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ECFIN Country Focus

ECONOMIC ANALYSIS FROM EUROPEAN COMMISSION'S DIRECTORATE-GENERAL FOR ECONOMIC AND FINANCIAL AFFAIRS

HIGHLIGHTS IN THIS ISSUE:

- *The average mass, engine power and CO_2 emissions of new passenger cars in the Baltics are among the highest in the EU.*
- *Low car and fuel taxation and favourable tax treatment of corporate passenger cars are factors behind the high energy-intensity of the car fleet.*
- *Consideration could be given to introducing a set of fiscal measures to foster the development of a less-polluting car fleet.*
- *Complementary measures would be needed to ensure a satisfactory renewal of the rather old car fleet.*

Do the Baltic States need to tax passenger cars more?

*By Baudouin Lamine and Erki Lõhmuste**

Summary

Energy and carbon intensities in the Baltics are among the highest in the EU, in particular in transport, where the passenger car fleet is one of the most energy-intensive. Apart from low fuel taxes, another explanatory factor is that Estonia and Lithuania do not apply any car tax while the purchase of corporate passenger cars benefits from full VAT deductibility in Estonia and from 80% VAT deductibility in Latvia. In view of the strong risk of the Baltic countries missing their greenhouse gas emissions targets and in order to reduce the welfare losses of the current setup, this note examines the case for applying fiscal measures aimed at reducing CO_2 emission by passenger cars. Such measures would consist of a mix of registration and circulation taxes that differentiate by emissions levels and higher fuel taxes. In addition, reducing the favourable tax treatment of corporate passenger cars used for private purposes compared with passenger cars owned by households could remove an important distortion. The policy mix should take into account country-specific characteristics like e.g. purchasing power, availability of public transport, or the need to renew the currently rather old car fleets.

Introduction

Road transport accounts for about a third of the total non-ETS[1] Greenhouse gas (GHG) emissions in Estonia and Latvia, as in the EU as a whole, and for one quarter in Lithuania. Passenger cars cause between one half to two thirds of the road transport emissions. Relatively high GDP growth expectations in the Baltic States (European Commission, 2014) suggest that in the absence of additional measures no real progress could be expected in the reduction of the non-ETS GHG emissions in the medium-term, given the high correlation between economic growth and CO_2 emissions in transport. Economic policy could aim at a significant change in the modal split, e.g. more use of railways or increased use of electric cars. However, this would need a quite comprehensive package of infrastructure investments and is, thus, unlikely to lead to tangible results given time needs and lack of financial resources. Faster results would follow from targeted measures aimed at making the current modal split more conducive to lower CO_2 emissions. This calls for an assessment of the possible impact of passenger car taxation. Indeed, excise duties on diesel in the Baltics are still slightly below the EU average and excise duties on petrol are well below the average. In addition, Estonia and Lithuania are the only EU Member States that do not apply any car tax. Finally, corporate passenger cars, which are often used for private purposes, benefit from

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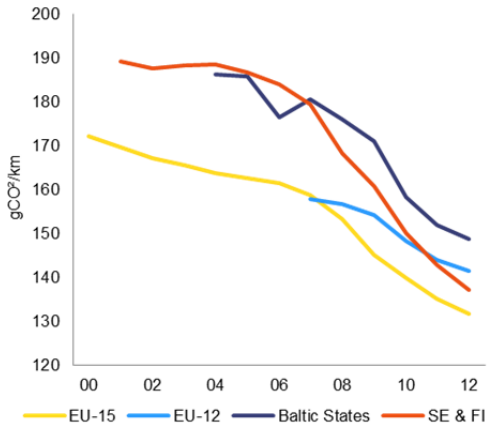
VAT deductibility in Estonia and Latvia for both purchase price and operating costs, including fuel. In 2002 Lithuania abolished the VAT deductibility for its corporate passenger car fleet amid widespread abuse, but the VAT deductibility of car maintenance and fuel expenses is still in place. The present Country Focus aims to identify the main determinants of the energy-intensity of the Baltic countries' passenger car fleets and to highlight possible options for reducing it so as to contribute to the achievement of the non-ETS GHG emission targets.

High energy intensity of the car fleet in the Baltics

The average mass, engine power and, thereby, CO_2 emissions of new passenger cars in the Baltic States are among the highest in the EU.

Graph 1: Average CO_2 emissions from new passenger cars by region 2000-12



Source: European Environment Agency (2013).

The average CO_2 emissions from new passenger cars declined steadily in various EU regions over the 2000-2012 period (Graph 1). However, in 2012 new passenger cars in the three Baltic States had an average mass of 1526 kg, well above the EU average of 1415 kg, and close to but higher than the corresponding levels in Sweden and Finland (European Environment Agency, 2013). Therefore, the CO_2 emissions from new passenger cars in the Baltic States were still among the highest in the EU at 149 gCO_2/km, higher than (even though close to) those in the EU-12, and greater than the corresponding levels in Sweden and Finland (137 gCO_2/km), which are wealthier but have comparable population density and climate. Although CO_2 emissions from new cars are on a downward trend in all EU Member States, the better performance of the EU-15 Member States compared with the EU-12 in reducing CO_2 emissions for new passenger cars could be linked to the adoption in recent years of taxation reflecting the environmental characteristics of the vehicle by using CO_2 emissions to determine either the circulation tax, the registration tax or both (ACEA, 2013).[2]

Low transport taxation as a factor behind the high energy intensity

The transport sector is an important area where efforts could be made to reduce a too-high level of GHG emission.

In general, transport taxes compensate for negative environmental externalities and serve as a major source of financing for infrastructure investments. In order to tackle this issue, different types of taxes are used: fuel taxes (excise duties), registration taxes, circulation taxes and road tolls. Although fuel excise duties might be preferable, since they are closely linked to car usage and pollution, other taxes (car registration and circulation taxes, road tolls) are used in order to obtain a more balanced outcome (transport availability/social aspect/financing infrastructure investment and maintenance/limit access to high pollution load areas/etc.) with specific purposes for each tax.

The high energy-intensity of the Baltic car fleet can be partly explained by the low rates of excise duty on motor fuels. In the Baltics, the excise duties on petrol are 20% below the EU average, while the excise duties on diesel are 15% below the average. However, the difference between the fuel excise duty rates is not very large compared with other EU-12 member states. Overall, the Baltic States have one of the lowest ratios of fuel tax revenue to GHG emissions, suggesting that there is room to raise environmental taxation.

Neither Estonia nor Lithuania have any tax on passenger cars. Latvia has moderate car taxes: a registration tax (CO_2-based) and a circulation tax (weight/size-based). Yet, Latvia's new car fleet is the most energy-intensive in the EU (European Environment Agency, 2013). This is supported by the low level of the new taxes compared with the price of a new car and its usage costs (Table 1).

Most new cars in the Baltics are company cars

A high share of company passenger cars and their favourable tax treatment

Company passenger cars constitute a significant part of the passenger car fleet. According to data from the Estonian Road Administration together with lease statistics from the Bank of Estonia, companies own about 16% of the total car fleet, some 96,680 cars in total. The share is much larger for new cars, where company passenger cars account for about 60%. In Lithuania, the share of company passenger cars in the total car fleet was 12% in 2010, and 50% of new cars, close to the EU average, (OECD 2013; Copenhagen Economics 2009). In Latvia, company passenger cars accounted for around 11% of the total car fleet in 2012.

Company cars have a higher average mileage and are about 30% more expensive.

According to the Bank of Estonia, new company passenger cars are on average 30% more expensive than new cars purchased by households. Copenhagen Economics (2009) estimates that the tax benefit provided to company cars not only leads to the purchase of cars that are between EUR 4,000 and 12,000 more expensive than otherwise, but also raises the total stock of passenger cars by 5.4%. During the 2006-2007 credit boom, this contributed to the then very large current account deficits in the Baltic States (17% of GDP on average): the net imports of passenger cars in these countries amounted on average to some 3.1% of GDP annually, with the lowest values registered in Lithuania, where the VAT deductibility on the company passenger car purchases was abolished long before the booming years. Also, as the price of a car and its emissions are positively correlated, company cars have higher CO_2 emissions per km driven. In parallel, the average mileage of a company car is found to be larger than that of private cars (OECD, 2013) and this has an impact on fuel consumption: Copenhagen Economics (2009), based on a previous study by Puigarnau *et al.* (2009), estimates that the extra kilometres driven by each company car are equivalent to an increase in fuel consumption of 4 to 8 percent. In Estonia, for instance, the average mileage of new cars, which are predominantly company cars, is above 30,000 km per year, while the average mileage of the total car fleet is about 15,000 km per year (Inseneribüroo Stratum, 2013). Finally company cars are to a significant degree used for private purposes: Copenhagen Economics (2009) estimates that business-related use generally constitutes barely 30% of the company passenger car usage. For those who do not benefit from company cars, the VAT deductibility therefore constitutes an unfair tax treatment.

Company passenger cars may also enjoy further distortive tax advantages compared with privately-owned cars, including full or partial VAT deductibility of the purchase and usage costs, the possibility of deducting the car-related costs from the corporate income tax base and favourable fringe benefit tax systems. According to Copenhagen Economics (2009), direct revenue losses may approach 0.5% of GDP annually. The fiscal losses needs to be compensated by higher tax rates elsewhere, which implies a loss of output that may reach 20 cents for every euro raised in taxes.[3] To this, one needs to add the welfare losses that the implicit subsidy entails in terms of misallocation of resources and environmental and infrastructure externalities, such as particulate matter emission, reduced life expectancy, and the number of people killed in road accidents.[4] Finally, the VAT deductibility makes the ownership and circulation of a company car significantly less expensive and gives an incentive to firms to provide company cars as part of their compensation packages.

Table 1. The tax system

	EE	LV	LT	SE	FI	EU average (arithmetic)
Fuel excises on petrol (2013, unleaded petrol, EUR per 1000 litres, excl. VAT)	422.77	415.1	434.43	664.46	650.4	532.5
Fuel excise on diesel (2013, EUR per 1000 litres, excl. VAT)	392.92	336.1	330.17	604.74	469.5	417.4
Standard VAT rate (%)	20%	21%	21%	25%	24%	22%
Size of registration tax for sample cars (2012)						
Small car (Peugeot 207, 1.4L 54kW, petrol)	-	207.3	-	-	3095.5	1766*
Medium-sized car (VW Golf 1.6L 77kW, diesel)	-	50.3	-	-	4395.1	2982*
Large car (Ford Mondeo 2.0L 149kW, petrol)	-	389.2	-	-	11567.0	7011*
Circulation/ownership taxes for sample cars (2012)						
Small car (Peugeot 207, 1.4L 54kW, petrol)	-	31.0	-	98.3	96.7	235*
Medium-sized car (VW Golf 1.6L 77kW, diesel)	-	56.4	-	344.7	428.8	226*
Large car (Ford Mondeo 2.0L 149kW, petrol)	-	86.0	-	179.1	110.2	458*
VAT deductibility on corporate passenger cars (2013)	100%	80%	-	-	-	Used in 15 out of EU27 MS

** Only if tax > 0*

Source: European Commission (2012a), European Commission (2013a, 2013b), OECD (2011), own calculations.

In Estonia, 100% VAT deductibility is available for company passenger cars, while the deductibility is 80% in Latvia (Table 1).[5] The deductibility generally includes the purchase, fuel, maintenance and repair costs of the vehicle – irrespective of its usage, private or professional. A widespread abuse of the VAT system was one of the reasons why the VAT deductibility on the company passenger car purchases was abolished in Lithuania in 2002, although the deductibility of car maintenance and fuel expenses is still in place. Abuse is an issue also in Estonia: in 2013 there were 5600 companies with virtually no turnover (less than EUR 1000 annual), which owned in total 7280 vehicles (Ministry of Finance of Estonia, 2013). Moreover, even though the private use of company cars is subject to a fringe benefit tax, controlling the actual use of a company car is difficult.

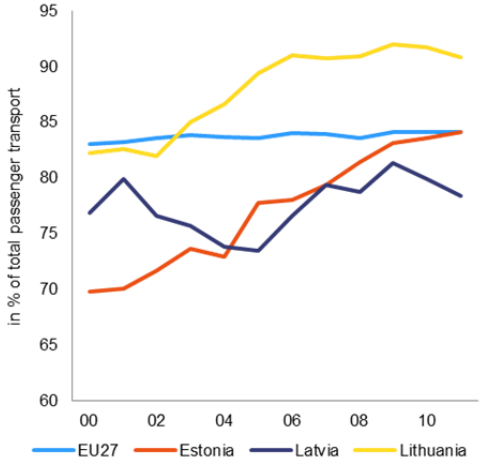
Few statistical data are available on the characteristics of the existing car non-corporate fleets, except for their age, thereby impeding any detailed impact assessment of a possible introduction or strengthening of car taxation in the Baltic States. However, a similar economic reasoning to that applied above to the VAT-deductibility can be applied *mutatis mutandis* to the other types of car taxes. This would suggest that higher car taxation could lead to smaller car fleets and to lower engine power, car mass, fuel consumption and CO_2 emissions, as well as to fiscal, output and welfare gains broadly in line with those estimated for the removal of the VAT-deductibility.

Low purchasing power: old and large cars rather than new and small cars

In 2011, 74% of the cars in the Baltic States were older than ten years, mostly reflecting low purchasing power.

Together with the high share of polluting cars in the new passenger car fleets, the large share of old cars in the existing car fleets is the second main concern in the Baltic States. This feature is having an impact on CO_2 emissions, since old technologies represent higher emissions at equivalent engine power. In the Baltic States 74% of the cars were older than ten years in 2011, while the corresponding figure was 56% for the other EU-12 Member States and 53% for Sweden and Finland. The average age of passenger cars in Estonia and Lithuania is around 14 and 15 years respectively (AMTEL, 2014) while the average age is between 7 and 8 in the EU.[6] Also, in Estonia, about 60% of the new registrations are for second-hand cars 8 years old or more (Estonian Road Administration, data for 2013).

Graph 2: Share of passenger car transport in the total passenger transport in Estonia, Latvia, Lithuania and the EU



Source: Eurostat.

The differences in these figures can be explained in part by differences in income: in the Baltic States GDP per capita in PPP is around 70% of EU average. In addition, in the more mature economies, approximately one person in two owns a car on average, while the proportion is one in three in the Baltic States and in the other EU-12 Member States. This can have an impact on the average size and power of new vehicles to the extent that second and third domestic cars are typically smaller and less powerful than the main family car.

Other possible factors: geography, population density and public transport

Geography, population density and availability of public transport are elements that can also influence the choice of a car. Climate conditions and population densities in the Baltics are broadly similar to those prevailing in Sweden or Finland.[7] However, road maintenance standards may be different and the Baltic States are also the countries with the lowest ratio of motorways in the EU.

A modal shift away from rail and bus transport is ongoing in all EU member states. Transport of passengers by car has been the main beneficiary of the decline in the other transport modes (Graph 2). In Estonia, the modal split for passenger cars is at the EU average of 84%, while it

is far higher in Lithuania (91%). In Latvia, the modal shift might have reversed amid the stronger crisis and, possibly also, a higher registration tax since 2010.

How passenger car taxation influences the consumer behaviour

Car taxation and CO_2 emissions of new passenger cars

This section argues that transport taxes have an effect on the energy efficiency of the passenger car fleet in the EU-27. This is shown for instance in a study by the European Commission (2013a). Regression analysis reveals that CO_2 emissions of new cars seem to be negatively correlated with fuel taxes and registration tax, while they are positively correlated with winter conditions and with the existence of VAT deductibility for company cars (Table 2 and Graph 3). A significant effect of circulation taxes on CO_2 emissions from new cars could not be demonstrated. This could be explained by the finding in European Commission (2002) that car purchases are more affected by retail prices than lifetime costs.[8] On the contrary, other studies (e.g. Ryan *et al.*, 2008) find a significant impact of circulation taxes on average fuel consumption.[9] Furthermore, in 2005, the European Commission noted that in the case of UK, where a CO_2-based annual circulation tax had been applied since 2001, a considerable CO_2 reduction was achieved simply by enhancing the tax differentiation.[10]

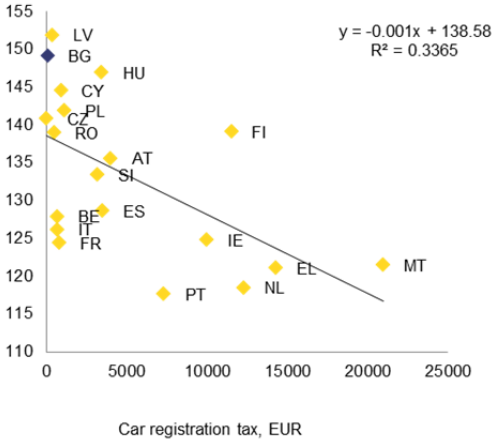
CO_2 emissions of new cars seem to be negatively correlated with registration and fuel taxes, while they are positively correlated with winter conditions and to the existence of VAT deductibility for company cars.

European Commission (2005) finds that potential CO_2 reductions do not depend on the type of taxes – registration or circulation tax – but rather on the CO_2 specificity and the level of tax differentiation (see also Van Meerkerk *et al.*, 2013). However, recent experience with CO_2-based registration and circulation taxes in Ireland (Rogan *et al.*, 2011) shows that, if emissions tax bands are not well designed, there could be a shift towards diesel and not towards smaller engine sizes, with negative consequences for pollution by nitrogen dioxides and particulate matter.[11–12]

Has car taxation any impact on the renewal of the passenger car fleet?

The main factor explaining the average age of the passenger car fleet is income per capita. However, in 2012 and among the countries with the highest purchasing power (Germany, Belgium, Netherlands, Finland, Italy), those with low transport taxation had the largest share of new cars (less than five years old) in their fleet. In contrast, in Finland and to a lesser extent in the Netherlands, where notably the registration tax was higher, the share of new cars was smaller, suggesting a potential negative effect of high purchase taxes on the renewal of car fleets.

Graph 3: Car registration tax for new large cars vs. average CO_2 emissions of new passenger cars



Source: Own calculations based on European Environment Agency (2013), European Commission (2013a).

A circulation tax and, in particular, its progressivity could have a positive effect on the renewal of the car fleets, while a registration tax could have the opposite effect.

In theory, partly supported by a regression analysis, overall circulation taxes can have a positive effect on the renewal of car fleets. The share of recent cars in national fleets seems to be positively correlated with the progressivity/differentiation of the circulation tax and, to a lesser extent, with the level of this tax.[13] Indeed, a higher progressivity/differentiation of the tax provides an implicit tax subsidy to the purchase of smaller cars, while a higher level of the tax could prompt drivers to buy new and more economical vehicles or to switch to other modes of transport, thereby supporting a renewal and reduction of the fleet. By contrast a registration tax slows the fleet renewal,[14] since the car owner delays the replacement of his vehicle. Further research on the effect of the VAT deductibility on corporate passenger cars on

the renewal of the car fleet may be warranted, notably given the existence of very large VAT subsidies to corporate passenger cars in certain countries and the very low share of recent cars in countries such as Lithuania, where the VAT deductibility was abolished several years ago. However, despite its possible positive effect on the renewal of the car fleet, VAT deductibility on company passenger cars does not allow for the integration of environmental criteria, which could improve the characteristics (mass, engine power, emissions) of the renewed car fleet.

Table 2. Model results

Dependent variable: Average CO_2 emissions from new passenger cars (2012)			
Country sample: EU Member States			
Included observations: 27			
Variables	Coefficient	Std. Error	Prob.
Constant	153.8	6.1	0.00
Registration tax for large car (Ford Mondeo 2.0L 149kW, petrol, 2012, EUR)	-0.00027	0.00011	0.02
Fuel excises on petrol (2013, unleaded petrol, EUR per 1000 litres, incl. VAT)	-0.02585	0.01050	0.02
Difference between petrol and diesel excises (2013, EUR per 1000 litres, incl. VAT)	-0.02863	0.01537	0.08
Winter effect [1]	9.1	2.9	0.01
VAT deductibility on corporate passenger cars (2013) [2]	0.041	0.029	0.17
R-squared	0.75		

[1)] Dummy variable for countries with low population density and/or heavy winter conditions (=1 for EE, FI, LV, LT, SE)

[2)] 100 if VAT on corporate passenger cars is fully deductible, 0 if the VAT deductibility is not available

Source: own calculations.

Policy options

In principle, both the introduction of CO_2-based passenger car taxes and the increase in fuel excise duties can be used to lower the overall GHG emissions from passenger cars. Applying the estimates in Table 2, if the Baltic States were to increase their transport tax rates to EU27 average levels and abolish the VAT deductibility for corporate passenger cars, they could reduce CO_2 emissions from new passenger cars by 6 to 9%, i.e. close to the EU27 average.

The main effect on CO_2 reductions could come from the rise in fuel taxes. The second largest effect could come from the abolition of the VAT deductibility for corporate passenger cars.

The main effect on CO_2 reductions would come from the rise in petrol excise duties (by EUR 0.14 per litre), which would account for 56 to 77% of the overall reduction in the CO_2 emissions from new passenger cars. The overall CO_2 effect of a fuel tax could even be higher as it would not only reduce the average car size but also the mileage driven. However, raising diesel excise duties in parallel could allow for a reduction in engine size rather than a shift to diesel cars (with higher particulate matter and NO_2 emissions), and lead to a reduction in the mileage as a knock-on effect. The second largest effect could come from the abolition of the VAT deductibility for corporate passenger cars (25-30%), while the introduction of registration taxes for cars with high emissions (EUR 7,600) could account for 15% of the total reduction in the CO_2 emissions.

Concerning the renewal of the car fleet, introducing a circulation tax at the EU average level would probably contribute to bringing the age of the fleet down. Should the circulation tax be effective in addressing the CO_2 concern, as suggested by several authors, policy synergies would appear possible to address both problems at the same time, namely CO_2 emissions and ageing car fleets.

Political economy

Efficient car taxes also have to consider the still relatively low purchasing power of households, the specific inequality situation in the Baltic States, the low population density and the absence of a well-functioning public transport network. Combining fuel excise duty increases[15] with differentiated registration and circulation taxes based on the car age and/or the value of the car would allow these measures to be introduced in a socially acceptable manner. This could also be made consistent with a CO_2-based approach.[16] Moreover, the renewal of the car fleet and the reduction in engine power and car mass could help reduce other externalities such as the very high number of people killed in road accidents in the

Baltic States. From a political point of view, this more advanced passenger-car taxation framework could be phased in over a transitional period to allow economic actors a period of adjustment.

With respect to the VAT deductibility on corporate passenger cars, the recent proposal made by the Ministry of Finance of Estonia to reduce the existing VAT deductibility by 50% from July 2014 is a step in the right direction in order to reduce the favourable tax treatment of company passenger cars used for private purposes. A similar proposition has now been incorporated in the recent coalition agreement of the new government.

Finally, given the mobility of the tax base (with car registration possible in neighbouring countries), coordination among the Baltic States on the scope and design for such policy changes would appear desirable.[17] Also, despite efforts to curb it, fuel smuggling on Lithuanian borders with Russia or Belarus reduces the effectiveness of fuel excise duties as an economic instrument.[18]

Conclusions

Leaving a sizeable share of the transport sector (almost) untaxed in the Baltic States could be seen as inefficient in the face of pressing environmental goals and in view of sizeable welfare losses due to the misallocation of resources. The virtual absence of passenger car taxation and low fuel taxation increase the mass and power of new cars in the Baltic States and therefore the CO_2 emissions of the car fleet as a whole. Also, the lack of environmental incentives to reduce the mass and average age of passenger cars could be contributing to other externalities such as road fatalities. Moreover, combining fuel excise duty increases with differentiated car taxation compatible with a CO_2-based approach could allow car taxation to be introduced in a socially acceptable manner, while keeping the reform neutral in budgetary terms if emissions tax bands are well designed. Transport taxation measures should be considered in the context of a wider transport policy aimed at reducing transport intensity and at shifting travellers towards more environmentally-friendly transport modes.

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[1] The EU emissions trading scheme (EU ETS) is a key element of the policy tools put forward for reducing greenhouse gas (GHG) emissions from the largest industrial enterprises in the EU. The non-ETS GHG emissions scheme includes CO_2 emissions from, by order of relative importance, transport, agriculture, buildings, other industrial processes (smaller industrial enterprises) and waste.

[2] In Estonia, only time-limited public support is granted to the acquisition of electric cars, but a quick charging infrastructure covering the whole country is being established. The country has also undertaken a sizeable financing programme focused on energy efficiency in public transport. In addition, to promote public transport, Tallinn introduced free public transport for its residents from 2013 onwards, with an estimated decrease in private traffic intensity of some 10% so far. However, for these initiatives to be entirely successful, private demand for electric cars should actually take off— evidence of this is unclear so far (OECD, 2012b) — and care should be taken that the loss of ticket revenue in public transport does not compromise service quality, and investment in new vehicles and in infrastructure.

[3] Recent literature suggests that the loss of output easily exceeds 20 cents for every 1 euro raised in taxes in countries with relatively high tax rates such as EU countries.

[4] Particulate matter pollution is a significant health issue in Tallinn, with fuel burning in vehicle engines, especially diesel, road abrasion, automobile tyre and brake wear being the main sources of emissions, together with construction. The analysis suggests that locally emitted pollution in the city could result in reduced life expectancy by an average of 7.7 months. In Riga, the number of days during which the particulate matter daily limit value for human health protection was exceeded was about three times higher than the maximum value of 35 calendar years. Also, in 2008, Latvia and Lithuania remained among the countries with the highest number of people killed in road accidents, together with Poland, Romania and Bulgaria. Estonia fared a bit better, together with most of the other EU-12 Member States. In 2008, J. Broughton noted that, in car-car collisions, the driver casualty rate rises with the age of the cars, while the relative size of the cars involved also matters.

[5] While VAT rates range from 15% in Luxembourg to 27% in Hungary, several countries have introduced more or less favourable VAT regimes for corporate passenger cars: Belgium, Czech Republic, Estonia, Germany, Italy, Latvia, Luxemburg, the Netherlands, Poland, Romania, Slovakia and Spain.

[6] Cars younger than two years only represented 5.7% of the total car fleet in Estonia (2012), 2.9% in Latvia (2012) and 0.9% in Lithuania (2010-11), while their share was around 11% in the EU as a whole (2010-11), and peaked at 20-24% in countries such as Austria (2010) and Belgium (2010). In a number of countries, car-scrapping schemes/programmes also had an impact.

[7] Compared with the EU average, the Baltic States have a low population density (39 inhab/km^2 vs. 117 inhab/km^2 in EU27), which, however, is even lower in Finland and Sweden (20 inhab/km^2).

[8] More likely, the range of the circulation tax in the EU Member States is not broad enough at its upper end to reach levels that could influence the purchasing decision for new cars. The usual purpose of a circulation tax so far has been to provide revenue to local governments, not to reduce CO_2 emissions.

[9] In Ryan *et al.*'s view, contrary to the circulation tax, the registration tax does not seem to be statistically significant in changing the average CO_2 emissions intensity of new cars in any of their models. This could mean that consumers appear to think ahead when purchasing new cars and are influenced by the annual taxes that they will pay on the vehicle more than the registration tax. In their view also, since the elasticities of the annual circulation taxes for petrol and diesel are nearly equal in size and opposite in sign, there appears to be a partial substitution effect between petrol and diesel vehicles purchases.

[10] Differentiated registration and circulation taxes can be modulated according to car mass, car age, engine size or CO_2 emissions. Databases contain the average specific emissions of cars disaggregated by engine size and emissions band. In the more advanced CO_2-based car taxation systems, tax rates are linked to CO_2 emissions. This is intended to influence the purchasing decisions of consumers towards more energy-efficient and less CO_2-emitting cars. The wide range of rates, or tax progressivity, applied across the emissions bands indicates the strength of the purchasing signal.

[11] In Ireland, while the policy was very effective in terms of CO_2 emissions' reduction, the tax change resulted in a doubling of the share of diesel cars, mostly with large engine size, while petrol cars remained predominant in a single category: 1201-1500 cc. To prevent such a shift, a differentiation between petrol and diesel cars could be introduced and, given the lower CO_2 emission by diesel engines, but higher emission of nitrogen dioxides and particulate matter, higher tax rates could be applied to diesel cars for identical emission bands.

[12] Conde-Ruiz (2014) notes that a legislative change in Spain, which has differentiated the existing registration tax according to CO_2 emissions alone and no longer according to the engine power of the car, has been very effective in terms of reducing CO_2 emissions, but has resulted in a dramatic fall in fiscal revenue, suggesting that fuel excise duties might be preferable instead.

[13] In their analysis of the purchase of new cars, Ryan *et al.* (2008) mention negative and significant correlation of fuel prices and car circulation taxes. However, their analysis covers the purchase of new cars only and leaves aside the possible impact of fuel excise duties and circulation tax on the existing stock of cars.

[14] However, for Ryan *et al.* the impact of the registration tax on the purchase of new cars is not statistically significant when fixed effects of individual countries are taken into account.

[15] Excise duties on fuels can be effective in reducing CO_2 emissions, especially if they are based on the individual characteristics of the fuel. In 2011, the Commission suggested the introduction of a CO_2 tax for energy products including motor fuels; the potential for emission reductions was calculated at almost 4% depending on the implementation by the Member States (see European Commission, 2011).

[16] Double taxation in the area of vehicle taxation should be avoided. Upon transfer of a car in the context of migration, high registration taxes may indeed create an obstacle to the functioning of a real Single Market: such high taxes or the lack of information from the Member States on their application of national taxes or on how they implement the principles developed by the Court of Justice of the European Union to solve the difficulties resulting from the absence of harmonisation at EU level of car registration and circulation taxes may hinder cross-border mobility (European Commission, 2012b).

[17] In Latvia, there is a tendency to register cars in Estonia and Lithuania, as these countries do not have car taxes.

[18] Fuel smuggling by private persons from third countries (Russia) has been significantly reduced in Estonia and Latvia after the introduction of stricter control and limitations on the import of excise goods.