2016	2017	2018	2019	2020	2021	2022
Tax on electricity in EV	0.0606	0.0795	0.1368	0.2396	0.3319	0.5902	0.88	1.2731
VAT on electricity in EV	1.79	2.38	4.11	7.52	11.54	21.83	30.95	48.44
Taxes relating to EV	*1.85*	*2.46*	*4.24*	*7.76*	*11.87*	*22.42*	*31.83*	*49.71*
Excise tax on fossil fuel	82,700	86,700	88,900	90,000	92,400	84,900	82,300	78,900
VAT on fossil fuel	40,973	37,722	41,350	44,649	45,222	37,681	44,796	62,087
Fossil fuel taxes	*123,673*	*124,422*	*130,250*	*134,649*	*137,622*	*122,581*	*127,096*	*140,987*
Road tax	5,800	6,000	6,200	6,300	6,500	6,000	5,400	1,700
Highway vignettes	4,422	4,758	5,007	5,202	5,382	4,814	5,467	5,852
Toll	no data	9,876	10,390	10,805	10,936	11,519	14,194	14,967
Road charges	*10,222*	*20,634*	*21,597*	*22,307*	*22,818*	*22,333*	*25,061*	*22,519*
Fossil fuel taxes + road charges / tax revenues	16%	16%	16%	15%	15%	14%	15%	14%
Total vehicles taxes	*133,896*	*145,059*	*151,851*	*156,964*	*160,452*	*144,935*	*152,189*	*163,556*

Although petrol and diesel consumption have been roughly stable since 2017 (with the exception of 2020 due to the Covid-19 pandemic), excise duty collection has decreased since

2020 as the applicable tax rate has been reduced by 1 CZK per liter since 2021 and by 1.5 CZK per liter since 6/2022. On the other hand, VAT collected from the consumption of petrol and diesel increased significantly in 2022 as it is dependent not only on the amount consumed but also on fuel price.

Due to the initial phase of the development of electromobility in the Czech Republic and the expected consequences of the C-19 pandemic and the Russian-Ukrainian conflict, it was not possible to statistically demonstrate that the increase in EV affects the corresponding decrease in fossil fuel consumption with the associated reduction in excise tax and VAT.

However, making a simplifying assumption that every EV in particular category (M1 – N3) replaced one with combustion engine, the research team calculated the taxes lost in respect of such replacement (Table 4).

Table 4. Taxes collection lost due to the exchange combustion engine cars for EV (in mil. CZK)

Lost taxes	2015	2016	2017	2018	2019	2020	2021	2022
Excise tax on fossil fuel	9.16	12.08	20.42	34.88	49.24	94.78	134.71	186.21
VAT on fossil fuel	4.25	5.02	9.10	16.71	23.51	39.68	66.37	128.41
Highway vignettes	0.85	1.24	1.9	3.37	6.65	13.52	20.72	26.17
Toll	0.00	0.00	0.00	0.00	0.00	0.00	3.58	5.63
Total tax collection lost	*14.26*	*18.34*	*31.42*	*54.96*	*79.4*	*147.98*	*225.38*	*346.42*

The same methodology as described in chapter 3.2 was applied in calculation of taxes lost, i.e. based on fossil fuel not consumed by combustion engine vehicles as they were hypothetically replaced by EV.

The toll lost was calculated only in respect of cargo trucks (N2+N3) because combustion engine buses exchanged to EV are operated mostly in city public transportation, i.e. not on toll obligated roads. The highway vignettes revenue lost was calculated from number of combustion engine vehicles hypothetically replaced by EV and the weighted average of vignette prices applicable with respect to their various periods. However, future highway vignettes revenue loss will probably not grow at the same rate as only BEV and FCEV have been exempted from road tax since 2024 (i.e. HEV and PHEV not exempted any more).

The potential loss of road tax was not included in the calculation as only the vehicles used for business were subject to road tax till 2021 and there have not been available data about a share of vehicles used for business purposes. Moreover, passenger cars, light commercial vehicles and busses regardless the type of engine have been excluded from the road tax subject since 2022.

Although the impact on 2015–2022 fiscal balance was calculated in hundreds of millions CZK so far, the model shows hypothetical tax revenue loss in respect of combustion engine cars replaced by EV approximately 7 time higher than tax revenue collected from the EV operation (e.g. in 2022 tax revenue loss of 346.42 mil CZK versus additional tax collection of 49.71 mil CZK connected with EV). Therefore, a significant impact on fiscal balance can be expected during electromobility development in a near future as the fossil fuel taxes and other road charges amounted approximately 15% of total tax revenues in 2015–2022 (Table 3).

4. Discussion

According to Bonzi Teixeira et al. (2022) as well as Mitteregger et al. (2019) this paper also determines a direct tax effect of the electromobility development on decrease of tax revenues relating to fuel consumption, especially excise tax on mineral oils and VAT and also decrease of other road charges which are not relevantly covered by the taxes collected from the increase of electricity consumption. Due to the limited data period and initial phase of electromobility development in the Czech Republic, non-validity of the statistical models applied on such narrow data set was experienced as well as Filla et al. (2020).

Nevertheless, the primary detailed data set showed significant development of electromobility in the Czech Republic during 2019–2022, especially in the segment of passenger's cars and LUV. While number of petrol and diesel vehicles increased year-on-year by 1.3% in 2022, the year-on-year increase of BEV was 37% and PHEV even 61% in 2022. However, exact data about the proportion of using PHEV as electric vehicle versus combustion engine vehicle were not available for the research.

The calculations of tax implications were based primarily on the number of vehicles in particular category and coefficients of annual average mileage and average fossil fuel or electricity consumption. However, such coefficients may differ in states based on the other socioeconomics factors as population density, average distance between municipalities or public transport development.

The model confirmed the hypothesis of the research team that the electromobility development has had the negative impact on the fiscal balance of the Czech Republic in the period 2015–2022 caused by approximately 7-time higher annual tax revenue loss of excise tax, VAT, toll and highway vignettes which has not been sufficiently covered by additional collection of the tax on electricity and VAT from electricity consumed by EV.

Furthermore, if the electronic vehicle is charged from the private photovoltaic power plant (PFV), no tax on electricity nor VAT is collected from this electricity consumed at all. As a result, negative impact on the fiscal balance might be even higher. However, there are not available relevant data for exact quantification of electricity produced by PFV and consumed in EV.

Although the quantified tax loss appears to be currently negligible (e.g. 346.42 mil CZK hypothetically lost versus 163,556 mil CZK collected in 2022), the effect will significantly multiply when the number of EV grows. The ultimate impact on the fiscal balance can be significant as the tax revenues collected from fossil fuel consumption and other road charges was approximately 15% of total tax revenues during the period 2015–2022.

However, the prediction models and determination of other tax revenue sources covering anticipated loss of tax revenues are subject to future part of the authors´ research.

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Conflict of interest: none.

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