CAR PURCHASE TAX: GREEN TAX REFORM IN ISRAEL

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For further information, please contact Nils Axel Braathen; tel: +33 (0) 1 45 24 76 97;
email: Nils-Axel.Braathen@oecd.org

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NOTE FROM THE SECRETARIAT[1]

This case study of the Israeli tax on motor vehicle purchases has been prepared by Victoria Roshal (independent consultant) and Alfred Tovias (The Hebrew University of Jerusalem).[2]

The paper has been endorsed for declassification by WPIEEP and is intended to be issued as a General Distribution document, and to serve as input for a shorter OECD Environment Policy Paper. This work is part of an initiative aiming at putting forward countries' best practices, encouraging exchange of experience.

The preparation of the case study was managed by Nils Axel Braathen, under the supervision of Nathalie Girouard.

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EXECUTIVE SUMMARY

The car tax in Israel has been historically the highest compared to any other country in the world, except for Denmark. This was one of the reasons for the lowest rate of motorisation among the OECD countries, increased amount of older cars on the roads, which also meant the vehicles were both less safe and emitted more pollution. Cars were considered a luxury that only the better off could afford.

In December 2005, a plan for a gradual tax reduction was introduced: the purchase tax was to be reduced from its original level of 95% in 2005 to 72% in 2010. Alongside, in an attempt to tackle the environmental effects from motor vehicles, Israel adopted European and US emission standards (since the mid-1990s), initiated several scrappage schemes, tightened annual emission tests and introduced roadside spot checks. These measures have been important in reducing negative effects of transportation, but still did not tackle the fact that the marginal cost to society of using a car is much more significant than the tax paid on it. Pollution, noise, congestion coming from an ever-increasing number of vehicles – all these negative effects are being experienced by the whole society, however, only the car owners enjoy the benefits. Without a tax differentiation based on different level of emissions, there was no incentive to purchase "greener" cars.

In August 2009, the recommendation of an inter-ministerial commission to implement a "green reform" came into effect, resulting in the vehicle purchase tax being adjusted according to 15 pollution grades, calculated by weighing all relevant and measureable emissions (NO_x, CO, PM, HC and CO_2) according to their harmful impacts, derived from each pollutant's relative cost to society. The goal was to create a differentiation between various levels of emission, while keeping tax revenues unchanged. New tax incentives to favour vehicles with enhanced safety mechanisms were also introduced.

This created incentives for reducing average health-related and greenhouse gas (GHG) emissions. Public revenues increased (by 12%) in the first two years after the tax implementation, mainly because of an increased number of cars being sold. However, revenues dropped in the following years (by 11% in 2012-13 compared to 2010-11) due to the significant change in the composition of the new fleet of vehicles, with fewer high-pollution ones being sold.

In 2013, following the decreased share of polluting vehicles, which resulted in an erosion of the tax base, the tax formula was updated to enhance even more the reduction of emission volumes, and to increase public revenues. The formula will continue to be adjusted every two years.

While the net effect of the reform was an increase in total emissions from new cars, its most important outcome was that it managed to reduce average CO_2 emissions (per car) without increasing harmful health-related pollution, particularly NO_X and PM, contrary as was the case in many EU countries, where tax incentives, based solely on CO_2 emissions, caused a dangerous increase in local air pollution. Unlike in the EU, the reform has not increased relative demand for diesel vehicles (which tend to emit less CO_2 but more local pollutants than petrol cars).

The car tax is still high; the average effective tax across all passenger vehicles still being 60.6% in 2014. However, a further reduction of the purchase tax might result in a steeper increase in the number of vehicles, and consequently cause further increase in pollution and other external effects – noise, congestion and so on. Demand-related taxation (like fuel taxes, or road charges) are good measures of demand

management, but this has to be implemented along with a major plan for creating efficient public transportation, already in place since 2008.

The Israeli experience here sets a precedent for creating one convenient formula for the tax that takes all pollutants into account, thus matching the marginal cost to society with the marginal cost of the car. However, in order to adapt this policy to other OECD member countries, some points need to be taken into account, namely:

1. Tax levels should be idiosyncratic to the specific country in question. Every market is different, and car fleets are not solely being determined by tax levels; family composition, urbanisation, efficiency and cost of public transport, as well as preferences and awareness all determine the composition of car fleets; hence each market should be considered separately.

2. The formula should incorporate several pollutants weighted according to their cost to society. This means that the formula of the tax should be country-specific, and not simply be transferred between countries, without conducting an extensive study as to the costs for each pollutant.

3. Politically, it is hard to impose higher taxes, and Israel succeeded partially because of the prevalence of initially high tax rates that could be modified to create differentiation in tax rates. Revenue-neutral schemes, however, although politically justified, might end in higher total pollution than before the differentiation was created.

4. Due to erosion in the tax base over time, the tax formula should be updated regularly, with the dates of the updates set in advance and according to pre-agreed procedures.

5. Extensive co-operation to launch the scheme is required between different authorities such as the tax authority, environment, finance, transport and infrastructure bodies.

6. The Israeli experience shows that there could be strong opposition to the tax, mainly from the supply side. It might be harder to introduce a tax based on emissions other than CO_2 in the markets where there is substantial manufacturing focused on CO_2 efficiency. An international directive (at the EU level, for example), might help to promote this kind of measure.

7. Car importers and manufacturers should be involved in order to supply a reliable source of emission data for each car model. There are a lot of local models and adjustments to existing models where emission levels have not been adjusted.

8. If an annual tax is selected because it can be easily differentiated (instead of focussing on first-time registration or import taxes), relevant authorities should think in advance how to deal with changing grades in existing cars each time the formula is being adjusted. Authorities should keep a history of grades if they wish to keep the annual tax unchanged for each individual vehicle as it ages.

9. Relevant authorities should consider how to promote awareness together with tax incentives, by compulsory and visually clear advertisement of green grades at the retail points.

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1. Introduction

1. In the last decades, growing population and income in Israel resulted in a substantial increase in consumption, which brought along considerable damages to the environment. In Israel in particular, the fast paced growth rate has put a pressure on the environment, especially significant in a small and densely populated country with hot climate and scarce water resources. Environmental awareness that accompanied that trend, however, enhanced the necessity to deal with the negative effects. Some of the main effects originate in the ever-increasing transport activity, and particularly, in the use of an increasing number of private vehicles. Travelling in a private vehicle brings benefits to the individual using it; however, alongside the positive effects of transport, it entails costs to the society as a whole. These social costs are beyond the private costs of the car and the fuel borne by the car user, imposing a burden on public health and the environment. Transport involves noise, pollution, congestion, accidents, climate change and wear and tear to the infrastructure. All of the above negatively affect public health and quality of life for the society, a fact not taken into account during the decision-making process, when an individual chooses whether to purchase or not a vehicle. This is a market failure, where the marginal costs of using a car faced by the car user are lower than the marginal social cost. This gap in marginal costs is the external cost, the existence of which leads to inefficient individual behaviour from the welfare viewpoint of society.

2. In the absence of external effects, it could be argued that the market solution would be considered to be efficient. However, in case there are externalities, governments can intervene to fix the inefficiency. The way to resolve this issue is to create a framework where the actual cost to society is internalised into the cost seen by the consumer, thus making the external costs part of the decision-making process. There are a range of tools that governments can use to internalise the external costs to the public and the environment, to create more efficient production processes and essentially, to change consumer behaviour. Implementing market-based instruments has been found to be an efficient way to limit the negative sides of transport use.[3]

3. In the past, Israel used direct regulatory measures (command and control in the form of emission standards) to manage vehicle emissions. Imposing standards, however, does not prove to be the best policy, one of the reasons being that once standards are met, there are no further incentives to reduce fuel use or emissions and to develop new technologies (Greene et al., 2005). Following the understanding that the external costs should be internalised, an inter-ministerial commission was set up by the Israeli government in 2006 to discuss the way to deal with the external costs, one of the main subjects being the application of green taxation on cars.

4. The purchase car tax in Israel has been historically the highest among the OECD countries, except for Denmark. This resulted in the lowest level of motorisation and an increased number of older cars on the roads, which also meant the vehicles were both less safe and emitted more pollution. Cars were

3. *Handbook on estimation of external costs in the transport sector* by Maibach et al. (2008) and its updated version by Ricardo-AEA (2014) provide an exhaustive list of estimations of various external effects.

considered a luxury that only the better off could afford, and the high purchase tax – levied also on fuel, alcohol, cigarettes and some other goods – was partially intended to cover for the negative external effects caused by the product use.

5. Since then, several reforms changed the private car market significantly. In December 2005, a plan of gradual tax reduction was introduced: the purchase tax was to be reduced from its original level of 95% in 2005 to 72% in 2010. In September 2007, a scrapping scheme was introduced and tighter emission standards required vehicles to pass tougher emission tests during annual vehicle licence renewal.

6. These steps, however, did not tackle the fact that there is a high cost to society of using a car – much more substantial than the tax paid on it. Without a differentiation between cars producing different levels of pollution, there was no incentive to purchase "greener" cars, thus requiring government-induced instruments to encourage a change in consumer behaviour.

7. Internalisation of external costs through market-based instruments requires estimation of external effects on public health and environment. External effects from transport can affect society in numerous ways: decreased public health and resulting decrease in productivity; congestion; diminishing real estate values (because of noise, for example); and increasing prices of goods and services due to parking costs. Therefore, it is vital to include all of the external costs and approximate the final price of using a private vehicle to the social marginal cost, taking into account size and type of the car, location, distance travelled and time of driving. Travelling in a small car during the night on the freeway entails different costs than when entering with a lorry into Tel-Aviv city centre during rush hours. Adding fixed costs of car usage (like an annual road tax) to the above might cover for infrastructure costs.

8. The Green Tax commission estimated that the external costs of using private vehicles in 2004 came up to 6% of GDP and exceeded the price paid for it (expressed through the taxes paid for the purchase and use of the car, all of which came up to 3.4% of GDP in 2004).[4] Following this, and after considering various options like distance-related taxation, the commission recommended to increase the purchase tax paid on private cars, but to introduce differentiation according to the negative externalities each type of car produces, both via the one-off purchase tax, and via the annual motor tax. The commission chose to focus on the environmental effects of transportation due to their high costs to public health (2% of the GDP), aggravated by the Israeli climate and high population density, and because it was believed that the market-based incentives could be particularly efficient in that case. As a secondary effect, the reform was expected to create a shift to newer vehicles which would be safer and therefore reduce the number of accidents.

9. The commission report was completed in January 2008, and subsequently, the government mandated the Minister of Transport to require car manufacturers to report on five major pollutants levels for each car model. It became compulsory to mark the green grade at every point of sale and this information was also published on the Ministry of Transport's website. After a year of preparations for the implementation of the new system, with major efforts directed at creating an extensive database of the emission levels of all the imported cars, the new tax came into force in August 2009.

10. According to the reform, the tax levied on each vehicle depends on the emission level of the vehicle, evaluated during the process of approving the prototype for each vehicle model.[5] The total level of emission – or the "green grade" – is then calculated, weighed by the costs of five main pollutants: Carbon

4. The commission found that the taxes paid on fuel equated or even exceeded the estimated costs from fuel use.

5. Detailed comparison of testing procedures in the EU and the United States can be found in Mock and German (2015).

Monoxide (CO), Nitrogen Oxide (NO_x), Hydrocarbons (HC), Particulate Matters (PM), and Carbon Dioxide (CO_2). The grades are split into 15 tax bands; band 1 exhibiting no emissions (electric vehicles), and band 15 being the most polluting. Originally, the system was meant to be of a classic "feebate" type: band 8, which also indicated the median car in terms of green grade, was supposed to be levied with a tax that was in place in that year (78% in 2008, 75% in 2009 and 72% in 2010 due to a five-year tax reduction plan that was already in place); all bands below 8 – a pivotal point – received tax rebates, whereas all bands above 8 involved an additional tax – a fee – added to it. However, due to legislative complications of employing this type of tax, the overall tax level was raised to 83%, levied on band 15, with all the bands below receiving rebates. No-emission electric vehicles were taxed at 8%, low-polluting hybrid vehicles were taxed at 30%, and all the other vehicles had higher effective tax rates up to 83%.[6]

11. Economic instruments like vehicle taxation based on fuel consumption and, recently, CO_2 emissions have been in increased use worldwide to incentivise the purchase of low-emission cars, either in the form of one-off purchase tax, or as part of an annual or recurring registration fee (Braathen, 2009; He and Bandivadekar, 2011; ACEA, 2015). Some countries have introduced a measure of differentiation in both taxes. "Feebate" (bonus/malus) schemes have been recently employed in some countries, such as France, Canada and the Netherlands. Under such schemes, rebates are offered to the buyers of low-emitting vehicles, and fees (taxes) are imposed on purchasers of gas-guzzlers. There are few studies that analyse the effects of such schemes, among them Greene et al. (2005) and Fischer (2008) for the US, Rogan et al. (2011) for Ireland, D'Haultfoeuil, Givord, and Boutin (2014) for France, Huse and Lucinda (2014) for Sweden, as well as Christodoulou and Clerides (2012) for Cyprus. Adamou, Clerides and Zachariadis (2014) conduct a simulation based on a hypothetical analysis for Germany. The important distinction of the Israeli scheme from similar schemes in other countries aiming to reduce mainly CO_2, is that it incorporated health-related emissions alongside CO_2 in the tax formula, thus deterring the shift towards diesel cars and reducing GHG emission at the expense of public health.

12. As demonstrated in Adamou et al. (2014), a revenue-neutral scheme produces modest environmental benefits in the short run. This benefit does not outweigh losses in welfare resulting from the decreased amount of vehicles sold. Welfare can be increased, if the rebates are dominated by the fee part, which produces enough government revenue to balance off the loss in consumer and supplier surplus. However, the welfare loss is expected to shrink over the long term, when less polluting cars replace older, high-polluting ones, and the total volume of emissions start decreasing. To intensify the signal to the suppliers, the system pivot point should decrease over the years, pushing car buyers to seek for less and less polluting cars.

13. Following the implementation of the Green Tax (as it became to be known in Israel), a significant shift in the demand for cars was observed, reducing the average emissions per car, but subsequently bringing along a sharp drop in purchase tax revenues – nearly 13% between 2008 and 2012. The magnitude of the effect of the reform was not anticipated. The vast majority of vehicles sold in 2012 belonged to tax bands 2-6, the tax lost its differentiation power and was not keeping up with the technological advancements on the supply side that increase the quality of fuel and decrease emission levels from cars. Given the extent of the market response to the Green Tax, and the fact that the original costs of emissions were calculated based on European estimates, some years after the reform was implemented, in 2012, an extensive study was commissioned by the Ministry of Environmental Protection (MoEP) to better evaluate the cost of external effects from air pollution and subsequently, update the green grade formula.

6. The effective tax rate is the tax level that remains after the deduction of the green grade rebates and tax credits for the additionally installed safety systems, from the base tax level of 83%.

14. Air pollution costs are caused by the emission of air pollutants such as CO, NO_x, HC and PM and consist of health costs, building and material damage through soiling and corrosive processes, crops damaged by acid deposition, and damages to the ecosystems – soil and water. Health costs (mainly caused by PM from exhaust emissions or transformation of other pollutants) are by far the most important cost category.

15. The accepted approach for measuring the effects of air pollution is the impact-pathway approach (ExternE, 1999 and 2005; Friedrich and Bickel, 2001), which follows the dose-response function, quantifying the explicit impact patterns on human health and nature. Main stages of the approach include measuring the level of emissions, estimating the spread of pollution and the population exposure, quantification of the damage impacts (to health, crops, etc.), and finally, economic evaluation of the impacts. The collective cost to society is usually derived from the individual's willingness-to-pay (WTP) to avoid the marginal damage.[7] The Value of Statistical Life (VSL) represents the amount of money an individual is ready to pay for a given reduction in the risk of premature death. Multiplied by the number of premature deaths caused by a pollution factor, it can be used to calculate the costs of mortality.

16. Even though the Green Tax commission recommended the use of the "Green Grade" formula where the costs of pollution are implied in the weights attached to each of the pollutants, these costs were transferred (adjusted for income and population density) from previous studies performed in the United States and the EU, and described in two internal reports submitted to the Ministry of Finance (MoF) and Ministry for Environmental Protection (MoEP). Later, before the formula update in 2013, a more extensive study was performed to estimate actual costs of pollution in Israel.

17. The report on air pollution costs in Israel (Becker, Rosenthal and Gabay, 2012) calculated the cost of air pollution in Israel, by adjusting the costs calculated in other studies elsewhere, using two approaches, namely benefit transfer meta-analysis, and dose-response function adjustments. The values obtained were used as a basis for the new formula, which came into effect in August 2013. The main difference between the old and the new formulas is the increased implied cost of PM, extremely dangerous to human health and ecosystems (penetrating deep into lungs and capable of causing cancer among other problems) and NO_X (linked to breathing problems and decreased lung function). NO_x emissions are also an important source of secondary formation of PM. Alongside the update of the formula, it was decided to update it every two years, adjusting the costs calculated in Becker et al. to the changes in income, population and prices.

18. At the time of the writing (December 2015), the purchase tax rate stands at 10% of the CIF value for electric cars, 30% for hybrid cars and 83% for the rest, with rebates ranging from ILS 2 035 (New Israeli sheqels) to ILS 15 261 (EUR 412 – EUR 3 087). CIF includes a customs tax of 7% for vehicles imported from countries, other than the EU or the United States.

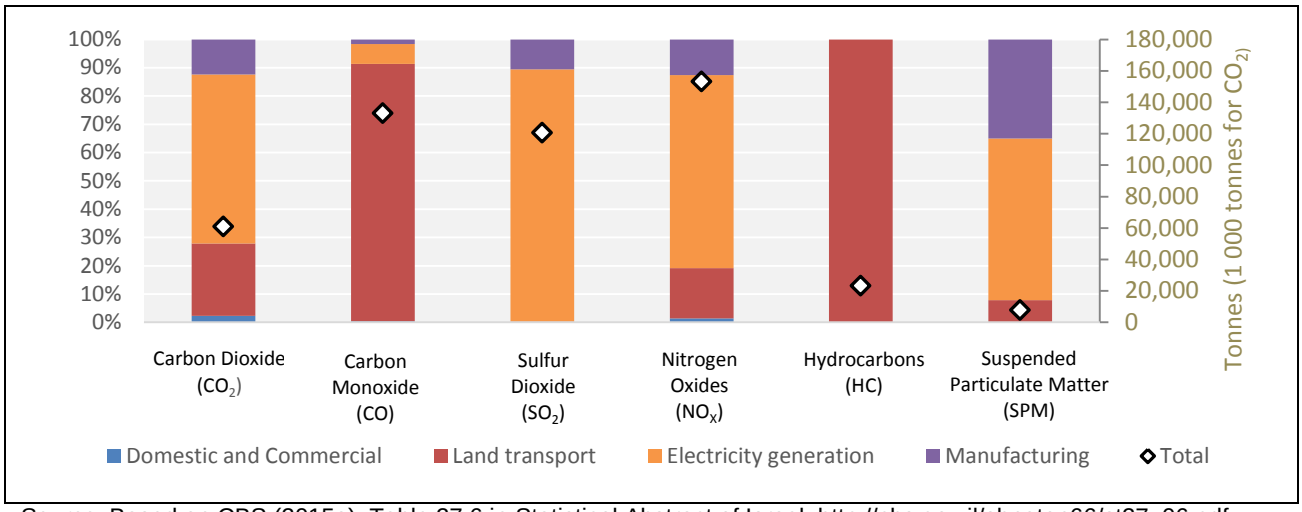
19. The rest of the paper is organised as follows: chapter 2 provides an overview of the private car market in Israel and the background to the tax reform; chapter 3 describes the considerations of the Green Tax commission and the workings of the original formula; chapter 4 provides a detailed account of the Becker et al. report and the formula update; chapter 5 discusses the effects of the tax; chapter 6 summarises what can be learned from the reform.

7. See, for example OECD (2012) for compilation and analysis of the WTP studies and recommendation for adjustments of costs when transferring between countries.

2. Background

20. The transport sector is responsible for 26% of the total CO_2 emissions in Israel.[8] With no underground service, limited railway lines, high train ticket prices and inconvenient location of train stations, and a complete halt of all public transport services during Saturdays and Jewish holidays,[9] road transport, and especially private cars have become the dominant transport mode. As such, it contributes a significant proportion of greenhouse gases emissions,[10] and is an important source of other pollutants (Figure 1). Nearly three quarters of the total transport distance travelled (and 90% of all passenger transport) is attributed to private cars in 2014 (Table 1), making them an important contributor to air pollution and the major objective of any policy aimed at reducing emissions from transport.

Figure 1. Emissions from fuel combustion by type of consumer and total emissions
Total annual emissions on right-hand axis, 2014



Source: Based on CBS (2015a), Table 27.6 in Statistical Abstract of Israel, http://cbs.gov.il/shnaton66/st27_06.pdf.

Table 1. Distance travelled, by type of vehicle
Million km per year, 2014

Private cars	Minibuses	Buses	Taxis	Motorcycles	All passenger	Trucks	Total
39 222	699	1 000	1 637	882	**43 523**	8 877	**52 400**
90.1%	1.6%	2.3%	3.8%	2.0%	**100%**		
74.9%	1.3%	1.9%	3.1%	1.7%	**83.1%**	16.9%	**100%**

Source: Adapted from CBS (2015a), Table 24.13 in Statistical Abstract of Israel, http://cbs.gov.il/shnaton66/st24_13.pdf.

21. In recent years, several major changes in legislation, particularly aimed at reducing air pollution from transport, have provoked a shift in the demand for private cars and the composition of the cars purchased.

2.1 The private car market in Israel

22. The Israeli car market is relatively small, and for new cars, relies completely on imports. There is only one direct (independent) importer for each manufacturer. The importers distribute cars through

8. CBS (2015a), Table 27.6 in *Statistical Abstract of Israel*, *http://cbs.gov.il/shnaton66/st27_06.pdf*.

9. There is no service on major bus lines, only by small private providers.

10. According to IEA (2014), transport accounts for 23% of world total CO_2 emissions.

commission agents, this way reducing the costs of holding large stocks – an impractical affair in a small country like Israel. Any added value is being created by the manufacturer, who sets the price and makes other supply-related decisions, hardly affected by Israeli importers. The existence of one importer for each manufacturer allows for constant dynamics in terms of market shares. In a recent report submitted to the government, the competition level in the Israeli new car market was found to be sufficient and similar to the rest of the world (Shaldor, 2012). With few tax rules favouring diesel cars, the passenger car market in Israel is dominated by petrol cars (96.5% of all private cars in Israel are petrol cars and 3.5% are diesel cars) unlike in the EU (44.3% of total EU sales in 2014 were vehicles powered by petrol and 53% by diesel), and is closer to the proportion seen in the United States (93.7% and 2.75% respectively).[11]

23. There were 3.0 million vehicles in Israel in 2014, of which 2.5 million were private cars (CBS, 2015). New private car registrations in 2014 reached 239 000, comparable with Norway, Denmark, Czech Republic and New Zealand (Appendix A). Israel is also comparable with these countries in terms of total volume of road traffic.

24. However, Israel is characterised by two factors that make it stand out in a comparison with other OECD countries: Israel has the largest average traffic density (Figure 2) among the OECD countries, almost highest annual average distance travelled per vehicle (Figure 3), and paradoxically – the lowest motorisation rate of 281 private cars per 1 000 inhabitants (Figure 4). Suburbanisation – population moving to the outskirts of major cities seeking for lower-priced homes and higher quality of life – alongside the limitations of public transport – creates higher dependency on car use and could explain the high average distances travelled. Low motorisation rates, however, are historical factors rooted in the peculiarity of the Israeli private car market.

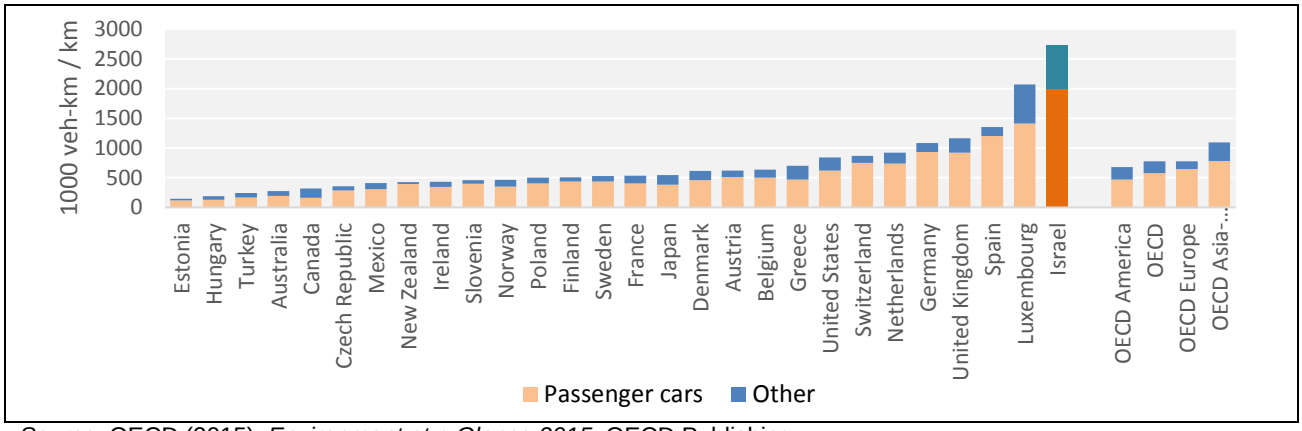
25. One of the reasons for the low motorisation rate is the high consumer price of acquiring a car. The income effect is relatively low – Israel has a relatively high GDP per capita (ranked 22nd among OECD countries in 2012). The car market in Israel relies solely on imported vehicles for new cars, but an independent report ordered by the Ministry of Finance in 2012 found that there were no market failures in terms of competition for new cars (Shaldor, 2012). However, the final consumer price was second only to that in Denmark. The report clearly showed that car prices in Israel would have been comparable to those in the rest of Europe, if all taxes were removed.

26. Taxes on vehicles are an important source of revenue for the Israeli government. Vehicle taxation uses the whole spectrum of consumption taxes, including purchase tax, customs duty and VAT on the final car price, all of which essentially more than double the (CIF) car price. This is in addition to annual registration renewal tax and usage taxes in the form of excise on petrol. In 2012, total annual revenue from all of the above taxes was about ILS 33.7 billion, or 3.6% of the Israeli GDP in that year (Figure 5).[12]

11. *Source*: For Israel: CBS (2015b), *Kilometers Travelled 2014*, Table 7, *www.cbs.gov.il/publications15/1621/pdf/t_07.pdf*; for the EU and the United States: FT (2015).

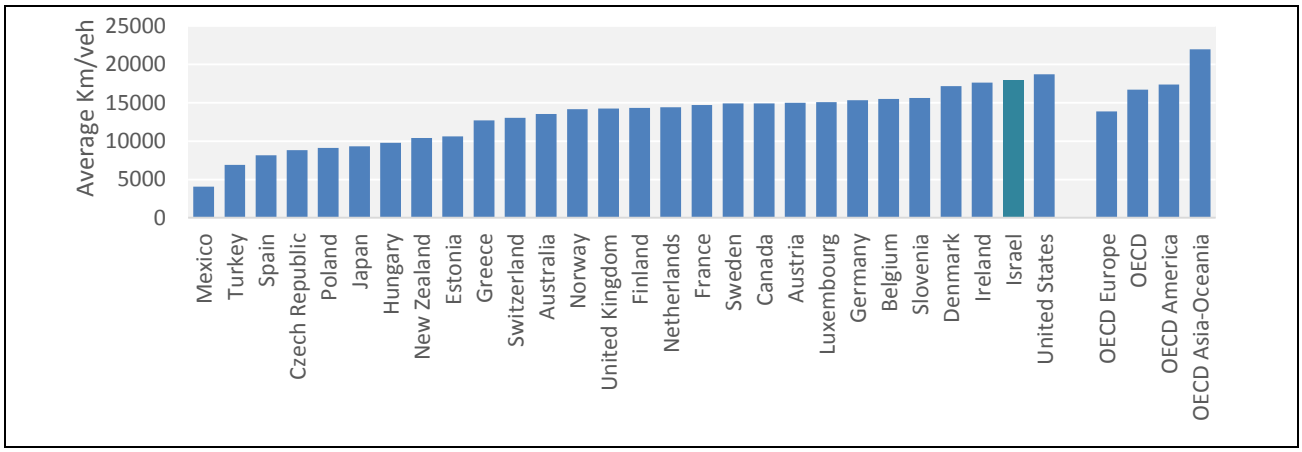
12. MoF (2013).

Figure 2. Road traffic density per network length
2014 or latest available



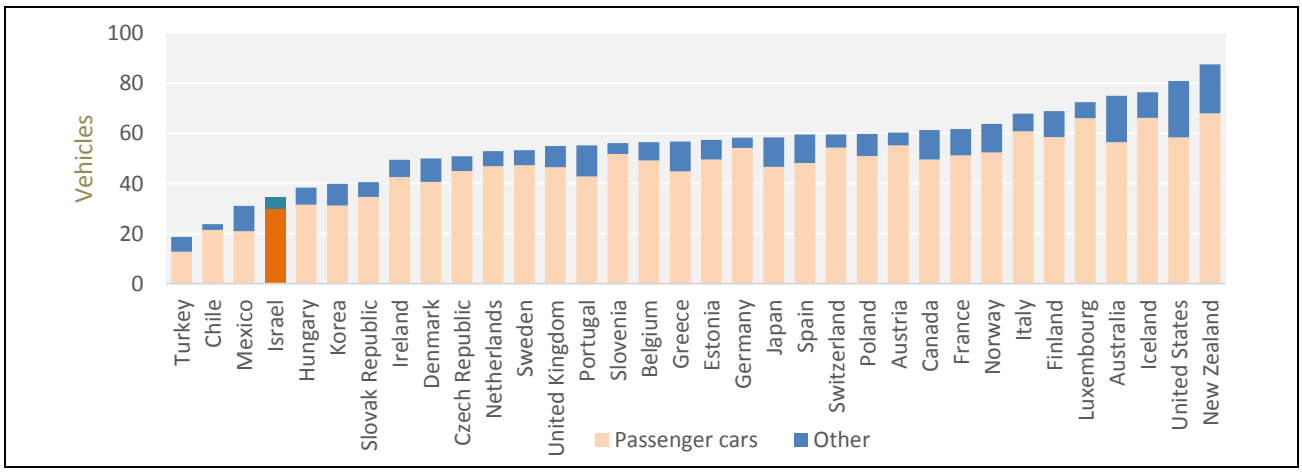
Source: OECD (2015), *Environment at a Glance 2015*, OECD Publishing.

Figure 3. Annual average kilometres per vehicle
2014 or latest available



Source: Authors' calculations based on OECD (2015), Environment at a Glance 2015, OECD Publishing.

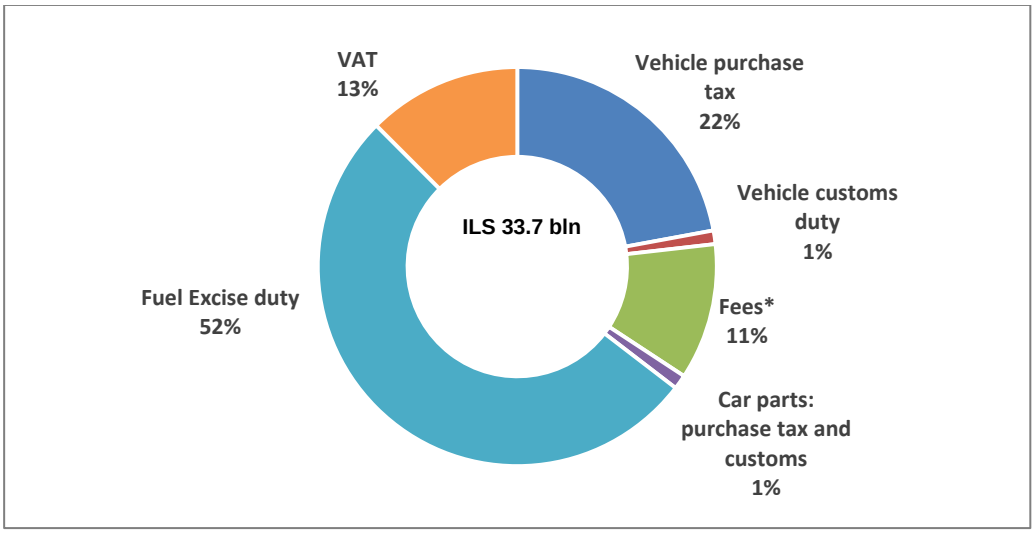
Figure 4. Number of vehicles per 1 000 residents
2014 or latest available



Source: OECD (2015), Environment at a Glance 2015, OECD Publishing.

27. With the customs rate of 0% for cars imported from the EU and the United States and some other countries, and 7% for countries without a free trade agreement, it is the high purchase tax rates in Israel that have caused the high retail prices of cars. A private car has historically been a symbol of status in Israel, so that a high purchase tax was imposed on it alongside taxes on other "luxury" goods, like consumer electronics, back in the 1950s, when cars were considered "non-essential". Gradually, while most of the products on which the initial tax was imposed became a natural part of the modern household (like household electronics), most of the purchase taxes were removed, with the tax on private cars still staying high.

Figure 5. Tax revenues from the car sector
2012



*Annual registration renewal fee, driving licence and others.
Source: Adapted from MoF (2013), Chapter 14: Vehicle taxation in State division annual report 2011-2012, http://ozar.mof.gov.il/hachnasot/doch11-12/docs/perek14.pdf.

Table 2. Private car taxes in selected countries[13]
2014

Country	Min	Max	Notes
Austria		32%	Based on CO_2, NO_X and PM emissions + bonus/malus, different for diesel vehicles;
Belgium			Based on cc + age; CO_2 emissions (Wallonia)
			CO_2 + Euro standards + fuel + age (Flanders)
Denmark	105%	180%	Registration: 105% of up to DKK 80 500 +180% on the remainder, based on fuel consumption and different for diesel vehicles; credits for safety systems. Annual progressive tax based on fuel consumption, different for petrol and diesel.
Finland	5%	50%	Registration tax based on Price + CO_2 emissions ; recurring tax based on CO_2 emissions
France	€ 150	€ 8,000	Registration based on CO_2 emissions (bonus/malus) and annual tax based on CO_2 emissions
Germany			No registration tax; recurring tax based on CO_2 emissions
Greece	5%	50%	Registration taxes based on cc + EURO standard; annual taxes based on cc and CO_2 emissions (for newer cars)
Ireland	14%	36%	Progressive registration tax based on CO_2 emissions; annual progressive tax based on CO_2 emissions
Italy			Based on kilowatt, weight, seats
Luxembourg			Recurring tax based on CO_2 emissions; higher for diesel vehicles
Netherlands			Based on price + CO_2 emissions, slightly higher for diesel; relatively high registration and annual circulation tax for non-electric/hybrid
Norway			Progressive registration tax based on weight, engine power, NO_X, CO_2 emissions; can come up to 50% of the vehicle total price
Portugal			Progressive registration tax based on cc and CO_2, higher for diesel; annual tax based on CO_2

Source: ACEA (2014); ACEA (2015a).

28. Up to 2009, the purchase tax rate was 95% of the private car value, and 75% on commercial vehicles, highest among the OECD, except for Denmark and Norway (Table 2). There existed no differentiation by weight, engine size or fuel consumption of the vehicle.[14] In 2012, the purchase tax on vehicles came up to ILS 7.4 billon, 54% of all purchase tax revenues excluding fuel,[15] or 0.6% of the GDP that year.

2.2 Five-year tax reduction reform (2005)

29. The general understanding that older cars are both less safe and emit more pollution led to the major decision to reduce the purchase tax on private cars in order to allow consumers to buy newer vehicles and by giving incentives to install safety accessories. Starting from December 2005, the purchase tax on motor vehicles was cut by 6%, from 95% to 89% for private and light commercial vehicles (not exceeding 3.5 tonnes), and the purchase tax rate on commercial vehicles fell from 75% to 73%. The process was supposed to be spread over 5 years; a slow implementation aiming to prevent creation of expectations that would lead to unwanted demand shifts. At the end of the period, by 2010, the purchase tax on private cars and commercial vehicles was to reach a uniform 72% (however, in 2009, the Green Tax

13. For a comprehensive comparison of various taxes and their progressive effects, see Braathen (2009).

14. Before 1990, there were four grades defined by engine size, which in 1990 were reduced to two (116% for engines bigger than 2000cm^2 and 180% for bigger engines). In 1991, all the grades were cancelled, and the tax stood at 100% for all vehicles, in 1993 reduced to 95%. In 1998 a distinction in taxes between private (95%) and commercial (75%) vehicles was established.

15. A purchase tax in Israel is imposed mainly on products with a negative external effect: fuel (55% of all purchase tax revenue), vehicles and parts (24%), tobacco products (17%), alcohol (2%), but also on additional products for fiscal reasons: entertainment electronics, mobile phones, fur clothing items etc., totalling ILS 31.9 million or 2.7% of GDP (MoF, 2013).

came into force one year before the completion of the reform). Additional tax credits were to be granted to those who installed safety accessories in their vehicles.

30. One of the main reasons for the reform was an attempt to reduce car accidents; therefore no differentiation was created between vehicles according to their pollution levels. The cost of the reform was estimated to be ILS 50 million in the first year, and ILS 100 million in 2007-2010 (approximately EUR 9 million and EUR 18 million respectively).

2.3 Pollution-related legislation

31. In 2006, Israel adopted the Euro 4 emission standards, which set maximum exhaust emissions (HC, CO, PM, NO_X) for all newly imported vehicles (up to 3.5 tonnes). This implied that new vehicles imported would be emitting less pollutants compared to the ones from earlier production years. From March 2006, all gasoline-powered vehicles in Israel (beginning with 1995 models) must undergo stringent air pollution checks within the framework of the annual car registration test. In subsequent years, Israel continued to adopt Euro standards (Euro 5 in 2008 and Euro 6 in 2013).

32. In 2007, in the next attempt to reduce the air pollution caused by transport, the Israeli Government reviewed the vehicle quality standards, introducing a scrappage scheme in order to remove old and polluting cars off the road. In addition, mandatory emission standards for smoke emissions (particulate matters) from diesel vehicles and carbon monoxide emissions from gasoline-powered vehicles were adopted. All cars made in 2001 and later were required to comply with these standards, during the annual registration renewal tests. These standards did not include GHG emissions from transport.

33. The government scrapping scheme offered ILS 3 000 ILS (EUR 550 in 2007) for vehicles aged 20 years or older. In 2007, there were nearly 1 779 thousand private cars in Israel (77% of all vehicles), with average age of 7.1 years. 75 000 of these were produced in 1989 or earlier, meaning nearly 3% of cars were aged 20 years or older. The incentive was clear – to remove unsafe cars from the road, that were estimated to pollute 10 times more than the new ones, consumed more fuel, and were not equipped with the newest accident prevention measures (like EPS) and safety devices (like additional air bags and seat belts with emergency locking retractors). The programme was justified from the fiscal standpoint as well, apart from the reduced cost of pollution and accidents; there would be also higher revenues from the purchase tax on new cars.

34. The original budget of the programme was ILS 20 million a year, over a period of five years. In 2013 the programme was re-launched with a reduced budget of ILS 5 million a year for 2013-7. However, with the re-launch of the programme, the whole annual budget was exhausted in just one day. As of the end of 2013, 28 000 vehicles were scrapped as part of the programme[16] (nearly 1.2% of all private cars in that year).[17]

35. In 2008, the *Clean Air Law* (that went into force in 2011) was the first legislation to create a regulatory framework to monitor and manage air pollution in the country, establishing pollution limits, creating a mechanism of permits and fines, with the vision to create a national plan by the year's end. The law mandated the Minister for Environmental Protection to update the emission standards. The government together with local municipalities was obliged to devise a plan for improvement in public transport to

16. MoEP (2015b), "Car Scrapping Program", *www.sviva.gov.il/English/env_topics/AirQuality/PollutionFromTransportation/GovtMeasures/Pages/CarScrappingProgram.aspx.*

17. CBS (2015a), Table 24.11 in *Statistical Abstract of Israel, http://cbs.gov.il/shnaton66/st24_11.pdf*.

reduce emissions. The level of pollution of a given vehicle should appear in the advertisements of that vehicle.

36. In September 2012, annual exhaust tests were tightened even further, requiring emission levels from the old vehicles to match those originally set by the manufacturer. Failure to pass the test would result in an impediment to renew the annual license for the car. In September 2013, the stringency of spot checks on the road was increased as well to ensure that the cars stand up to the emission standards set by the manufacturer. Failure to pass the roadside check results in the owner being fined or obliged to correct the problem and re-do the test. According to the MoEP, nearly 30 000 roadside spot checks are conducted annually, most of them on diesel vehicles, and about 10% of vehicles fail the roadside tests (MoEP, 2015a). Both of the above regulations are in accordance with similar directives of the European Parliament.

37. Adopting emission standards, enforcing annual emission checks and other regulatory measures that establish pollution limitations were not enough, however, to create significant shifts in demand. Economic measures were called for to influence consumers to buy cars with lower pollution levels than those required by law.

3. Green Tax Reform

38. None of the measures prior to 2009 dealt with the fact that there is a high cost to society of using a car – much more substantial than the tax paid on it. Direct regulatory measures like complying with European standards for new cars and obligatory annual emission tests do not create an incentive strong enough to affect consumer behaviour and ensure that the economy moves towards a social optimum. In turn, economic instruments can be used in order to impose the costs of using the vehicle on the actual vehicle user and to encourage behavioural change through market signals. There are several instruments in the policy makers' toolkit, including taxes and rebates, to correct market failures and approximate the market price of using a vehicle with the actual cost of using it, taking into account as many externalities as possible.

39. In 2006, following an initiative from the Tax Authority and chaired by its Head of the Planning and Economics Division, Boaz Soffer, an inter-ministerial commission (with the participation of the Ministries of Finance, Transport and Road Safety, National Infrastructures, and Environmental Protection) was assembled to formulate a policy aimed at reducing air pollution from transport, and to discuss possible solutions to the damage it causes. Apart from government representatives, the commission included external experts from various fields – car engineers, industry and management engineers and economists.

40. The initiative was an outcome of the general global trend of increased environmental awareness, technological advancement aimed at reducing the damaging effects on the environment from various sources, development of new types of fuel and continuous tightening of emission standards. Many countries have implemented laws that impose emission taxes of one type or another (Table 2). In view of all these changes, there was a need to devise a policy that would be based on environmental considerations. The commission had several objectives, namely: establishing the criteria to define grades of pollution from vehicles, which would later be used for tax rebates/fines definitions; evaluating the differences between external effects from various fuel types and the actual tax levels for these fuels; testing for the possibility of providing rebates to fuels produced from renewable sources; establishing incentives for devices reducing emissions and reducing the dependence on crude oil and its products.

3.1 External effects of transportation

41. The commission discussed several external effects from transportation that should be internalised:

- Air and water pollution – affecting public health and causing biosphere damage;
- Congestion – loss of time, missed economic activity, reduced security and reliability;
- Accidents – pain, suffering and grief caused by fatalities, damage to property, decreased productivity, medical costs and costs of services (police, ambulance), etc., which are not covered by own and third party insurance;
- Global warming – long-term effects due to GHG emissions;
- Noise – affecting everybody located close to main roads;
- Transport infrastructure – construction and maintenance of roads, enforcement and legal frameworks;
- Land use – alternative use of parking areas.

42. Expert reports to the Ministry of Finance and the Ministry of Environmental Protection estimated the external effects from transportation at 6% of GDP (Table 3).[18] These costs were compared to the total revenues received by the state from the purchase tax on vehicles and vehicle parts plus, the annual road tax and taxes on fuel, all of which came up to 3.4% of GDP (in 2004). This implied that the society subsidises private car usage by an amount of 2.6% of GDP at least. The meaning of this is that the costs are imposed on the part of the population which does not use the car, or uses it at much lower rate, leading to favouring of private cars rather than alternative ways of transportation (like public transport, walking and cycling). These costs come in the form of increased medical expenditure, reduced property values (in areas of pollution and noise), increased costs of products in city centres and shopping malls that provide parking, the cost of which is implied in the goods prices.

18. The estimations were based on a range of works, among ExternE (2005). The Value of a Statistical Life was estimated to be USD 930 000 for the years 2000-2002. Several different studies were used for benchmarking purposes, including Delucci et al., 1998, and Litman, 2003. The figures received ranged between 0.3% and 17.3% of the GDP. OECD (2001) estimated the external costs from transport between 8-10% of GDP. The minimal costs of climate change range between 4% and 7.3% according to INFRAS (2004).

Table 3. External costs from transport usage

Category	Cost estimate (% of GDP)
Accidents	0.67
Noise	0.36
Air pollution	2.08
Climate change	0.18
Congestion	1.92
Infrastructure building and maintenance	0.34
Value of free parking	0.49
Total	**6.04**

Source: Green Tax report (2008).

43. In order to internalise the external costs and create a better linkage between the market price of using the vehicle and the actual cost, several types of instruments were considered for possible implementation (Green tax report, 2008):

- Purchase tax – can affect the volumes and type of car, but does not resolve usage-related problems, like noise and congestion.
- Fuel taxes – allows skewing the demand towards using more environmentally friendly cars, and can affect travelled distances, which in turn affects other externalities like accidents and noise. Such taxes only partially tackle congestion, since they are not linked to the time of travel, and they do not help solving the parking problem.
- Distance-related taxes – can reduce externalities affecting infrastructure, pollution, noise, accidents, but hard to implement, since it requires systematic reporting on kilometres driven (as it was found). This gives a lot of room for fraud.
- Congestion charges – can successfully reduce air pollution, noise, congestion and parking problems.
- Pollution-reducing taxes – with rates linked to the type and volume of pollution, distance travelled and the size of the affected population.
- Varying parking charges – as a function of place and time.
- Insurance premiums – to reflect the cost of accidents to society, and this is on top of the premium charged by the insurance company.

3.2 The Green Grade formula

44. Attempting to deal with all of the external effects at once is either impossible or it implies unrealistic operational costs. The volume of pollution caused by any vehicle depends on the car model, distance and conditions of travel. In practice, even though it is impossible to attach a price tag to each vehicle for every trip it makes, it is still desirable to attempt to improve the efficiency of the tax regime that existed before the reform. Since it is difficult to impose a tax on fuel with the rate varying according to the car model, it made sense to impose a differential tax on vehicles by the level of pollution they cause per litre of fuel.

45. In the 2008 report on green taxation, the evaluations of the damages caused by vehicle emissions were based on the UTOPIA study from 2001 (Commission Transport RTD Programme, 2001), which provided the necessary information base, tools and guidelines to support the introduction of urban transport solutions based on cleaner vehicles. The costs to society were obtained from the ExternE report (ExternE, 1999 and 2005) and were based on the costs for travel in typical urban conditions in Europe. Table 4 shows the cost of damage to public health, buildings and agriculture caused by transport emissions.

Table 4. Estimated cost of pollution from transport
EUR per tonne

Pollutant	Cost
CO	500
HC	900
NO_x	10 000
PM_{10}	20 000
CO_2	30

Source: Green Tax report (2008).

46. There are several possible ways to internalise the external costs in the form of a particular rate to be applied for a vehicle purchase tax, as being implemented in the EU and the United States, i.e. to base it on CO_2 emissions or fuel consumption, engine size and type (diesel, gasoline, hybrid, etc.). Israel, being a country not having as a declared objective to reduce fuel consumption, has the advantage to be free to adopt any formula that incorporates all the pollutants, rather than focus only on CO_2. Therefore it was decided to create a system that would differentiate by the level of pollution, taking into account all the five pollutants listed above, rather than linking the tax only to fuel consumption, engine size and type.

47. It was decided to use 15 pollution ratings, according to the "Green Grade" which was calculated by the formula that incorporated five pollutants with the parameters reflecting the costs from Table 4.[19]

$$Green\ Grade = \frac{500 * CO + 900 * HC + 10000 * NO_X + 20000 * PM_{2.5} + 30 * CO_2}{30}$$

48. The new tax came into effect on 2 August 2009 (ratified by the Knesset on 25 November 2010) and affected all vehicles up to 3.5 tonne. The purchase tax was set at 83% with rebates being given to all vehicles with pollution rating below 15.[20] In order to motivate the purchase of hybrid and electrical cars, the tax rate was set at 30% for hybrids and 8% for plug-in vehicles. As a result, the prices of less polluting vehicles were lowered, while the more polluting vehicles did now cost more. Table 5 shows the split between different green grades, their respective tax levels and the sales distribution of cars in 2012. The effective purchase tax rate is a function of the pollution rating and the car price – since the purchase tax is calculated as a percentage of the price, the cheaper the car, the lower will the effective tax be.

49. In addition to rebates given to less polluting vehicles, tax credits were given to additional security mechanisms – ABS+4 airbags – and for the installation of additional emission-lowering devices, like catalytic converters and diesel particulate filters. VAT creates an additional leverage to the tax effectiveness, it being calculated on the taxed car price.

19. There is no particular meaning attached to the denominator (30), and it is used for mere convenience.

20. The purchase tax at the time was 78% and was supposed to go down to 72% the following year. Initially, it was suggested to give rebates to all ratings below 8 (median rank), and increase taxes for the ranks above it. However, due to practical and legal reasons, it was decided to set the initial tax rate at a higher level, and provide credits for all ratings but the highest. The initial level was set at 90%, which came down to 83% in November 2010 in return for cancelling the tax credit of ILS 2 400 for cars equipped with Electronic Stability Control (ESC).

Table 5. Pollution rating, green grade, tax rebate, share of sales and effective purchase tax
2009

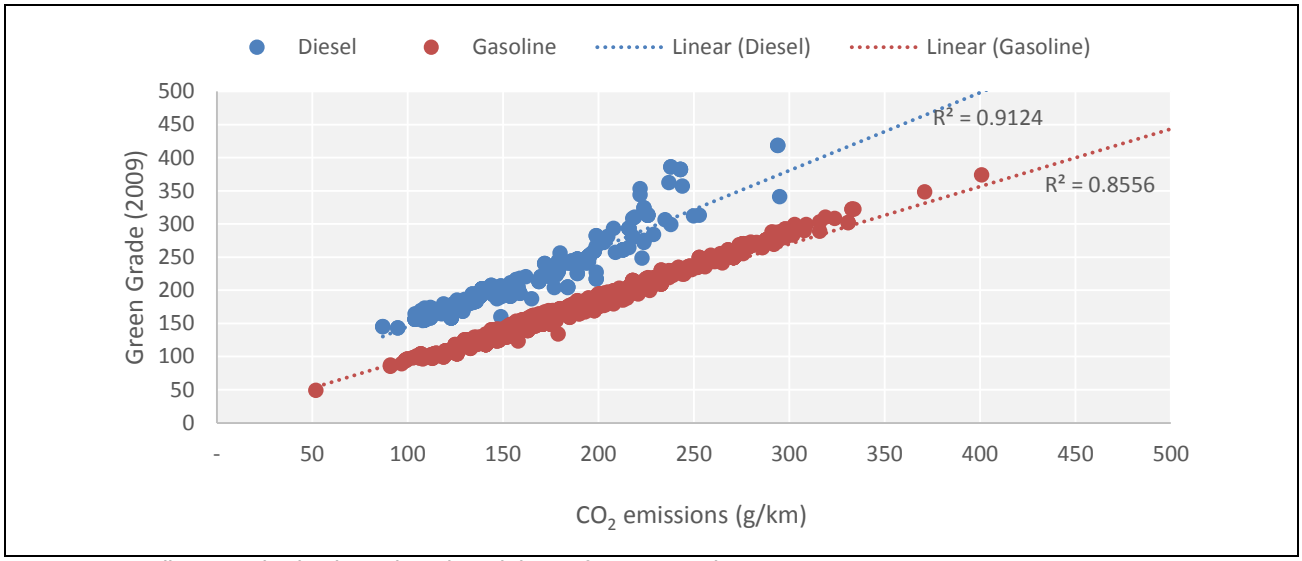
Pollution rating	Green Grade	Purchase tax rebate (ILS, 2009 prices)	% of sales in 2009*	Effective purchase tax rate
1 (no emissions)	0-50	Purchase tax=10%	0.0%	10%
2 (hybrid)	51-130	Purchase tax=30%	1.4%	30%
2	51-130	15 000	0.3%	38%
3	131-150	13 750	0.9%	50%
4	151-170	12 000	10.4%	54%
5	171-175	10 500	6.1%	58%
6	176-180	9 250	11.5%	60%
7	181-185	8 250	8.6%	64%
8	186-190	7 250	9.4%	67%
9	191-195	6 500	5.9%	70%
10	196-200	5 500	13.1%	71%
11	201-205	5 000	3.4%	73%
12	206-210	4 000	6.9%	74%
13	211-220	3 250	5.1%	77%
14	221-250	2 000	7.4%	80%
15	251 and above	-	9.6%	83%

*Calendar year, includes 5 months of Green Tax.
Source: Tax Authority – Taxes and overview of the car sector, 2010.

50. The Green Grade is strongly correlated with CO_2 – even though the "cost" of CO_2 is low relative to other pollutants, the volume of it is invariably higher (Figure 6). However, there is a strong distinction between diesel and gasoline vehicles – with the same amount of CO_2 emissions as gasoline vehicles, diesel vehicles receive higher grade, resulting in lower rebate and higher effective tax (Figure 7).

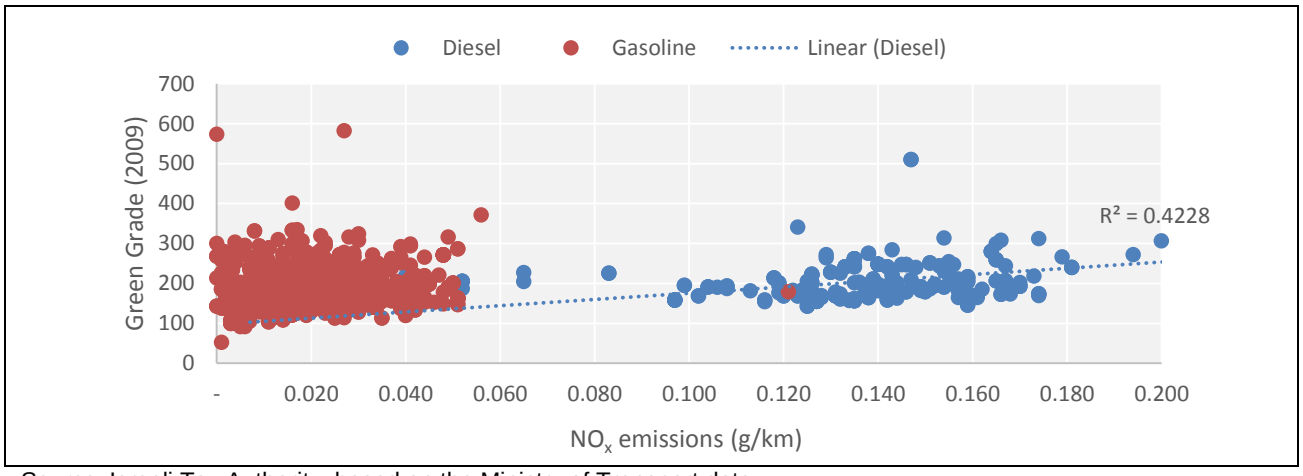
51. Due to the high weight of CO_2, the green grade is strongly correlated with engine size; however, from Figure 8 it is evident that engine size alone is not a good predictor of the expected Green Grade. There is quite a big dispersion within each group of engine size. For example, based on 2012 import data, the 1 598 cc group of engines includes cars between grade 138 (BMW mini) to Renault Kangoo, reaching grade 212, both gasoline vehicles.

Figure 6. Green Grade and CO_2 emissions of passenger cars imported in 2012



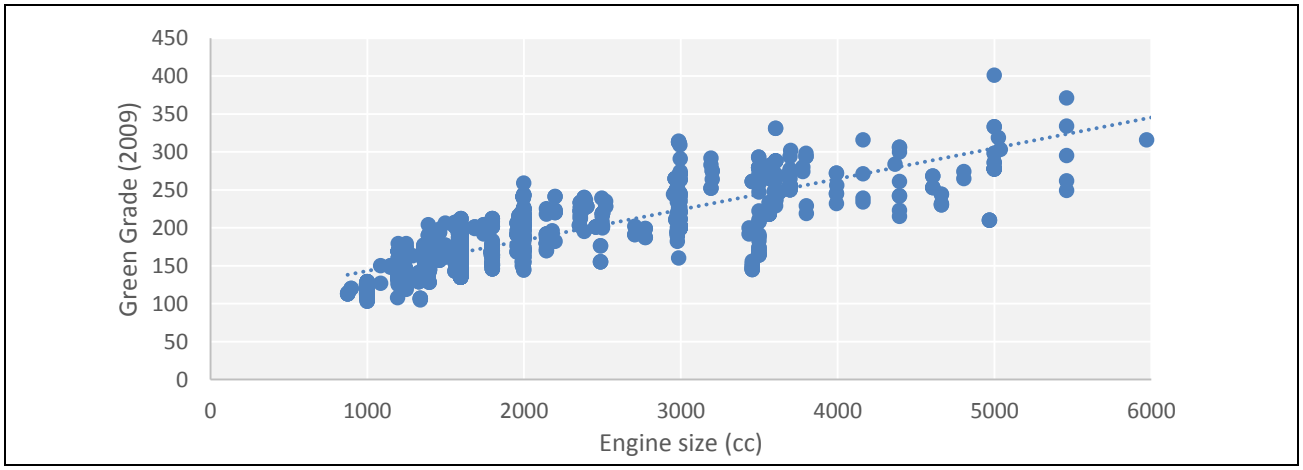
Source: Israeli Tax Authority, based on the Ministry of Transport data.

Figure 7. Green Grade and NO_x emissions of passenger cars imported in 2012



Source: Israeli Tax Authority, based on the Ministry of Transport data.

Figure 8. Green Grade and engine size of passenger cars imported in 2012



Source: Israeli Tax Authority, based on the Ministry of Transport data.

3.3 Company cars

52. According to the Green Tax report, nearly 270 thousand Israelis enjoyed the usage of company-owned cars, which they can also drive for their personal use, and benefit from free gasoline. On top of that, the employer provides service and what goes with it, which is not less important – a peace of mind. Central Bureau of Statistics reports[21] that in 2012, company cars (excluding self-employment) travelled on average twice as much annually as private cars (28.0 thousand km/year, compared to 14.4 thousand km/year). This has long been considered an ultimate privilege in the financial, information technology sectors, and senior directors in the public service and local authorities. Another, smaller group is of the employees who require the car due to the nature of their business – estate and insurance agents, delivery workers and service providers. By law, company cars have been seen as a benefit that should be taxed, i.e. employees

21. CBS, 2015b, Table 8 in *Kilometers travelled 2014, http://www.cbs.gov.il/publications15/1621/pdf/t_08.pdf.*

who use company cars have been required to pay income tax, national insurance and health insurance tax,[22] as if the benefit was part of their income.

53. The base for the tax on company cars is the "usage value", which for practical reasons is estimated based on the cost of maintenance of the car, or the usage cost. Up until 2009, there existed seven grades for usage value, according to the price of the car when new, as illustrated in Table 6. This is considered as an additional income, which must bear all the required taxes. Even so the value of the benefit usually exceeded the cost of maintenance, leading to increased use of company cars, and therefore, increased external costs.

54. The Green Tax commission proposed two changes to the existing situation: first, the usage cost would increase over subsequent years (Table 6). Second, rather than using brackets for car usage based on the new car price, a linear assessment of the usage value was proposed (and implemented, starting 2010), meaning that the usage value would not be linked to the price group, but to the retail price of the specific car the employee uses. This would better reflect the "green" purchase tax paid on the car, and would prevent the "crowding" of cars at the upper end of the brackets.

55. Starting from 1 January 2010, the brackets were removed, and the usage value for all new cars was set at 2.48% of the retail price of the car. The amount calculated would then be corrected for inflation in all subsequent years. The usage value of the older cars, however, would continue to be calculated according to the price brackets.

Table 6. Usage value brackets for company cars
As proposed by the Green Tax commission (ILS)

Price grade	Prices (ILS)	2008	2009	2010	2011
1	92 000 or less	1 380	1 580	1 920	2 260
2	92 001-111 000	1 530	1 730	2 090	2 450
3	111 001-130 000	2 100	2 450	2 800	3 150
4	130 001-147 000	2 570	2 980	3 380	3 780
5	147 001-19 1000	3 580	4 130	4 680	5 230
6	191 001-273 000	4 580	5 310	6 040	6 780
7	273 001 and up	5 820	6 790	7 760	8 720

Source: Green Tax Report (2008).

3.4 Other recommendations

56. Apart from the main recommendation on the changes to the purchase tax, and the usage value, the commission proposed several additional measures to deal with externalities from transportation, namely:

- Congestion charges – they should be differentiated according to places and times of travel, distance and particular lanes.
- Heavy vehicles – differential taxes should be applied according to levels of pollution (purchase tax on these vehicles was 0% in 2008) and adjust depreciation rates from 20% to 25%. In practice, limited information on heavy vehicles and limited supply of "green" alternatives prevented increasing the tax on these vehicles.
- Taxis – similar to heavy vehicles, it was proposed to increase the purchase tax (0% at the time of the report) to 10%, but to create differentiation according to pollution level. In order to avoid

22. The Health insurance tax is a compulsory tax in Israel dedicated specifically for the provision of medical services.

harming the taxi sector, annual depreciation rates (for tax purposes) were increased from 20% to 25%.

- Fuel – motivate usage of "green" fuels like bio-diesel by providing a tax credit for using this type of fuel. The commission found, however, that the external costs of using other fuels, gasoline and diesel used for cars was already internalised in the tax (excise) on them.
- Scrapping scheme – promote scrapping schemes by providing the necessary budgets.
- Annual Road Tax – increase it with the age of the car to reflect its relative pollution levels.

3.5 Implementation of the tax

57. The modifications to the vehicle purchase tax provided a transparent and comprehensive measure of the level of pollution that is reflected in the final price of the car,[23] and incorporated on average all of the pollutants weighed by their relative social costs. It is a market tool which links in a better way the final costs of the car to the environmental costs of using it. However, this measure required strong government support from all the related ministries, and was, hence, not achievable without the co-operation of all the relevant bodies. A major effort was required to bring the conceptual change among car importers, politicians and the public. Even more had to be invested in public relations, describing the benefits of the tax, which was perceived as yet another attempt to increase tax revenues. A number of the most popular car models' prices were about to increase – mostly large family, luxury and sport cars – but for many models, the retail price actually was reduced. The fact that the only criterion for the tax was the level of emissions meant that even if the Tax Authority's aim was to increase revenues, it was done in a way that would benefit the environment and the society as a whole.[24] The expected differentiation in car prices, often classifying cars of similar type and engine size in completely different pollution grade categories, was expected to cause significant market changes in the short run (while in the long run, car manufacturers were expected to adjust to the change in legislation in favour of "greener" technologies). This of course led to very strong opposition from several bodies, mainly from car importers, who albeit being consulted during the commission's work, aggressively attacked the forthcoming changes, trying to push for a tax based solely on CO_2 emissions, like in Europe. This would have implied an increase in the market share of diesel-engine cars and increased pollution deriving from increased emission of extremely harmful NO_X and particulate matters.[25]

58. In January 2008, Government decision 2935 mandated the Ministry of Transport and the Road Safety Authority to regulate the reporting of the emission levels by the importers, and to set the rules on advertising these levels alongside the green grade of each vehicle. It became compulsory to mark the green grade and fuel consumption at every advertisement (in Print, on TV or digital), at every point of sale and on the Ministry of Transport website. Since consumers are not immediately aware of the tax rebate, and see only the final price of a car (with tax rebate already applied), the inclusion of clear notification of the vehicle's green grade on every advertisement is extremely important in increasing public awareness, and

23. Even though no link was made with car usage, and given that the received distribution of car prices reflected average cost of damage without factoring in variable costs, for example, distance travelled, effectively penalizing cars that are used less, it can be argued that individuals that tend to use less their car will prefer a cheaper – "greener" – car anyway, to reduce their average costs per km travelled.

24. Actually, some sport cars fell into low grades of the tax, like VW Cherokee 1.4. This only strengthened the idea of the environmentally friendly tax.

25. Euro 4 standards allowed 0.25g per km of NO_X for diesel cars, and 0.08g per km for petrol cars, thus giving a preference for diesel cars that emit less CO_2.

consequently, influence their choice towards a more efficient cars, with higher tax rebates that are essentially, less polluting.[26]

59. Alongside public relations, an extensive logistic and technical work had to be done. Importers, that were now required to report on five main pollutants, were not prepared for the change, obliging them to submit requests for detailed pollution level information for each model from the manufacturers. It took a full year for all the relevant parties to build a full and comprehensive database of all the car models and their respective pollution volumes (now maintained by the Ministry of Transport), to check for any inconsistencies in the data, and address any unexpected issues. One of the problems faced by the team responsible for the creation of the database was the differences between the American and the European testing standards, which could provide different pollution levels for the same car model. Thus, cars of American origin had to have their pollution levels adjusted by a factor calculated by technical experts that provided their view on the differences in testing procedures. Another issue was the variety of features that could be added to a specific car model and cause a potential change in the emission volumes – all these were not taken into account by the importer, who would report emission levels of a "generic" model. Similar problems arose in relation to the models that were produced specifically for Israel, with emission levels reported for the "original" model.[27]

60. All in all, it took slightly more than a year and a half between the publication of the final commission report and the implementation of the tax. In order not to create a distortion in demand, the official announcement of the impending tax was made two month before the initial date of implementation, on 8 June 2009. In mid-July, two weeks before the reform was about to be launched, several car importers (BMW, Peugeot, Citroen and Renault)[28] submitted a petition to the High Court of Justice in an attempt to prevent the implementation of the reform, claiming that due to the fact that the models they import were at the higher end of the market in terms of price, security, design and performance, the reform would cause severe damage to their market share, hinder free competition, and would not bring savings in energy use. Again, the importers touched on key aspects of the new tax formula, claiming that it gave relatively high weight to the PM and NO_X gases, but lower weight to CO_2, against the trend in Europe and US, where the taxes were based on CO_2 emissions. This, they argued, would favour vehicles with lower fuel consumption. In order to demonstrate how the importers of BMW, Peugeot, Citroen and Renault would be harmed by the reform, several comparisons were made between the models which used to fall within the same category of size, and engine power, but would differ substantially in price after the reform was implemented. For example, a Citroen C4 which would have pollution level 10 was compared to a Toyota Corolla (level 4). The petition was overruled for reasons that included late submission (the importers waited for more than a month in order to submit it), and for not exhausting other means, like direct appeal to the Ministry of Finance.

61. The announcement of the tax modification created a substantial stir in the car market. During the few months in the run-up to the reform, there were increased sales of all the vehicles, whose retail price was expected to rise. Also, personal imports, which usually relates to luxury cars, increased. After that, the public quickly adjusted to the change. Critique is still being heard in various circles, touching upon the social and fiscal aspects of the tax, but so will any major change, particularly if it is initiated by the Tax Authority.

26. A recent research by Tikotsky and Peer (2015) tested the effect of various ways of advertisement of the green grade, tax, rebates, car price, fuel consumption and other attributes on the choice of a car.

27. Boaz Soffer and Natalia Mironichev, personal communication.

28. An attempt was made to make more importers to sign the petition, but failed. The Association of Car Importers also refused to take part in the petition.

4. Formula Update

62. The full impact of the reform will be discussed in more detail in Chapter 5; however, it is worth mentioning here that within three years since implementation, the effect of the Green Tax reform was remarkable: before the reform, in 2008, the median pollution level was 10; in 2012, the median level was already 4, and in 2012, most of the cars fell within the 2-6 range in pollution levels. This meant that even though in the previous years there was a vast shift in demand toward less polluting cars, the differentiation between the levels of pollution emitted by new cars became less pronounced, and the tax had lost its effect on the distribution of emissions. Several factors determined the need to update the formula. The average tax per car went down, making private cars more affordable, adding to a higher motorisation rate, without the infrastructure being able to catch up; an increase in total number of cars brought an increase in the total amount of emissions – even though an average car was less polluting; the decrease in the total tax revenues implied that there was less budget to deal with increased pollution and infrastructure needs. Alongside the understanding that the original formula, which used European externalities costs estimates, had to be adjusted to better reflect Israeli reality, all of the above meant that additional measures were to be applied to enforce an even bigger shift in demand towards less polluting cars, without reducing the tax revenues.

63. Therefore, two major steps were taken: first, pollution level brackets were modified to create more differentiation within lower grades; and second, an extensive study was commissioned to update the parameters of the green grade formula, via better estimation of the external costs of pollution. Four years after the first implementation, an updated formula came into effect on the 1 August 2013.

4.1 Estimating the external costs in Israel

64. Estimating the economic costs of the health impact of air pollution from road transport is extremely difficult for a number of reasons – isolating the effect of an environmental factor is a non-trivial task; attaching an economic value to the outcome (be it a symptom, a disease or death) is even harder; and vast data must be collected, which many times requires extensive resources and time. In Israel, only a few studies have been made: one is Shechter (1991), who used an hedonic prices approach to estimate the effect of pollution on public health in Haifa (without attaching economic value to it); another one is Becker (2009) who attempted to estimate the cost of certain types of cancer; Becker (2000) used compensating wage differences to estimate the value of statistical life (VSL) in Israel; Pareto Engineering (2006) used value transfer to calculate the costs. OECD (2014) reports VSL of USD 2.6 million in Israel, also using simple unit value transfer.

65. The initial Green Tax report from 2008 used the costs of external effects which were reported in studies conducted in Europe and transferred to Israel using value transfer, adjusted for income and inflation. Understanding that European estimates cannot be directly applied in Israel, the Department of Economy and Standards at the Ministry of Environmental Protection commissioned a special analysis to estimate the external costs of the pollutants from transportation, manufacturing and electricity production and which directly affect the quality of air and therefore, public health (Becker et al., 2012).

66. The analysis collected the results from multiple studies across the world and transferred them to Israel, using a Meta-Analysis Benefit Transfer approach. These results were then benchmarked against a dose-response method, which combined the response functions described in epidemiological literature, adjusted for Israel by the population composition, and applied mortality and morbidity costs calculated in Europe (ExternE, 1999 and 2005) and the United States (US EPA, 1999), and adjusted by GDP percentages. The costs to the environment, the flora and the fauna were not considered. Therefore the costs evaluated in that study were under-estimated. The pollutants analysed were PM_{10}, $PM_{2.5}$, NO_X, VOC, CO and SO_2.

67. Table 7 summarises the volume of emissions for the pollutants analysed. Almost a third of all emissions originate in transport activity. Becker et al. (2012) analysed seven geographical regions with different characteristics (population density, level of industrial or transport activity, and so on) and different emission levels, i.e.: four large cities (Jerusalem, Tel-Aviv area, Haifa and Beer-Sheba) and three rural areas (North, Centre and South). The authors found out that more than 50% of total pollutant emissions and 72% of transport emissions originated in the country's centre. Comparing urban and rural areas, 87% of total emissions were in rural or open space areas, rather than large cities, strictly speaking.

Table 7. Emissions from fuel combustion, by sector
Tonnes, 2010

Pollutant	Manufacturing	Electricity	Transport	Total
SO_2	28 760	133 505	252	**162 517**
VOC	44 085	-	13 434	**57 520**
NO_X	30 345	144 251	45 204	**219 799**
PM_{10} (incl. $PM_{2.5}$)	7 607	4 320	2 129	**14 056**
CO	2 913	2 208	117 726	**122 847**
Total	**113 711**	**284 284**	**178 745**	**576 739**

Source: Data reported in Becker et al. (2012).

4.1.1 Benefit transfer: Meta-analysis

68. Benefit Transfer uses the economic parameters estimated elsewhere ("study site") and transfers them to a different location ("policy site"), by adjusting the variables, such as population size, age, density, and so on. According to the pollutant evaluated, it is important to take into account the sector, the size of the affected population, and the percentage of weaker groups (children and seniors). The approach does not require large budgets; however, it does require a database for primary valuation studies, with enough detail to compare with the policy context, where a comparably extensive database is required to perform meta-analysis (OECD, 2012).

69. Simple (naïve) unit value transfer, where mean value estimates from several studies is used to simply transfer to the context of the study was not applicable for Israel. This is so because the approach assumes that the utility gained from mortality risk reduction is similar across the study and the policy sites. Value transfer with adjustments of income, population density and other Israel-specific characteristics would provide much more robust results. Additional adjustments could include the level of original pollution, and pollution target levels; elevation of pollution; density of population with relevant risk; GDP per capita and adjusted income elasticity.

70. Income elasticity represents the percentage increase in the willingness-to-pay to reduce the risk of mortality resulting from a 1% increase in income (OECD, 2012). Adjusting for income is particularly important as the willingness-to-pay changes with income levels, and is likely to vary depending on the type of illness and other factors (Kleckner and Neumann, 1999).

71. Using one study for benefit transfer could be problematic due to exclusion of relevant variables in the willingness-to-pay function. If there is low variation in an independent variable, this usually prohibits inclusion of this variable for transfer. Therefore, a number of studies were combined in a meta-analysis to estimate one common benefit function. The meta-analysis allows evaluating the influence of a wide range of characteristics affecting the estimated value of statistical life (or actual willingness-to-pay).

72. The final data set for primary valuation estimates contained 114 values for different pollutants from 23 countries.[29] Each of the studies had a similar range of variables (GDP per capita, population density, urban or rural areas, source of pollution – either from transport or industry according to elevation of the emission source, and so on). A similar set of variables was collected in Israel for simulation purposes. All values were brought forward to 2011 using a discount rate of 5%.

73. The final regression model explained the damage from one tonne of emissions from each of the five pollutants estimated in the studies collated for the analysis, as a function of a set of the following explanatory variables. One was GDP per capita, which was used as a proxy for income. A distinction was made between emissions at ground level and from elevated sources, using a transport/industry dummy variable. Background pollution was an important control variable. Other explanatory variables included percentages of affected population (population density, population exposed, % rural population, % aged 60+ and % aged 14 or less). Compared to the original studies, which included estimates from the EU-27, the United States, Canada, Mexico, China and others, Israel had a higher average GDP per capita, higher population density, larger amount of children, but smaller rural population (Table 8).

Table 8. Averages, median and standard deviation of the study sites and Israel
Selected explanatory variables

Variable	Mean in sample	Median	Standard Deviation	Israel
GDP per capita (ILS)	37 816	38 640	12 058	90 060
Population density (per km^2)	167	110	22.41	321
% adults	16	17	2.42	14
% children	16	15	2.29	26
Exposed population	299 000	170 700	22,940	143 980
% rural population	28	31	12.32	8

Source: Becker et al. (2012).

74. Regression results obtained by Becker et al. are presented in Table 9. Number of observations in each regression reflected the number of studies from which the data was collected. Regression parameters were then used to perform simulations on the costs of pollution in various locations in Israel, using data from the Central Bureau of Statistics.

29. The range of studies used is vast, examples include (but not limited to) studies estimating the cost of treatment, loss of time, coasts of pain and suffering from Canada (Steib et al., 2002), France (van Ganse et al., 2002), the United Kingdom (Department of Health, 1999) and others; WTP to reduce air pollution in Taiwan (Albernini and Krupnik, 2002) and others; Value of Statistical Life (VSL) based on the Willingness to Pay (WTP) to reduce the risk of death in the United States, Canada and EU (Markandya et al., 2004); Value of Life Year Lost (VOLY) from the EU (Rabl, 2004), Czech Republic (Alberini et al., 2006), Mexico (Hammit and Ibarraran, 2002) and others.

Table 9. Results of linear multiple regression
t-statistics in parentheses; dependent variable: cost of damage per tonne of emissions

Coefficient/Pollutant	SO_2	NO_x	$PM_{2.5}$	VOC	PM_{10}
Constant	6 017* (2.10)	3 738* (2.03)	21 804* (2.08)	1 666* (3.38)	2 298* (6.54)
GDP per capita	0.08* (2.20)	0.02* (2.43)	0.20* (2.66)	0.01* (2.58)	0.15* (4.82)
Population density	20.52* (5.42)	3.15* (1.86)	4.8* (2.14)	1.2* (2.89)	28.81* (2.52)
Transport		40 406* (2.47)	338 247* (3.49)	637 4* (2.47)	148 402* (5.05)
% elderly (65+)	43.15* (1.68)	70.36* (2.31)	70.44* (2.59)	30.62 (1.05)	42.24* (2.06)
% children (under 14)	41.65* (2.09)	225.04* (2.12)	313.2* (2.10)	11.53* (1.08)	187.92* (2.11)
Exposed population	0.10* (1.93)	0.11* (2.49)	0.4* (2.28)	0.09* (2.54)	2.43* (1.93)
Background pollution	14.31 (1.05)	2.23 (0.34)	11.87 (1.18)	1.85 (1.04)	712.2 (0.92)
% rural population	-3.00* (-2.14)	-48.84* (2.21)	-40.66* (2.01)	17.69 (1.10)	-24.40* (2.11)
R^2	0.61	0.35	0.42	0.53	0.40
$N^{\#}$	60	36	41	40	37
F	7.77	11.6	12.38	13.17	23.2

*denotes significance of 90%. # Indicates the number of studies upon which the regression is based.
Source: Becker et al. (2012).

4.1.2 Dose-response estimates transfer

75. A dose-response method aims to estimate the relationship between public exposure to a particular pollutant and morbidity on the one hand, and mortality on the other hand. An Impact-Pathway approach, formalised in the ExternE report (ExternE, 2005) follows a long progression of events from emission, through dispersion, exposure, impact and finally, quantification of the damage of the impact translated into monetary terms. Whereas the level and spread of pollution is defined by vehicle emission factors, traffic conditions and atmospheric dispersion models, exposure is related to population density within the exposed area. The impact is evaluated by estimating a function that represents the changes in the effect on public health caused by different levels of exposure to pollution, based on epidemiological studies. Finally, the impacts are translated into monetary values. A standard method of evaluating the cost of impact is derived from the individual's Willingness-to-Pay (WTP) for a marginal reduction of risk posed by the damage of pollution. The final output of the model is interpreted as the marginal cost of damage that was prevented from reducing one tonne of emissions from each pollutant.

76. In order to estimate the number of cases of morbidity and mortality that were spared by reducing pollution by one tonne, it is essential to know the number of people exposed to emissions and the length of time of exposure; how emissions are being translated into pollution concentrations; the symptoms accompanying each pollutant; the WTP to reduce the risk, or, alternatively, the costs of treatment of the symptoms (cost of treating chronic bronchitis, for example), costs of lost productivity, and the base level of morbidity (to separate it from the effect of pollution).[30]

77. Dose-response curves for environmental effects are hard to estimate due to the extensive data required, including multiple control variables, this in order to isolate the effects of pollution. This data, which often is being collected over a lengthy time period (cohorts) is not always available. The research itself might take several years and incur high costs. Due to limited time and resources, Becker et al. used

30. See, for example, OECD (2014) for a discussion regarding the valuation of life and health.

the effects of pollutants on various symptoms and mortality rates from epidemiological literature and cost estimates from the ExternE and EPA studies, adjusted for Israel using relevant GDP percentages. Since different dose-response curves exist for different populations (younger than 14 year olds, or older than 65; asthma sufferers and other population), the final costs were weighted by these population groups. The resulting costs were then reported for mean and median cities.

78. First, the number of cases for each symptom, caused by each pollutant per square kilometre was collated from the epidemiological literature. Second, the percentage of the affected population in Israel was calculated from the CBS data: number of children, seniors, asthma sufferers, and the number of cases relevant for Israel were calculated. Finally, the cost per symptom from the ExternE and EPA studies (adjusted by % of GDP) was attached to each symptom, thus providing the cost per 1 000 tonnes of emissions (Table 10).

Table 10. Economic evaluation of the cost of selected pollutants
ILS, 2011

Symptom	Cost* of avoided cases per 1 000 tonnes of emissions			
	SO_2	NO_x	VOC	$PM_{2.5}$
Acute death	12 619 800	12 619 800	10 627 200	0
Chronic heart failure	6 495	6 495	0	28 148
Restricted activity	1 729 378	1 729 378	0	7 650 322
Adult bronchitis	142 404	142 404	0	630 458
Cough (adults)	164 987	164 987	0	730 188
Lower respiratory disease (adults)	10 574	10 574	0	46 812
Bronchitis (children)	17 003	17 003	0	74 656
Cough (children)	32 877	32 877	0	145 260
Lower respiratory disease (children)	4 516	4 516	0	19 926
Respiratory hospital admissions	22 667	22 667	28 119	31 562
Cerebrovascular hospital admissions	65 561	65 561	0	288 913
Chronic death	15 621 984	1 5621 984	0	68 346 180
Chronic bronchitis (adults)	2 474 318	2 474 318	0	11 246 899
Chronic bronchitis (children)	78 109	78 109	0	344 321
Asthma attack	0	0	11 158	0
Minor restricted activity	0	0	115 358	0
Total per 1 000 tonne	32 990 678	27 651 416	10 781 836	89 583 650

*Cost of a symptom multiplied by the number of avoided cases
Source: Becker et al. (2012).

79. Since the original literature estimating dose-response functions mostly does not distinguish between sources of pollution, in this second approach Becker et al. (2012) reported total cost of emissions for the five pollutants, without splitting between transportation and industry.

4.1.3 Estimating the external cost of carbon dioxide (CO_2)

80. In relation to CO_2, which influence global climate changes rather than increase local pollution, meaning that there is no direct effect on public health, no adjustments were required, and the analysis used estimates of two studies: one in the United States (Greenstone et al., 2011) and one in the EU (Maibach et al., 2008).[31] The studies relate to several costs of climate change: sea level rise (cost of protection and loss of land), energy use (through effect on temperatures), agricultural changes (due to changes in rainfall and temperatures, but also levels of carbon dioxide in the atmosphere), water supply (changes in rate of precipitation, evapo-transpiration and demand changes), health impacts (increase in heat stress and

31. Since Becker et al. (2012) report was submitted, an updated version of the EU study was published at *http://ec.europa.eu/transport/themes/sustainable/studies/doc/2014-handbook-external-costs-transport.pdf.*

decrease in cold stress), ecosystems and biodiversity, extreme weather events, and increased risk of catastrophic events.

81. Maibach et al. focused on the transport sector and used two approaches – the avoidance cost (for 2010 and 2020) – and the damage cost approach (for 2030, 2040 and 2050). The latter uses detailed modelling to estimate the cost of damage caused by the temperature increase as a result of an additional tonne of GHG. The model incorporates various effects connected to changes in the sea level, landscape, fresh water availability, and so on. The economic implications of the sea level rise can be expressed as the costs of land loss and agricultural impacts can be expressed as costs and benefits for producers and consumers, and so on. Non-market impacts are much harder to measure, mainly because the physical impact caused by global warming is hard to predict, but also because it is even harder to assess the secondary impacts, like social damages. The damage costs approach allows for the wide range of externalities to be taken into account, but it also bears high uncertainty due to complex pathways of various effects and the long term horizon involved.

82. Avoidance cost is a cost-effectiveness analysis that assesses the least-cost option of avoiding CO_2 emissions. Given known longer-term reduction targets for CO_2, it is possible to estimate the cost of achieving the given amount of emissions reduction. Therefore for the short and medium run (2010 and 2020) the avoidance cost analysis by Maibach et al. provided better results.

83. Greenstone et al. have used a damage cost approach without sector limitations. Their results are much lower than in Maibach et al. (USD 21.4 vs USD 35[32] for 2010), which could be explained by differences in assumptions between the two studies (for example, higher discount rates used in Greenstone et al.).

84. Eventually, Becker et al. (2012) decided to use average estimates between the two studies, which was set at ILS 103 (EUR 18.8) for 2011. The reason is that even though there is a tendency in Israel to benchmark against the EU, it would be harder to promote higher parameters. It was also proposed to impose a 3.5% annual real interest rate and to re-evaluate the cost in 5 years.

4.1.4 Estimating the external cost of carbon monoxide (CO)

85. In order to estimate the effect of CO, simple unit value benefit transfer was applied from the estimates provided by Wang, Santini and Warinner (1994; 1995). Wang et al. used two approaches – the damage value method and the control cost method – to estimate air pollution emission values. The damage value method estimates the monetary cost of damage cost caused by air pollutant emissions, whereas the control cost method assumes that the current standards of air pollution are established at the ideal level, where the marginal damage of air pollution equals to the marginal control cost, and that the cost required to meet predetermined air quality standards reveals the value that the society is ready to pay (Wang et al., 1994).

86. Transferring the values to Israel revealed that the estimates were much higher than the EUR 500[33] used in the original Green Tax report (see Table 4 above). However, Becker et al. (2012) address the fact that there is a strong assumption implied in control cost analysis, namely, that public policy always operates at an optimal level, when in reality, the values are over-estimated, and as evidence for it, shows that the estimates obtained using the damage cost approach are 2.35 times lower than those obtained by the control cost approach. Since CO was not estimated using the damage cost approach, Becker et al. down-

32. Converted from EUR 25 by Becker et al. (2012).

33. Becker reports ILS 13 644 and ILS 8 663 for mean and median cities respectively, adjusted in 2011 prices and income. This translates into EUR 2 490 and EUR 1 580, using an exchange rate of 5.48.

scaled the CO cost by a factor of 2.35, which was later discounted to 2010 using the consumer price index and the rate of growth of the GDP per capita between 2010/2011. In the end, he used average values between the old and the new estimates. Admittedly, that was not the optimal solution, and a more extensive research should be made to estimate the real values of the effect of CO in Israel.

87. Following this recommendation, the Ministry of Environmental Protection turned to CE Delft, which published the "Handbook on estimation of external costs in the transport sector" in 2008 (Maibach et al., 2008) and "Shadow prices handbook" in 2010 (de Bruyn et al., 2010). De Bruyn et al. estimate the cost of 400 pollutants for the EU-27. The transfer to Israel was made by adjusting the result for population density and income ratios (expressed as the ratio between GDP per capita PPP adjusted). In Israel, population density is more than three times higher than in the EU27 (336 vs 116 per km^2 in 2008); however, due to the shape of the dose-response function, the estimated damage for this density went up only by 44%. It was decided by the experts in the MoEP to assume a linear response, and rather than transferring the whole dose-response function, to multiply the original value of EUR 59 by the ratio of the population density in Israel and EU27 (2.89), and the ratio in the GDP per capita (0.8) (MoEP, 2013).

4.2 Results and the updated Green Tax formula

88. Using a simple transfer of the dose-response approach, Becker et al. (2012) obtained a VSL of ILS 6.6 million for Israel, or USD 1.4 million. This is substantially lower than the figure that was found before in other studies in Israel, or the figure of USD 2.9 million, calculated in OECD (2014), which uses unit value transfer with income adjustment. Becker et al. admit their figure is low and recommend undertaking a more detailed research in the future.

89. The results of the two approaches they use are summarised in Table 11, showing the cost of one tonne of emission in an average city in Israel (144 000 residents, according to the CBS). As mentioned above, the dose-response functions used did not distinguish between sectors of pollution, whereas with the benefit transfer model it was possible to estimate the cost separately for the transport and industry sectors. Total cost obtained using the benefit transfer approach is an average between transport and industry sectors, weighted by the proportion of emissions from each of the sectors as reported in Table 7. The average cost of dose-response and benefit transfer costs is a simple average.

90. It is reassuring to learn that the estimated cost values from the two approaches are very similar, and follow the same order. This would not necessarily be the case when comparing between different countries. The cost of SO_2 and NO_x are very close, but for example, in Belgium and Netherlands, the cost of SO_2 is twice the cost of NO_x, whereas in Hungary it is lower, which only stresses the importance of the correct adjusted transfer. It is evident that PM entails by far the biggest cost, which is in line with other studies (Maibach et al., 2008, Korzhenevych et al., 2014).

Table 11. Cost of emissions per tonne in an average city in Israel
By Dose-Response and Benefit Transfer approaches, ILS per tonne

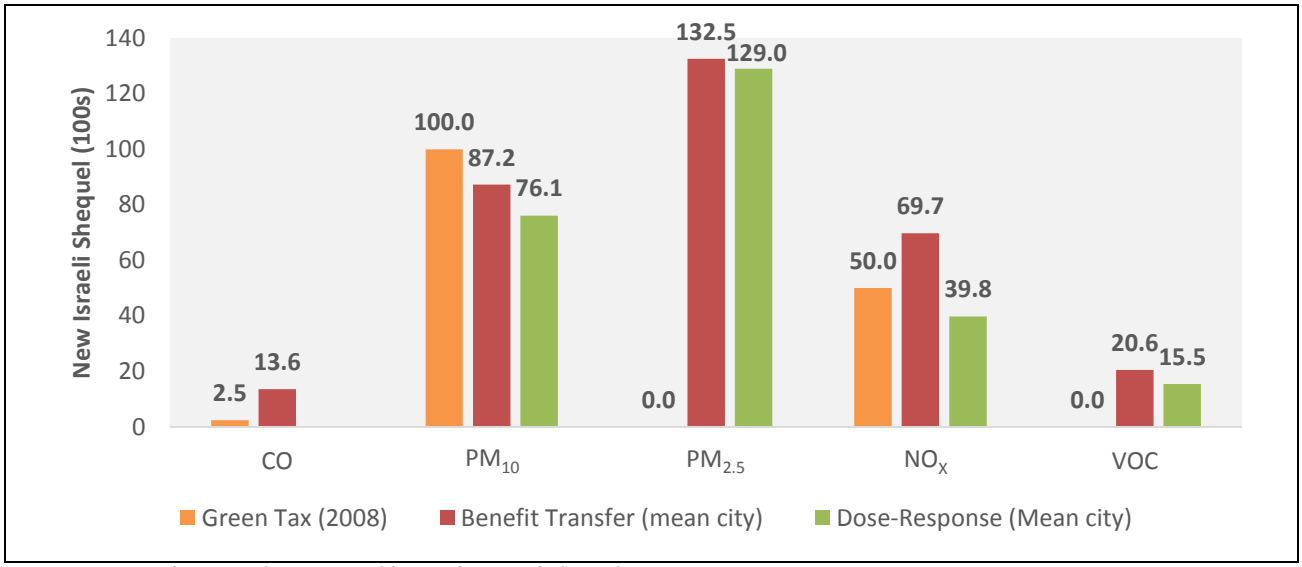
Pollutant	Dose-Response	Benefit Transfer (Transport)	Benefit Transfer (Industry)	Benefit Transfer (Average)	Average of DR+BT
SO_2	47 506	NA	36 093	36 037	41 772
VOC	15 525	20 557	15 920	17 003	16 264
NO_x	39 817	69 714	29 308	37 618	38 717
$PM_{2.5}$	129 000	132 527	108 419	114 762	121 881
PM_{10}	76 113	87 216	71 040	71 040	73 577
CO	NA	6 118	NA	6 118	6 118

Source: Based on the results reported in Becker et al. (2012).

91. Comparing the results of the two approaches with the initial Green Tax weightings (Figure 9), it is evident that even though the initial weights were based on simple cost transfers mainly from the energy

sector, the cost of PM was the highest, and higher than the cost calculated by Becker et al. However, the costs of CO and NO_x were underestimated.

Figure 9. Comparison of the estimated costs of emission for mean city
Green Tax, Benefit Transfer (Transport) and Dose-Response



Source: Based on results reported in Becker et al. (2012).

92. The final cost of pollution for each sector was calculated by adjusting the BT sector-specific results by the difference between the two last columns in Table 11 and represents the actual recommendation from Becker et al. report for the measure of external costs of emissions (Table 12).

Table 12. Cost of emissions per tonne in an average city in Israel
Two approaches combined, ILS per tonne

Pollutant	Industry and Electricity	Transport
SO_2	41 836	41 836
VOC	15 574	20 110
NO_x	29 736	70 733
$PM_{2.5}$	111 782	136 638
PM_{10}	72 308	88 773
CO	6 118	6 118

Source: Becker et al. (2012).

93. The total cost of emissions from five major pollutants was estimated to be ILS 18.3 million – or 2.5% of the GDP (Table 13), to which the transport sector contributes 25%. The biggest contributor to the pollution cost from transport is NO_x and SO_2. The costs of NO_x make up 71% of total costs of transport emissions, even though they are only 25% of the total emissions, stressing the harmful nature of the gas. This implied that even if the weight (or the cost per tonne) of NO_x is not the highest in the final Green Tax formula, the proportion in the total cost might be high for highly polluting vehicles. Within the Euro 6 framework (2014), the limits for NO_x emissions went down drastically, from 180 mg/km to 80 mg/km, and more stringent tests are required for the NO_x emissions, including on-road testing.[34] With the diesel market

34. It is interesting to note, that even though the German models are the most popular in the EU market, it was actually the Japanese model Mazda, one of the most popular models in Israel, that sold the highest proportion of cars complying with the Euro-6 in the EU (Yang et al., 2015).

in Israel being less than 3%, this actually might bring more diesel cars in Israel as a result of the manufacturers adopting the new standards.[35]

Table 13. Total cost of emissions from fuel combustion by sector
ILS billion, 2010

Pollutant	Manufacturing	Electricity	Transport	Total
SO_2	1 203	5 585	11	6 799
VOC	687	0	270	957
NO_x	902	4 289	3 197	8 389
$PM_{2.5}$	425	241	291	958
PM_{10}	275	156	0	431
CO	18	14	720	752
Total	3 510	10 286	4 489	18 285

Source: Becker et al. (2012).

94. The old and the new weightings are presented in Table 14 below. The new formula was based on the calculations from Becker et al. (2012) and the adjusted calculations for CO as explained above. All the estimated costs were brought forward by adjusting for changes in population, inflation and real GDP (discounted by 0.85 to reflect the assumed income elasticity of the willingness-to-pay).

Table 14. Comparison between the 2009 Green Grade formula weights and the 2013 update
Actual and indexed by the cost of CO_2 in 2009 in parentheses

	2009	2013
CO	500	1 042 (303)
HC	900	21 454 (73 659)
NO_x	10 000	75 461 (21 979)
PM_{10}	20 000	145 772 (500 484)
CO_2	30	103 (30)

95. The updated Green Grade formula now bears the estimated costs of each pollutant as weights (ILS per tonne):

$$Green\ Grade = \frac{1042 * CO + 21454 * HC + 75461 * NO_X + 145772 * PM_{2.5} + 103 * CO_2}{100}$$

96. In 2013, when the update came into force, the median car was in band 4. The new weighting shifted the median to pollution band 6, thus reducing the rebates given to the same car model. The new rebates are detailed in Table 15.

35. While this paper was being written, it was revealed that Volkswagen has admitted cheating in its diesel emission tests. 11 000 cars sold between 2009 and 2015 in Israel were recalled to remove the software that made the cars cause low NO_x emissions only while being tested. A class action has been filed in Israel against Volkswagen and the importer, claiming compensation.

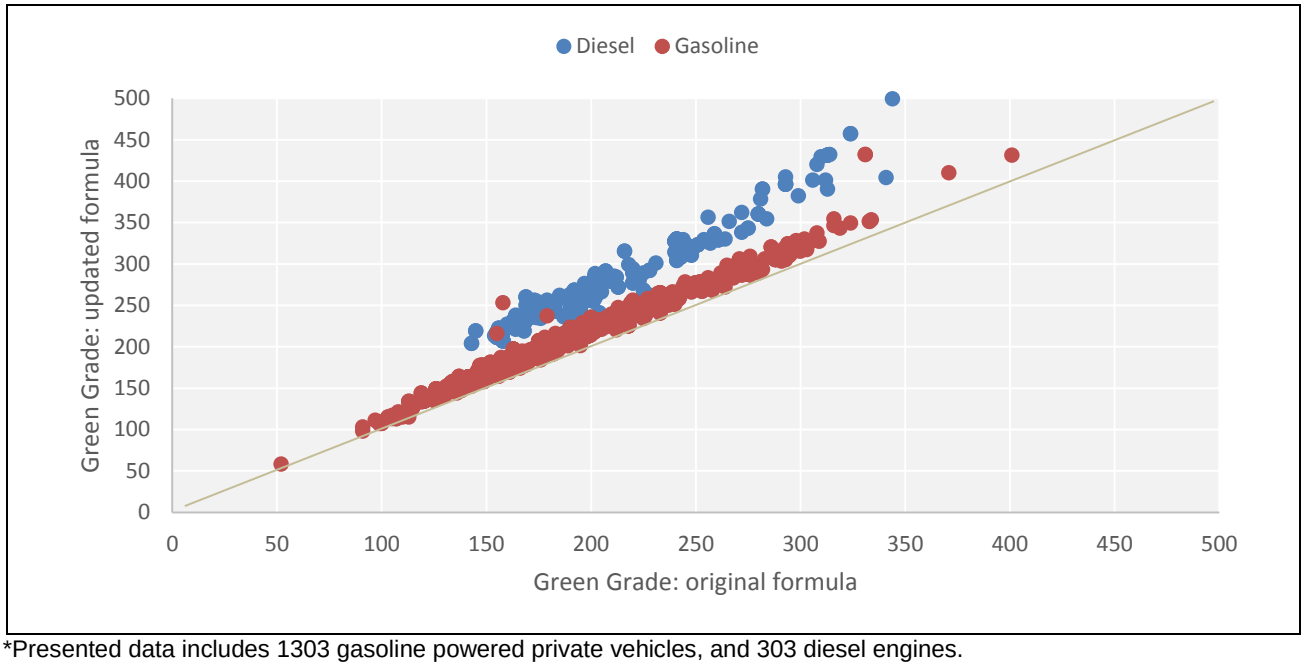
Table 15. Pollution rating, green grade, tax rebate and effective purchase tax
2014

Pollution rating	Green Grade	Purchase tax rebate (2014 prices)	Effective average purchase tax rate*
1 (no emissions)	0-50	p.tax=8%	8%
2 (hybrid plug-in up to the green grade =100)		p.tax=20%	18%
2 (hybrid)	51-130	p.tax=30%	28%
2	51-130	16 548	29%
3	131-150	15 169	49%
4	151-170	13 239	58%
5	171-175	11 585	63%
6	176-180	10 204	63%
7	181-185	9 102	67%
8	186-190	7 998	69%
9	191-195	7 170	72%
10	196-200	6 069	75%
11	201-205	5 516	73%
12	206-210	4 414	79%
13	211-220	3 585	75%
14	221-250	2 206	80%
15	251 and above	-	81%

*Including credits on safety mechanisms.
Source: Tax Authority – Taxes and overview of the car sector, 2014.

97. Effectively, all grades were shifted upward, and a higher grade was implicitly attached to diesel vehicles, as demonstrated in Figure 10.

Figure 10. Green Grade before and after formula update
2012 vehicle import data



*Presented data includes 1303 gasoline powered private vehicles, and 303 diesel engines.
Source: Israeli Tax Authority.

4.3 Formula update 2015

98. In January 2015, the Green Tax was updated with all the implied costs being adjusted for the changes in real GDP and population increase, as was done in 2013. Relative weights for each pollutant did

not change. However, the update will imply that there will be a linear shift upward along the green grades, essentially increasing the grade for the same car, and potentially moving it to a higher tax bracket.

99. The new formula that is effective until the end of December 2017 is as follows:

$$Green\ Grade = \frac{1119 * CO + 23023 * HC + 80978 * NO_X + 156528 * PM_{2.5} + 110 * CO_2}{100}$$

5. Impact of the Green Tax

100. When attempting to evaluate the effect of a policy on changes in sales, on composition of cars by engine size and emission levels as well as total pollution and tax revenues, multiple factors have to be taken into account in order to isolate the different effects. The decision to purchase a car, followed by the decision of its size, type, features and the price an individual is willing to pay is complex and is usually taken over a prolonged period of time. During the discussed period, there were several changes in the Israeli market, both in terms of supply and demand, and changes in legislation. Several other exogenous effects (new regulations in the EU and other non-member countries that affect manufacturing standards, consumer's income, local conflicts (Lebanon war, intifada), financial crisis of 2007-8, world prices of gasoline and availability of alternatives like public transport, etc.) have all contributed to the shifts in demand and the composition of it in terms of engine size and pollution levels.

5.1 Sales and usage

101. Figure 11 shows six month moving average data for new car registrations per capita, in order to account for the increase in population. Surprisingly, the effect of the 2005 tax reform had no immediate impact on the newly registered cars per capita. However, the timing of the reform marked the end of several years of high unemployment and negative GDP growth rates (Figure 5.2), which might have created cautious expenditure patterns among the consumers and/or expectations for further changes. This coincided with the discussions around the increase of "usage cost" of company cars, which lead to a slowdown in the car sector, lasting several months. The effect of the Lebanon war in the summer of 2006 contributed to low demand.

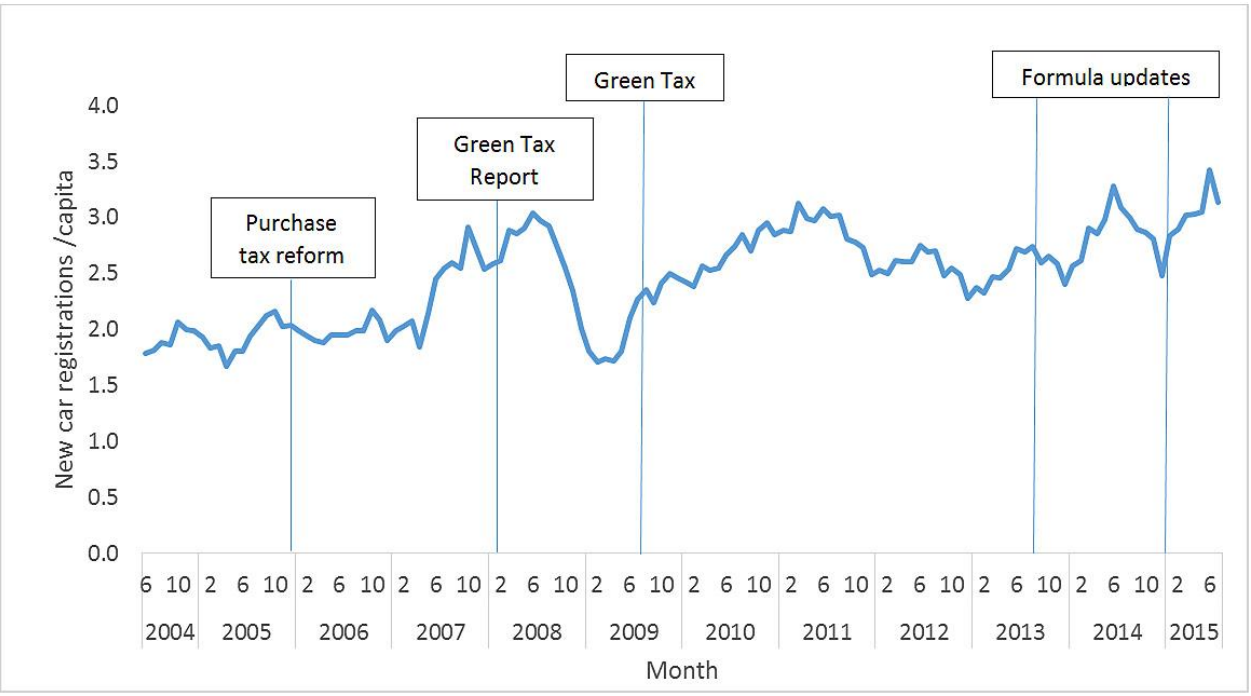
102. In 2007, after the second step in the purchase tax reduction and bolstered by the booming economy, there was a strong increase in demand for all durable goods, cars included. Partially, the increase was attributed to the ever-increasing proportion in company cars in total imports, which reached 60% in 2007 (compared to 35% in 2001 and 50% in 2004 – Israeli Tax Authority, 2007). Another reason was the expected change in legislation related to the registration of the model year of the car, artificially updated in May every year.[36] The trend continued well into 2008, with yet another reduction in the purchase tax (from 84% to 78%), supported by the economic growth in Israel in the first half of the year. This year marked the beginning of the world recession, resulting in a price reduction of cars in Israel due to depreciation of the US dollar and the Euro. However, in the summer of 2008, the expectations of the recession put their mark on car demand – combined with the increased usage costs of company cars, and the change in model year

36. Up until 2008, the model year was updated on 1 May every year, meaning that a car produced, say, in June 2007, would be registered as "model 2008". This caused the prices of relatively new cars to drop significantly every time after the new "model year" opened. Moreover, since the model year depended on the tenth digit of the Vehicle Identification Number (VIN), some of the importers managed to negotiate an artificial change of the 10th digit with the car manufacturer. Starting April 2008, the concept of "model year" was replaced with the "year on the road", which is essentially the year when the car was first registered. In addition, importers ceased to be able to sell a car as "new" if more than 12 months passed since its production day.

legislation, which, according to the Tax Authority (2008), prevented the usual uplift in sales in the months following the model year change in May. The slowdown, however, lasted for about a year, until June and July 2009 – just after the announcement of the forthcoming reform was published and the expectation of an increase in the purchase tax for many popular models – when a sharp shift in demand resulted in the importers "clearing the shelves" off the large and polluting vehicles. The increasing trend continued ever since, with minor slowdown in 2013, then spiking again – first in 2014 and beating this in 2015, when the drop in energy prices[37] contributed to pent-up demand for private cars.

Figure 11. New car registrations per capita

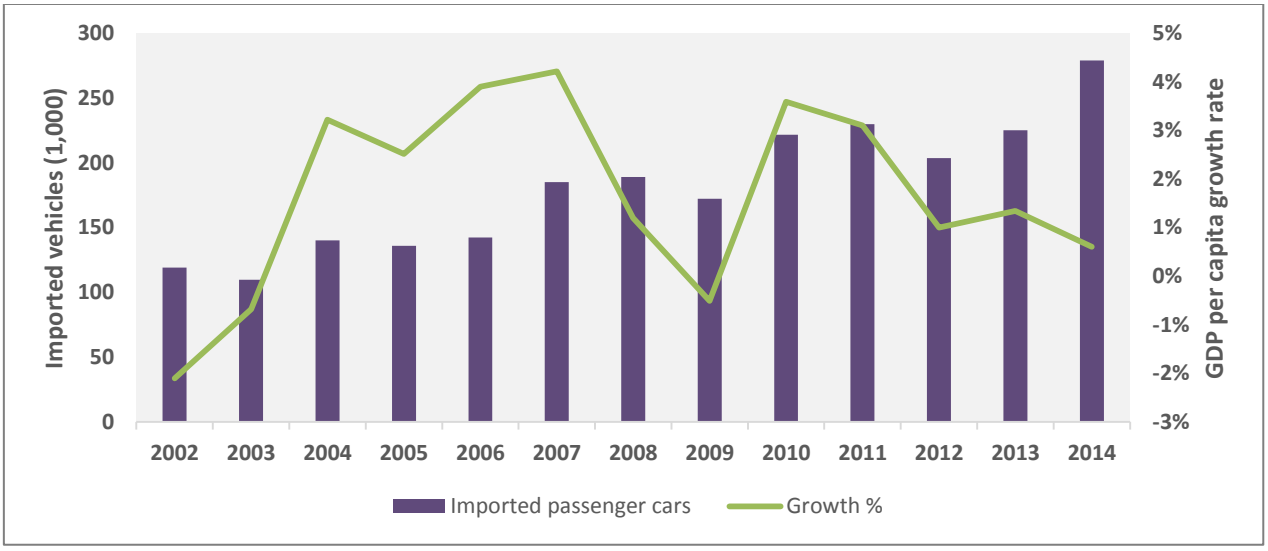
6-month moving average



Source: CBS (2015c), "Transport and Communication" (database), http://cbs.gov.il/ts/ID704d665e950e94/databank/building_func_e.html?level_1=17.

37. Prices on gasoline 95 octane at petrol stations have been under government control since 2006. Prices are updated every month and represent an average of the European prices in the five days preceding the update.

Figure 12. Imported vehicles and GDP per capita
Year on year changes, 2002-2014



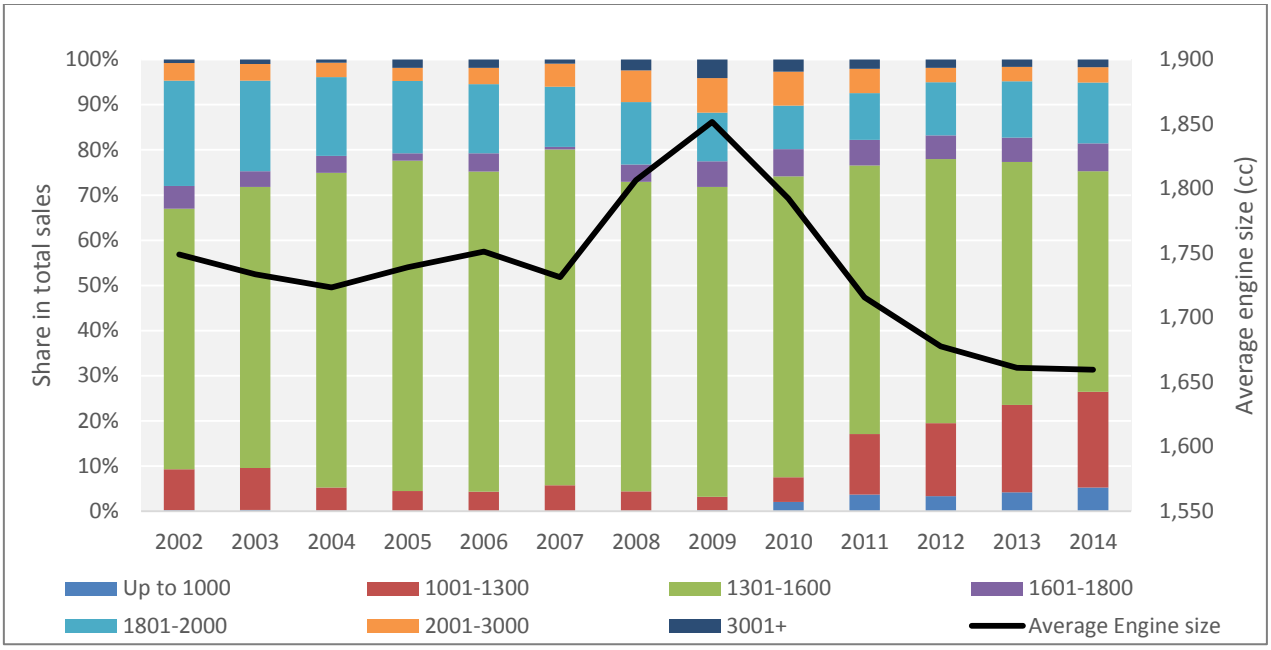
Source: Israeli Tax Authority (2015) and CBS (2015d), National Accounts (database), http://cbs.gov.il/ts/ID704d665e950e94/databank/building_func_e.html?level_1=37.

103. One can argue that the effect of increased new car registrations in 2010-11 could be an outcome of the improved economic situation. It is evident that real GDP per capita showed strong growth rates during these two years (Figure 12). However, in a similar situation during the period 2004-2007, the effect on car sales was only marginal well into 2007. Even more striking is the continuous increase in car imports in 2013-2014 even though economic growth rates were low in comparison to previous years.

104. The composition of imported cars in terms of engine size changed dramatically in the years following the reform (Figure 13). Engines below 1000cc were almost non-existent in the market before 2010, and engines between 1001 and 1300cc did not take up more than 5% between 2004 and 2009 – whereas by 2014, these two groups combined took up nearly 25% of all new car sales. The remarkable increase in average engine size during 2008-2009 could be explained by the market preparation for the new tax, and bringing forward purchase of larger, more expensive cars that were expected to carry lower rebates.[38] Interestingly, though, the major "squeeze" was experienced by the middle 1301-1600 engine size group, suggesting a much stronger income effect in the category. The income effect was effectively magnified by the Green Tax reform through reduction in retail car prices. As will be demonstrated further on, the effective tax rate for smaller, low-polluting vehicles dropped significantly, bringing the average effective tax rate from 80.1% in 2002 to 60.6% in 2014.

38. This increase in average engine size is counter-intuitive when the world financial crisis is considered. However, the Israeli economy was only mildly affected by the economic crisis, slowing down only in the last quarter of 2008, and quickly recovering by the end of 2009.

Figure 13. New car imports, by engine capacity (cc) and average engine size
2002-2014



Source: Adapted from CBS (various years), Table 16: "Private cars, by engine capacity, manufacturer and year of registration", *http://cbs.gov.il/publications15/1607_motor_vehicles_2014/pdf/t16.pdf*.

105. Changes in engine size are known to be linked with gasoline prices (Klier and Lynn, 2010; Busse, Knittel and Zettlemeyer, 2012). However, the latter seem to have more effect on the average distance travelled by car, than on the purchase of cars. Average distance travelled by car was decreasing in the years 2012-14, down from 16 840 km a year in 2011, to under 16 000 km in 2014 (Figure 14).[39] Increased gasoline prices are partly responsible for this fact, which could have also contributed to the increased usage of the train (Figure 15) compared to car and even bus travel. With that, gasoline prices seem to have opposite effects on the average engine size before and after the reform (Table 16). Engine size was increasing continuously before the reform came into effect, despite increasing gasoline prices, supported by increasing real income. However, after the new tax came into effect, the trend reversed, suggesting that gasoline prices were not the main factor contributing to the decreased engine size.[40]

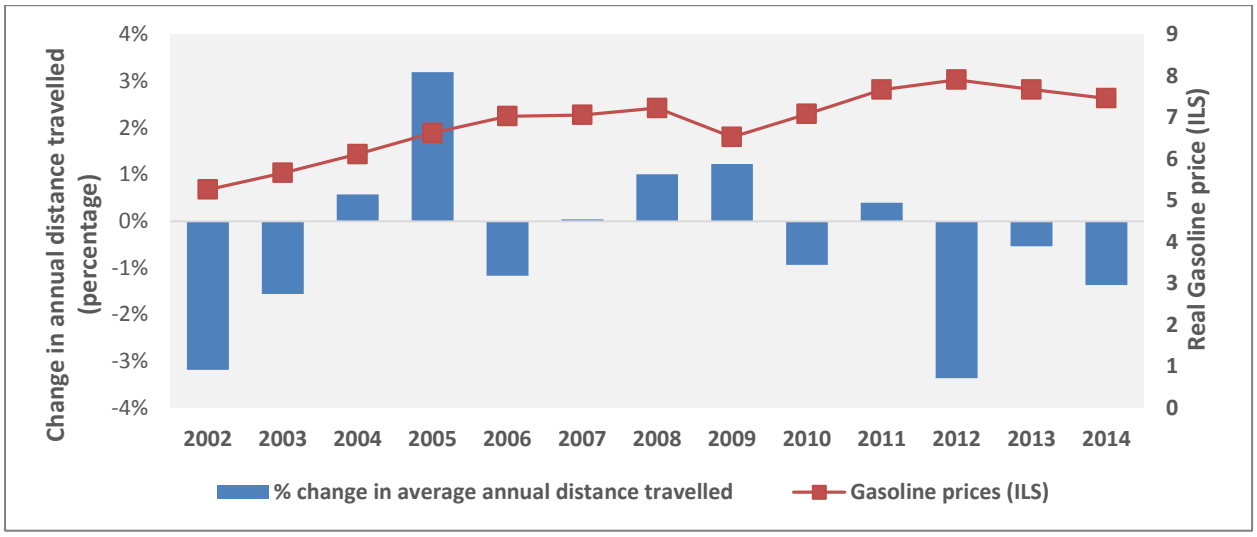
39. It could be argued that the decrease in distance travelled and engine size are derived from the growth of two-vehicle households. An examination of the rate of change in the number of households with more than one vehicles conducted by the Bank of Israel in 2013 showed that the growth was linear and did not change after the implementation of the Green Tax (Bank of Israel, 2014).

40. Even though there was a distinctive slowdown in 2009, as appears from Figure 12, there was a significant increase in the sales of larger, more expensive cars in 2008-9 (Figure 13). In order to support the argument that there was a shift in price and income effects between the periods before and after the policy, the correlation coefficients were recalculated for the years 2010-14. For the years 2010-14, the correlation coefficient between engine size and gasoline prices was -0.734; the correlation coefficient between engine size and GDP per capita was -0.983.

Table 16. Correlation coefficients between engine size, gasoline prices and real GDP per capita

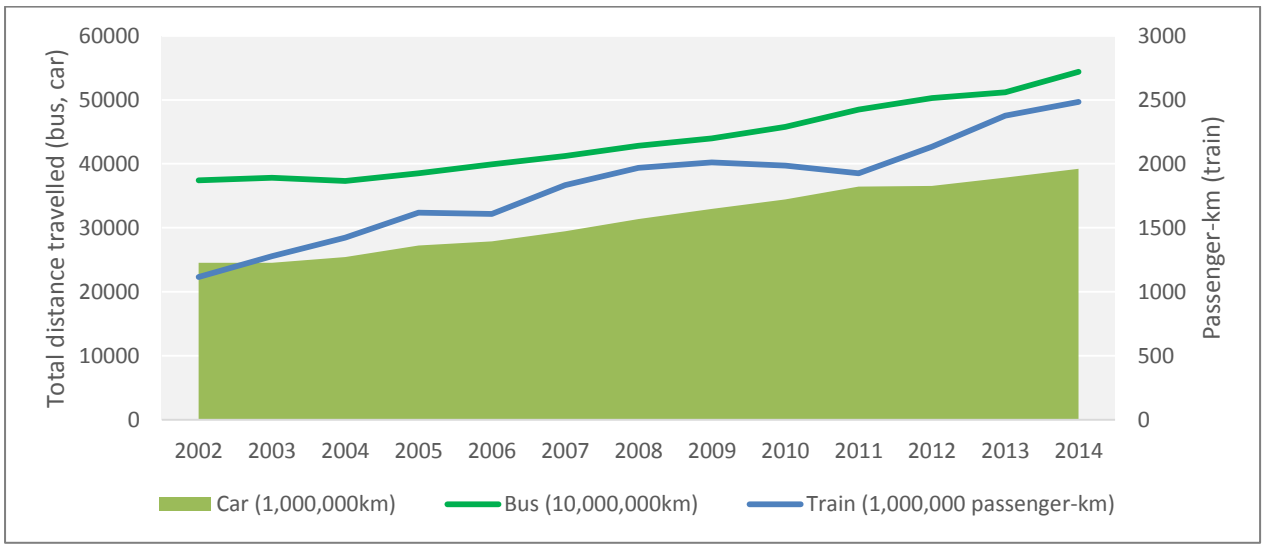
	2002-2008		2009-2014	
	Gasoline prices	GDP per capita	Gasoline prices	GDP per capita
Engine size	0.427	0.564	-0.903	-0.992

Figure 14. Changes in the annual distance travelled by car and real gasoline 95 octane prices
2002-2014



Source: Authors' calculations based on the data obtained from CBS (2015b) and CBS (2015e).

Figure 15. Distance travelled by car, bus and passenger-km travelled by train
2002-2014



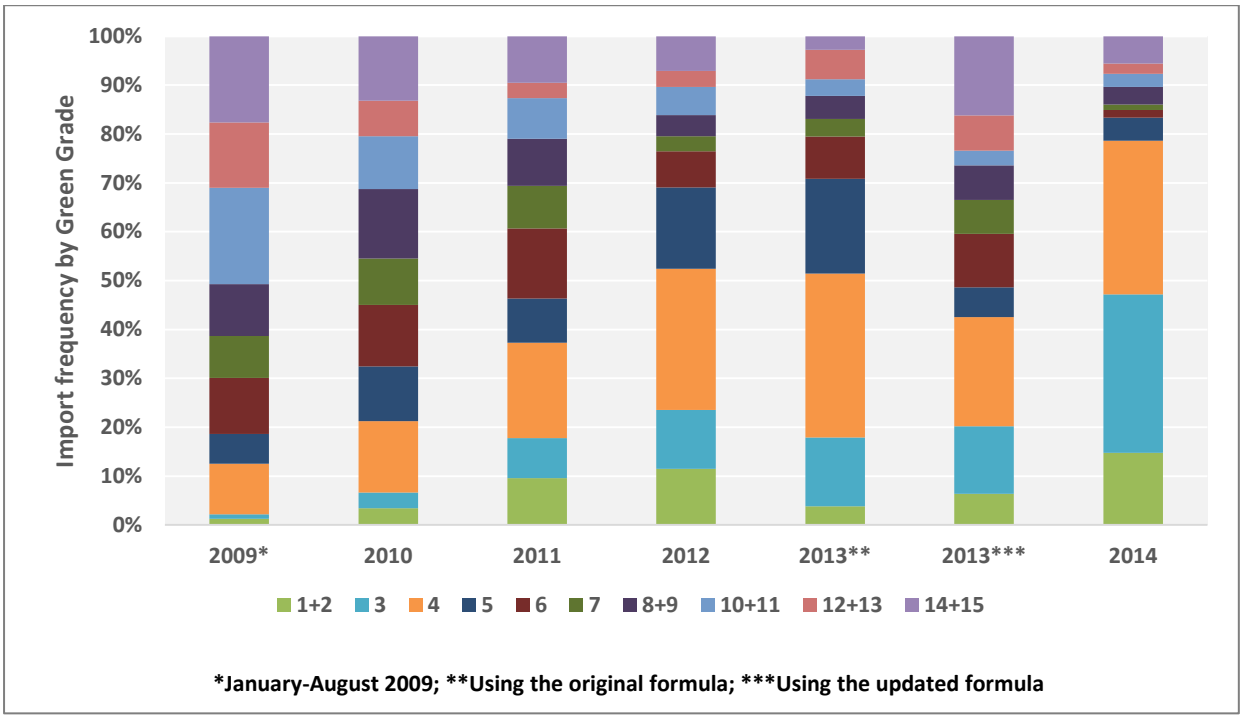
Source: CBS (2015b).

5.2 Volume and cost of emissions

106. The apparent effect of the policy on the composition of vehicles by their pollution level was tremendous. Figure 16 presents the proportion of 15 pollution levels of total cars sold in a specific year. The 2009 figures include only sales between January-August 2009, before the reform came into effect. In

order to facilitate the comparison between the formula changes, 2013 is represented according to two different formulas for calculating the green grade – the original formula of 2009 to compare with the years 2009-2012, and the updated formula which came into effect in August 2013, to compare with 2014.

Figure 16. Share of car imports by pollution level
2009 - 2014

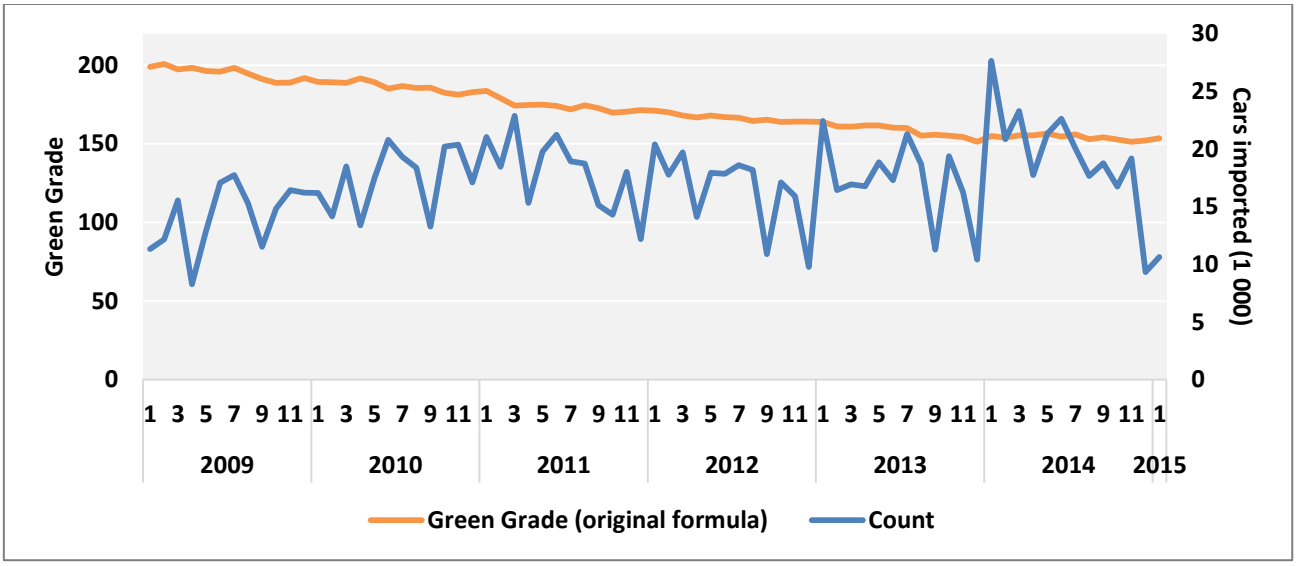


Source: Adapted from Israeli Tax Authority (2014), Annual review of the car sector.

107. Starting in 2010, there was a significant reduction in sales of the cars with pollution levels 10-15. The average level went from 10 in the first seven months of 2009 to 7 in 2010 and down to 4 already in 2012. By 2013, nearly 70% of all new cars fell into the first five pollution levels – compared to 19% of the cars within these levels in 2009. The formula update in August 2013 had an even stronger impact, increasing the share of imported cars in levels 1-5 from 49% (according to new formula) in 2013 to 83% in 2014.

108. Since the introduction of the reform, the decrease in average emissions was continuous and consistent (Figure 17), reaching an average of 150 by the end of 2013 (according to the original formula). Table 17 shows the detailed reduction in average emission levels by pollutant over the years 2009-2014. The 21% reduction in average CO_2 emissions per car (from 178 g/km to 140 g/km) indicates that Israel has not reached the average CO_2 targets of 130g/km set in Europe; however, the change is still impressive. A significant factor is the drastic reduction in health-related emissions, particularly NO_X and PM. Compared to the schemes that many EU countries have applied, this is probably the most important impact of the Israeli scheme – by including the local air pollutants in the scheme, Israel has managed to reduce CO_2 emissions per vehicle significantly, without causing additional public health damage.

Figure 17. Average green grade vs number of imported cars
Monthly data



Source: Adapted from Israeli Tax Authority (2014), Annual review of the car sector.

Table 17. Average level of emissions from new registered passenger cars
2009-2014

		Average emission level (g/km)				
Year	New registrations	CO_2	HC	PM	NO_x	CO
2009	169 426	178	.049	.00053	.028	.351
2010	209 185	170	.047	.00066	.025	.337
2011	216 068	160	.043	.00049	.022	.356
2012	198 271	152	.042	.00024	.024	.363
2013	206 075	144	.038	.00020	.024	.344
2014	235 269	140	.037	.00029	.021	.338
% change (2009-2014)	39%	-21%	-24%	-45%	-25%	-4%

Source: Israeli Tax Authority (2015).

109. And still, the increase in the total number of the imported cars (39% from 2009 to 2014) had the potential to create an overall negative effect. According to Table 18, which summarises total emissions from new cars (per km travelled), apart from PM emissions, which decreased by 24.2%, all emissions went up, particularly CO. It is also evident that in the first year after the reform, as well as a year after the formula update, the market reacted by the most significant increase in the number of imported cars accompanied by the increase in total emissions.

Table 18. Total level of emissions from new registered passenger cars
2009-2014

		Total emission level (g/km)				
Year	New registrations	CO_2	HC	PM	NO_x	CO
2009	169 426	30 115 848	8 280	90	4 806	59 402
2010	209 185	35 661 756	9 748	137	5 170	70 594
2011	216 068	34 493 734	9 362	105	4 791	77 006
2012	198 271	30 050 734	8 348	47	4 672	71 963
2013	206 075	29 652 857	7 897	42	4 936	70 875
2014	235 269	33 023 327	8 687	68	4 984	79 556
% change (2009-2014)	39%	9.7%	4.9%	-24.2%	3.7%	33.9%

110. In order to quantify the total effect of the emissions, one has to take into account the total distance a car is expected to travel, as well as road conditions and time spent travelling. It was shown that the average annual distance travelled by car is decreasing. However, the number of cars on the road increases much faster than the infrastructure to accommodate it. In 2002, there were 88.2 cars per km of road in Israel, while in 2009, there were already 106 cars. In 2014, the number of cars per km of road reached 129, indicating an almost 46% increase just over 13 years.[41] Congestion increases emissions significantly, which can again have additional negative effects on pollution levels. The stocks of older cars have different levels of pollution and emission levels might change with aging of the car. For simplicity, it is assumed the abovementioned factors remain unchanged.

111. For the purpose of evaluation of the effect that the reform had on total emissions, three counterfactual scenarios are considered in Table 19.

112. In the first scenario, the annual number of cars imported and their distribution in terms of emission levels remain the same as in 2009. However, the assumption that the number of cars would have stayed the same over six years is unrealistic given the continuous upward trend in new car registrations, therefore two additional scenarios are considered: Scenario 2, in which the number of cars imported is the same as it actually was, but an average car emits the same amount as in 2009, and Scenario 3, which assumes 4% annual growth in number of cars sold – a plausible assumption, given it is the actual of new registration growth rate between 1995-2014. Again, the "average car" is assumed to be the same as in 2009 in terms of emissions. Results of the change in emission volumes according to different scenarios are presented.

41. Congestion could explain the increasing train usage, alongside fuel prices.

Table 19. Changes in total emissions from new imports (per km) for different scenarios

Year	2009	2010	2011	2012	2013	2014	Total
Actual numbers							
Average CO_2 (g/km)	178	170	160	152	144	140	
Average HC (g/km)	.049	.047	.043	.042	.038	.037	
Average PM (g/km)	.0005	.0007	.0005	.0002	.0002	.0003	
Average NO_x (g/km)	.028	.025	.022	.024	.024	.021	
Average CO (g/km)	.351	.337	.356	.363	.344	.338	
Total new cars[(1)]	**172 459**	**221 923**	**229 944**	**203 727**	**225 297**	**279 205**	**1 332 555**
Total CO_2 (tonne)	30.7	37.8	36.7	30.9	32.4	39.2	208
Total non-CO_2 (g), of which	73 878	90 864	97 125	87 370	91 562	110 718	551 518
HC (g)	8 429	10 342	9 964	8 578	8 634	10 309	56 255
PM (g)	91.6	145.4	111.6	48.2	46.0	80.9	524
NO_x (g)	4 892	5 484	5 099	4 801	5 397	5 915	31 588
CO (g)	60 465	74 893	81 951	73 943	77 486	94 413	463 150
Scenario 1: same number of cars as in 2009							
Total new cars	172 459	172 459	172 459	172 459	172 459	172 459	1 034 754
Difference in [(2)]							
CO_2		-19%	-16%	-1%	-5%	-22%	-11%
Non-CO_2, of which		-19%	-24%	-15%	-19%	-33%	-20%
HC		-19%	-15%	-2%	-2%	-18%	-10%
PM		-37%	-18%	90%	99%	13%	5%
NO_x		-11%	-4%	2%	-9%	-17%	-7%
CO		-19%	-26%	-18%	-22%	-36%	-22%
Scenario 2: same number of cars as actual							
Total new cars	172 459	221 923	229 944	203 727	225 297	279 205	1 332 555
Difference in [(2)]							
CO_2		4%	11%	17%	24%	27%	14%
Non-CO_2, of which		5%	1%	0%	5%	8%	4%
HC		5%	13%	16%	28%	32%	16%
PM		-19%	9%	125%	160%	83%	35%
NO_x		15%	28%	20%	18%	34%	20%
CO		4%	-2%	-3%	2%	4%	1%
Scenario 3: number of cars grows by 4% each year							
Total new cars	172 459	179 357	186 532	193 993	201 753	209 823	1 143 916
Difference in [(2)]							
CO_2		-16%	-10%	12%	11%	-5%	-2%
Non-CO_2, of which		-19%	-19%	-5%	-10%	-25%	-14%
HC		-15%	-9%	11%	14%	-1%	-1%
PM		-34%	-11%	114%	133%	38%	16%
NO_X		-7%	4%	15%	6%	1%	3%
CO		-16%	-20%	-8%	-9%	-22%	-13%

[(1)] Includes all imported cars. Note that the number of newly imported cars differs to the new registrations, presented in Tables 17 and 18, which include only cars already registered.
[(2)] Negative (positive) number means the alternative scenario emissions are lower (higher) than the actual.

113. Total cost of pollution for the years 2010-2014 are calculated in Table 20. Emission costs used in the calculations of the total cost are derived from the formula that came into effect in 2013 (with weights representing the cost per tonne emissions), and updated by the Ministry of Environmental Protection in January 2014, adjusting for inflation and the change in GDP. Costs for 2009-2012 were backdated, using the same adjustment procedure as in the approach used by the MoEP. Resulting total costs are for new imported cars and are calculated per km of travel for convenience of the presentation.

Table 20. Changes in cost per tonne of total emissions from new imports for different scenarios
ILS million, 2014 prices

Year	2009	2010	2011	2012	2013	2014	Total
Actual numbers							
Total new cars	**172 459**	**221 923**	**229 944**	**203 727**	**225 297**	**279 205**	**1 332 555**
Cost of emissions	**3 301**	**4 139**	**4 099**	**3 653**	**4 035**	**5 151**	**24 377**
Cost of CO_2	2 755	3 400	3 379	2 909	3 200	4 052	19 695
Cost non-CO_2 (g)	546	739	720	744	834	1 099	4 682
Scenario 1: same number of cars as in 2009							
Total new cars	172 459	172 459	172 459	172 459	172 459	172 459	1 034 754
Cost of emissions	**3 301**	**3 381**	**3 461**	**3 627**	**3 799**	**4 049**	**21 617**
Difference in total cost[(1)]		-18%	-16%	-1%	-6%	-21%	-11%
In CO_2 cost		-19%	-16%	-1%	-5%	-22%	-12%
In non-CO_2 cost		-15%	-11%	-1%	-8%	-19%	-10%
Scenario 2: same number of cars as actual							
Total new cars	172 459	221 923	229 944	203 727	225 297	279 205	1 332 555
Cost of emissions	**3 301**	**4 351**	**4 614**	**4 284**	**4 963**	**6 555**	**28 068**
Difference in total cost[(1)]		5%	13%	17%	23%	27%	15%
In CO_2 cost		4%	11%	17%	24%	27%	15%
In non-CO_2 cost		10%	19%	17%	20%	30%	17%
Scenario 3: number of cars grows by 4% each year							
Total new cars	172 459	179 357	186 532	193 993	201 753	209 823	1 143 916
Cost of emissions	**3 301**	**3 516**	**3 743**	**4 080**	**4 444**	**4 926**	**24 010**
Difference in total cost[(1)]		-15%	-9%	12%	10%	-4%	-2%[(2)]
In CO_2 cost		-16%	-10%	12%	11%	-5%	-2%
In non-CO_2 cost		-11%	-3%	12%	8%	-2%	0%

[(1)] Negative (positive) number means the alternative scenario costs are lower (higher) than the actual.
[(2)] For no change in cost, the total number of cars sold in 2009-14 should equal 1 160 641, implying average growth rate of 4.5%.

114. According to Table 19, in a static Scenario 1, with a highly polluting average car, but with fewer cars sold than the actual number, emissions from CO_2 and total health-related emissions are lower than actual. However, of the five pollutants in question, the volume of PM – an extremely "expensive" pollutant from the cost to public health standpoint – is actually lower under the Green Tax regime, compared to the static scenario. A remarkable shift in PM emissions happened in 2012, when the average emissions more than halved. As expressed through costs, total emissions from CO_2 pollution is higher (by 12%) compared to the counterfactual scenario, but the cost of health-related pollution is not as high (10%), suggesting that the scheme successfully avoided increasing the negative effects on health on the back of CO_2 reduction.

115. It is not surprising that emissions are higher in every year according to Scenario 2, so is the total cost (by 15%). The volumes of PM and NO_x however, are again standing out: compared to Scenario 2, the reduction in PM and NO_x is most prominent, affecting the difference between the costs of CO_2 and non-CO_2 emissions. Of course, assuming that average emissions stayed the same is a strong assumption and one needs to bear in mind that part of the decrease in emissions should be attributed to changes in technology – since 2009, progressively stricter Euro standards pushed the car industry to develop less polluting cars. However, since this was coupled with reductions in average CO_2 due to legislation and taxation policies, and diesel cars make up only a small share of the Israeli imports, it is reasonable to assume that the direction of the simulated impact still holds.

116. Scenario 3 shows mixed effects over the years, where total emissions decrease in the first two years after the reform came into effect compared to the actual outcome, reinforcing the conclusion that the strong reaction of the market in the short run was responsible for the increased pollution. A similar effect is seen in 2014, when after the formula update there was another boost in demand, which in overall increased pollution more than expected if the amount of cars would grow only by 4%. This reinforces two major findings described by the literature: consumers respond strongly to tax-related incentives; and in the

presence of alternatives (D'Haultfoeuille et al., 2014), the base of environmental tax quickly erodes (Bovenberg and de Mooij, 1994).

117. The difference in the rates of change in total emissions of various pollutants is important. The fact that health-related pollutants, particularly extremely harmful NO_X increased less than CO_2, and even more harmful PM emission level went down, should be regarded as a positive factor. One of the reasons for this is that unlike in Europe, Israeli consumers did not switch to diesel vehicles, efficient in CO_2 but emitting more local air pollutants harmful to health and disastrous to the nature. In Europe, where CO_2 reduction targets were adopted in the 1990s as well as CO_2-based taxation, diesel cars (efficient in terms of CO_2) were seen as a cheap and easy way to achieve the targets. CO_2 taxation policy caused a shift to diesel vehicles. This was coupled with policies providing subsidies to manufacturers and keeping diesel fuel prices below those of petrol. Diesel cars, however, even though they produce significantly less CO_2, emit several times more NO_X, which, emitted in large quantities, contributes to the formation of secondary PM. The switch to diesel subsequently increased the emission of health related pollutants.[42]

118. The important aspect of the Israeli scheme is that it avoided the increase in local air pollution that similar schemes in other countries have caused. Compared to any alternative scenarios, health-related pollutants did not increase as much as CO_2 did, and in terms of costs, the increase was lower than the increase in CO_2, and negligible compared to a plausible Scenario 3, which assumes a moderate growth in the number of cars sold.

119. If instead of imposing a tax on all the major emissions, the Israeli scheme would focus solely on CO_2, it is reasonable to assume that the consumers would have shifted towards diesel cars, as happened in the EU. It is then possible to calculate the effect on emissions from switching to diesel cars. This requires strong assumptions regarding the emissions from an average "alternative car", which would incorporate various possible market shares of diesel cars in imports.

120. Between 2009 and 2014, and with an approximately 2% of all cars being diesel engines (ranging between 1% and 3% over the six years), CO_2 emissions from all newly imported passenger cars averaged 155.9 gram per km, according to the Israeli Tax Authority (2015). In order to re-calculate the average emissions from an alternative regime, the next step would be to obtain average emissions from petrol and diesel cars separately, and then combining them weighted by different diesel market shares. Unfortunately, because of the low amount of diesel cars sold in Israel, which inevitably leads to high fluctuations in average emission levels across the years, actual average emission levels are hard to obtain. Most diesel cars sold in Israel in 2009 were high-end power engines, which emit significantly more CO_2 than any average petrol car. Therefore, an assumption is made on average emissions across the years to approximate emission levels from diesel cars in 2012.[43] Using 2012 is a plausible approximation due to this year being in the middle of the period analysed, and before the 2013 formula update, which increased the relative price of diesel vehicles, thus causing a bigger distortion in demand towards cars polluting less NO_x and PM. A diesel car is assumed to emit less CO_2, CO and HC, but more NO_x and PM. Average petrol car emissions have then been calculated based on assumed diesel emissions and actual total emissions levels from all the new cars in the 2009-14 period. Average emission levels for total (actual) and assumed petrol and diesel cars are summarised in Table 21.

42. The effect is widely discussed. For a scholarly resource, see for example, Leihert et al., 2013, discussing the shift to diesel vehicles in Ireland after the CO_2-based tax came into effect.

43. Authors would like to acknowledge the help of Itamar Milrad in obtaining this number.

Table 21. Average emissions from all, petrol and diesel cars

	Average emissions (actual)	Average petrol	Average diesel
Total CO_2 (g/km)	155.9	156.4	123.0
Total HC (g/km)	0.042	0.042	0.030
Total PM (g/km)	0.000	0.000	0.001
Total NO_X (g/km)	0.024	0.022	0.143
Total CO (g/km)	0.348	0.350	0.238

121. Using emission levels in Table 21, it is now possible to estimate the effect on emissions from switching to diesel cars (Table 22). In several European countries, the share of diesel cars is above 60% (Belgium, France, Greece, Ireland, Luxemburg, Portugal, Spain), and in some others it is close to 50% (Austria, Germany, Italy, Sweden, United Kingdom).[44] However, it is reasonable to assume that within six years since the implementation of the reform, on average, the share of imports would not go above 30%. Extreme scenarios are still considered in the calculations, as a longer-term effect of the reform.

Table 22. Average emissions per car and total cost of pollution under different diesel regimes

	% diesel cars in imports						
	2%(1)	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**
Total new cars	**1 332 555**	**1 332 555**	**1 332 555**	**1 332 555**	**1 332 555**	**1 332 555**	**1 332 555**
Average CO_2	155.9	153.1	149.8	146.4	143.1	139.7	136.4
Average HC	0.042	0.041	0.040	0.039	0.038	0.036	0.035
Average PM	0.000	0.000	0.001	0.001	0.001	0.001	0.001
Average NO_x	0.024	0.034	0.046	0.058	0.070	0.082	0.094
Average CO	0.348	0.338	0.327	0.316	0.305	0.294	0.282
Total CO_2 (tonne/km)	208	204	200	195	191	186	182
Total HC (g/km)	56 255	54 919	53 302	51 685	50 068	48 451	46 834
Total PM (g/km)	524	605	702	800	898	996	1 094
Total NO_x (g/km)	31 588	44 963	61 144	77 326	93 507	109 688	125 869
Total CO (g/km)	463 150	450 838	435 942	421 046	406 149	391 253	376 357
Total cost	25 541	26 142	26 869	27 596	28 322	29 049	29 776
Cost of CO_2	19 897	19 545	19 119	18 693	18 266	17 840	17 414
Cost of non-CO_2	5 644	6 597	7 750	8 903	10 056	11 209	12 362
Difference in total cost		2.4%	5.2%	8.0%	10.9%	13.7%	16.6%
In cost of CO_2		-1.8%	-3.9%	-6.1%	-8.2%	-10.3%	-12.5%
In cost of non-CO_2		16.9%	37.3%	57.8%	78.2%	98.6%	119.0%

*2013 costs, published by the MoEP are used for simplicity. The costs (ILS per tonne) are: 103 for CO2; 21 454 for HC; 145 772 for PM; 75 461 for NO_X; 1 042 for CO.
(1) Average percentage of diesel cars in imports between the years 2009-2014.
(2) Total costs differ from the actual total cost in Table 5.4 due to different cost per tonne used in the calculations.

122. The base scenario is 2% share of diesels in imports (actual average share), therefore all the alternative regimes are compared to it. It is evident, that with 60% diesel cars in the share of imports, the volume of PM is twice as high, whereas the amount of NOX is four times higher than in the actual case, pointing clearly to the danger of programmes based on solely on CO2 for public health. But even in less extreme scenarios, the benefit of reduction in CO2 does not compensate for the cost of increasing health-related pollution.

5.3 Tax revenues

123. With the continuously upward trend of car imports, tax revenues have been increasing already prior to the Green Tax reform, reaching a peak in 2007 (Table 23), when incentives for the installation of safety mechanisms were introduced, which provided tax credits, thus reducing the effective tax. This was accompanied by the decreasing tax rate as part of the five-year plan. Following the Green Tax reform,

44. ACEA (2015b).

however, initially a sharp increase in revenues due to initial rise in sales, was followed by a steep decline when consumers started to switch to cheaper, less polluting vehicles: even though the number of imported vehicles increased by 7.6% between 2008 and 2012 (before the formula update), total revenues dropped by 13%. The average effective tax rate went down from 73.1% to 61.3% – essentially, a much lower level than the intended final tax contemplated in the 2005 tax reduction reform. In other words, what was meant to be a revenue-neutral bonus-malus system turned out to be a net subsidy for new vehicle purchases. Negative environmental effects then seem to be the result of increasing demand rather than a failure of the tax to create a shift from polluting cars, but, as mentioned, a stronger increase in local pollution was avoided by integrating health-related pollutants in the scheme. Sharply decreasing revenues were one of the reasons for the green grade formula update in 2013, and the subsequent decision to update the formula every two years.

Table 23. Value of import and tax imposed on passenger vehicles
ILS million

Year	Vehicles imported	Value of import (current prices)	Value of import (2014 prices)	Purchase tax (2014 prices)	Custom tax (2014 prices)	% Purchase tax*	Average purchase tax (2014 prices)
2002	119 287	5 533	6 872	5 503	224	80.1%	46 136
2003	109 911	5 342	6 589	5 183	243	78.7%	47 154
2004	140 218	7 051	8 731	7 088	353	81.2%	50 551
2005	135 939	6 954	8 501	7 188	363	84.6%	52 877
2006	142 528	7 267	8 695	7 116	347	81.8%	49 927
2007	185 171	9 415	11 210	8 820	455	78.7%	47 632
2008	189 289	9 489	10 803	7 899	463	73.1%	41 729
2009	172 459	9 649	10 634	7 406	431	69.6%	42 945
2010	221 923	11 785	12 646	8 521	483	67.4%	38 396
2011	229 944	12 330	12 783	8 095	428	63.3%	35 204
2012	203 727	11 365	11 592	7 110	353	61.3%	34 902
2013	225 297	11 812	11 859	7 073	317	59.6%	31 393
2014	279 205	14 754	14 754	8 934	441	60.6%	31 998

*Effective purchase tax includes credits given for installation of safety mechanisms.
Source: Israeli Tax Authority (2015).

124. The effect of the reform on revenues was simulated in a similar form as the effect on pollution (Table 24). Apart from VAT and average car value, all actual numbers are obtained from the annual reports of the Israeli Tax Authority.

125. As before, three different scenarios are considered: Scenario 1 assumes that the amount and distribution of the cars is the same as in 2009, which implies an average tax level of 70%. This is less than 73.1 in 2008; however, given that the tax was expected to go down in 2009 according to the five-year tax reduction plan, and it is a plausible assumption to make. Scenario 2 assumes that the number of cars is the same as actually sold (again, adjusting the value of the car in each year for inflation), and Scenario 3 assumes that the number of cars grows by 4% each year.

126. Assuming that the number of cars would not have changed without the reform (Scenario 1), the latter brought a considerable increase in income of ILS 2.5 billion in the first two years, and additional ILS 2.2 billion in 2014 after the formula change. The hypothetical "losses" in 2012-2013 are incomparably smaller.

127. If the total number of cars sold would have been as observed (extreme scenario), the estimated losses come up to ILS 11.4 billion over the five years. Under a reasonable assumption of Scenario 3 (4% annual growth in the number of cars), however, a mixed picture is observed again. There is a significant gain in the first year after implementation is followed by a reasonably neutral result, which is then taken

over by two years of considerable loss, meaning that even if in the short term the reform would bring additional income, the net effect on revenues would be negative. The programme would stay revenue-neutral only if the annual growth in the number of cars would be lower (at around 3.0%).

Table 24. Simulated effect of the Green Tax on revenues from purchase tax and VAT
ILS million, 2014 prices

Year	2009	2010	2011	2012	2013	2014	Total
Actual numbers							
Total new cars	172 459	221 923	229 944	203 727	225 297	279 205	1 332 555
Value of imports	10 634	12 646	12 783	11 592	11 859	14 754	74 268
Effective tax rate	70%	67%	63%	61%	60%	61%	
Average car value	61 663	56 983	55 593	56 901	52 635	52 843	
Purchase tax revenue	7 406	8 521	8 095	7 110	7 073	8 934	47 139
VAT revenue	1 702	2 023	2 045	1 893	2 085	2 656	12 404
Total revenue	9 108	10 544	10 140	9 004	9 158	11 590	59 544
Scenario 1 (base): same number of cars as in 2009; effective tax as in 2009							
Total new cars	172 459	172 459	172 459	172 459	172 459	172 459	1 034 754
Value of imports	10 634	10 634	10 634	10 634	10 634	10 634	63 806
Average car value	61 663	61 663	61 663	61 663	61 663	61 663	
Purchase tax revenue	7 406	7 406	7 406	7 406	7 406	7 406	44 438
Purchase tax difference		1 115	689	-296	-334	1 528	2 702
VAT revenue	1 702	1 702	1 702	1 737	1 870	1 914	
Total revenue	9 108	9 108	9 108	9 143	9 276	9 320	55 063
Revenue difference		1 437	1 032	-139	-118	2 269	4 481
Scenario 2: same number of cars as actual; effective tax as in 2009							
Total new cars	172 459	221 923	229 944	203 727	225 297	279 205	1 332 555
Value of imports	10 634	13 685	14 179	12 562	13 893	17 217	82 170
Average car value	61 663	61 663	61 663	61 663	61 663	61 663	
Purchase tax revenue	7 406	9 531	9 875	8 749	9 675	11 991	57 227
Purchase tax difference		-1 010	-1 780	-1 639	-2 603	-3 057	-10 087
VAT revenue	1 702	2 190	2 269	2 052	2 443	3 099	
Total revenue	9 108	11 720	12 144	10 801	12 118	15 090	70 980
Revenue difference		-1 176	-2 003	-1 797	-2 960	-3 500	-11 436
Scenario 3: number of cars grows annually by 4%; effective tax as in 2009							
Total new cars	172 459	179 357	186 532	193 993	201 753	209 823	1 143 916
Value of imports	10 634	11 060	11 502	11 962	12 441	12 938	70 538
Average car value	61 663	61 663	61 663	61 663	61 663	61 663	
Purchase tax revenue	7 406	7 703	8 011	8 331	8 664	9 011	49 126
Purchase tax difference		818	84	-1 221	-1 592	-77	-1 986
VAT revenue	1 702	1 770	1 840	1 954	2 187	2 329	
Total revenue	9 108	9 472	9 851	10 285	10 852	11 340	60 907
Revenue difference		1 072	289	-1 281	-1 694	250	-1 364
VAT (average)	16.0%	16.0%	16.0%	16.3%	17.6%	18.0%	

*Revenue-neutral scenario over 5 years would assume annual growth in the number of cars = 3.1%. If only purchase tax taken into account, annual growth in the number of cars = 2.3%.
**VAT revenues are calculated using VAT rate in a specific year multiplied by the price of the car and number of cars sold.
***Customs excluded from calculation; average car assumed to be the same as in 2009, therefore no influences from gas prices, income, changes in preferences and other shocks to the system are assumed.

5.4 Subsidy of the externalities

128. A cost-benefit analysis of a tax reform is complex: taxation creates distortion in relative prices, which might negatively affect both the consumer and producer surplus. Environmental taxes, however, increase wellbeing by reducing pollution and increase welfare compared to revenue-generating taxes by correcting the inefficient market outcome where marginal costs to society of polluting are higher than the marginal private costs. Thus, in comparison to the previously flat rate purchase tax, the Green Tax was expected to reduce distortions caused by pollution externalities, and increase economic efficiency. The main concern of the Green Tax commission was the subsidy that the society provides for the car users, who

do not face the full costs of the vehicle usage. If tax revenues could be (hypothetically) directed to specific uses, one of which would be to cover the costs to society from using the car, then by simply combining the effects of the reform on total pollution (Table 22) and total revenues (Table 24) and evaluating whether the gains (losses) of revenues did actually cover the losses (gains) of the externalities, it is possible to answer whether the Green Tax achieved its effect in imposing the costs of externalities on the actual car user and reducing the social subsidy that car owners receive.

129. In order to calculate this, more assumptions are required. First, the only external effect taken into account is the cost of pollution. The cost of having an increased number of cars on the road, which results in more congestion, noise, accidents, is disregarded, but so is the effect on welfare of the changes in consumer surplus and importers' profits. Since Israel does not manufacture cars, external costs of production are not being taken into account either. Second, it is assumed that a car travels 200 000 km during its lifetime, without experiencing any changes in the emission levels. And finally, no logistical or administrative costs (building and maintaining the database of pollution, additional advertising by car importers, etc.) are taken into account, and the focus is purely on the changes in pollution levels of the new cars. Finally, the assumption of no effect on the existing fleet still holds.

130. The results are summarised in Table 25. Three scenarios, as discussed above, are evaluated. The subsidy gap is defined as the difference between additional revenues received and additional costs incurred. A positive subsidy gap indicates that an alternative scenario produces less revenue than additional costs, and the reform entails gains compared to the counterfactual scenario.

Table 25. Total cost of pollution from new cars, total revenue from taxes and the subsidy gap
ILS million, 2014 prices

		2010	2011	2012	2013	2014	Total
Actual numbers							
Total cost of pollution		827.8	819.7	730.5	807.0	1 030.2	4 875.5
Total tax revenue		10 544	10 140	9 004	9 158	11 590	59 544
Scenario 1 (base): same number of cars as in 2009							
Total cost of pollution		676.2	692.2	725.3	759.8	809.7	4 323.5
Total tax revenue		9 108	9 108	9 143	9 276	9 320	55 063
Difference in cost of pollution[(1)]		-152	-128	-5	-47	-221	-552
Difference in revenues[(1)]		-1 437	-1 032	139	118	-2 269	-4 481
Subsidy gap[(2)]		1 285	905	-145	-166	2,049	3 929
Scenario 2: same number of cars as actual							
Total cost of pollution		870.2	922.9	856.9	992.5	1 310.9	5 613.6
Total tax revenue		11 720	12 144	10 801	12 118	15 090	70 980
Difference in cost of pollution[(1)]		42	103	126	186	281	738
Difference in revenues[(1)]		1 176	2 003	1 797	2 960	3 500	11 436
Subsidy gap[(2)]		-1 133	-1 900	-1 671	-2 775	-3 219	-10 698
Scenario 3: number of cars grows by 4% each year							
Total cost of pollution		707.2	757.0	829.6	908.7	1 012.8	4 875.5
Total tax revenue		9 472	9 851	10 285	10 852	11 340	60 907
Difference in cost of pollution[(1)]		-121	-63	99	102	-17	0
Difference in revenues[(1)]		-1 072	-289	1 281	1 694	-250	1 364
Subsidy gap[(2)]		952	227	-1 182	-1 592	233	-1 364

[(1)] Negative (positive) number means the alternative scenario figures are lower (higher) than the actual.
[(2)] Additional costs minus additional revenues.

131. Considering the first scenario, where the number of cars is constant and equal to the number in 2009, it is evident that during the first two years after the reform came into force, and in 2014, after the formula change, the additional revenue covers the increased costs. However, in the longer run, the costs exceed revenues, and without the formula update, the losses would have been bigger than the gains.

132. In the extreme Scenario 2, the costs of additional pollution increase compared to the actual ones, but revenues increase even more, meaning that in the case that the number of cars sold without the reform would have been the same as was actually sold, the reform would not have been justified.

133. The results in Scenario 3 confirm that the reform was creating more costs to society in terms of pollution than it was gaining revenues to cover for these costs: only in the first two years did additional revenues cover additional costs, but in the longer run, when the tax base started to erode, the effect turned negative even in 2014, when considerable increases in revenues due to the large number of cars sold were expected to cover for the increased costs.

134. For a complete picture, however, two additional points should be made. First, the effect of reduced average prices and increased number of sold cars would potentially create a welfare-increasing higher consumer surplus. And second, even though the programme led to a net subsidy for the purchase of new vehicles, this was done with a less negative impact on local air pollution that what similar schemes in other countries have triggered.

5.5 Using the demand function to quantify the effect

135. It is evident that there was a significant structural change in the market following the tax reform. However, as shown, there are many factors that may have an effect on the number of cars and the composition of the demand, and therefore, the magnitude of the effect is a mere speculation, since the number of cars sold without the effect of the reform cannot be evaluated by descriptive analysis. In order to isolate the long-term effect of the reform, while taking into account all of the factors discussed above, a long-term time series data is required, which can be the subject of further analysis. However, recently Milrad (2015) used an estimation of the demand equation for new cars in Israel, and using a simulation based on the estimation results, quantified the impact of the reform on the number of cars sold in the short term, the average and the total emission levels and the tax revenues.

136. The demand equation for a new car, estimated by Milrad, uses a nested logit model of deriving a market share from a random utility of a discrete choice at the individual consumer level (Berry, 1994), and applied in various studies dealing with the automobile sector (e.g., Adamou, Clerides, and Zachariadis, 2014; Vance and Mehlin, 2009; Greene et al., 2005; Fershtman, Gandal, and Markovich, 1999). Various specifications were tested to resolve the endogeneity problem, arising from the car's price being endogenous to the system. The analysis was conducted on the new cars sold between January 2008 and August 2014.

137. Table 26 summarises Milrad's simulations on the monthly data between September 2013 and August 2014. The base scenario is the actual figures observed in the market. Other scenarios are simulated changes to tax regimes, constrained to keep constant several different factors: similar base tax level, number of total cars sold, same green grade and same total revenues.

138. The results of the simulations indicate that abolishing the rebate scheme and keeping the tax at the higher rate of 83% might result in less emissions (GHG and health-related) and higher tax revenues – but fewer cars sold. However, if the Tax Authority aimed to preserve the level of revenues, it could have decreased the purchase tax to 56.8%. Then the amount of cars would have increased to provide higher revenues; concomitantly, average and total emissions would have risen significantly.

139. Milrad then uses the scenario that produces the same number of cars (column 3) to calculate the economic payoff of the scheme, by comparing the difference in tax revenue (alternative cost of the programme) to the costs of emissions saved. He employs the 2013 costs per tonne of emission published by the MoEP, and evaluates the total cost of emissions from a new car based on three different estimates

for the distance travelled: an average annual distance of 14.6 thousand km, total 200 000 km and 400 000 km (a theoretical upper bound). The results of this evaluation are presented in Table 27, with the "emission gap cost" being the difference between columns (1) and (3) in Table 26.

Table 26. The estimated impact of abolishing the green rebate

	Base	Without rebate	Without rebate same number of consumed cars	Without rebate same total green score	Without rebate same total revenues
	(1)	(2)	(3)	(4)	(5)
Purchase tax	83%	83%	61.79%	63.46%	56.80%
Rebate	Yes	No	No	No	No
Consumed Cars					
Total	**199 354**	**166 903**	**199 354**	**196 797**	**206 997**
By segment:					
Mini	26 606	21 134	23 868	23 652	24 512
Small	22 896	18,685	21 665	21 430	22 367
Compact	110 237	91 701	109 819	108 390	114 097
Medium	16 025	13 788	16,663	16 436	17 340
Large	1 617	1 543	1 937	1 906	2 030
SUV	21 649	19 721	25,079	24 658	26 329
Green Indicators					
Average base green score	**165.5**	**166.7**	**167.7**	**167.6**	**167.8**
Total Green Score	**32 986 318**	**27 830 601**	**33 427 100**	32 986 318	**34 744 255**
Average base emission level	5.4	5.7	5.7	5.7	5.7
Total emission level	1 082 506	944 833	1 141 849	1 126 343	1 188 129
Emission					
Average CO_2	137.0	137.8	138.6	138.6	138.8
Total CO_2	27 314 219	23 007 175	27 640 441	27 275 490	28 731 004
Average CO	0.34	0.34	0.34	0.34	0.34
Total CO	68 071	57 241	68 327	67 453	70 939
Average NO_x	0.017	0.018	0.018	0.018	0.018
Total NO_x	3 476	3 025	3 654	3 604	3 801
Average HC	0.038	0.039	0.039	0.039	0.039
Total HC	7 659	6 432	7 691	7 592	7 988
Average PM	0.000	0.000	0.000	0.000	0.000
Total PM	25.6	21.5	26.9	26.5	28.2
Revenue					
Average revenue purchase tax	32 182.7	43 408.0	32 897.2	33 749.6	30 328.6
Total revenue purchase tax (ILS millions)	6 415.7	7 244.9	6 558.2	6 641.8	6 277.9
Total revenues: purchase tax and VAT (ILS millions)	**10 227.2**	**10 801.8**	**10 450.0**	**10 512.5**	**10 227.2**

Source: Milrad (2015).

140. The conclusion of Milrad's study is that if bearing in mind that the reform aimed to internalise external costs, then it was not successful in doing so, with the costs saved ranging between ILS 8.82 million to ILS 17.63 million, depending on the distance estimate, and lost tax revenues coming up to a much higher ILS 222.7 million (the difference between columns (1) and (3) in Table 26). This conclusion support the findings presented earlier.

Table 27. Estimated emission externalities cost saving

Period	Travel distance of new car (km)	Emission gap cost (ILS million)	Emission gap cost (USD million)	Profit (ILS million)	Profit (USD million)
Year	37 787	1.67	0.47	-221.05	-61.78
Car Life (low)	200 000	8.82	2.46	-213.90	-59.79
Car Life (high)	400 000	17.63	4.93	-205.09	-57.32

Source: Milrad (2015).

6. Summary and further research

141. Vehicle-related taxation, apart from being an important source of revenue in Israel, aims to internalise external costs imposed on the rest of the society by those who directly benefit from using the car, and to regulate demand in the market. These external costs include congestion, noise, loss of land, accidents and pollution. However, with the tax being a constant percentage of the value of the car, the purchase tax was not geared to provide incentives to consumers to buy more efficient and "greener" cars. The Green Tax reform was introduced in order to employ economic incentives to reduce the purchase of high-polluting vehicles, by setting a transparent, coherent and indisputable tax framework that internalises the external costs from health-related and GHG emissions. The new tax scheme was designed to account for all relevant emissions and to do it as accurately as possible, by weighting the emissions according to their harmful effects, rather than focusing only on GHG emissions or fuel consumption. A large volume of CO_2 emissions make up for a heavy weight of it in the Green Grade formula, resulting in high correlation between the amount of CO_2 and the Green Grade; however, other harmful effects are also being internalised, the main feature which distinguishes the Israeli scheme from similar schemes in other countries. An extensive research was done to inform the original formula, and an even deeper analysis was performed to introduce the updated weights, which reflected the specifics of Israeli climate and population characteristics.

142. The Green Tax reform seems to have had a large impact: starting 2009, when the tax came into force, the share of heavy-polluting cars (bands 13-15) was reduced from 23.5% in Jan-Aug 2009 to 7.4% (according to the original formula) in 2014, while the share of low-polluting vehicles went from 1.8% to 47.2%. Even though detailed emission data does not exist before the green tax report, it is evident that the share of smaller, more efficient cars (up to 1300 cc), which had averaged 5% in the years preceding the tax, started rapidly increasing as from 2009 and reached 26% in 2014. With that, the value of sales started growing rapidly since the implementation of the tax, and continued to grow even after the formula update that reduced the rebates given to cleaner cars.

143. An average car nowadays pollutes much less than a decade ago, but the substantial increase in the total number of cars being purchased and the high overall traffic density in Israel has exacerbated the total amount of emissions and created secondary effects in the form of increasing congestion of roads, thus increasing emissions even more. The average distance travelled by each car has decreased over last years (although only slightly), and could be the effect of increased fuel costs and the reform in company car usage costs, which essentially reduced the share of company cars in the new cars' imports (from 60% in 2007-2010 to just above 30% in 2013-2014, according to the Tax Authority, 2014).

144. It appears that the reform had biggest effect in the first two years after the new tax came into force – while the market was adjusting to the change, i.e. in 2010-2011, tax revenues went up and so did total pollution levels, before starting to decrease in the subsequent two years. The 2013 update stirred the market again, bringing along a steep shift in demand, increasing tax revenues by 25% and total emission costs by 28%. This sharp change after two years of low revenues and gradually decreasing total emissions meant that the update was required much earlier than it was actually implemented. Learning from this experience, the Government decided to update the formula every two years in the future.

145. With the number of vehicles per capita continuously increasing even before the introduction of the tax, however, it is hard to say if the implementation of the tax was responsible for the increase in the volume of emissions. Train and bus travel experienced a similar relative increase as the total distance travelled by private cars, and private car ownership still stays well below the OECD average. Changes in supply – newer, more efficient cars, particularly in light of the ever-decreasing limits of the pollution standards – would have probably brought down the emissions of an average car over the years.

146. Considering alternative scenarios for changes in the number of cars, there are three main points to make: (1) the amount of emissions has *increased* as a result of the reform, compared to the "no change" scenario, as well as compared to an assumed 4% increase in the annual number of cars sold. This implies that the reform was effectively subsidising new vehicle purchases. The main effect is evident mainly in the short term, when the reduction in the price of cars caused a high increase in demand; (2) tax revenues increased as well in the short term, but started to decline rapidly, somewhat recovering only after a formula change; (3) from the standpoint of internalising the external costs, the reform was not effective in the long run, with the additional revenues managing to cover additional environmental costs only in the first two years. Welfare effects, however, could be more positive, if the increase in consumer and importer surplus are taken into account.

147. An approach based on the estimation of the demand function for cars, performed by Milrad, confirms these finding, suggesting that without the rebate, the number of cars would have been lower, total emissions would also have been lower, but an average car would pollute more. The simulation shows that the level of tax (without the rebate) that generates the lowest total emissions would be higher than 63.5%. Keeping in mind that the 2005 reform intended to set the purchase tax at 72% without rebates, one might conclude that the number of cars and amount of emissions would have been lower under this regime, suggesting that the Green Tax reform was too generous with the rebates it was providing.

148. This outcome was not unexpected, given how strongly people react to tax-related price incentives. For example, D'Haultfoeuille et al. (2014) show that the feebate policy in France was too generous, and led to an increase in total vehicles purchased in a way that increased total CO_2 emissions (both from manufacturing and travel), suggesting that the design of such policy should be sales-neutral (or reduce sales) rather than revenue-neutral.[45] The 2013 and – even more so – the 2015 formula updates, which reduce the rebates given, might partially correct this issue.

149. The main advantage of the Israeli Green Tax scheme, however, is that even though the CO_2 emissions went up, health-related pollution increased by a lower degree, and even decreased for PM, whereas schemes focusing solely on CO_2 were shown to have negative effect on local pollution. The CO_2 emissions of an average car have diminished after the reform, but NO_X and PM have diminished even more.

150. The reform had no direct effect on the pre-existing vehicle fleet: Israel does not export used cars, and the import of the latter is marginal. The indirect effect is reflected in the prices of used vehicles, decreasing seriously as a result of the alternatives provided by cheaper and more fuel-efficient new cars.

151. The success of the reform was substantial in shifting the demand towards less polluting vehicles, proving the efficiency of economic incentives in changing behaviour. However, it also proves that any public administration should be careful when designing a similar scheme so as not to reduce car prices too much. With GDP per capita continuing to grow and investment in infrastructure lagging behind the increase in car ownership, a further reduction of the purchase tax would mean even more vehicles on the

45. See, for example, Greene et al. (2005) for a discussion on the optimal design of the feebate system and how crucial the "pivot point" that divides fees and rebates.

road and a further increase of negative externalities. Future legislation should be focused on regulating demand for using private vehicle, as was suggested in the OECD Economic Survey, Israel, in 2013 (OECD 2013). The Green Tax Report (2008) proposed several complementary steps to the Green Tax, and specified that any increase in car-related taxation should be accompanied by creating viable alternatives, including: reducing vehicle-related employee benefits; developing public transportation; focusing on policies that reduce demand for motor transport altogether by investing in cycling lanes, in local business and areas and entertainment facilities. Car scrappage schemes are another important complementary step, designed to move old and polluting cars off the road.

152. Given, first, a relatively high excise on fuel and second, prices that are already at similar relative levels as in European countries, increasing fuel prices even further is difficult to justify politically, particularly since the Green Tax commission found that the revenues from fuel taxation exceeded the external costs of fuel consumption. Alternative means could be considered, like introducing usage taxes that would reflect the marginal cost of using a private vehicle in different road conditions: city centres, congestion, and times of day. A test scheme, initiated by the Ministry of Finance and the Ministry of Transport, was launched in 2013 with the objective to test the efficiency of financial rewards in reducing car use. Volunteers who took part in the experiment, had a tracking system installed in their cars, which, for the first six months, recorded their driving habits – distance, type of car used, day part and roads taken. In the subsequent eighteen months, a set "budget" was then provided, which was used to pay a "tax" on each km driven. The level of the "tax" depended on the area (metropolitan/marginal metropolitan/ periphery), days of week and day parts (rush hour or not) and the pollution level of the car used. Any money left in the budget at the end of the experiment would then be paid to the participant's account (up to a certain amount). The results of the test are meant to inform the new policy, designed to change travel habits and reduce congestion on the roads.

153. Due to previous planning that encouraged car-dependent lifestyles and inefficient public transportation, any of the tax-based measures, however, could potentially create a burden on weaker populations, many of which tend to have traditionally large families, live in the peripheral areas of the country, and where many groups rely heavily on private cars. In the current situation of limited railway lines, high train ticket prices and inconvenient train stations, increasing prices on car usage might paradoxically decrease welfare before a solution is found to reduce dependency on private cars. The negative effects of car usage taxation on social welfare could be reduced by providing useful and convenient alternatives; therefore, any measures that would introduce taxes on distance, place and time of travel should be accompanied by the development of efficient public transport. Even though there has been a major plan in place for the development of public transport since 2008, particularly by rail, progress has been slow so far, both because of the long time it takes to complete the new rail projects, but also due to long times required to complete detailed planning of the project.[46]

154. Further improvements to vehicle taxation should also focus on heavier vehicles, the challenge being to tackle the lack of mandatory practice of measuring their emission levels. Additional improvements to the tax system would come from further research regarding lifetime changes in emission levels in vehicles, and the implementation of re-checking of emission data provided by car makers in independent laboratories, so that biases could be spotted and the variance of the measured levels of emissions be evaluated. A particularly sensitive issue is the difference between the EU and the US testing rules and procedures.[47] In the United States, the conditions of the test (the driving cycle) are different from those in the EU, and the tests are being conducted by a manufacturer and not monitored by an independent approval

46. "Plan 42" for development of effective and sustainable inland transportation has been in preparation since 2008 and includes promotion of increases in welfare and economic development, efficient use of land, and reducing environmental damage. The goal is to complete the projects covered by the plan by 2040.

47. For a detailed description of the differences see, for example, Mock and German (2015).

agency. Currently, the Israeli Tax Authority uses adjustment coefficients set by professional consultants. Certain research provide ready-made adjustment coefficients (see, for example, Kuhlwein J., J. German and A. Bandivadekar, 2014), but unfortunately, only for CO_2 emission.[48]

155. The Green Tax reform emerged from the recognition that external costs should be imposed on the user of the vehicle, and succeeded mainly due to an extensive co-operation between various bodies: the Israeli Tax Authority, Ministries of Finance, Environmental Protection, Transport and Infrastructure, and others. However, the reform met several obstacles, mainly opposition from the general public and particularly from car importers, who feared an unfavourable change in their market shares. They questioned the legality of a differentiating tax that would cause a "distortion" in demand, and were pushing for taxes based on engine efficiency and CO_2 emissions, resembling European schemes. The opposition was particularly vociferous from the importers of models originating in the EU, where manufacturers had perfected the production of CO_2-efficient diesel engines for a European market committed to reduce CO_2 emissions.

156. The thorough analysis of the external costs produced by all the pollutants and the necessity to internalise all of them, as outlined in the Green Tax report, helped to overrule the opposition. This was also feasible because unlike in Europe, the share of diesel vehicles in total car sales is very small. Israel has the advantage of being a small, import-based country that cannot affect supply and production standards; otherwise opposition to the reform would have probably included several additional bodies, mainly car manufacturers, focused on CO_2 reductions. In larger countries, where the demand can have an impact on the manufacturers, the implementation of a similar tax would mean costly adjustments at the production level, therefore any such scheme might require a directive on an international level.

157. The existing high purchase tax also facilitated the implementation of the scheme from the political point of view. Therefore for the public it was easier to accept the reform. The reform did not increase taxes, but created differentiation according to pollution levels, and households had the option to choose between a range of cars according to their income and requirements. Calibration of the scheme is extremely important, as proved by previous research. Due to erosion of the tax base over time, the tax formula should be updated regularly, with the dates of the updates set in advance and according to the pre-agreed procedures.

158. The Israeli experience sets a precedent for creating one convenient formula for a single tax that successfully integrates both GHG and local air pollutants, thus matching the marginal cost to society with the marginal cost of using the car. However, every market is different, both in terms of the relative costs to society of the various pollutants, and because car fleets are not solely being determined by tax levels; family composition, urbanisation, efficiency and cost of public transport, as well as preferences and awareness all determine the composition of car fleets and usage habits, and what works in one country might not particularly be adaptable in another.

159. Costs to society differ across countries and populations; therefore, given a high economic sensitivity to tax levels, transferring a formula should be handled with great care and incorporate as much of the country-specifics as possible. Climate differences can aggravate the impact of pollutants. The share in the population of children, who are more susceptible to the effects of pollution and whose productive period lays in the future, increases the costs even more. A higher percentage of older people in the population adds to these – all these affect the weightings of the formula.

48. The concern regarding the lack of additional and independent testing and a more educated adjustment of the tests performed in the United States was expressed by Natalia Mironichev of the Tax Authority. This seems particularly important in view of recent developments in on-road NO_x testing, and the Volkswagen scandal.

160. Another lesson from the Israeli experience is that the date for the formula updates should be set in advance. After first implementation, it is hard to introduce another change, unless it is agreed and expected. The effectiveness of the tax in creating a distribution of cars with various emission levels is reduced quickly when demand shifts towards greener cars, and an update is required to create a further push in that direction and prevent substantial tax revenue losses. If an annual road tax is the one to be differentiated (instead of a first-time registration or an import tax), relevant authorities should think in advance how to deal with changing grades of existing cars each time the formula is being adjusted. Maintaining a historical record of original grades is paramount if the objective is to keep the annual tax unchanged for each individual vehicle as it ages. Scrappage schemes to remove old cars off the road (proven to be effective in reducing emissions and accident casualties,[49] but requiring significant investments) and taxes on usage of old highly polluting vehicles could supplement the system.

161. Extensive co-operation to launch the scheme is required between different authorities, such as the tax authority, environment, finance, transport and infrastructure bodies. Car importers and manufacturers should be involved in order to ensure their co-operation in supplying a reliable source of emission data for each car (with the testing being performed by an independent tester). For a substantial amount of local models (and adjustments to existing models) emission levels have not been adjusted as they should have been in the case of Israel (for example, after a catalytic converter was installed, or there were slight changes to the weight of the car). A reliable and transparent database should be built and managed by the relevant authorities. These authorities should also be responsible for the promotion of awareness alongside tax incentives, by compulsory and visually clear advertisement of tax bands. Clear marking of the pollution levels plays an important role in increasing public awareness. Authorities should also make publicly available their calculations.

162. Evidently, a reform and its update can cause significant shifts in demand in the short term. Hence, any real effect should be estimated over the longer term, taking into account supply effects, such as production of less polluting and more efficient cars, and additional exogenous effects, such as changes in the availability and costs of alternatives – higher taxes on company cars, provision of public transport and the effect of expectations and longer-term trends of car ownership.

49. MoEP estimated the annual rate of reduction in transport-related emissions at 3%, and annual savings from reduction in air pollution after the first year and a half of the scrapping programme (launched in 2010) at ILS 30 million (MoEP, 2015b). The Bank of Israel Report showed that the probability of being killed in an accident with a car aged 20 years and older is more than twice than in a newer car, and the probability of being seriously injured is nearly one third higher. Following that evidence, the report concludes that the economic gain from the reduction in accident casualties was ILS 1 000 per scrapped vehicle, in addition to the estimated ILS 3 300 gain from emissions reduction – much higher than the price paid for each vehicle (ILS 3 000).

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Appendix A: Selected indicators for OECD countries

	Traffic volume (bn veh-km) 2014*	Traffic volume % change 2000-2014	Traffic density (1 000 veh-km/km) 2014*	Vehicle stock (1 000) 2014*	Vehicles % change 2000-2014	Veh/100 inh 2014*	Veh/100inh % change 2000-2014*	New registrations in 2014*	GDP per capita USD, PPP adjusted) 2014*	GDP % change 2000-2014
Australia	239	30	274	17 633	49	57	11	883 949	44 706	52
Austria	77	19	621	5 130	15	55	8	356 145	45 133	21
Belgium	99	9	636	6 380	22	49	8	487 711	41 595	20
Canada	333	8	320	22 334	27	50	10	1 017 397	43 038	33
Chile	..	..	..	4 169	105	22	86		21 888	82
Czech Republic	47	16	355	5 330	42	45	34	192 923	28 963	40
Denmark	46	12	615	2 681	19	41	17	188 413	43 797	8
Estonia	8	30	143	754	22	50	48	21 135	26 160	63
Finland	54	16	507	3 766	53	58	42	106 235	40 017	18
France	560	14	532	38 057	13	51	8	1 765 855	37 617	16
Germany	709	9	1 081	46 268	-1	54	2	3 036 773	43 282	16
Greece	82	-10	698	6 456	51	45	53	83 620	25 523	-2
Hungary	37	59	189	3 778	38	32	36	71 779	23 507	29
Iceland	..	..	..	246	37	66	17	9 429	41 987	44
Ireland	40	38	429	2 271	47	43	22	96 363	46 858	34
Israel	**51**	**39**	2 730	**2 846**	**62**	**30**	**35**	**239 314**	**32 713**	**59**
Italy	..	..	..	41 321	14	61	6	1 360 551	34 781	-1
Japan	694	-11	547	74 482	5	47	13	4 674 281	36 225	12
Korea	1,463	27	13 809	20 118	67	31	82	1 213 012	33 089	75
Luxembourg	6	56	2 070	398	40	66	12	49 793	93 234	39
Mexico	150	140	398	36 742	135	21	108	745 250	16 891	37
Netherlands	129	11	921	8 956	20	47	14	387 567	46 749	15
New Zealand	40	12	428	3 840	65	68	35	258 256	34 989	43
Norway	44	24	462	3 106	58	52	27	144 202	65 635	25
Poland	207	50	501	22 734	90	51	95	282 359	23 616	64
Portugal	..	..	..	5 807	22	43	22	142 826	27 651	2
Slovak Republic	..	..	..	2 196	53	35	47	125 813	26 586	74
Slovenia	18	34	456	1 153	25	52	19	54 086	28 675	29
Spain	224	8	1 354	27 456	28	48	11	890 125	32 546	21
Sweden	77	11	527	5 167	18	47	5	324 037	44 586	30
Switzerland	61	16	854	4 675	21	54	10	304 083	56 897	29
Turkey	99	77	244	14 333	140	13	95	585 814	18 599	76
United Kingdom	489	2	1 165	34 348	21	47	9	2 438 340	38 743	27
United States	4,743	8	737	253 639	12	58	23	7 585 867	52 592	29
OECD Europe	4,058	23	773	292 766	28	46	17		36 862	22
OECD America	5,500	15	679	316 884	25	49	32			31
OECD Asia-Oceania	2,611	19	1 092	118 919	22	45	25			29

*Or latest available.

Source: OECD.STAT; Central Bureau of Statistics, Israel.