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Examining the impact of carbon price changes under a personalised carbon trading scheme for transport

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ABSTRACT

The research presented in this paper investigates the welfare effects of a Personal Carbon Trading Scheme (PCTS). A consumer surplus analysis is used to determine the welfare loss to individuals who undertake travel-to-work trips in the Dublin and the Western Border Region (WBR) of Ireland. Three CO_2 price scenarios are analysed: a low, medium and high carbon price. These results are compared at an aggregate level for each electoral division to existing measures of deprivation derived from the Census 2006 to determine if electoral wards designated as relatively deprived also incur the largest welfare losses. The results are also compared to the density of population in each electoral division to investigate any link between density levels and welfare changes, particularly in rural regions.

The welfare model found a significant divergence in the changes in consumer surplus between both the study regions. While welfare changes were minimal in the low price scenario, divergences occurred in the medium and high price scenarios as individuals using more sustainable modes in urban areas benefited from the higher market price. Large welfare losses were found in the more rural WBR whilst most areas in Dublin were found to experience a welfare gain.

1. Carbon reduction policies

In Ireland, the transport sector has become one of the major sources of green house gas emissions growth in recent years. In 2009 transport emissions accounted for 21.1% of Ireland's green house gases (EPA, 2010). This was a 176% increase on 1990 levels, second only to Cyprus amongst the 27 EU countries. Road transport emissions accounted for 97% of transport emissions. Evidently, significant reductions of road transport emissions, as part of overall GHG emissions is required in meeting Ireland's Kyoto targets. A number of supply-side and demand-side policies have been advocated to reduce CO_2 emissions. Research has mainly focused on fiscal measures such the carbon taxation. These measures will be discussed in the following sections.

In 2010, a carbon tax on fuel and gas was introduced in Ireland. This tax was levied on transport and home heating fuels as well as natural gas. It currently stands at €15 per tonne of CO_2. The idea of reducing CO_2 emissions by imposing a tax is not a new concept. The idea of negating an externality using taxation was first suggested by Pigou (1952). Pigou (1952) argued that the agents who create the benefits or costs in an economy do not always have to bear the outcomes. A tax would internalise any negative outcomes while incentivising agents to reduce activities which would incur a tax. This type of tax is known as a Pigouvian tax. Using a Pigouvian type tax to reduce CO_2 has become a popular policy tool subsequent to the signing of the Kyoto protocol in 1997. This treaty provided flexibility to implement a number of policies to share the burden of reduction amongst nation such as trading schemes. While the EU created the Emissions Trading Scheme to provide a pan-European mechanism to reduce CO_2, many countries have implemented carbon taxes within each state as the primary policy tool for reduction. One of the reasons for the popularity of taxation is the relative simplicity of levying a tax as opposed to designing and implementing a complex trading scheme. To date all of Norway, Sweden, Finland, Switzerland, Netherlands and Ireland have implemented various forms of carbon related taxation.

Early studies investigating measures to mitigate climate change have advocated the use of carbon taxation as a means of reducing CO_2 (Symons et al., 1994; Baumol, 1972; Pearce, 1991). Baumol (1972) built on the work of Pigou in investigating the effectiveness of Pigouvian type taxes in reducing emissions. This approach also advocated using subsidies as a supplementary measure to incentivise polluters to reduce their emissions. Baumol (1972) suggested a persuasive case could be made for the use of taxation, although in reality the environmental outcomes would be less optimal than predicted. Pearce (1991) and Symons et al. (1994) both studied the

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potential effects of a carbon tax levied across the UK economy. Their conclusions endorsed the view that carbon taxes can effectively reduce emissions at a minimum cost to the economy. Another benefit cited is the 'double dividend' effect (Goulder, 1995). This is the concept that the tax will reduce emissions while substituting for revenues from so-called 'good' sources such as income tax.

Sovacool (2010) conducted a study of carbon taxation while comparing it to carbon trading in the USA. This article advocates using carbon taxes over other mechanisms such as carbon trading due to the price stability it provides, net benefits up to 16 times greater than other schemes, simplicity of implementation and a minimisation of transaction costs.

While the majority of research to date has focused on potential emissions reductions, recent studies have investigated equity. Ekins and Dresner (2004) modelled the equity effects of a carbon tax in the UK. The findings emphasise the importance of compensating the lowest income earners, who were found to be the largest net losers in the event of taxation being introduced. Despite including for measures to compensate low-income individuals in their model, some low-earners still remained the largest net losers. Callen et al. (2009) also studied the equity effects of a carbon tax in Ireland concluding that a tax would be regressive, costing the poorest households €3 euro per week while only costing the richest €4 per week. Compensation through social welfare payments was cited as a mechanism of redress; however, this would seem an unlikely course of action in the current economic climate.

Public Acceptability of carbon taxation has also been researched in recent years (Agrawal et al., 2010; Bristow et al., 2010). Agrawal et al. (2010) found that up to 50% would support some form of environmental taxation. Individuals with pro-environment or pro-government attitudes tended to be most likely to support these measures. This is a very high acceptance rate, taking into account most individual's aversion to new forms of taxation. In Britain, Bristow et al. (2010) carried out similar research to determine societal attitudes towards carbon taxation. This paper used a stated preference model to determine individual's attitudes to carbon taxation and carbon trading. This study predicted up to 70% acceptability of taxation under a number conditions. Acceptability of carbon taxation falls to under 50% when the proceeds of the tax are not explicitly stated by the Government. In contrast, acceptability of carbon trading was found to be as high as 80% is some cases in this study.

While some authors suggest that carbon taxes are the most efficient means of reducing emissions, the common thread from the literature reviewed in this section is one of a justification for taxation based on grounds of efficiency and cost effectiveness. However, research has shown that a flat carbon tax is an inherently regressive measure without compensatory mechanisms for lower income groups. Moreover, the environmental dividend is ambiguous. The research presented in this paper adds to the body of work in this area by examining the impacts that a carbon trading scheme would have and demonstrates the large urban/rural divide if such a policy were implemented.

2. Data source and study areas

The primary data used in this research are taken from a subset of the Census of Population, 2006, which tabulates 1,834,472 individual travel-to-work trips of persons over the age of 15 and working for payment or profit and includes 32 separate variables detailing a number of travel specific and socio-economic characteristics (CSO, 2006). The census data used in this study does not include income levels. Variables such as socio-economic group are used in this study as a proxy for income.

The two study regions are examined in this paper the WBR and the Dublin region. According to the Census of Population, 2011 the population of the Dublin region was 1,187,176 persons (CSO, 2011). The population of the WBR region was 698,971 persons in 2011. Aside from the rural-urban differential, the geographical size of each region differs significantly. Dublin is a small densely populated region with covering 921 km^2, while the rural WBR is a much larger sprawling region covering 25,700 km^2. The geographical spread of these regions is illustrated in Fig. 1. From transportation perspective the main difference between the WBR and Dublin is that 62% of those living in the WBR drive to work alone on a regular basis compared to 49% in Dublin.

3. Personal carbon trading scheme

In order to estimate the average annual emissions, the emissions per trip had to be calculated. This was estimated by multiplying the distance travelled by an emissions factor (specific to each mode) and then adjusted for vehicle occupancy. McNamara and Caulfield (2011a) describe the approach used to estimate emissions in greater detail. The PCTS follows a cap and share approach. Under this scheme the average annual emissions for individuals daily commute was calculated. This was found to be 2.5 kg of CO_2. The scheme would allocate a free quota of 2.5 kg of CO_2 for each commuting trip, and individuals that emit more that this would have to purchase a carbon quota from individuals that emit less than their own quota. This 2.5 kg of CO_2 is called the carbon cap.

The effect of imposing a cap on individuals is presented in Table 1. This shows the percentage of commuters who would fall above and below a cap in each study region. A cap based on average national emissions would leave 11.2% of commuters above the cap in Dublin, much lower than the national average of 26%. In the WBR, the cap would result in 33.5% of commuters falling above the cap. The percentage share of individuals in the WBR

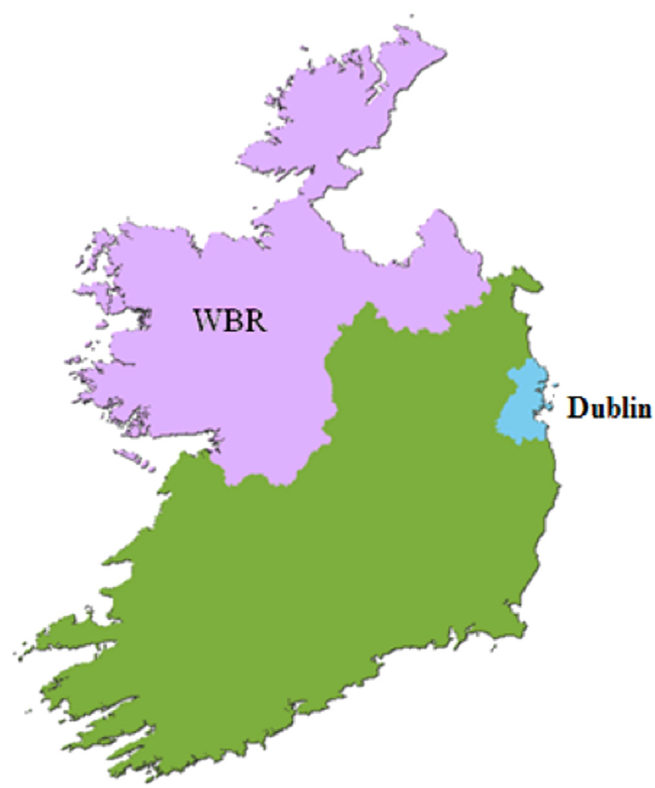

Fig. 1. Dublin and WBR regions.