THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

BRIEFING

APRIL 2019

Vehicle registration tax as a policy instrument to help reducing CO_2 emissions and fuel consumption in Turkey

Vehicle taxes in Turkey are among the highest in all of Europe. In particular, the Turkish registration tax on new passenger cars (Özel Tüketim Vergisi, or ÖTV) has a strong impact on consumer purchase behavior and vehicle market structure.[1] However, the ÖTV currently does not directly take into account the emissions level of a vehicle, and thereby provides only a limited incentive for consumers to opt for passenger cars with low- or zero-emissions. This is different from most of the European Union (EU) member states, where vehicle manufacturers are obliged to reduce the average carbon dioxide (CO_2) level of their new cars and consumer purchase decisions are driven by taxation systems based partly or entirely on the CO_2 emission level of the vehicles available on the market.[2]

1 Murat Şenzeybek and Peter Mock, *Passenger car emissions in Turkey: A baseline analysis of current vehicle taxation policies in Turkey and their impact on new and used passenger cars*, (ICCT: Washington, DC, 2019), https://www.theicct.org/publications/passenger-car-emissions-turkey

2 Peter Mock, *CO_2 emission standards for passenger cars and light-commercial vehicles in the European Union*, (ICCT: Washington, DC 2019), https://www.theicct.org/publications/ldv-co2-stds-eu-2030-update-jan2019; Sandra Wappelhorst, Peter Mock, and Zifei Yang, *Using vehicle taxation policy to lower transport emissions - an overview for passenger cars in Europe*, (ICCT: Washington, DC 2019),https://www.theicct.org/publications/using-vehicle-taxation-policy-lower-transport-emissions

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Figure 1 provides a comparison of the average CO_2 emission level of newly registered cars in Turkey and the EU. The emission level in the EU decreased, according to the New European Driving Cycle (NEDC), from a level of 159 grams CO_2 per kilometer (g/km) in 2007 to 119 g/km in 2017. Regulation ensures that emissions will further decrease, to a level of about 59 g/km by 2030. In cases of non-compliance, vehicle manufacturers will be subject to high penalties. In Turkey, on the other hand, average new car CO_2 emissions were lower than in the EU until the year 2013 but now are at approximately the same level as the heavier and more powerful EU fleet. Currently, Turkey has no mandatory CO_2 targets in place for vehicle manufacturers, nor does it account for CO_2 emissions as part of its vehicle taxation scheme. As a result, it is likely that new car CO_2 emission levels will decrease only at the same pace as in previous years at about 2.5 g/km per year. This would result in Turkey's new car fleet having nearly 50% higher CO_2 emissions by 2030 than the EU new car fleet, or about 87 g/km vs. 59 g/km.

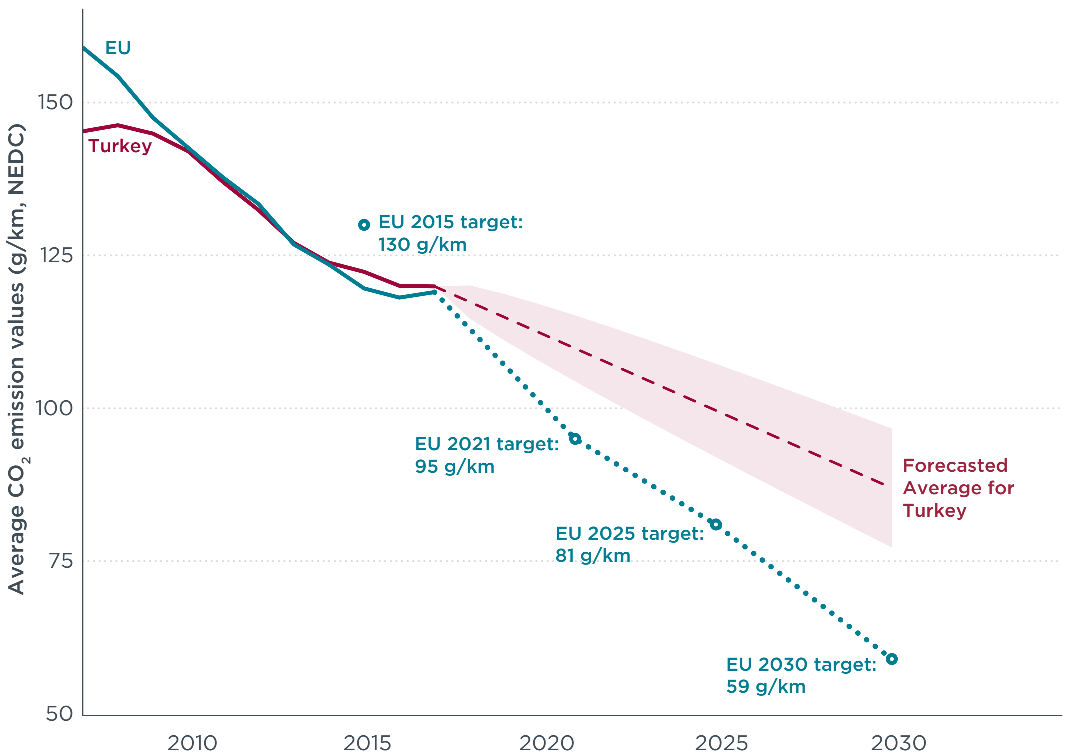

Figure 1. 2007 to 2017 average CO_2 emission levels of newly registered cars in Turkey and in the EU, according to the New European Driving Cycle (NEDC). Mandatory EU targets are estimated based on adopted regulations. Forecasted averages for Turkey are estimated using a time series ARIMA model from Rob Hyndman & George Athanasopoulos, Forecasting Functions for Time Series and Linear Models (Updated January 18, 2019), https://cran.r-project.org/web/packages/forecast/forecast.pdf. Source: ODD [Turkish Automotive Distributer's Association], "Passenger Car and Light Commercial Vehicle Market Evaluation"; Peter Mock, *CO_2 emission standards for passenger cars and light-commercial vehicles in the European Union*

This paper provides an overview of the current passenger car ÖTV scheme in Turkey, illustrates alternative approaches introduced in other countries, and develops a scenario for how the Turkish government could modify the current passenger car ÖTV scheme by adding a CO_2 component.

THE CURRENT SITUATION IN TURKEY

Currently, the ÖTV system for passenger cars is solely based on the engine displacement and the net, or pre-tax, price of a vehicle. For hybrid-electric vehicles (HEVs) and battery-electric vehicles (BEVs), the power of the electric engine is also taken into account and in some cases linked to discounted ÖTV rates (Table 1).

Table 1. ÖTV rates for conventional combustion engine, hybrid-electric and battery-electric passenger cars.

Engine displacement [liters - l]	Electric engine power [kilowatt - kW]	Vehicle net price [Turkish Lira - ₺]	ÖTV rate [%]	ÖTV group	New car market share (2017)
Conventional combustion engine passenger cars					
≤1.6l	n/a	≤70,000 ₺	45%	1	36%
≤1.6l	n/a	70,000 ₺ - 120,000 ₺	50%	2	54%
≤1.6l	n/a	>120,000 ₺	60%	3	6%
1.6 - 2.0l	n/a	≤170,000 ₺	100%	4	3%
1.6 - 2.0l	n/a	>170,000 ₺	110%	5	<1%
>2.0l	n/a	n/a	160%	6	<1%
Hybrid-electric passenger cars					
≤1.6l	any	≤70,000 ₺	45%	1	<0.1 %
≤1.6l	any	70,000 ₺ - 120,000 ₺	50%	2	-
≤1.6l	any	>120,000 ₺	60%	3	-
1.6 - 1.8l	>50 kW	≤85,000 ₺	45%	1	<1%
1.6 - 1.8l	>50 kW	85,000 ₺ - 135,000 ₺	50%	2	-
1.6 - 1.8l	>50 kW	>135,000 ₺	60%	3	-
1.6 - 1.8l	≤50 kW	≤170,000 ₺	100%	4	-
1.6 - 1.8l	≤50 kW	>170,000 ₺	110%	5	-
1.8 - 2.0l	any	≤170,000 ₺	100%	4	-
1.8 - 2.0l	any	>170,000 ₺	110%	5	-
2.0 - 2.5l	<100 kW	any	160%	6	-
2.0 - 2.5l	>100 kW	≤170,000 ₺	100%	4	<0.1%
2.0 - 2.5l	>100 kW	>170,000 ₺	110%	5	-
>2.5l	any	any	160%	6	-
Battery-electric passenger cars					
n/a	<85 kW	any	3%	E1	<0.1%
n/a	85 - 120 kW	any	7%	E2	-
n/a	>120 kW	any	15%	E3	<0.1%

Notes: ÖTV rates are multiplied with vehicle net price to result in the absolute tax level. In November 2018, the Turkish government announced a temporary (until 2019, without a date currently specified) ÖTV reduction for passenger cars in tax category 1 (ÖTV rate 30% instead of 45%) and 2 (ÖTV rate 35% instead of 50%).
Source: Revenue Administration, Özel Tüketim Vergisi Tutarları Ve Oranları. (January 7, 2019), http://www.gib.gov.tr/fileadmin/mevzuatek/otv_oranlari_tum/ozeltuketimoranlari-OpenPage.htm

For combustion engine vehicles with a displacement of 1.6l and more, the ÖTV is at least as much as the net price of the vehicle. This provides a strong incentive for consumers to choose a vehicle with a smaller engine displacement, although not necessarily with less engine power (96% of all new cars in Turkey have an engine displacement of less than 1.6l).

At the same time, the tax does not take the level of CO_2 emissions from vehicles into consideration. For HEVs and BEVs, reduced ÖTV rates apply, but tax reductions for HEVs are limited to only specific vehicle models.[3] As a result, the incentive structure for HEVs is complex to understand from a consumers' perspective. For BEVs, despite a rather clear incentive structure and strong incentive levels, the resulting tax benefit is not sufficient to balance out the typical price differential between a conventional combustion engine vehicle and a BEV in Turkey. Consequently, the market shares of HEVs and BEVs in Turkey are well below those in other markets, at approximately 0.6% in 2017, compared to 4.1% in the EU.[4] However, HEV sales in Turkey have strongly increased from about 1,000 in 2016 to about 4,500 in 2017, after the Turkish government introduced a reduction in ÖTV rates for a selection of HEV models in 2016.[5]

Figure 2 illustrates the current ÖTV rates and CO_2 emission levels for the top-selling vehicle models, differentiated by fuel type. All the top-selling vehicles fall into the first three tax categories, with an ÖTV rate between 45-60%. The figure also shows that the ÖTV rate is not linked to the CO_2 emission level of a vehicle. For example, the Renault Mégane which is manufactured domestically in Turkey, emits 99 g CO_2/km and is subject to a 50% ÖTV rate, while the Dacia Duster, produced in Romania, emits 129 g CO_2/km and is only subject to a 45% ÖTV rate.[6] Taking into account the price of the Mégane is about 25.000₺ higher pre-tax than the Duster, the overall ÖTV payment for the Mégane turns out to be nearly 60% higher than for the Duster, despite its significantly lower CO_2 emission level.

3 As a result of the tax incentives, HEVs with 1.6-1.8l engine displacement and more than 50 kW engine power fall into ÖTV groups 1, 2 or 3 instead of 4 or 5. Similarly, HEVs with 2.0-2.5l engine displacement and more than 100 kW engine power fall into ÖTV groups 4 or 5 instead of 6.

4 Peter Mock (ed.), *European Market Statistics Pocketbook 2018/19,* (ICCT: Washington, DC, 2018), http://eupocketbook.org.

5 Murat Şenzeybek and Peter Mock, *Passenger car emissions in Turkey: A baseline analysis of current vehicle taxation policies in Turkey and their impact on new and used passenger cars*

6 "Mioveni Plant (DACIA)," Groupe Renault, accessed April 10, 2019, https://group.renault.com/en/our-company/locations/our-industrial-locations/pitesti-plant-2/.

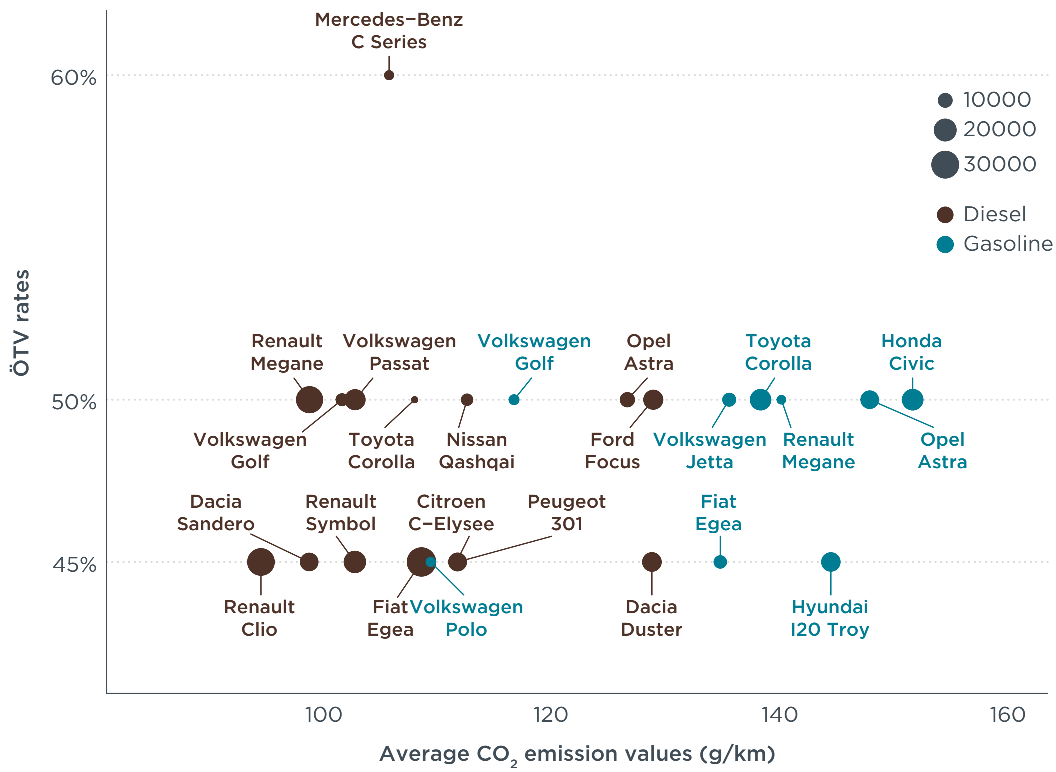

Figure 2. ÖTV rates vs. CO_2 emissions of top selling passenger car models in Turkey in 2017. *Notes*: Only model / fuel type configurations with at least 7,500 registrations are shown. The bubble size indicates the number of registrations. Sources: Peter Mock (ed.), *European Market Statistics Pocketbook 2018/19*; ODD [Turkish Automotive Distributer's Association], "Passenger Car and Light Commercial Vehicle Market Evaluation"

ALTERNATIVE APPROACHES IN SELECTED EUROPEAN COUNTRIES

Figure 3 compares the passenger car tax systems in place in Turkey, France, Germany, the Netherlands, and the United Kingdom (UK). In addition to the registration tax, the comparison takes into account other elements, such as value added tax (VAT), ownership and fuel taxes, and one-time bonus payments on vehicle acquisition. Vehicle registration tax and one-time incentives at the point of purchase provide the strongest driver for consumers in all these markets. The figure shows that taxes are the lowest for BEV models in all countries, as they provide substantial fiscal incentives for BEVs and, in the case of France, Germany, and UK, for plug-in hybrid electric vehicles (PHEVs). At the same time, the Netherlands and France apply exponentially increasing taxes for vehicles with higher CO_2 emission levels. Turkey, on the other hand, is the only country in which the tax for a PHEV is higher than for a comparable gasoline car. Furthermore, unlike the other countries shown, the tax for a gasoline car in Turkey does not increase with increasing CO_2 emission levels.

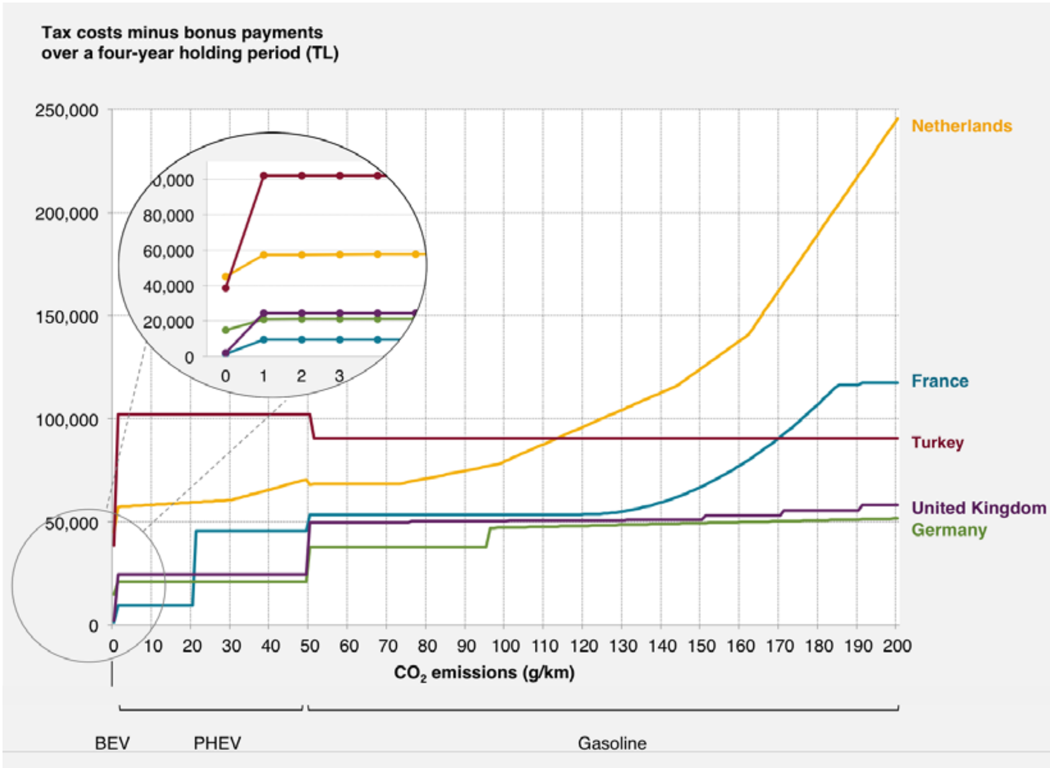

Figure 3. Comparison of vehicle taxation policies over a four-years holding period for cars in private ownership, based on CO_2 emissions and applicable for the tax year 2018. Pre-tax vehicle prices of BEV, PHEV and gasoline versions of the VW Golf model are used for the underlying calculations. On the Turkish market, BEV and PHEV versions of the VW Golf are not available, which is why for these versions, pre-tax prices for the German market were applied and adjusted according to the price difference of the gasoline version between the two countries. Source: Adapted to include Turkey based on figure from Sandra Wappelhorst, Peter Mock, and Zifei Yang, *Using vehicle taxation policy to lower transport emissions - an overview for passenger cars in Europe*

Fiscal incentives for zero- and low-emission vehicles, in combination with increased taxes for vehicles with higher CO_2 levels, have a notable effect on new car fleet emissions (Figure 4). The Netherlands is a good example, as the average CO_2 level decreased strongly after a reform of the vehicle tax system in 2009.[7] In Turkey, however, in the absence of CO_2 performance standards for manufacturers as well as a CO_2 based vehicle taxation scheme, emission values have decreased at a slower pace than for the other markets.

7 Peter Mock, *The role of standards in reducing CO_2 emissions of passenger cars in the EU*, (ICCT: Washington, DC, 2018), https://www.theicct.org/publications/role-standards-reducing-co2-emissions-passenger-cars-eu.

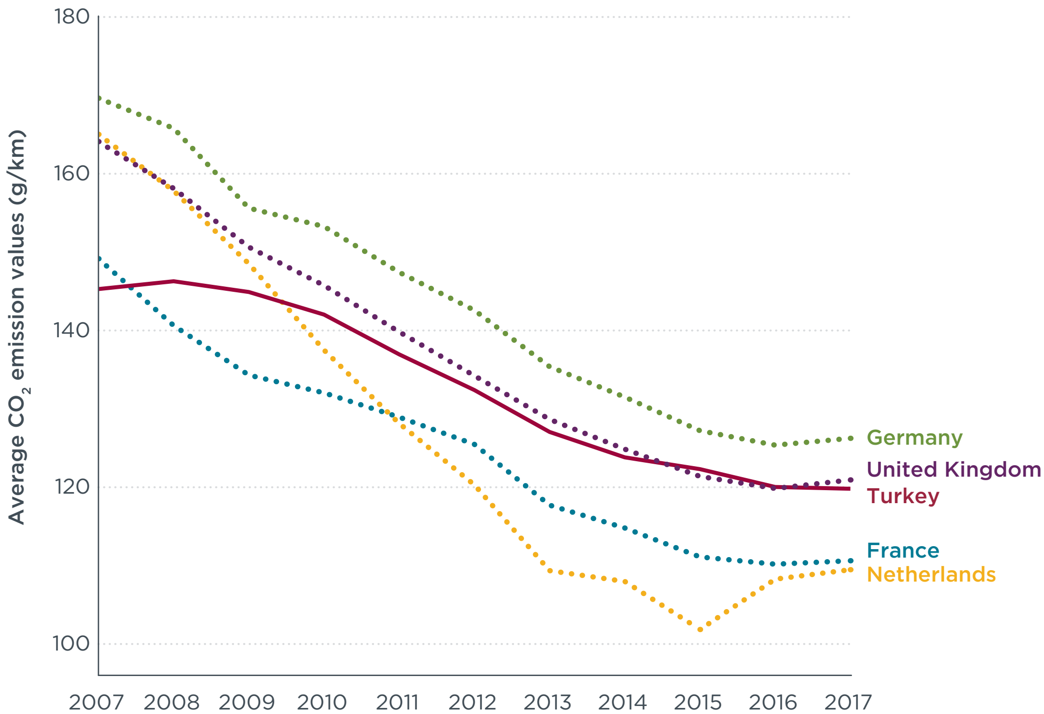

Figure 4. Average CO_2 emission level (in NEDC) of new passenger cars for selected markets from 2007 to 2017. Sources: Peter Mock (ed.), *European Market Statistics Pocketbook 2018/19*; ODD [Turkish Automotive Distributer's Association], "Passenger Car and Light Commercial Vehicle Market Evaluation"

Given the particularly high ÖTV rates for vehicles with an engine size of 1.6l and above in Turkey, transitioning directly from today's ÖTV system based on engine displacement and net price of a vehicle to a system solely or largely based on CO_2 emissions could cause strong market distortions. However, introducing a CO_2 component to the current tax scheme and strengthening it over time provides a viable option. Figure 5 illustrates how such a transition could be initiated by maintaining the current six ÖTV categories that are differentiated by engine displacement and net price and adding CO_2 as an additional determining factor.

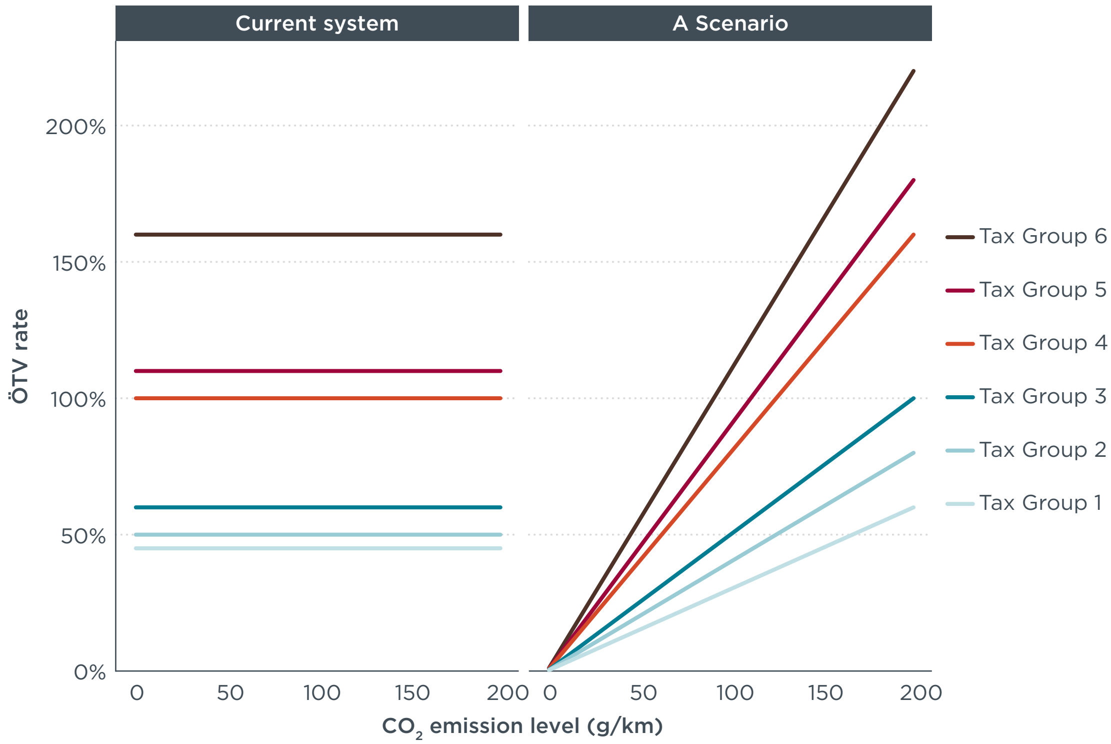

Figure 5. Illustration of the current ÖTV system for passenger cars in Turkey (left), in comparison to an alternative scenario that introduces a vehicle's CO_2 emission level as another component to the tax system (right).

SCENARIO FOR INTRODUCING A CO_2 COMPONENT TO THE TURKISH VEHICLE TAX

A scenario for modifying the Turkish ÖTV to take into account CO_2 emissions of a vehicle, as shown in Table 2, is based on the following principles:

» The overall tax revenue before and after modifying the ÖTV system is kept constant. Expected changes in consumer preference for individual vehicle models are taken into account by modeling price-demand elasticity.[8] This will ensure that there will be no loss in revenue for the government. To assure there is constant tax revenue over time, a regular re-adjustment of the ÖTV tax rates is necessary.

» The basic structure of the current ÖTV system, with six tax categories for combustion engine vehicles based on engine displacement and net price, is kept the same. The new ÖTV rate for each tax category respectively is now calculated taking into account the CO_2 emission level of a vehicle.

» The base tax rate, to be multiplied with the CO_2 emission level, is the same for all vehicles within a ÖTV group. It is calibrated so that a vehicle with the same CO_2 level as the average CO_2 level of all vehicles within its ÖTV group will be subject to the same ÖTV rate than before modifying the ÖTV system (see Appendix, Table A1). Vehicles

8 Vehicle sales after adapting the tax system were estimated by using current sales data and applying assumptions regarding consumer price-demand elasticity for the following one year. New car sales are negatively correlated with price increase and positively correlated with price increase for similar vehicles and changes of the market share within a vehicle segment. See Appendix, Table A1, for details.

with below-average CO_2 will be subject to a lower ÖTV rate and vehicles with above-average CO_2 will be subject to a higher ÖTV rate than before.

» For diesel cars, an extra surcharge is introduced. This is to take into account that diesel passenger cars of the Euro 6 standard in 2018 were found to emit on average about six times higher nitrogen oxides (NO_x) emissions than Euro 6 gasoline cars.[9] Without adding a surcharge, because CO_2 emission levels tend to be slightly lower for diesel cars, vehicles with diesel engines would have a tax advantage, thereby disregarding their higher NO_x emissions. By including a surcharge, the sales-weighted average of the ÖTV rates for diesel and gasoline vehicles are approximately the same, no longer providing diesel cars with a tax advantage. A similar diesel surcharge is, for example, applied in the Netherlands.[10]

Table 2. Current ÖTV scheme for combustion engine vehicles as well as alternative tax rates taking into account vehicle CO_2 emission levels.

ÖTV group	Current ÖTV rate	New ÖTV rate	
		CO_2 part (gCO_2/km * CO_2 component)	Diesel surcharge (only for diesel cars)
1	45%	(CO_2 * 0.3)%	(CO_2 * 0.05)%
2	50%	(CO_2 * 0.4)%	(CO_2 * 0.05)%
3	60%	(CO_2 * 0.5)%	(CO_2 * 0.05)%
4	100%	(CO_2 * 0.8)%	(CO_2 * 0.05)%
5	110%	(CO_2 * 0.9)%	(CO_2 * 0.05)%
6	160%	(CO_2 * 1.1)%	(CO_2 * 0.05)%

Figure 6 shows, analogous to Figure 2, the tax rates of the top-selling vehicle models in Turkey, however applying the alternative ÖTV scheme taking into account CO_2 emission levels. In addition to the top-selling model by fuel type configurations, the hybrid-electric version of the Toyota C-HR is shown to illustrate the effect of the alternative ÖTV scheme on HEVs.

9 Yoann Bernard, Uwe Tietge, John German, & Rachel Muncrief, *Determination of real-world emissions from passenger vehicles using remote sensing data*, (ICCT: Washington, DC, 2018). Retrieved from: https://www.theicct.org/publications/realworld-emissions-using-remote-sensing-data

10 The surcharge in the Netherlands is 87 Euro for diesel passenger cars above 63 g CO_2/km in 2018. An average new diesel car in the Netherlands emits 110 g/km of CO_2 and costs 40,000 Euro. As a result, the diesel surcharge is 4,100 Euro for an average diesel car, which corresponds to approximately 10% of vehicle price and 16% of vehicle pre-tax price. Peter Mock (ed.), *European Market Statistics Pocketbook 2018/19*; ACEA [European Automobile Manufacturers' Association], "ACEA Tax Guide", https://www.acea.be/uploads/news_documents/ACEA_Tax_Guide_2018.pdf

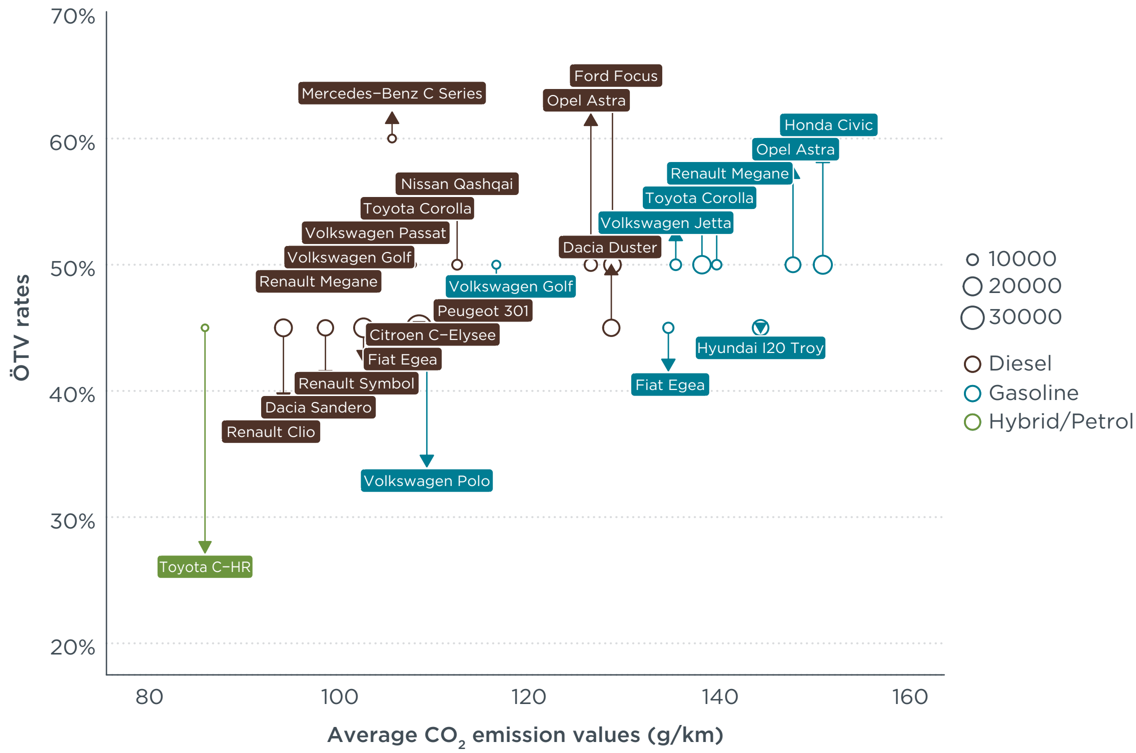

Figure 6. ÖTV rates vs. CO_2 emissions of top selling passenger car models in Turkey in 2017. Only model by fuel type configurations with more than 7,500 registrations are shown with the exemption of the Toyota C-HR HEV). Circles illustrate current ÖTV rates, arrows indicate new ÖTV rates in alternative scenario.

As shown, HEVs tend to have the strongest advantage in the CO_2-based ÖTV system; the tax rate for the Toyota C-HR drops from 45% to 26%. Conventional gasoline and diesel vehicles can also benefit in the alternative scenario, despite the diesel surcharge, depending on their CO_2 emission level. Unlike the case in Figure 2, the ÖTV rate of 54% for the Dacia Duster, which emitted 129 g/km, would be higher than for the Renault Mégane (99 g/km, 49%) under the revised tax system.

All manufacturers were found to either have a low-CO_2 vehicle model available for sale in the Turkish market or a model in production, so consumer demand could be shifted towards these low-emission configurations without a major impact on manufacturer market share. Examples include the Toyota C-HR (87 g/km), the Renault Clio (95 g/km) and Symbol (103 g/km), or the Volkswagen Polo (109 g/km). In the case of Honda, the gasoline version of the Civic had a relatively high CO_2 emission level (151 g/km) but an updated diesel version of the Civic with a significantly lower CO_2 emission level (91 g/km) has been produced in Turkey since 2018.

CONCLUSIONS

The registration tax on new passenger cars in Turkey has a strong impact on consumer purchase behavior and vehicle market structure by effectively limiting 96% of the fleet to engines of less than 1.6l displacement. However, the current tax system does not take into account the CO_2 emission level of a vehicle. Incentives for HEVs and BEVs exist but are, in the case of HEVs, rather complex and, in the case of BEVs, not sufficient to drive a significant market uptake. In absence of mandatory CO_2

targets for vehicle manufacturers and a CO_2-based vehicle taxation system, such as it is already in place in most EU member states, Turkey risks falling behind in reducing emissions from passenger cars and in driving technology innovation in one of the country's key industries.

The alternative ÖTV scenario outlined in this paper demonstrates how it would be possible to modify the current ÖTV scheme by adding a CO_2 component, thereby providing an incentive for consumers to opt for vehicles with lower emission levels. An important aspect of the analysis was to ensure tax budget neutrality from a government perspective and to avoid any sudden major market distortions. The results show that every major manufacturer operating in the Turkish market already offers vehicle versions with lower CO_2 emission levels. Transitioning to a ÖTV system with a CO_2 component would therefore provide an opportunity for manufacturers to promote these low-CO_2 options, thereby driving technology innovation and emission reductions.

It is important to emphasize that the scenario provided in this paper is only one possible alternative for a revised ÖTV system. The coefficients derived should be updated on a regular basis to take into account recent market developments, and rates should be adjusted to ensure sustainable tax revenue flow while continuing to drive further technology innovation and emission reductions.

Applying a demand-price elasticity function, it is estimated that the one-year effect of transitioning to a ÖTV system that accounts for CO_2 emission levels using the coefficients suggested in this paper would be a fleet-wide CO_2 reduction of about 1.5 g/km for new passenger cars. Assuming 500,000 new car sales per year[11] and a lifetime mileage of 150,000 km per car, this translates to about 113,000 tons of CO_2 saved. Given that CO_2 emissions of a vehicle and its fuel consumption are directly linked, this figure can be translated into about 4.5 billion liters of fuel saved. The expected savings in the long-run are much higher. The experience in other markets such as the Netherlands show that vehicle manufacturers adapt their product portfolio to the structure of the taxation scheme, thereby offering an increasing number of low-emission vehicles and further leveraging the effect on consumer choice. For Turkey, as a fuel importing country with a strong automotive industry, this shift towards innovative technologies and away from high fuel-consuming imports implies not only significant emission reductions, but also a strong opportunity for economic growth.

11 ODD [Turkish Automotive Distributer's Association], "Passenger Car and Light Commercial Vehicle Market Evaluation"

APPENDIX

AVERAGE FLEET VALUES FOR EACH ÖTV GROUP

Table A1 shows the sales-weighted average CO_2 emission level and the average pre-tax price for each of the ÖTV tax groups. Using this data, it is possible to calculate the average ÖTV tax paid for a vehicle within each group, and the ÖTV tax amount and ÖTV rate per g CO_2/km. These figures provide the input for calibrating the base tax rates shown in Table 2.

Table A1. Sales-weighted average fleet values for each ÖTV group.

ÖTV Group	Fuel type	CO_2 average (g/km)	Average pre-tax price (TL)	Average ÖTV amount (TL)	Average ÖTV per gCO_2/km (TL)	ÖTV rate per g CO_2/km
1	Diesel	109	58,011	26,105	240	0.004
1	Gasoline	130	58,498	26,324	203	0.003
2	Diesel	109	94,549	47,274	434	0.005
2	Gasoline	139	88,427	44,213	319	0.004
3	Diesel	119	124,206	74,523	624	0.005
3	Gasoline	135	127,540	76,524	569	0.004
4	Diesel	132	123,468	123,468	938	0.008
4	Gasoline	155	133,438	133,438	860	0.006
5	Diesel	156	176,631	194,295	1243	0.007
5	Gasoline	145	221,683	243,851	1681	0.008
6	Diesel	193	147,694	236,311	1224	0.008
6	Gasoline	217	210,860	337,377	1557	0.007

Note: Data from Peter Mock (ed.), European Market Statistics Pocketbook 2018/19, (ICCT: Washington, DC, 2018), http://eupocketbook.org ; ODD [Turkish Automotive Distributer's Association], "Passenger Car and Light Commercial Vehicle Market Evaluation (2018)," http://www.odd.org.tr

ESTIMATING NEW VEHICLE REGISTRATIONS AFTER ADAPTING THE ÖTV SYSTEM

Equation 1: Estimating total price of a vehicle

$$\text{Price of vehicle}_i = (\text{Pre-tax price of vehicle}_i) \times (1 + \text{ÖTV rate vehicle}_i) \times (1 + \text{VAT})$$

Equation 2.1: Estimating new registrations of a vehicle

$$\textit{New registration of vehicle } i = \textit{old registration of vehicle } i \times (1 + \%\Delta Ri)$$

$\%\Delta Ri$ = percentage change in sales of vehicle$_i$, determined by applying the elasticity for vehicle$_i$ and the corresponding segment of vehicle$_i$.

Equation 2.2: Estimating the percentage change in demand for a vehicle$_i$

$$\%\Delta Ri = eo(\%\Delta Pi) + ec(\%\Delta PRi) + \%\Delta S$$

eo = *Price-demand elasticity of vehicle$_i$*
$\%\Delta Pi$ = *Percentage change of the price of vehicle$_i$*

ec = *Cross price-demand elasticity of similar models (models within the same segment)*

$\%\Delta PRi$ = *Percentage change of the average price of similar models (within the same segment)*

$\%\Delta S$ = *Percentage changes in the market share of Segment (the segment of vehiclei)*

eo and *ec* are taken from literature.[12] The term $eo(\%\Delta Pi) + ec(\%\Delta PRi)$ represents the effect of the price change of an individual vehicle model as well as its competing vehicle models. Only price changes vehicles within the same segment are included, therefore, exogenous effects of segment price and demand changes are added as $\%\Delta S$[13], representing percentage changes in the market share of vehicle segments.

Equation 2.3: Estimating the percentage change in demand within segment j

$$\%\Delta Sj = \frac{\left(\frac{NSj}{\Sigma_j NSj} - \frac{OSj}{\Sigma_j OSj}\right)}{\frac{OSj}{\Sigma_s OSj}}$$

NSj = New total sales of segment j

OSj = Old total sales of segment j

Equation 2.4: Estimating the new total sales of segment j

$$NSj = OSj \times \left(1 + \left(\sum_t (\%\Delta P(St) \times ejt)\right)\right)$$

$\%\Delta P(St)$ = *Percentage change of average price of segment t*

ejt = Cross elasticity of segment t and segment j (see Table A2)

SEGMENT ELASTICITY AND TRANSFORMATION

To be able to determine the term *NSj* in Equation 2.4, and subsequently, $\%\Delta S$ in Equation 2.1, the elasticity for individual segments is required. There is no analysis in this respect available in literature specifically for the Turkish passenger car market, so instead established factors for other markets are used (Table A2).

12 C. Emre Alper & Ayse Mumcu, *Türkiye'de Otomobil Talebinin Tahmini*, (Bogazici University, Department of Economics: Istanbul, 2005), https://ideas.repec.org/p/bou/wpaper/2005-01.html.

13 Andrew Kleit, "Impacts of Long-Range Increases in the Fuel Economy Standards," *Economic Inquiry, 42* (2), 279-294.

Table A2. Demand elasticities of vehicle segments

Elasticity	Small car	Medium car	Large car	Sport car	Luxury car	Small truck	Large truck	Small SUV	Large SUV	Minivan	Van
Small car	-2.808	0.423	0.063	0.018	0	0.036	0.027	0.009	0.009	0.009	0
Medium car	0.684	-3.528	1.107	0.027	0.018	0.018	0.018	0.036	0.045	0.054	0.009
Large car	0.27	1.926	-4.5	0.027	0.216	0.009	0.054	0.018	0.063	0.054	0.009
Sport car	0.549	0.423	0.324	-2.25	0.009	0.09	0.198	0.045	0.108	0.018	0
Luxury car	0.045	0.405	1.062	0.009	-1.737	0	0.027	0.045	0.189	0.072	0.009
Small truck	0.162	0.099	0	0.009	0	-2.988	0.702	0.045	0.054	0.009	0.009
Large truck	0.063	0.072	0.018	0.009	0	0.234	-1.548	0.027	0.09	0.018	0.036
Small SUV	0.216	0.279	0.099	0.027	0.009	0.09	0.351	-3.645	0.747	0.108	0.072
Large SUV	0.117	0.243	0.171	0.018	0.018	0.054	0.387	0.414	-2.043	0.234	0.108
Minivan	0.081	0.171	0.063	0	0.009	0.009	0.045	0.027	0.135	-2.286	0.18
Van	0.027	0.036	0.009	0.009	0	0.009	0.054	0.036	0.072	0.387	-2.385

Source: Table data from Andrew Kleit, "Impacts of Long-Range Increases in the Fuel Economy Standards," *Economic Inquiry, 42* (2), 279-294.