



Working Paper No. 342

April 2010

The Impact of Climate Policy on Private Car Ownership in Ireland

Hugh Hennessy^a and Richard S.J. Tol^{a,b,c}

Abstract: We construct a model of the stock of private cars in the Republic of Ireland. The model distinguishes cars by fuel, engine size and age. The modelled car stock is built up from a long history of data on sales, and calibrated to recent data on actual stock. We complement the data on the number of cars with data on fuel efficiency and distance driven – which together give fuel use and emissions – and the costs of purchase, ownership and use. We use the model to project the car stock from 2010 to 2025. The following results emerge. The 2009 reform of the vehicle registration and motor tax has led to a dramatic shift from petrol to diesel cars. Fuel efficiency has improved and will improve further as a result, but because diesel cars are heavier, carbon dioxide emissions are reduced but not substantially so. The projected emissions in 2020 are roughly the same as in 2007. In a second set of simulations, we impose the government targets for electrification of transport. As all-electric vehicles are likely to displace small, efficient, and little-driven petrol cars, the effect on carbon dioxide emissions is minimal. We also consider the scrappage scheme, which has little effect as it applies to a small fraction of the car stock only.

Corresponding Author: Hugh.Hennessy@esri.ie

Keywords: Private car transport, Republic of Ireland, carbon dioxide emissions, scenarios

^a Economic and Social Research Institute, Dublin, Ireland

^b Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands

^c Department of Spatial Economics, Vrije Universiteit, Amsterdam, The Netherlands

ESRI working papers represent un-refereed work-in-progress by researchers who are solely responsible for the content and any views expressed therein. Any comments on these papers will be welcome and should be sent to the author(s) by email. Papers may be downloaded for personal use only.

The Impact of Climate Policy on Private Car Ownership in Ireland

1. Introduction

Private car transport has seen some considerable changes in the period of rapid economic growth in Ireland. Increased levels of ownership combined with changes in car choice have meant that the private car stock in Ireland now is very different than a decade previous (Howley et al., 2007a). If government plans come to fruition, the car stock will again look very different in 10 years time.

Private car transport emits carbon dioxide through its fuel consumption. As elsewhere, transport emissions as a share of total emissions in Ireland are high and rising (Howley et al., 2007a). The Government of Ireland has attempted to change this trend by a range of policies, including recent changes in taxation. Car transport has always been subject to a heavy tax burden. This was in part due to its negative externalities but also due to the inelastic demand schedules associated with driver behaviour. Furthermore, the Government favours the adoption of electric vehicles. Ambitious targets of 230,000 electric vehicles by 2020 (more precisely, 10% of the stock) have been announced (DCENR, 2009). This has the ultimate aim of making private transport more sustainable both in terms of environmental impact and oil dependence. This paper evaluates the impact of government policy on car ownership, and assesses the prospects of all-electric vehicles.

Modal shifts, commuting patterns and efficient driving can also have a substantial impact on emissions. These aspects are beyond the scope of this paper. We focus solely on emission improvements brought about by changes in the composition of the car stock. Emissions from private car transport are driven by fuel consumption. Quantifying these emissions requires data on the composition of the car stock, the associated fuel efficiency and distance travelled. We project these output variables using the ISus Car Model. The evolution of the car stock follows a standard scrap and sales approach which allows us to project the stock by size, age and fuel type. This allows us to examine exogenous shocks to the car fleet, focusing on the composition of the car stock and its resultant emissions. The scenarios we simulate are the inclusion of electric vehicles, a reform of the tax system and the impact of a scrappage scheme.

Estimating CO₂ emissions directly attributable to private car transport is not an exact science. O'Gallachoir et al. (2009) estimate that private car transport accounted for 6.0 Mt CO₂ in 2006. This represents approximately 40% of total transport CO₂ emissions and 12% of total CO₂ emissions in Ireland. Kelly et al. (2009) present a methodology for converting data taken from the National Car Test (NCT) into total CO₂ emissions. Broadly similar estimates of private car CO₂ emissions are found. However, neither of these two studies examines the future links between the car stock composition, vehicle kilometres travelled and CO₂ emissions.

Giblin and McNabola (2009) examine the recent tax changes in Ireland using a Danish version of the COWI cross-country car choice model. They find that the tax change will result in a 3.6-3.8% decrease in the carbon intensity of new car purchases along with a €191 million fall in tax revenue. Ryan (2009) highlights the bias towards CO₂ emissions over NO_x emissions in the recent Irish tax change.

The future prospect of electric cars in Ireland has attracted significant research efforts. Smith (2010) simulates the possible future CO₂ reductions associated with significant electric and plug-in hybrid vehicle penetration. He concludes that substantial reductions can be made assuming that vehicle usage increases 1% per annum. The level of CO₂ reduction associated with electric vehicles will depend on the carbon intensity of the power generation sector. Leahy et al. (2009) assesses the possibility of electricity storage in Ireland and its benefits for both wind power generation and electric vehicles.

Section 2 describes of the data used in the model. In Section 3, we outline the equations and modular components used in construction of the model. The results of the model applications are displayed in section 4 along with the assumptions needed to implement these scenarios. Finally, we conclude in section 5 with a discussion of the results and their implications to current policy analysis.

2. Data

2.1 The total number of private cars

According to the Central Statistics Office, the stock of private cars in the Republic of Ireland in 2006 was 1,778,861.¹ While precise, this number need not be accurate. Census 2006 data suggest that the actual stock is 1,944,914, a difference of 8%. However, a certain amount of this discrepancy can be explained by cars which are exempt from motor tax. Another explanation is the use of vehicles in private transport that may be taxed as public service vehicles or goods vehicles.

Until recently, Ireland enjoyed high levels of economic growth which in turn led to an expansion of the car stock. A crude measure of saturation is the number of cars per 1000 people. In this respect, Ireland has converged on comparative countries (Howley et al., 2007a) and is close to this level of saturation at present. However, future emissions and efficiency are driven by the composition rather than the size of the car stock.

2.2 The stock of cars by engine size and fuel

Vehicle Licensing Statistics are collected by the CSO². These data divide registrations of private cars into 10 different engine size categories from 1965. Data are provided monthly but have been aggregated to annual observations for this paper. These data initialize our model and allows us to compute a stock (after correcting for scrappage).

Our other main data source is the anonymised 2004/05 Household Budget Survey (HBS), which is a survey of a representative sample of private households in Ireland. In 2004/05, 6,884 households participated in the survey which was carried out by the CSO. This survey has many transport related variables including the number of cars per household, the amount spent on different fuel types and the amount of motor tax paid per household. Motor Tax rates in 2004 were the same for both petrol and diesel powered cars. We compared the summary statistics of the HBS with information available from the 2006 Census. The comparisons are shown in Table 1. Although

¹ CSO data based on Vehicle Licensing Statistics

² Available on CSO website

there is a disparity in the some of the variables, this difference is not substantial. In terms of fuel type, the sample is representative of our Department of Transport data for the year 2004, the year of the survey.

In July 2008, the car taxes changed. Taxation levels are now based on (expected) emissions per kilometre rather than engine size. Thus, both Vehicle Registration Tax and Motor Tax rates were changed into seven bands with Band A representing the lowest emission band. We have constructed concordances (Table 2) for both petrol and diesel powered cars in line with recent new car registrations. The major shift towards midsize diesel cars (E-H in ISus categories) is evident here with a significant decrease in tax incidence apparent.

The CSO vehicle licensing data was disaggregated by fuel type only in 1997. This disaggregation was not broken down into engine size components. Thus, we used a different source of data to compute the stock of diesel cars. As of 2009, this registration data is available by fuel type, emission band, make, and price and engine size. We used data obtained from the Department of Transport which gives detailed information on the stock of cars in Ireland from 2001-2007 by fuel type, engine size and age. From the Bulletin of Vehicle Licensing Statistics, we know total diesel sales in each year back to 1986. To interpolate the new vehicle registrations of diesel cars from these data sources, we assume that the scrappage overtime of petrol and diesel cars are equal. From this we can then compute new registrations of diesel cars from the period 1985 to present. We initialise our diesel car stock in 1985 and build up our diesel stock in the same way as the total stock.

2.3 Fuel Efficiency

Data on fuel efficiency is constructed using two different sources. The most recent data is taken from Sustainable Energy Ireland (SEI) and is available for 2000 up until 2007. This dataset provides estimates of fuel efficiency by fuel type and by engine size (at a more disaggregated level than CSO engine size categories). This fuel efficiency data has been constructed by weighting new car registrations with a database of new car attributes provided by the Vehicle Certificate Agency (VCA) in the UK. This data is based on test statistics so a 20% on-road factor is applied to account for normal road driving. In order to correspond to the CSO engine size

categories, we simply compute average values for each CSO category. In this time period, there has been a steady improvement in terms of fuel efficiency in each engine category (Figure 1).

Since we initialise our stock of cars in 1965, we require historical data on fuel efficiency. No previous work in Ireland has investigated fuel efficiency back to this time. Some transport models³ simply impose an assumed 1% fuel efficiency gain in each year from 1965. Using the Irish Times newspaper digital archives, we constructed a dataset of tested fuel efficiency for the years 1965-1999. The data was again averaged to correspond to the CSO categories (A-K). Categories E, F and G were combined to give an average fuel efficiency of this new category (1301-1600cc).

2.4 Distance and Age Distribution

Two other important variables needed in accessing the environmental impact of the car stock are the average distance travelled and the age distribution of this stock. The distance figures are taken from CSO estimates. These are based on odometer readings taken as part of the National Car Test⁴. This test is compulsory on all vehicles that are 4 years old or older. The CSO have merged this data with data collected on cars that are less than 4 years old which makes the sample more robust. This data is available for the years 1999-2008 and is disaggregated by fuel type and engine size. We assume a constant fuel efficiency of a car over its lifetime as in Kelly et al. (2009). This gives us the mean values for distance travelled but we can also examine distributional characteristics from this data. Figure 2 shows that the distance profile differs considerably across the engine classes.

Data on the age distribution of the car stock is taken from the Bulletin on Vehicle Statistics. This data analyses the stock of cars by its year of first purchase and thus provides information on the car stock disaggregated by 15 age categories and is examined for the time period 1986-2007. This data is used to compute the survival probabilities of the ISus Car model. We calibrate this parameter to represent the historical data. However, it should be noted that the presence of imports are observed in the data and this complicates the computation of a scrappage parameter. Figure 3

³ Tremove – a Transportation model designed for the European Union

⁴ See Kelly et al. (2009) for a full description of the testing procedure

shows how the average age of the car stock decreased sharply up until the year 2000 and has slowly risen back to its level in 1986, our first year of car vintage data. It should be noted that these age averages are biased downward because no age distinction on vehicles that are 15 years old and cars that are older than this.

3. Model

3.1 Prevalence of Car Ownership

The notion of saturation is crucial in forecasting the future level of the car stock. At the saturation point, changes in the car total stock are directly proportional to the changes in the population or its demographic components.

HERMES is a macroeconomic model, used for making forecasts about the Irish economy, including a forecast of the car stock C at time t (Fitzgerald et al., 2002):

$$(1) \quad \Delta \ln \frac{0.8}{C_t / P_t - 1} = \alpha + \beta \frac{Y_t}{P_t}$$

where Y is the level of disposable income and P is the population between 15 and 64. This model saturates the rate of car ownership at 0.8 cars per adult population and uses an error correction procedure to predict the car stock. This gives us a stock of private cars, forecasted out until 2025.⁵

3.2 Type of Car

Once we have a future level of car ownership, we then estimate what the share of this stock will be in terms of engine size. We use information from the Household Budget Survey (HBS) on expenditure on motor tax to establish the engine size of the car owned. We specify a multi-nominal regression with the 9 categories of engine size as the dependent variable and estimate an income elasticity for each engine size. We also ran separate regressions by fuel type and the estimates were very similar. Thus, we chose to use the aggregated income elasticities; see Table 4. We then use these

⁵ Nolan (2009) estimates the drivers of car ownership from household data. Applying her equation to the same scenario of economic growth leads to an almost identical projection of the future car stock.

income elasticities to forecast the number of cars per engine size using information on future levels of disposable income, taken from the HERMES model.

The historical progression of the diesel car stock is tracked in the model but we cannot simply extrapolate this trend out to predict the future size of the diesel car stock due to recent policy changes. This has essentially caused a structural break in the series. For this reason, we apply a breakeven distance methodology⁶ along with information on the mileage distribution by engine size, to forecast the diesel car stock by engine size. This works as follows. Diesel cars are more expensive to buy and to own, but cheaper to drive. So, a diesel is more attractive to people who drive long distances – anyone who drives more than the break-even distance. The mileage distribution function specifies the fraction of the population who drive more than any distance, and thus also gives the market share of diesel cars. This type of approach has been used previously to explain the share of diesels in new car sales (Rouweldal, 1999; Mayeres and Proost, 2001). Similar approaches have also been used to examine the modal share of rail in freight choice (Van Schijndel et al., 2000). Existing research (Mayeres and Proost, 2001; Verboven, 2002) on the share of diesel cars is limited by the assumption that all diesel cars are homogenous and will be distributed evenly across all engine classes. Our methodology is disaggregated by engine size which allows us to predict the diesel share in each of the engine classes that have been constructed within the model.

We estimate these using various data sources on new cars to construct representative cars. This gives us computed Break-Even distance figures for each engine class. However, this alone tells us little about the rational share of diesel sales. We use mileage distribution data to compute these diesel market shares. This distribution data shows that there are clear differences in the driving profiles of the different engine classes. This allows us to compute a market share for each engine class.

⁶ A mathematical derivation of the Break-Even distance is detailed in the appendix.

3.3 Stock Demographics

The car demographic model distinguishes 10 engine sizes and 25 age classes. The dynamic equations are

$$(3a) \quad C_{t,1,s,f} = S_{t,1,s,f}$$

$$(3b) \quad C_{t,a,s,f} = (1 - \rho_{t,a,s,f}) C_{t-1,a-1,s,f}; a = 2, 3, \dots, 24$$

$$(3c) \quad C_{t,24,s,f} = (1 - \rho_{t,24,s,f}) C_{t-1,24,s,f} + (1 - \rho_{t,25,s,f}) C_{t-1,24,s,f}$$

where $C_{t,a,s,f}$ is the stock of private cars in year t , of age a , of engine size s and of fuel f ; S is the sales, and

$$(4) \quad \rho_{t,a,s,f} = 1 - \frac{0.015(a-1)}{1 + 0.03(a-1)}$$

is the probability of scrapping which is independent of time, size and fuel.

The demographic model is driven by historical data on new car registrations starting in 1965 and a scrappage parameter which affects the probability of scrappage. Under the assumption that the life cycle of cars is no longer than 25 years, then the modelled car stock is representative of the real stock from 1990 onwards. From 1985, the diesel car model is initialized. The same dynamic equations are used and assuming that diesel cars last no longer than 15 years, then the model becomes representative of the population in 2000. The stock of petrol cars can then be simply calculated by differencing the two stock variables. Thus from 2000, the stock is representative of both fuel types and the corresponding total.

The scrappage parameter (ρ_a – Equation (4)) has been calibrated to the age distribution data taken from the Bulletin of Vehicle Statistics. The scrappage parameter is time invariant and assumes that the durability of cars remains constant.

3.4 Distance Model

For the distance driven per year, we follow Hayashi et al. (2001), accounting for the impact of change in the composition of the car stock. Specifically, distance D_i is given by:

$$(5) \quad D_{t+1} = \left(1 + \varepsilon_{i,t} \left(1 - \frac{P_{t+1}}{P_t} \right) \right) D_t \Delta \frac{C_{i,j,t}}{C_t}$$

where C_{ijt} is the number of cars of size i and fuel j at time t ; $\varepsilon_{i,t}$ is the price elasticity of distance travelled for engine size i in time period t . The elasticities are similar to those reported in Hayashi et al. (2001)⁷. In theory, this elasticity should be lower for higher engine sizes as the higher incomes associated with larger cars make the owners more inelastic in the consumption patterns. Conversely, the elasticity estimates are higher for small cars. This is indeed the case with elasticities on the 2 largest engine sizes not being statistically different from zero. We calibrated Equation (5) against data on distance travelled from the years 2000-2008 (See Table 6).

Thus, Equation (5) estimates distance driven by engine size and is driven by the elasticity estimate and the change in the relative price. This dynamic equation is weighted by the change in new car sales per engine class. This essentially takes into the account that changing consumer preferences for cars does not equal different preferences for vehicle kilometres travelled.

3.5 Emissions

To convert to emissions, we need to compute how many litres of each fuel is consumed. As we have approximated the composition of the car stock and the distance travelled, all we need is the fuel efficiency for each of representative cars.

From the SEI fuel efficiency estimates, we simply extrapolate the trend out to 2025. This combined with our earlier data gives a fuel efficiency estimate of each car by its engine size, age and fuel type. Since the National Car Test compels cars to remain road worthy, we also assume that there is no depreciation of cars in terms of fuel efficiency and that any significant effects of age on efficiency will result in scrappage. One litre of diesel fuel has greater emissions than one litre of its petrol substitution. The conversion factors are as in Howley et al., 2007a (see Table 7). Note that a litre of diesel takes one further, so that the emissions per kilometre travelled are lower for diesel cars (of equivalent size).

⁷ Hayashi (2007) reports price elasticity estimates of -0.23. This is the value for the entire stock and is not disaggregated by engine size. It is consistent with other short-run elasticity estimates like Goodwin et al. (2004) who estimates a mean price elasticity of -0.25.

4. Applications:

4.1 Baseline Projections:

The ISus Car Model described above calculates projections of the car stock by engine size, age and fuel type (Figure 4). The projections are driven by forecasts of the economy and the population (Bergin et al. 2009). These results show a small dip in the car stock due to the current depression, but steady increase in the car stock after 2010 when an economic recovery is expected. We project to have nearly 2.4 million private cars in Ireland by 2025. This represents a significant slow down in growth rates compared with the boom period. This is in line with earlier analysis of the convergence to a saturation rate that has been apparent in Ireland.

Between 1990 and 2008, the average engine size of the car stock increased significantly. Projections based on the income elasticities suggest that this trend will continue once the economy recovers. See Figure 5.

There will be a minor increase in carbon dioxide emissions (Figure 6). The switch to diesel offsets the project increase in vehicle kilometres travelled. This is largely because of the tax reform of 2009, without which CO₂ emissions would be almost one million tonnes higher in 2025. Stabilisation of emissions, however, would still exceed the government target on emissions from private car transport.

4.2 The effects of tax reform

In July 2008, the car tax system in Ireland was revamped so that the tax rates are now based on the emissions of the vehicle in contrast to the engine size. Monthly sales data from the CSO show a very significant increase in the market share of diesel cars. Figure 7 shows how this change in market share evolves over time and feeds into the car stock. The share of diesel car grows considerable. This implies an improvement in the car stock efficiency (Figure 8) and reduces associated emissions (Figure 6). These emissions will only transpire if the increase in diesel share has no effect on average vehicle kilometres travelled.

The diesel market shares in each engine class are estimated using the break-even distance methodology described previously. As can be seen from Table 6 and in

Figure 9, the effect is especially strong on mid size diesel cars. Conversely, there is little effect on small cars with an engine size less than 1.3 litres. The key aspect is the differences across engine classes in terms of the mileage distribution. Consumers who drive a lot place a greater weight on efficiency than consumers who drive little; those who drive more than the break even point will chose a diesel fuelled car. The lower driving costs make up for the higher price of the diesel car.

4.3 The prospects for electric vehicles

Recent government announcements have praised the ability of electric vehicles to curb fossil fuel consumption and lower carbon dioxide emissions from private car transport. The current government target is that 10% of all vehicles in the private car stock be fully electric by 2020. At present, the car stock includes a small amount of hybrid vehicles and a smaller amount of plug-in hybrids.

To examine the impact of electric vehicles on the car stock in terms of its efficiency and emissions, we run various scenarios where a certain percentage of new car sales are electric. We make assumptions about fuel efficiency of electric vehicles along the lines of best current thought (Smith, 2009; see Figure 1). Reflecting government policy, we examine solely Battery Electric Vehicles (BEV's) as opposed to plug-in hybrid vehicles.

The penetration of electric vehicle depends on replacement rates within the current stock. The effect on emissions depends on what cars are replaced by BEV's. Our model does not allow us to examine whether these new BEV's replace old high emitting vehicles or are they only purchased by environmental sensitive consumers who already had a relatively low emission vehicle already. A discrete choice model of consumer preferences to assess the impact of the consumer on BEV purchase along the lines of Train et al. (1999) would be required. We would also need detailed information on the various attributes of electric vehicles. As such information is not available, we instead run simulations of electric vehicle sales taking into account what they replace and how certain targets will be reached in terms of market share of sales.

The scenarios are described below and all assume that electric vehicles make up about 10% of the car stock by 2025.⁸

- Scenario 1 is based on a constant 10% market penetration from 2012-2025. The share of electric vehicles is distributed equally across other fuel types and engine sizes.
- Scenario 2 is based on a growth rate of 10% in the share of electric vehicles with initial market penetration being 5% in 2012. Again, these electric vehicles are distributed equally across other fuel types and engine sizes.
- Scenario 3 is based on a market penetration as in Scenario 1 but these electric vehicles predominantly replace cars that emit most (such as petrol SUVs).
- Scenario 4 is again based on a market penetration as in Scenario 1 but electric cars replace low emitting cars (such as small petrol and medium diesel cars).

Figure 10 shows the effect on emissions. BEV's reduce emissions in all scenarios. However, the effect is small if BEV's disproportionately replace small cars, as seems likely given that electric cars are small and light. This means that not alone do we end up replacing the most efficient cars but we also end up replacing ones that have the lowest average driving distances. This highlights the importance of modelling a disaggregated car stock when making policy conclusions.

We assume that all electric vehicles are homogenous in terms of emissions. The fuel mix of the electrical generation sector is crucial when computing the emission directly attributable to electric vehicles. In turn, this potential fuel mix may be determined by the way in which electric vehicles are used and subsequently recharged. Leahy et al. (2009) highlight the mutual benefits of increasing wind power and electric vehicle penetration. When electric vehicles are recharged at night, excess capacity that is generated by wind power can help meet this demand and this greatly reduces the associated emissions. These factors mean there is a certain level of uncertainty in our estimation of emissions from the electric car fleet. We estimate that the electric vehicle stock, which accounts for 10% of the total stock in 2025, will account for between 2-3% of total vehicle emissions (Figure 11). This shows the

⁸ Current government policy aims to meet this target by 2020

potential of electric vehicles to reduce emissions, assuming that they are used efficiently and the power generation sector increases its share of renewables in time.

4.4 Scrappage Scheme

In Budget 2010, a car scrappage scheme was introduced. This amounted to a subsidy (in the form of a VRT reduction) of €1500 on the purchase price of a new car in exchange for the scrappage of a car greater than ten years old. The model does not explicitly consider the decision to scrap a car; see Equation (4). Nonetheless, we have knowledge of some of the most important factors. The number of cars that are 10 years or older has greatly increased since 2000 (Figure 3). We examine the impact of the scrappage scheme by changing our scrappage parameter for vehicles with age greater than 10. We increased the probability of scrappage for all vehicles that are ten years or older by 5 per cent. This change has little effect on overall emissions, because the number of extra cars replaced due to the scrappage scheme is extremely small when compared with the total car stock. In terms of emissions, the recent scrappage scheme will have little or no effect (Figure 12).

5. Discussions and Conclusions

We construct a model of private cars by age, engine size and fuel type to examine CO₂ emissions from transport in Ireland. We find that emissions from private cars are likely to continue to increase over the next 15 years, albeit at a slower rate than in the past. The rise in emissions is due to an increasing car stock and a preference for larger cars. This is partly offset by the switch towards diesel cars. The 2009 reforms of the vehicle registration tax and motor tax have substantially increased the market share of diesel engines. This structurally improves the fuel efficiency of the car stock over time, but as distances driven do not change (and indeed may even increase), the drop in emissions is limited. Emissions in 2020 will be well above the policy target.

The expected characteristics of electric vehicles are such that they will likely substitute already relatively efficient cars. Therefore, the government's target of a 10% share of all-electric cars by 2020 will have a minimal effect on carbon dioxide emissions. The impact of the scrappage scheme for old cars is even smaller because few cars are eligible.

There are caveats to the results in this paper. The car choice model is simple, and should be replaced with a more realistic representation of car purchases and how they respond to prices, taxes, and technical specifications (e.g., range). This would require micro-data and econometric analysis that is well beyond the scope of the current paper. Our specification of car scrappage is simple, probably too simple. However, we are not aware of data that would permit a more realistic model. The model similarly lacks a representation of the market in used cars. All this is deferred to future versions of the model. Transport is, of course, wider than the ownership of private cars. Freight accounts for about half of transport emissions in Ireland. The current paper also leaves to future research biofuels, modal choice, and settlement and lifestyle patterns that drive mobility. In the long term, these factors may have a greater effect on emissions than the three policy options explored in the current paper.

References:

Bergin, A., Conefrey, T., Fitz Gerald, J. D., & Kearney, I. 2009. "Recovery Scenarios for Ireland", Policy Research Series 7, Dublin: Economic and Social Research Institute.

Central Statistics Office. 2008 Vehicles Licensed for the First Time.

Central Statistics Office. 2008 Household Budget Survey 2004-2005 Stationary Office, Dublin.

Department of Transport. 2008 Bulletin of Vehicle Licensing Statistics.

Fitz Gerald, J. D., Hore, J., & Kearney, I. 2002. "A Model for Forecasting Energy Demand and Greenhouse Gas Emissions in Ireland", Working Paper 146, Dublin: Economic and Social Research Institute.

Foley, A., Gallachoir, B. O., Leahy, P., & McKeogh, E. "Electric Vehicles and energy storage — a case study on Ireland", at *Vehicle Power and Propulsion Conference, 2009. VPPC '09. IEEE*.

Gallachoir, B., Howley, M., Cunningham, S., & Bazilian, M. 2009. "How private car purchasing trends offset efficiency gains and the successful energy policy response", *Energy Policy*, Vol. 37, No. 10, pp. 3790-3802.

Giblin, S. & McNabola, A. 2009. "Modelling the impacts of a carbon emission-differentiated vehicle tax system on CO2 emissions intensity from new vehicle purchases in Ireland", *Energy Policy*, Vol. 37, No. 4, pp. 1404-1411.

- Greenspan, A. & Cohen, D. 1999. "Motor Vehicle Stocks, Scrappage, and Sales", *The Review of Economics and Statistics*, Vol. 81, No. 3, pp. 369-383.
- Hayashi, Y., Kato, H., & Teodoro, R. V. 2001. "A model system for the assessment of the effects of car and fuel green taxes on CO2 emission", *Transportation Research Part D: Transport and Environment*, Vol. 6, No. 2, pp. 123-139.
- Howley, M., O'Leary, F., & Gallachoir, B.. 2007 Energy in Transport.
- Howley, M., O'Leary, F., & Gallachoir, B.. 2007 Energy in Ireland 1990-2006.
- Johansson-Stenman, O. 2002. "Estimating individual driving distance by car and public transport use in Sweden", *Applied Economics*, Vol. 34, No. 8, pp. 959-967.
- Mayeres, I. & Proost, S. 2001. "Should Diesel Cars in Europe Be Discouraged?", *Regional Science and Urban Economics*, Vol. 31, No. 4, pp. 453-470.
- Nolan, A. 2008, *A Dynamic Analysis of Household Car Ownership in Ireland*. Working Paper, Dublin: Economic and Social Research Institute.
- Pock, M. 2010. "Gasoline demand in Europe: New insights", *Energy Economics*, Vol. 32, No. 1, pp. 54-62.
- Rouwendal, J. & de Vries, F. 1999. "The Taxation of Drivers and the Choice of Car Fuel Type", *Energy Economics*, Vol. 21, No. 1, pp. 17-35.
- Smith, W. J. 2010. "Plug-in hybrid electric vehicles--A low-carbon solution for Ireland?", *Energy Policy*, Vol. 38, No. 3, pp. 1485-1499.
- Sustainable Energy Ireland. 2008 Average Fuel Consumption and Distance travelled for Private Cars.
- Van Schijndel, W.-J. & Dinwoodie, J. 2000. "Congestion and multimodal transport: a survey of cargo transport operators in the Netherlands", *Transport Policy*, Vol. 7, No. 4, pp. 231-241.
- Vickerman, R. 2000. "Evaluation methodologies for transport projects in the United Kingdom", *Transport Policy*, Vol. 7, No. 1, pp. 7-16.

Appendix: Breakeven Distance Model of Fuel type choice:

The cost of a car consists of the cost of purchase, operation, maintenance, and sell value:

$$(1) \quad C_i = P_i(1 + \alpha_i) + \beta_i + \sum_{t=0}^{T_i} \frac{M_{i,t} + \gamma_{i,t} + (\pi_{i,t} + \delta_{i,t})\varepsilon_{i,t}D_t}{(1 + \rho)^t} - \frac{S_i}{(1 + \rho)^t}$$

where

- C_i is the net present cost of a car of type i ;
- P is the purchase price;
- α is the value added tax and stamp duty;
- β is the vehicle registration tax;
- M is the annual maintenance;
- γ is the annual motor tax;
- π is the price of fuel;
- δ is the excise duty on fuel;
- ε is the fuel efficiency of the car;
- D is the annual distance drive;
- ρ is the discount rate;
- T is the life-time of the car; and
- S is the sell value of the car.

If we hold all parameters constant over time and at their current value (as a car buyer might), then (1) simplifies to:

$$(2) \quad C_i = P_i(1 + \alpha_i) + \beta_i + \frac{(1 + \rho)^{T_i} - 1}{\rho} \frac{1 + \rho}{(1 + \rho)^{T_i}} [M_i + \gamma_i + (\pi_i + \delta_i)\varepsilon_i D] - \frac{S_i}{(1 + \rho)^{T_i}}$$

When choosing for a car that is more expensive to buy but cheaper to drive (a diesel, that is) but has the same life-time, the break-even distance is then given by:

$$(3) \quad D^* = \frac{\frac{(1 + \rho)^T}{(1 + \rho)^T - 1} \frac{\rho}{1 + \rho} \left[\Delta(P(1 + \alpha)) + \Delta\beta - \frac{\Delta S}{(1 + \rho)^T} \right] + \Delta M + \Delta\gamma}{\Delta((\pi + \delta)\varepsilon)}$$

where the Δ s denote the difference between car type i and j .

Table 1. Fraction of the population that own no car, one car, two cars, or three or more cars according to three alternative sources.

No. of Cars	0	1	2	3
Census2006	0.20	0.38	0.33	0.09
Census2002	0.22	0.41	0.30	0.07
HBS 2004	0.18	0.46	0.31	0.05

Table 2. Tax rates before and after the 2009 reform.

Diesel						Petrol					
Tax ^a	ISus	VRT ^b		MT ^c		Tax ^a	Isus	VRT ^b		MT ^c	
		bef	aft	bef	aft			bef	aft	bef	aft
A	A	22.5%	14%	165	104	A	A	22.5%	14%	165	104
B	B	22.5%	16%	165	156	B	B	22.5%	16%	165	156
B	D	22.5%	16%	275	156	B	D	22.5%	16%	275	156
B	E	25%	16%	320	156	C	E	25%	20%	320	302
B	F	25%	16%	343	156	D	F	25%	24%	343	447
B	G	25%	16%	428	156	D	G	25%	24%	428	447
C	H	25%	20%	550	302	E	H	25%	28%	550	630
E	I	30%	28%	800	550	F	I	30%	32%	800	1050
G	J	30%	36%	1150	2100	G	J	30%	36%	1150	2100

* This table shows how the engine size classes in the ISus car model (A-J) are transformed into new emissions bands (A-G). Note this is an illustrative example. The concordance table used to create emissions bands is based on actual sales in 2008-2009. This shows that petrol with the same engine size do not necessarily end up in the same emission bands

^a Classification in the tax code

^b Vehicle Registration Tax, ad valorem

^c Motor Tax, specific duty, €/year

Table 3: Income Elasticities

Engine size	Income semi-elasticity	
	Mean	St.dev
<900 cc	-0.3301	0.0934
900-1000 cc	-0.3301	0.0934
C	Not observed	
1001-1300 cc	Not observed	
1301-1400 cc	-0.0898	0.0808
1401-1500 cc	-0.0640	0.1029
1501-1600 cc	0.4114	0.0874
1601-2000 cc	0.5691	0.0861
2001-2400 cc	0.7287	0.1220
>2400 cc	1.1377	0.1938

Table 4: Average distance (1000 kilometre per year) by fuel type and engine size

Mean Distance for Petrol Cars										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
<900 cc	10.9	11.0	10.9	10.5	10.2	9.8	9.6	9.1	8.9	8776
900-1000 cc	13.9	14.0	14.1	13.6	13.5	13.2	13.0	12.4	12.2	11883
1001-1300 cc	14.4	14.5	14.6	14.2	14.0	13.8	13.5	13.1	12.9	12623
1301-1400 cc	17.2	17.4	17.3	17.0	16.8	16.5	16.3	16.0	15.7	15520
1401-1500 cc	19.8	20.2	20.0	19.0	18.8	18.4	18.1	17.5	17.3	17154
1501-1600 cc	19.5	19.5	19.5	19.0	18.8	18.5	18.4	18.1	18.0	18046
1601-2000 cc	19.6	19.6	19.4	18.8	18.5	18.4	18.4	18.2	18.2	18275
2001-2400 cc	20.5	20.3	19.9	19.1	18.9	19.0	19.1	18.9	19.1	19634
>2400 cc	17.8	17.8	17.8	17.2	17.0	16.8	17.1	16.9	17.2	17176
Mean Distance for Diesel Cars										
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
<900 cc	34.5	33.1	33.1	33.5	29.7	29.2	33.5	35.3	36.5	33923
900-1000 cc	11.3	11.9	12.9	13.9	13.7	12.8	12.8	12.6	12.4	12427
1001-1300 cc	17.7	18.3	20.9	19.3	20.0	20.6	20.9	20.9	21.6	21970
1301-1400 cc	18.6	18.5	17.7	21.0	22.3	23.0	23.7	24.4	24.6	24382
1401-1500 cc	23.1	23.1	22.1	20.2	21.2	22.3	22.2	22.6	22.8	23744
1501-1600 cc	22.4	21.3	19.1	17.9	16.9	17.2	17.6	17.6	19.0	20114
1601-2000 cc	26.5	26.8	26.7	26.1	25.6	25.4	25.2	25.1	25.0	25625
2001-2400 cc	27.4	27.7	27.9	27.4	27.4	27.4	27.8	27.8	27.7	28300
>2400 cc	25.6	25.8	25.9	25.5	25.4	25.4	25.6	25.4	25.4	26181

Source: CSO

Table 5: Effect of tax reform on break-even distance

Engine size	year	
	2007	2008
< 900 CC	50.7	51.6
901-1000 CC	50.7	51.3
1001-1300 CC	27.2	23.5
1301-1400 CC	26.4	18.3
1401-1500 CC	21.2	9.7
1501-1600 CC	27.5	14.4
1601-2000 CC	14.0	8.6
2001-2400 CC	18.1	5.6
> 2401 CC	17.8	10.3

Table 6: Emission coefficients.

Fuel	Consumption	Emissions
Petrol	1 litre	2.31 kg CO ₂
Diesel	1 litre	2.68 kg CO ₂

Source Howley, M., O'Leary, F., & Gallachoir, B. 2007

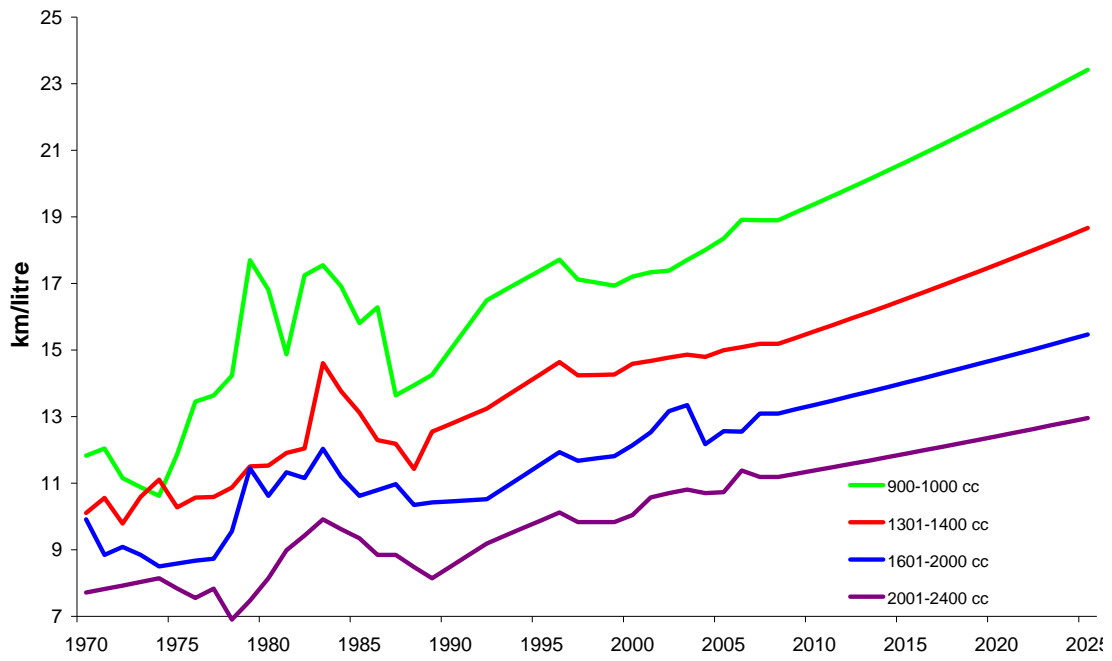


Figure 1. Fuel efficiency of new cars per petrol engine size.

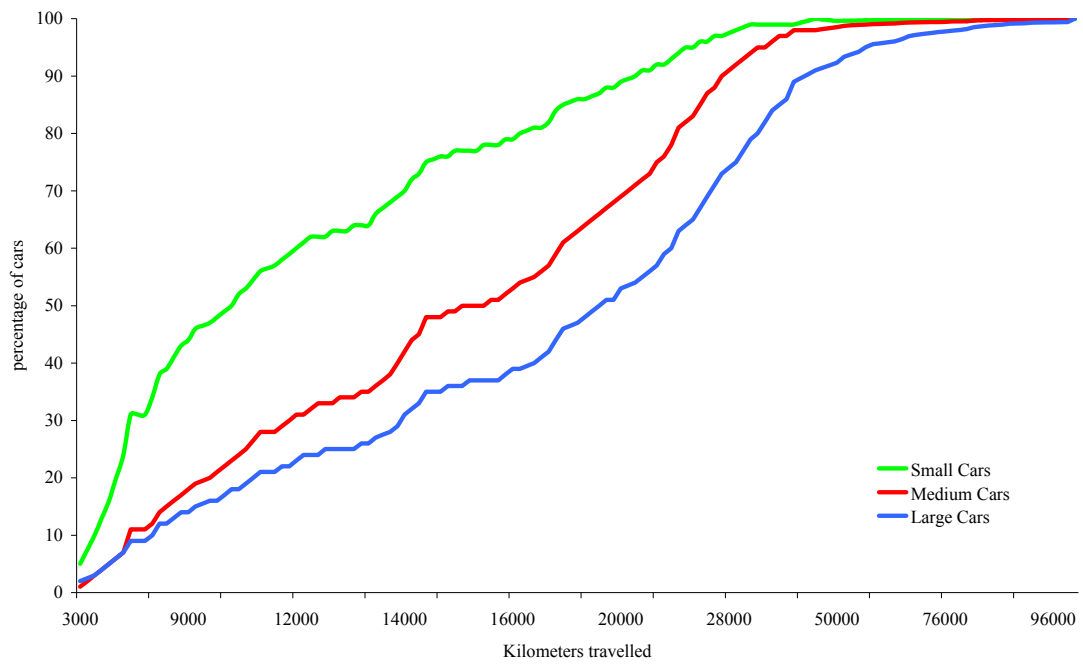


Figure 2: Cumulative distribution of mileage by engine size

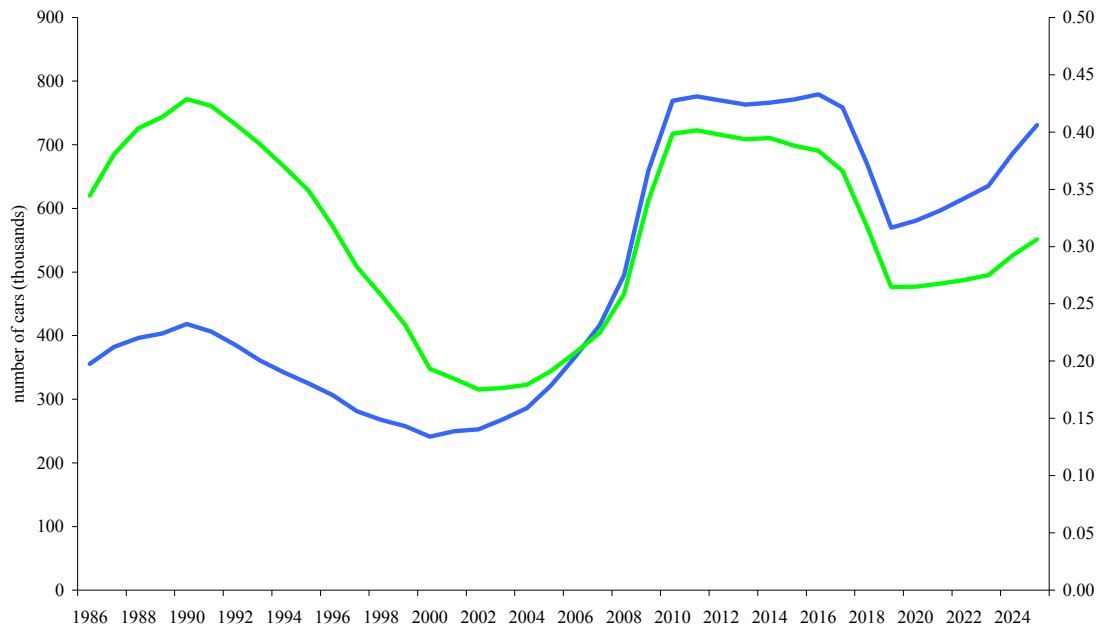


Figure 3: The number of cars that are 10 years old or older (left axis) and the fraction of the total car stock (right axis).

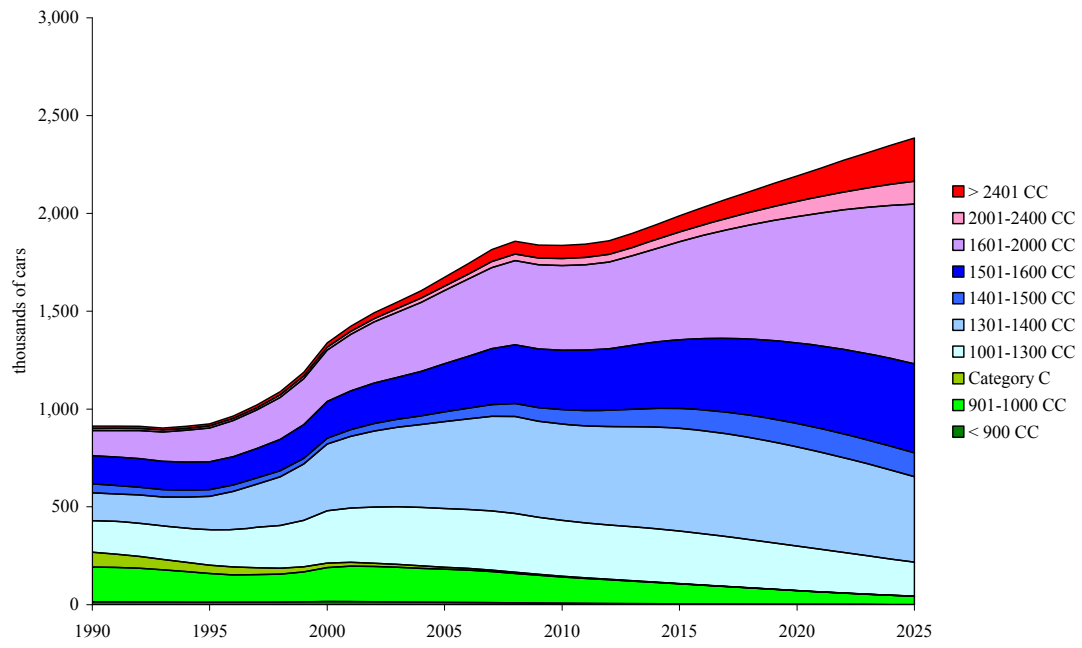


Figure 4: The observed and projected number of cars by engine size

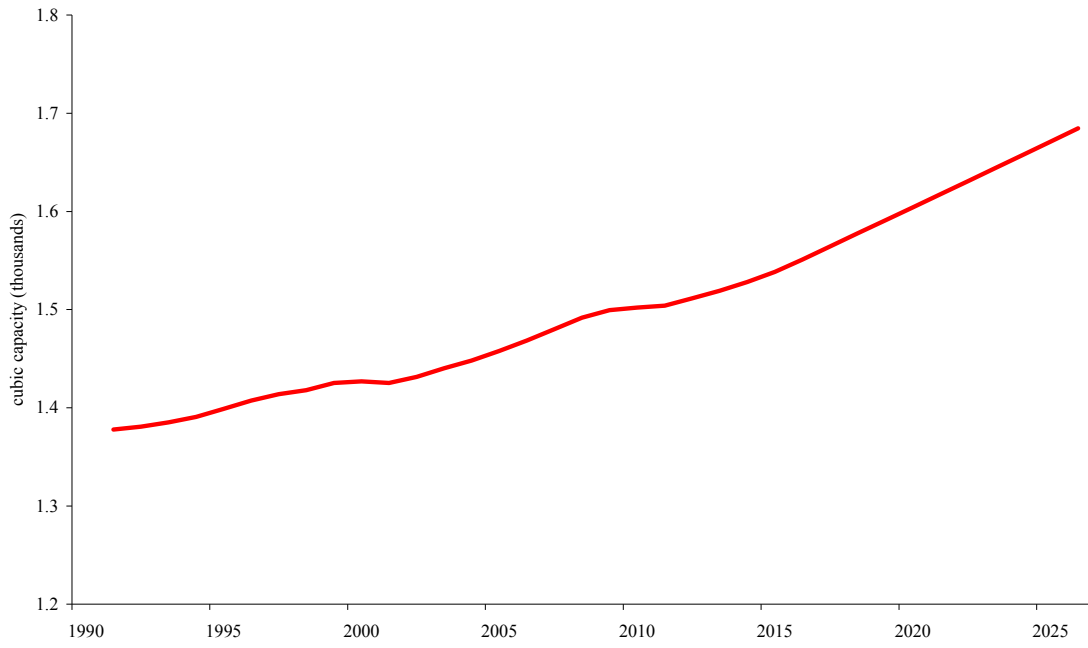


Figure 5: The average engine size of the car stock

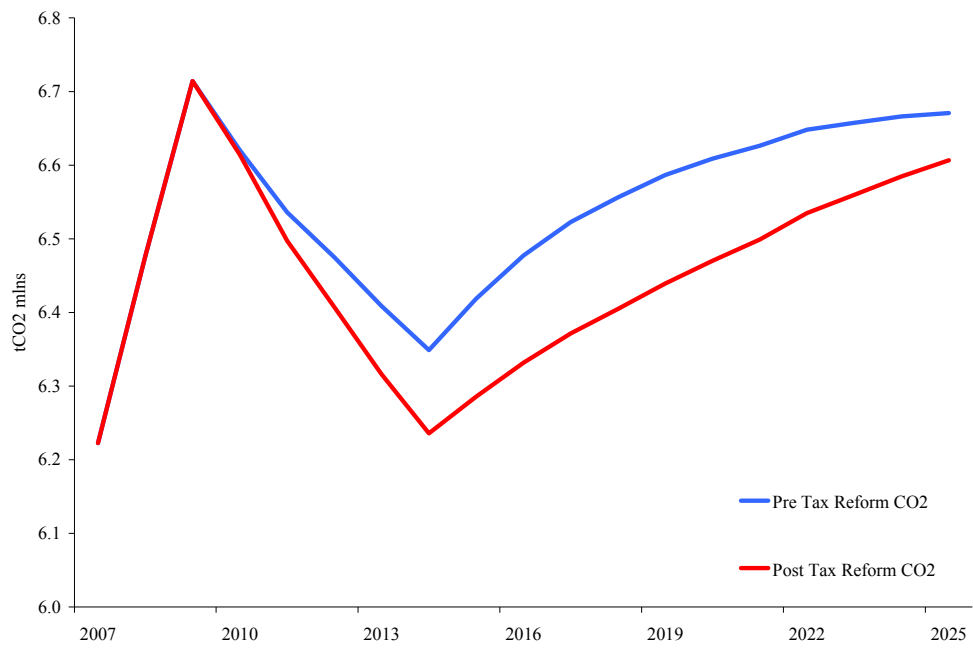


Figure 6: The effect of tax reform on CO2

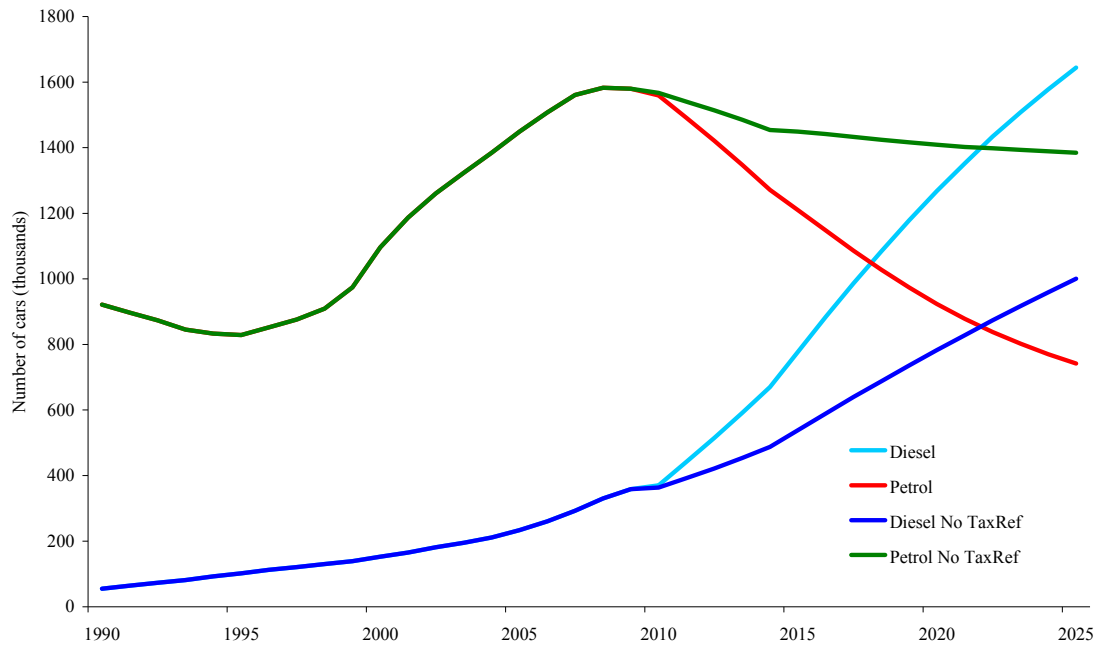


Figure 7: The impact of the recent tax reform on the number of diesel and petrol cars

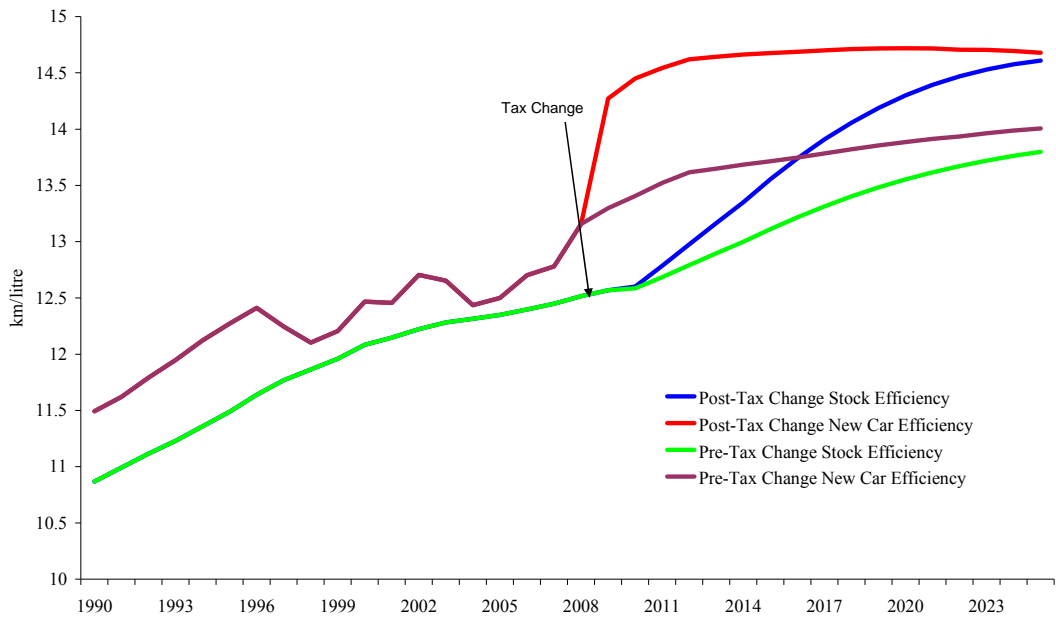


Figure 8: The effect of tax reform on the efficiency of the car stock

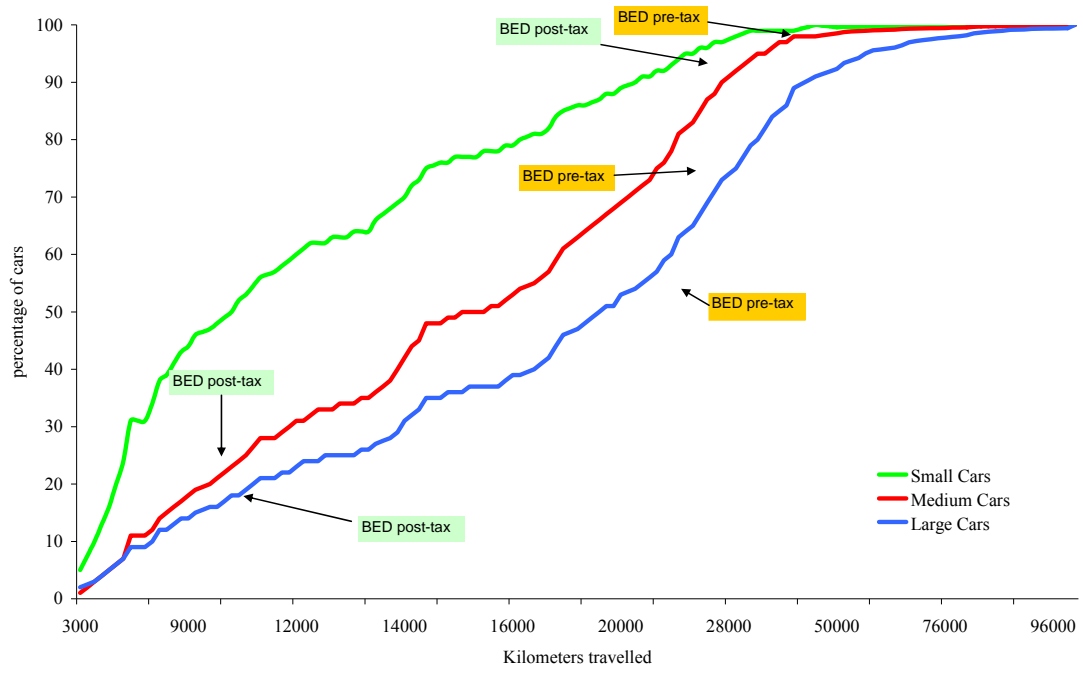


Figure 9: The effect of tax reform on break-even distance

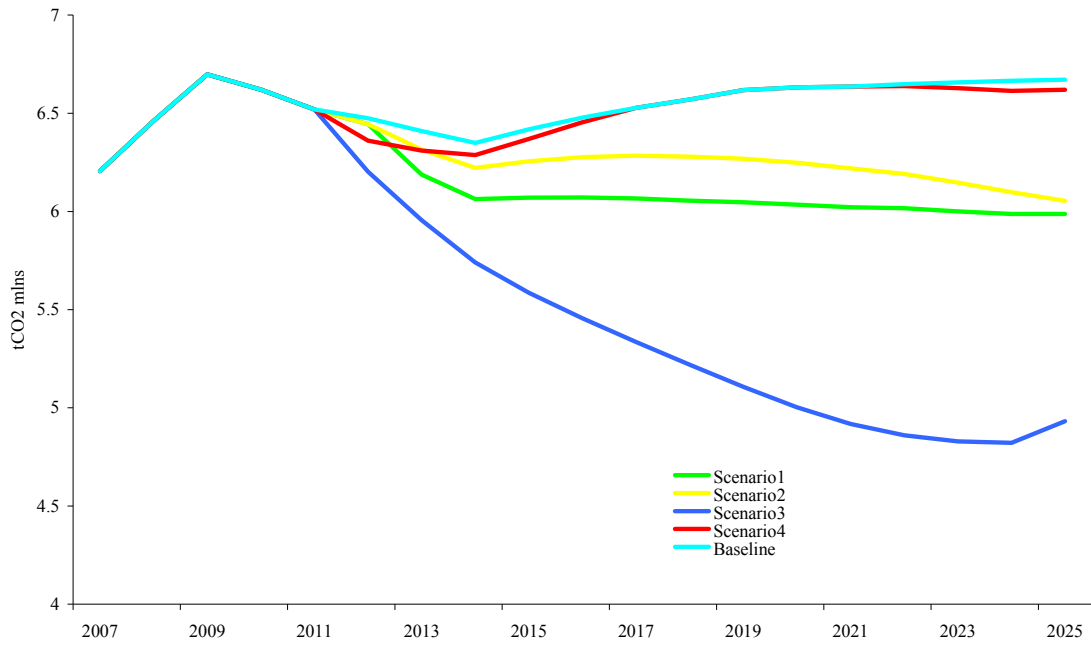


Figure 10: The effect of electric vehicles on carbon dioxide emissions

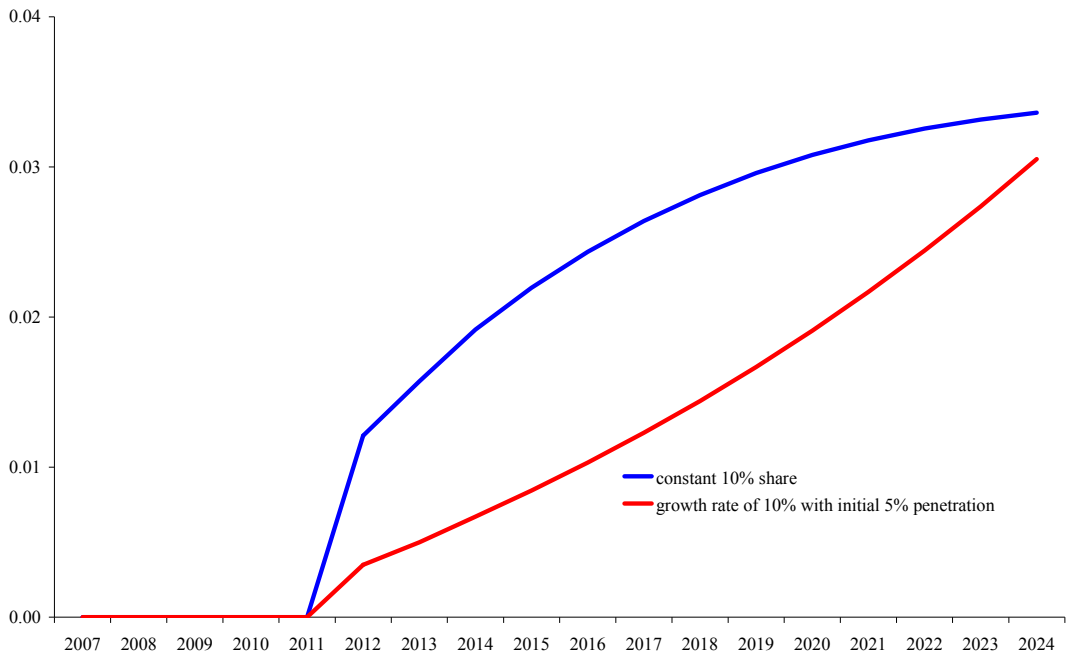


Figure 11: Shares of total private car transport emissions

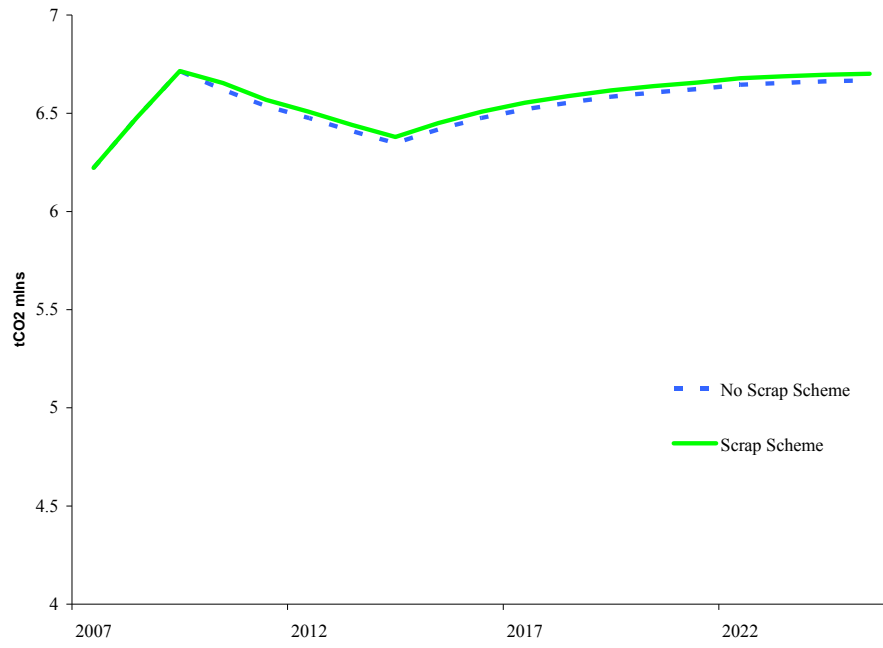


Figure 12: The effect of the scrappage scheme on carbon dioxide emissions

Year	Number	Title/Author(s) ESRI Authors/Co-authors Italicised
2010	341	National Determinants of Vegetarianism <i>Eimear Leahy, Seán Lyons and Richard S.J. Tol</i>
	340	An Estimate of the Number of Vegetarians in the World <i>Eimear Leahy, Seán Lyons and Richard S.J. Tol</i>
	339	International Migration in Ireland, 2009 <i>Philip J O'Connell and Corona Joyce</i>
	338	The Euro Through the Looking-Glass: Perceived Inflation Following the 2002 Currency Changeover <i>Pete Lunn and David Duffy</i>
	337	Returning to the Question of a Wage Premium for Returning Migrants <i>Alan Barrett and Jean Goggin</i>
2009	336	What Determines the Location Choice of Multinational Firms in the ICT Sector? <i>Julia Siedschlag, Xiaoheng Zhang, Donal Smith</i>
	335	Cost-benefit analysis of the introduction of weight-based charges for domestic waste – West Cork's experience <i>Sue Scott and Dorothy Watson</i>
	334	The Likely Economic Impact of Increasing Investment in Wind on the Island of Ireland <i>Conor Devitt, Seán Diffney, John Fitz Gerald, Seán Lyons and Laura Malaguzzi Valeri</i>
	333	Estimating Historical Landfill Quantities to Predict Methane Emissions <i>Seán Lyons, Liam Murphy and Richard S.J. Tol</i>
	332	International Climate Policy and Regional Welfare Weights <i>Daiju Narita, Richard S. J. Tol, and David Anthoff</i>
	331	A Hedonic Analysis of the Value of Parks and Green Spaces in the Dublin Area

Karen Mayor, Seán Lyons, David Duffy and Richard S.J. Tol

- 330 Measuring International Technology Spillovers and Progress Towards the European Research Area
Iulia Siedschlag
- 329 Climate Policy and Corporate Behaviour
Nicola Commins, Seán Lyons, Marc Schiffbauer, and Richard S.J. Tol
- 328 The Association Between Income Inequality and Mental Health: Social Cohesion or Social Infrastructure
Richard Layte and Bertrand Maître
- 327 A Computational Theory of Exchange: Willingness to pay, willingness to accept and the endowment effect
Pete Lunn and Mary Lunn
- 326 Fiscal Policy for Recovery
John Fitz Gerald
- 325 The EU 20/20/2020 Targets: An Overview of the EMF22 Assessment
Christoph Böhringer, Thomas F. Rutherford, and *Richard S.J. Tol*
- 324 Counting Only the Hits? The Risk of Underestimating the Costs of Stringent Climate Policy
Massimo Tavoni, *Richard S.J. Tol*
- 323 International Cooperation on Climate Change Adaptation from an Economic Perspective
Kelly C. de Bruin, Rob B. Dellink and *Richard S.J. Tol*
- 322 What Role for Property Taxes in Ireland?
T. Callan, C. Keane and J.R. Walsh
- 321 The Public-Private Sector Pay Gap in Ireland: What Lies Beneath?
Elish Kelly, Seamus McGuinness, Philip O'Connell
- 320 A Code of Practice for Grocery Goods Undertakings and An Ombudsman: How to Do a Lot of Harm by Trying to Do a Little Good

Paul K Gorecki

- 319 Negative Equity in the Irish Housing Market
David Duffy
- 318 Estimating the Impact of Immigration on Wages in Ireland
Alan Barrett, Adele Bergin and Elish Kelly
- 317 Assessing the Impact of Wage Bargaining and Worker Preferences on the Gender Pay Gap in Ireland Using the National Employment Survey 2003
Seamus McGuinness, Elish Kelly, Philip O'Connell, Tim Callan
- 316 Mismatch in the Graduate Labour Market Among Immigrants and Second-Generation Ethnic Minority Groups
Delma Byrne and Seamus McGuinness
- 315 Managing Housing Bubbles in Regional Economies under EMU: Ireland and Spain
Thomas Conefrey and John Fitz Gerald
- 314 Job Mismatches and Labour Market Outcomes
Kostas Mavromaras, *Seamus McGuinness*, Nigel O'Leary, Peter Sloane and Yin King Fok
- 313 Immigrants and Employer-provided Training
Alan Barrett, Séamus McGuinness, Martin O'Brien and *Philip O'Connell*
- 312 Did the Celtic Tiger Decrease Socio-Economic Differentials in Perinatal Mortality in Ireland?
Richard Layte and Barbara Clyne
- 311 Exploring International Differences in Rates of Return to Education: Evidence from EU SILC
Maria A. Davia, *Seamus McGuinness* and *Philip, J. O'Connell*
- 310 Car Ownership and Mode of Transport to Work in Ireland
Nicola Commins and Anne Nolan
- 309 Recent Trends in the Caesarean Section Rate in Ireland 1999-2006

Aoife Brick and Richard Layte

- 308 Price Inflation and Income Distribution
Anne Jennings, Seán Lyons and Richard S.J. Tol
- 307 Overskilling Dynamics and Education Pathways
Kostas Mavromaras, *Seamus McGuinness*, Yin King
Fok
- 306 What Determines the Attractiveness of the
European Union to the Location of R&D
Multinational Firms?
Iulia Siedschlag, Donal Smith, Camelia Turcu,
Xiaoheng Zhang
- 305 Do Foreign Mergers and Acquisitions Boost Firm
Productivity?
Marc Schiffbauer, Iulia Siedschlag, Frances Ruane
- 304 Inclusion or Diversion in Higher Education in the
Republic of Ireland?
Delma Byrne
- 303 Welfare Regime and Social Class Variation in
Poverty and Economic Vulnerability in Europe: An
Analysis of EU-SILC
Christopher T. Whelan and *Bertrand Maitre*
- 302 Understanding the Socio-Economic Distribution and
Consequences of Patterns of Multiple Deprivation:
An Application of Self-Organising Maps
Christopher T. Whelan, Mario Lucchini, Maurizio
Pisati and *Bertrand Maitre*
- 301 Estimating the Impact of Metro North
Edgar Morgenroth
- 300 Explaining Structural Change in Cardiovascular
Mortality in Ireland 1995-2005: A Time Series
Analysis
Richard Layte, Sinead O'Hara and Kathleen Bennett
- 299 EU Climate Change Policy 2013-2020: Using the
Clean Development Mechanism More Effectively
Paul K Gorecki, Seán Lyons and Richard S.J. Tol
- 298 Irish Public Capital Spending in a Recession
Edgar Morgenroth

- 297 Exporting and Ownership Contributions to Irish Manufacturing Productivity Growth
Anne Marie Gleeson, Frances Ruane
- 296 Eligibility for Free Primary Care and Avoidable Hospitalisations in Ireland
Anne Nolan
- 295 Managing Household Waste in Ireland: Behavioural Parameters and Policy Options
John Curtis, Seán Lyons and Abigail O'Callaghan-Platt
- 294 Labour Market Mismatch Among UK Graduates; An Analysis Using REFLEX Data
Seamus McGuinness and Peter J. Sloane
- 293 Towards Regional Environmental Accounts for Ireland
Richard S.J. Tol, Nicola Commins, Niamh Crilly, Sean Lyons and Edgar Morgenroth
- 292 EU Climate Change Policy 2013-2020: Thoughts on Property Rights and Market Choices
Paul K. Gorecki, Sean Lyons and Richard S.J. Tol
- 291 Measuring House Price Change
David Duffy
- 290 Intra-and Extra-Union Flexibility in Meeting the European Union's Emission Reduction Targets
Richard S.J. Tol
- 289 The Determinants and Effects of Training at Work: Bringing the Workplace Back In
Philip J. O'Connell and Delma Byrne
- 288 Climate Feedbacks on the Terrestrial Biosphere and the Economics of Climate Policy: An Application of *FUND*
Richard S.J. Tol
- 287 The Behaviour of the Irish Economy: Insights from the HERMES macro-economic model
Adele Bergin, Thomas Conefrey, John FitzGerald and Ide Kearney

- 286 Mapping Patterns of Multiple Deprivation Using Self-Organising Maps: An Application to EU-SILC Data for Ireland
Maurizio Pisati, *Christopher T. Whelan*, Mario Lucchini and *Bertrand Maitre*
- 285 The Feasibility of Low Concentration Targets: An Application of FUND
Richard S.J. Tol
- 284 Policy Options to Reduce Ireland's GHG Emissions Instrument choice: the pros and cons of alternative policy instruments
Thomas Legge and *Sue Scott*
- 283 Accounting for Taste: An Examination of Socioeconomic Gradients in Attendance at Arts Events
Pete Lunn and *Elish Kelly*
- 282 The Economic Impact of Ocean Acidification on Coral Reefs
Luke M. Brander, Katrin Rehdanz, *Richard S.J. Tol*, and Pieter J.H. van Beukering
- 281 Assessing the impact of biodiversity on tourism flows: A model for tourist behaviour and its policy implications
Giulia Macagno, Maria Loureiro, Paulo A.L.D. Nunes and *Richard S.J. Tol*
- 280 Advertising to boost energy efficiency: the Power of One campaign and natural gas consumption
Seán Diffney, *Seán Lyons* and *Laura Malaguzzi Valeri*
- 279 International Transmission of Business Cycles Between Ireland and its Trading Partners
Jean Goggin and *Iulia Siedschlag*
- 278 Optimal Global Dynamic Carbon Taxation
David Anthoff
- 277 Energy Use and Appliance Ownership in Ireland
Eimear Leahy and *Seán Lyons*

- 276 Discounting for Climate Change
David Anthoff, Richard S.J. Tol and Gary W. Yohe
- 275 Projecting the Future Numbers of Migrant Workers
in the Health and Social Care Sectors in Ireland
Alan Barrett and Anna Rust
- 274 Economic Costs of Extratropical Storms under
Climate Change: An application of FUND
Daiju Narita, Richard S.J. Tol, David Anthoff
- 273 The Macro-Economic Impact of Changing the Rate
of Corporation Tax
Thomas Conefrey and John D. Fitz Gerald
- 272 The Games We Used to Play
An Application of Survival Analysis to the Sporting
Life-course
Pete Lunn
- 2008**
- 271 Exploring the Economic Geography of Ireland
Edgar Morgenroth
- 270 Benchmarking, Social Partnership and Higher
Remuneration: Wage Settling Institutions and the
Public-Private Sector Wage Gap in Ireland
Elish Kelly, Seamus McGuinness, Philip O'Connell
- 269 A Dynamic Analysis of Household Car Ownership in
Ireland
Anne Nolan
- 268 The Determinants of Mode of Transport to Work in
the Greater Dublin Area
Nicola Commins and Anne Nolan
- 267 Resonances from *Economic Development* for
Current Economic Policymaking
Frances Ruane
- 266 The Impact of Wage Bargaining Regime on Firm-
Level Competitiveness and Wage Inequality: The
Case of Ireland
Seamus McGuinness, Elish Kelly and Philip O'Connell
- 265 Poverty in Ireland in Comparative European
Perspective

Christopher T. Whelan and Bertrand Maitre

- 264 A Hedonic Analysis of the Value of Rail Transport in the Greater Dublin Area
Karen Mayor, Seán Lyons, David Duffy and Richard S.J. Tol
- 263 Comparing Poverty Indicators in an Enlarged EU
Christopher T. Whelan and Bertrand Maitre
- 262 Fuel Poverty in Ireland: Extent, Affected Groups and Policy Issues
Sue Scott, Seán Lyons, Claire Keane, Donal McCarthy and Richard S.J. Tol
- 261 The Misperception of Inflation by Irish Consumers
David Duffy and Pete Lunn
- 260 The Direct Impact of Climate Change on Regional Labour Productivity
Tord Kjellstrom, R Sari Kovats, Simon J. Lloyd, Tom Holt, *Richard S.J. Tol*
- 259 Damage Costs of Climate Change through Intensification of Tropical Cyclone Activities: An Application of FUND
Daiju Narita, *Richard S. J. Tol* and *David Anthoff*
- 258 Are Over-educated People Insiders or Outsiders? A Case of Job Search Methods and Over-education in UK
Aleksander Kucel, Delma Byrne
- 257 Metrics for Aggregating the Climate Effect of Different Emissions: A Unifying Framework
Richard S.J. Tol, Terje K. Berntsen, Brian C. O'Neill, Jan S. Fuglestedt, Keith P. Shine, Yves Balkanski and Laszlo Makra
- 256 Intra-Union Flexibility of Non-ETS Emission Reduction Obligations in the European Union
Richard S.J. Tol
- 255 The Economic Impact of Climate Change
Richard S.J. Tol
- 254 Measuring International Inequity Aversion
Richard S.J. Tol

- 253 Using a Census to Assess the Reliability of a National Household Survey for Migration Research: The Case of Ireland
Alan Barrett and Elish Kelly
- 252 Risk Aversion, Time Preference, and the Social Cost of Carbon
David Anthoff, Richard S.J. Tol and Gary W. Yohe
- 251 The Impact of a Carbon Tax on Economic Growth and Carbon Dioxide Emissions in Ireland
Thomas Conefrey, John D. Fitz Gerald, Laura Malaguzzi Valeri and Richard S.J. Tol
- 250 The Distributional Implications of a Carbon Tax in Ireland
Tim Callan, Sean Lyons, Susan Scott, Richard S.J. Tol and Stefano Verde
- 249 Measuring Material Deprivation in the Enlarged EU
Christopher T. Whelan, Brian Nolan and Bertrand Maitre
- 248 Marginal Abatement Costs on Carbon-Dioxide Emissions: A Meta-Analysis
Onno Kuik, Luke Brander and Richard S.J. Tol
- 247 Incorporating GHG Emission Costs in the Economic Appraisal of Projects Supported by State Development Agencies
Richard S.J. Tol and Seán Lyons
- 246 A Carbon Tax for Ireland
Richard S.J. Tol, Tim Callan, Thomas Conefrey, John D. Fitz Gerald, Seán Lyons, Laura Malaguzzi Valeri and Susan Scott
- 245 Non-cash Benefits and the Distribution of Economic Welfare
Tim Callan and Claire Keane
- 244 Scenarios of Carbon Dioxide Emissions from Aviation
Karen Mayor and Richard S.J. Tol
- 243 The Effect of the Euro on Export Patterns: Empirical Evidence from Industry Data
Gavin Murphy and Iulia Siedschlag

- 242 The Economic Returns to Field of Study and Competencies Among Higher Education Graduates in Ireland
Elish Kelly, Philip O'Connell and Emer Smyth
- 241 European Climate Policy and Aviation Emissions
Karen Mayor and Richard S.J. Tol
- 240 Aviation and the Environment in the Context of the EU-US Open Skies Agreement
Karen Mayor and Richard S.J. Tol
- 239 Yuppie Kvetch? Work-life Conflict and Social Class in Western Europe
Frances McGinnity and Emma Calvert
- 238 Immigrants and Welfare Programmes: Exploring the Interactions between Immigrant Characteristics, Immigrant Welfare Dependence and Welfare Policy
Alan Barrett and Yvonne McCarthy
- 237 How Local is Hospital Treatment? An Exploratory Analysis of Public/Private Variation in Location of Treatment in Irish Acute Public Hospitals
Jacqueline O'Reilly and Miriam M. Wiley
- 236 The Immigrant Earnings Disadvantage Across the Earnings and Skills Distributions: The Case of Immigrants from the EU's New Member States in Ireland
Alan Barrett, Seamus McGuinness and Martin O'Brien
- 235 Europeanisation of Inequality and European Reference Groups
Christopher T. Whelan and Bertrand Maitre
- 234 Managing Capital Flows: Experiences from Central and Eastern Europe
Jürgen von Hagen and *Iulia Siedschlag*
- 233 ICT Diffusion, Innovation Systems, Globalisation and Regional Economic Dynamics: Theory and Empirical Evidence
Charlie Karlsson, Gunther Maier, Michaela Trippl, *Iulia Siedschlag*, Robert Owen and *Gavin Murphy*
- 232 Welfare and Competition Effects of Electricity

		Interconnection between Great Britain and Ireland <i>Laura Malaguzzi Valeri</i>
231		Is FDI into China Crowding Out the FDI into the European Union? Laura Resmini and <i>Iulia Siedschlag</i>
230		Estimating the Economic Cost of Disability in Ireland John Cullinan, Brenda Gannon and <i>Seán Lyons</i>
229		Controlling the Cost of Controlling the Climate: The Irish Government's Climate Change Strategy Colm McCarthy, <i>Sue Scott</i>
228		The Impact of Climate Change on the Balanced-Growth-Equivalent: An Application of <i>FUND</i> <i>David Anthoff, Richard S.J. Tol</i>
227		Changing Returns to Education During a Boom? The Case of Ireland <i>Seamus McGuinness, Frances McGinnity, Philip O'Connell</i>
226		'New' and 'Old' Social Risks: Life Cycle and Social Class Perspectives on Social Exclusion in Ireland <i>Christopher T. Whelan and Bertrand Maitre</i>
225		The Climate Preferences of Irish Tourists by Purpose of Travel <i>Seán Lyons, Karen Mayor and Richard S.J. Tol</i>
224		A Hirsch Measure for the Quality of Research Supervision, and an Illustration with Trade Economists <i>Frances P. Ruane and Richard S.J. Tol</i>
223		Environmental Accounts for the Republic of Ireland: 1990-2005 <i>Seán Lyons, Karen Mayor and Richard S.J. Tol</i>
2007	222	Assessing Vulnerability of Selected Sectors under Environmental Tax Reform: The issue of pricing power <i>J. Fitz Gerald, M. Keeney and S. Scott</i>
	221	Climate Policy Versus Development Aid <i>Richard S.J. Tol</i>

- 220 Exports and Productivity – Comparable Evidence for 14 Countries
The International Study Group on Exports and Productivity
- 219 Energy-Using Appliances and Energy-Saving Features: Determinants of Ownership in Ireland
Joe O'Doherty, *Seán Lyons* and *Richard S.J. Tol*
- 218 The Public/Private Mix in Irish Acute Public Hospitals: Trends and Implications
Jacqueline O'Reilly and *Miriam M. Wiley*
- 217 Regret About the Timing of First Sexual Intercourse: The Role of Age and Context
Richard Layte, Hannah McGee
- 216 Determinants of Water Connection Type and Ownership of Water-Using Appliances in Ireland
Joe O'Doherty, *Seán Lyons* and *Richard S.J. Tol*
- 215 Unemployment – Stage or Stigma? Being Unemployed During an Economic Boom
Emer Smyth
- 214 The Value of Lost Load
Richard S.J. Tol
- 213 Adolescents' Educational Attainment and School Experiences in Contemporary Ireland
Merike Darmody, *Selina McCoy*, *Emer Smyth*
- 212 Acting Up or Opting Out? Truancy in Irish Secondary Schools
Merike Darmody, *Emer Smyth* and *Selina McCoy*
- 211 Where do MNEs Expand Production: Location Choices of the Pharmaceutical Industry in Europe after 1992
Frances P. Ruane, Xiaoheng Zhang
- 210 Holiday Destinations: Understanding the Travel Choices of Irish Tourists
Seán Lyons, *Karen Mayor* and *Richard S.J. Tol*
- 209 The Effectiveness of Competition Policy and the Price-Cost Margin: Evidence from Panel Data
Patrick McCloughan, *Seán Lyons* and William Batt

208

Tax Structure and Female Labour Market
Participation: Evidence from Ireland
Tim Callan, A. Van Soest, J.R. Walsh