www.esri.ie

Working Paper No. 357

October 2010

An Estimate of the Value of Lost Load for Ireland

Eimear Leahy and Richard S.J. Tol[a,b c]

Abstract: This paper estimates the value of short term lost load in the all island electricity market which includes the Republic of Ireland and Northern Ireland. The value of lost load, also known as the value of security of electricity supply, is inferred using a production function approach. Detailed electricity use data for the Republic of Ireland allows us to estimate the value of lost load by time of day, time of week and type of user. We find that the value of lost load is highest in the residential sector in both the Republic of Ireland and Northern Ireland. Our results can be used to advise policy decisions in the case of supply outages and to encourage optimum supply security. In the context of this study short term is taken to be a matter of hours rather than days or weeks.

Corresponding Author: eimear.leahy@esri.ie

Key words: Value of lost load; Ireland

[a] *Department of Economics, Trinity College, Dublin, Ireland*
[b] *Institute for Environmental Studies, Vrije Universiteit, Amsterdam, The Netherlands*
[c] *Department of Spatial Economics, Vrije Universiteit, Amsterdam, The Netherlands*

An Estimate of the Value of Lost Load for Ireland

1. Introduction

The value of lost load is the average willingness of electricity consumers to pay to avoid an additional period without power. In an efficient market, it should be equal to the wholesale peak price of electricity. The value of lost load would then affect decisions regarding investment in new generation capacity and closure of older, less efficient plants. Due to regulation in the Irish electricity market, customers cannot express their willingness to pay. Thus, the value of lost load has to be inferred.

It appears that peak and reserve capacity is undersupplied in Ireland (Lyons et al. 2007) and the possibility of supply shortages is real (Bazilian et al., 2006; Lyons et al., 2007; Malaguzzi Valeri and Tol, 2006), although the risk is smaller now due to the recession. As Ireland's electricity supply becomes increasingly variable, primarily because of the growing share of wind power in total power generation, capacity management and reward is extremely important. New forms of electricity demand, such as electric and hybrid vehicles, as well as increased interconnection will also lead to variability in demand and supply. An accurate and up to date assessment of the value of lost load is therefore essential to inform future planning.

This paper updates Tol (2007) which is the first and only published empirical estimate of the value of lost load for the Republic of Ireland. The main advantage of this paper is that access has now been provided to data on the time profile of electricity use per type of user in the Republic of Ireland. Whereas Tol (2007) assumed that the probability of a brown-out[1] is constant across consumer groups, we can now estimate which users would be hardest hit by such an event. We use this data to estimate the value of lost load in the Republic of Ireland between 2001 and 2008. We also estimate the value of lost load for Northern Ireland between 2000 and 2007. Thus, this paper constitutes a substantially refined estimate of the value of lost load in the all island market.

The value of lost load can be estimated in three ways. The first is that used by Beenstock et al. (1998) which relies on consumer surveys and is based on stated preferences. Since no Irish data of this kind exists, this method is unavailable to us.

[1] A brown-out is defined as a condition where the voltage supplied to the system falls below the specified operating range, but above zero volts. A black-out is a total loss of electrical power in a region.

Corwin and Miles (1978) estimated the value of lost load using cost estimates from previous supply outages. The underlying assumption is that the past and the future are similar, which is not appropriate for Ireland given the rapid economic and structural changes that have taken place. The third alternative, which is employed in this paper, is based on estimates of production functions. This approach relates electricity use to firm output, or in the case of households, the value of time spent on non paid work. Our methodology is discussed further in section 2.

In 2007 the regulatory authorities of the Single Electricity Market[2], the CER and NIAUR, set the value of lost load at €10/KWh based on the estimated peak price of planned electricity capacity (CER and NIAUR, 2007). The stated reasoning is rather unrealistic since it assumes that planned capacity will always equal desired capacity. The value has been re-estimated on an annual basis by using the previous year's value and adjusting it by applying the weighted average of the year-on-year increase in the Irish Harmonised Index of Consumer Prices (HICP) and the UK HICP.[3] Using this method the value of lost load for 2010 is €10.27/KWh (CER and NIAUR, 2009).

The paper continues as follows. Section 2 presents the data and methods and Section 3 the results. Section 4 provides a discussion and Section 5 concludes.

2. Data and Methods

We follow the methodology of de Nooij et al. (2007), Tol (2007) and de Nooij et al. (2009) and estimate the value of lost load using the production function technique. The value of lost load can be derived by dividing Gross Value Added (GVA) (in € millions) in a specific sector by the amount of electricity (in GWh) used. This will give the value per KWh that this sector generates, roughly equal to the value that would be lost in the case of a brown-out.

For Northern Ireland, we assume that each sector's production function is linear and that companies are able to shift production within the year. Thus, the time at which the brown-out occurs is not important, but of course some production will be lost due to the brown-out. This assumption is a reasonable one for most activities. Another

[2] The Single Electricity Market is a joint electricity market between the Republic of Ireland and Northern Ireland.

[3] The Irish HICP is given a weight of 2/3 and the UK HICP is given a weight of 1/3. Year on year increases are based on July estimates.

assumption is that the duration of the electricity outage does not matter. This is also reasonable as any brown-outs that could occur in Northern Ireland are likely to be for short periods. For households we define the value of lost load as the value of time spent on non paid work divided by electricity used. We assume that all activity stops when there is no electricity. Thus, an hour without electricity is an hour of time lost. This seems a generous assumption, but risk and annoyance are not taken into account. The value placed on time spent on non paid work varies with electricity use by time of day. Exelon (2007) shows that in the UK 44% of household electricity is used during the day, 35% in the evening, and 20% at night. For Northern Ireland we estimate the value of time spent at non paid work by day, evening and night for midweek days and weekend days.

Estimates of annual electricity use in Northern Ireland are taken from DECC (2008). NIAUR (2010) provides figures for household electricity use. However, estimates of electricity use in other sectors are not available. Instead, we allocate electricity use in these sectors using the appropriate UK and ROI shares. Thus, we have two estimates for the value of lost load in these sectors. GVA per sector data is taken from ONS (2009) and we convert these to constant prices (HM Treasury, 2010). Operating hours in the industrial and service sectors are taken from de Nooij et al. (2007). Estimates of the number of hours worked and average earnings are from the Annual Survey of Hours and Earnings (ASHE) 1999-2008 (ONS, 2010a). UK tax rates are taken from OECD (2009) while estimates of the number employed are taken from DETI (2010). Wages are adjusted for inflation using the Consumer Price Index for the UK (ONS, 2010b). The population of Northern Ireland is estimated by NISRA (2008).

With regard to the Republic of Ireland, ESBI (2009) has provided data on the electricity profiles of the residential, industrial and commercial sectors for each hour of 2001. We derive the proportion of electricity used by each sector at each hour and use it as a proxy for the proportion used by each sector in each hour in later years. Data on annual electricity use per sector are taken from SEAI (2009). For the industrial and commercial sectors, we estimate the annual average value of 1 KWh of electricity as before. Since we do not know the value added by the industrial and commercial sectors per day and hour, we cannot derive the value of lost load per time of day or year. However, we can estimate the total hourly value of electricity by multiplying the average value of 1 KWh of electricity by the amount of electricity used.

To evaluate lost load in the residential sector, we incorporate data from the 2005 Time Use in Ireland Survey (ESRI, 2005). Using this data we can assess the activities in which people are involved over two 24 hour periods; one midweek and the other weekend. For those who are not at home or at home but asleep, the cost of a brown-out is zero. For those who are working from home we assume that the opportunity cost of time spent on non paid work is equal to the average wage after tax. For those at home and neither working nor asleep, the opportunity cost of time spent on non paid work is equal to half of the average wage as in de Nooij et al. (2007) and Tol (2007). Thus, the opportunity cost varies throughout the day and between midweek and weekend days. As we have data on the profile of household electricity use, we can find hourly values of lost load by dividing the value of time spent on non paid work in that hour by the amount of electricity used.

Estimates of GVA per sector in constant prices are taken from CSO (2010). Population and labour force data are taken from GGDC (2010). Data on after tax non agricultural wages in constant prices[4] are taken from the ESRI databank (Bergin and FitzGerald, 2009).

There are of course limitations associated with the use of production functions to estimate the value of lost load. One drawback is that additional assumptions are required such as rationality of economic agents and divisibility of goods and services. Also, production functions are usually estimated on an annual basis and thus may not be appropriate for estimating the impact of hourly electricity interruptions. We are unable to account for restart time in businesses after an outage or annoyance in households caused by a supply interruption.

3. Results

Figure 1 shows the value of lost load in Northern Ireland if power outages had occurred in 2007. The value of electricity to the industrial and commercial sectors varies depending on whether electricity use was allocated using ROI or NI shares. The use of ROI and UK shares result is a surprisingly similar value of lost load in the industrial sector. The value of lost load in the commercial sector varies depending on whether UK or ROI shares are used. This can be attributed to the higher share of

[4] 2004=100

electricity use in the UK services sector relative to that of ROI. The value of lost load in the residential sector far outweighs that of the other sectors.

Figure 1. The Value of Lost Load in NI 2007

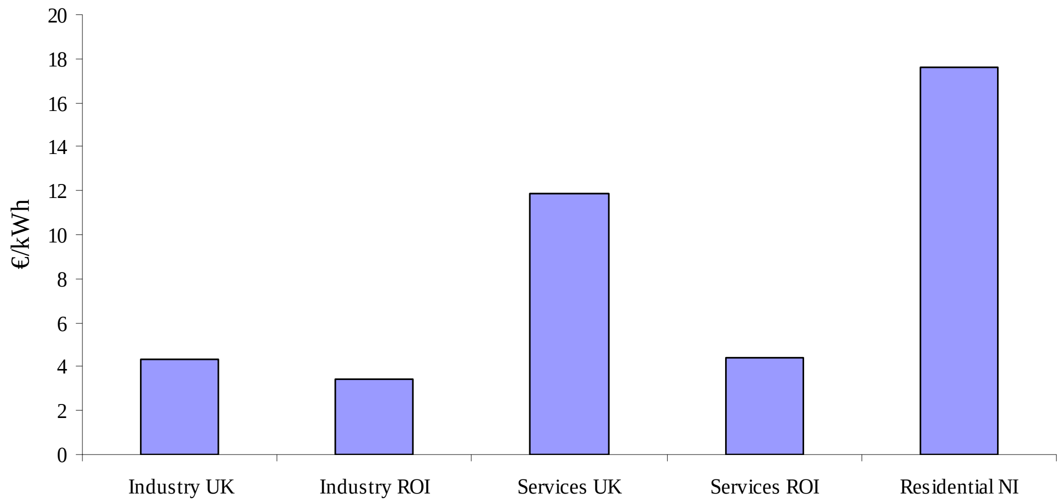
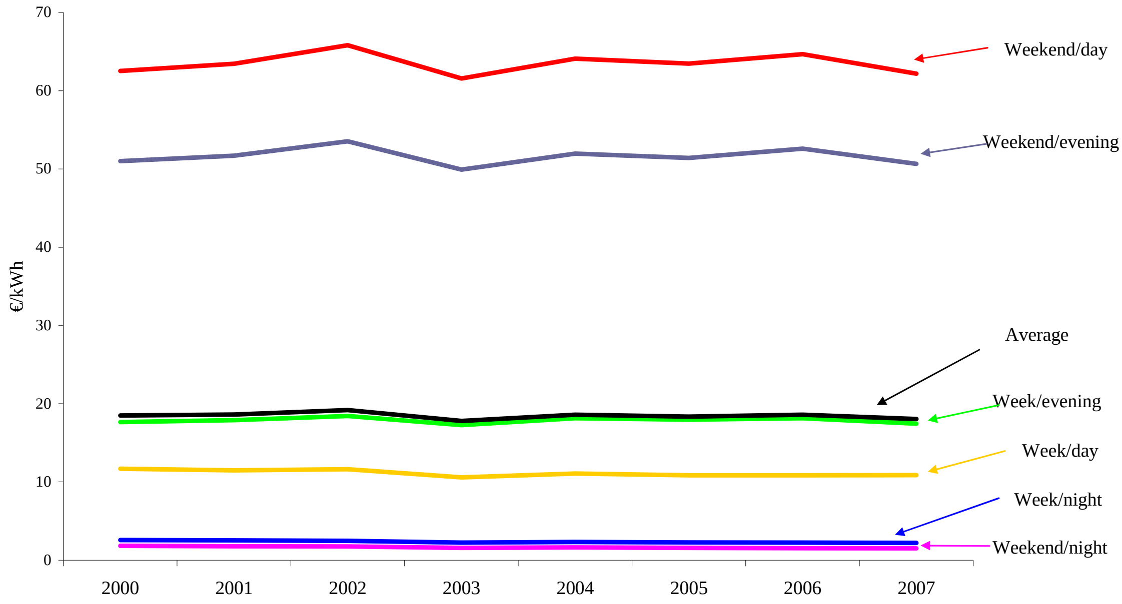


Figure 2 shows the value of lost load in Northern Ireland by time of day over the period 2000 to 2007.[5] The value differs substantially between midweek and weekend days and by time of day. The value of lost electricity to industry is highest on midweek days between the hours of 8am and 6pm. For households, the value of electricity is highest at the weekends, especially during the day. Because the value of lost load is so much greater to households than it is to industry, we see that this pattern is repeated in the average results. As expected, the loss is lowest during the night both midweek and at the weekend.

[5] We estimated these values using both ROI and NI electricity shares in the non residential sector and found that the results were very similar. This graph represents an average of the two results.

Figure 2. NI value of lost load by time of week and year (2000-2007)



With regard to the Republic of Ireland, the average value of lost load is highest in the residential sector. This happens because of the relatively high value which is placed on time spent at non paid work on both midweek and weekend days and evenings. The total value of hourly electricity is also much higher in the residential sector than it is in the industrial and commercial sectors. The total cost of a lost hour of electricity varies considerably by time of day, especially in the commercial and residential sectors.

Figure 3 shows the average value in 2008 of a lost hour to the industrial sector at different times of year. Note that figure 3 shows the value per hour rather than the value per KWh. The bars and lines represent midweek and weekend days respectively. The pattern is somewhat similar across seasons. The value of a lost hour is lowest between the hours of 16.00 and 18.00 in winter. This may be partly due to a lower demand for cooling at this time of year. The value of a lost hour is highest at 07.00 on midweek days all year round. At weekends, however, the value of a lost hour falls between 6am and 8am and between 3pm and 6pm. This pattern is repeated throughout the year. In general, the value of a lost hour is lower at weekends than it is midweek due to reduced activity on Saturdays and Sundays.

Figure 3. ROI Industry hourly value of electricity by season and time of week (2008)

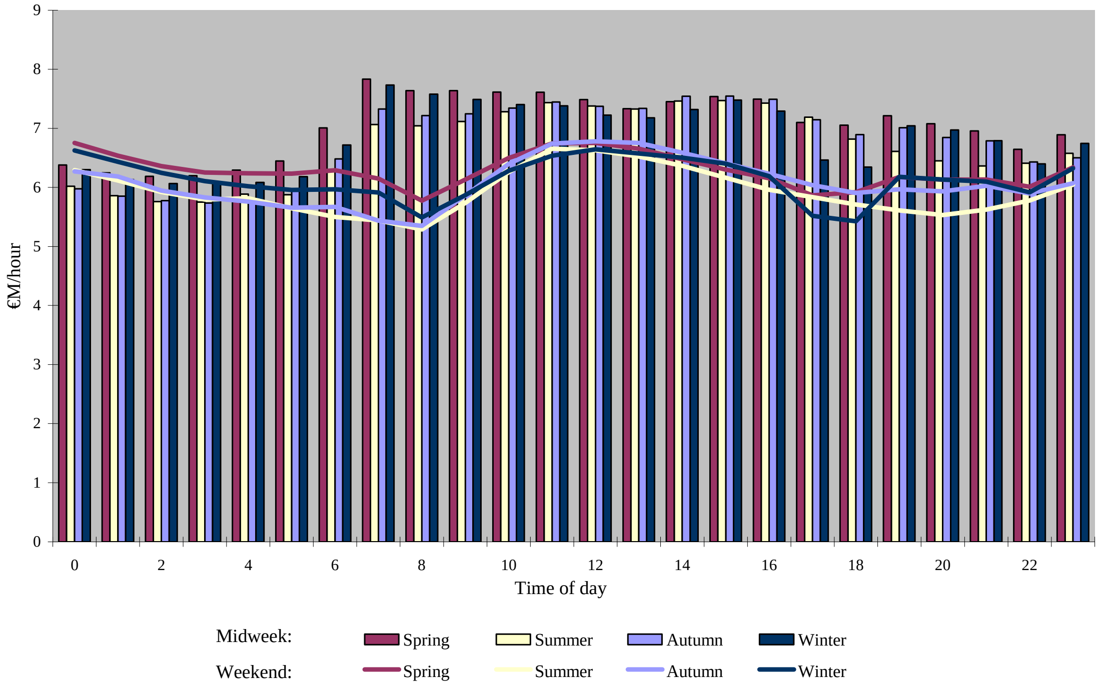


Figure 4 shows the average value in 2008 of a lost hour of electricity in the commercial sector at different times of year for midweek (represented by bars) and weekend (represented by lines) days. Again, figure 4 shows the value of electricity per hour rather than per KWh. Both midweek and weekend days follow a similar pattern. As expected, in each case, the loss is highest during standard business hours. The value can be as high as €17 million per hour. As the commercial sector represents all of the service industry and the public service, it is not surprising that the loss is lowest in summer when the demand for electricity is also low because of natural light.

Figure 4. ROI Commercial hourly value of electricity by season and time of week (2008)

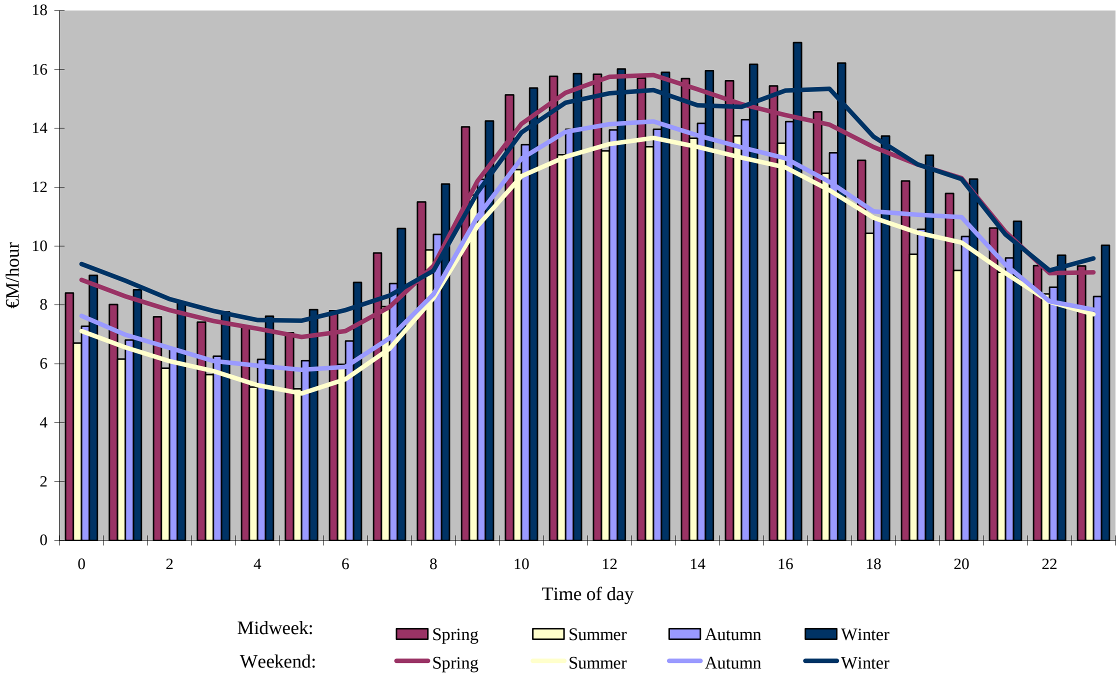


Figure 5 shows the value of a lost unit of electricity in households in 2008. Unlike figures 3 and 4, figure 5 shows the value of lost load. The bars, which represent midweek days, show that the value of lost load is low during the night and increases substantially between the hours of 5am and 7am. It then remains relatively steady until evening time, mainly driven by the fact that the value of time spent on non paid work is low and stable between 8-9am and 17-18pm when most people are at work. On midweek days, in the evening time, the value is highest in summer and lowest in winter. Although electricity use is highest in winter, electricity is valued in terms of time spent on non paid work and thus the amount people are willing to pay per unit of electricity falls.[6] However, the hourly value of electricity will remain high in winter. The continuous lines represent the value of lost load at weekends. Again, the value is lowest during the night and increases between the hours of 5am and 8am. From midday onwards, the value varies by season. At 20.00 on weekend evenings in summer, the value of lost load reaches an average of €51/KWh when most people are at home but

[6] Because the value of lost load is defined as loss of time spent on non paid work divided by electricity use, the overall value people are willing to pay for a lost unit of electricity will fall when electricity use, the denominator, increases.

not asleep. For the most part, the value of lost load on weekend days exceeds that of midweek days.

Figure 5. Household value of lost load by season and time of week in ROI (2008)

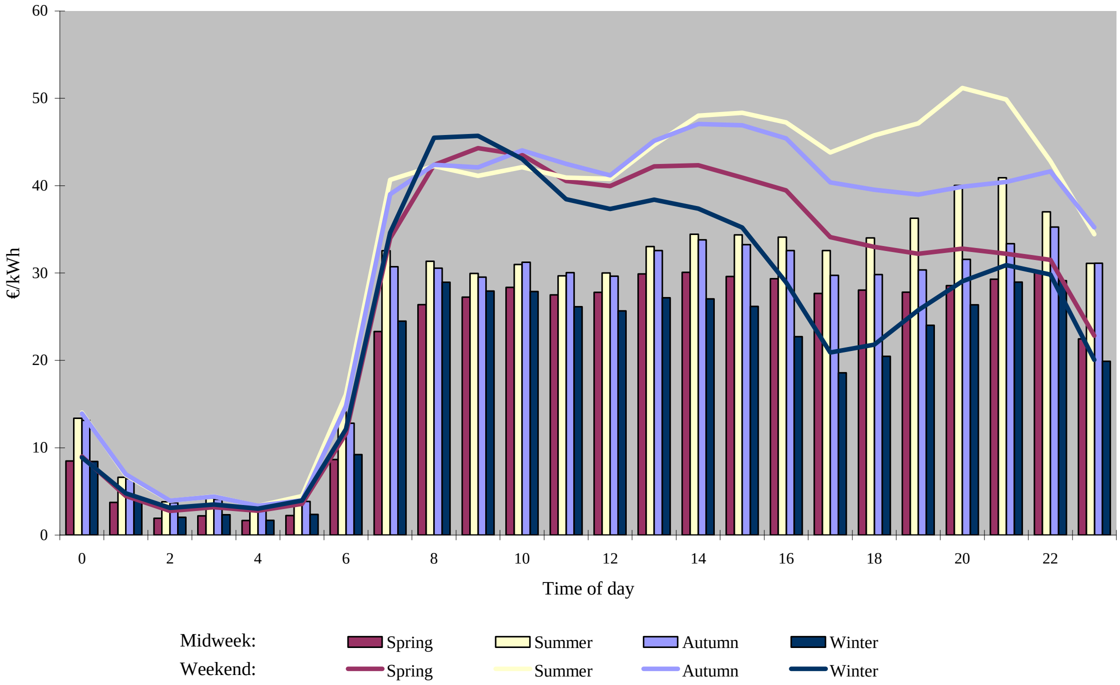
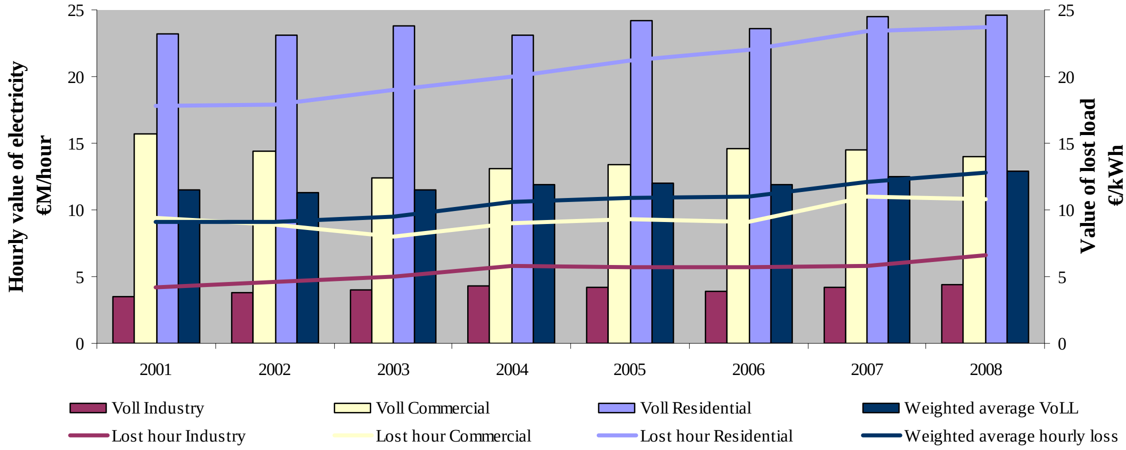


Figure 6 shows the evolution of the value of electricity over time for both the hourly value (€/hr) and the value of lost load (€/KWh). The total value of a lost hour of electricity to all three sectors (indicated by the lines on the chart) increased between 2001 and 2008. We estimate the cumulative annual growth rates in the value of a lost hour of electricity in the industrial, commercial and residential sectors as being 6.7%, 1.9% and 4.2% respectively. The bars (and secondary axis) on the chart show the average value of losing 1 KWh of electricity in each of the sectors. The residential values increased only slightly over the period (by 0.8%). This trend is largely due to the stabilisation of wage taxes and saturation of the employment ratio. The industrial value of lost load increased over the period as GVA outgrew electricity use in this sector, however, the commercial value decreased slightly.

Figure 6. Hourly value of electricity and value of lost load in ROI 2001-2008



4. Discussion

4.1. Current capacity regulations

On 1st November 2007 the trading of wholesale electricity in the Republic of Ireland and Northern Ireland began on an all-island basis. In this Single Electricity Market (SEM) all electricity generated in or imported into Ireland must be sold into a common pool and all electricity for consumption in Ireland or export to other countries must be purchased from the pool. The SEM replaces the old system in which a central planner would specify a level of capacity (for example, by estimating expected demand plus a reserve margin) thought sufficient to meet a defined standard for system reliability. The aim of the SEM is to allow market forces to ensure that adequate capacity is built in an efficient and timely manner. It is hoped that this will lower prices in the long run.

The market operates on pool arrangements whereby all suppliers pay and generators receive the same System Marginal Price.[7] Generators also receive capacity payments, which are based on annually determined fixed amounts and are ultimately paid for by consumers. The aim of such payments is to increase certainty of revenues, encourage investment and ensure that capacity is made available when it is required. The benefit for generators is that if they make plant available when capacity margins are tight, revenues can be earned which are greater than the short run costs. The level of payments is based on estimates of the tightness of the market and the cost of new

[7] The system marginal price is determined by the bid price of the marginal dispatched plant and all dispatched plants receive this price. Dispatched plants are chosen on the basis that all plants are stacked according to their bid, from the cheapest to the most expensive. The cheapest plants that are needed to match demand in each half hour are dispatched.

peaking capacity. Since this system has been implemented availability of plants has increased slightly in the Republic of Ireland.

Current dispatchable capacity stands at approximately 7,000 MW. At times of high demand, surplus capacity is currently about 800MW (Eirgrid, 2009). However, forced outages among a small number of ageing generation units could sharply increase the risk of shortages if they were to coincide with peak winter demand (Malaguzzi Valeri and Tol, 2006). Continued increases in demand (although the recession resulted in decreased demand last year) and planned retirement of old plant have increased the need for investment in new plants over the coming years. According to the energy forecasts of SEAI (Walker et al., 2009), electricity demand is set to increase by 12% between 2008 and 2020.[8] The growing importance of wind generation in the SEM suggests that the system will need more mid-merit and peaking capacity to help meet system reliability goals in future. Peaking plants can be switched on and off relatively easily due to the relatively high level of variable costs to fixed costs that they face. Thus, these plants can be used to meet fluctuating demand. Base load plants, on the other hand, face relatively high fixed costs to variable costs and so, it is most efficient to use them in a continuous way. Mid-merit plants generally produce electricity for several hours at a time but can be shut down and restarted on a daily basis.

4.2. The implications of using the estimated value of lost load

The value placed on lost load should be used to assist decisions regarding investment in new capacity and closure of older, less efficient plants in order to meet the desired supply security. Capacity management is increasingly important as electricity supply and demand become more variable. In Ireland, the growing share of wind power in total generation means that supply is already less predictable than it used to be. The expected growth in interconnection, electric and hybrid vehicles, and smart appliances will further complicate capacity management.

Our results show that the weighted average value of lost load in ROI is €12.9/KWh. This indicates that the €10/KWh set by CER & NIAUR is too low for short term loss of load (several hours). The average value of lost load in Northern Ireland in 2007 was

[8] Despite forecasted decreases in demand between 2008 and 2012, the average annual growth rate for both electricity and total energy is estimated to be 0.9% between 2008 and 2020.

€4/KWh for the industrial sector, €13/KWh for the commercial sector and €18/KWh for the residential sector. In contrast, in the Republic of Ireland in 2008, the average value of lost load was around €4/KWh for the industrial sector, €14/KWh for the commercial sector and €24.6/KWh for households. The residential value is an average, brought down by the very low values which occur during the night. It can reach values over €60/KWh, usually at weekends when most people are at home. Between the hours of 18.00 and 21.00 on midweek days, when brown-outs are most likely, hourly values of electricity are at their highest; between €41 million and €45 million. In 2008, peak electricity demand occurred at 17.00 on 15th December. At this time, the average value of lost load was €15.2/KWh but it was even higher at €35/KWh between 08.00 and 09.00 that day. Thus, the peak value of lost load and peak electricity demand do not occur simultaneously. This opens some opportunities for peak shifting to minimise the damage of brown-outs.

The estimate for Northern Ireland suffers from a lack of detailed data on residential electricity use and time use. The average VoLL we have estimated for NI may be an overestimate, as the incorporation of detailed data on residential electricity use for the Republic of Ireland has resulted in a downward revision of the weighted average value of lost load compared to that estimated by Tol (2007).

At present, during a brown-out, it is policy to shut off electricity in residential areas first, and in industrial estates later. As the value of lost load is highest in the residential sector, in both Northern Ireland and in the Republic of Ireland (during the relevant hours), this policy may be reconsidered. However, the decision as to which sector will be subject to rationing should depend on the day and time at which the shortage occurs. During the hours of 1am and 6am the value of a lost hour of electricity in the industrial and commercial sectors is much higher than it is in the residential sector.

5. Conclusion

In this paper, we use a simple version of the production function approach to estimate the short term value of lost load in Northern Ireland for the period 2000-2007 and in the Republic of Ireland for the period 2001-2008.

These results come with a number of caveats. More detailed data on electricity use per type of user in Northern Ireland would enable us to deliver more accurate results. It would be good to test the validity of our results based on the production function approach with estimates based on contingent valuation and contingent choice methods as well as with estimates based on observed black-outs. Our estimates are valid only for short interruptions of the power supply. Longer interruptions, while much more unlikely, may well be disproportionally damaging. All this is deferred to future research.

Acknowledgements

Sean Lyons, Laura Malaguzzi Valeri, Pat McCullen and Gerry White had excellent comments on an earlier version of this paper. Financial support by ESBI is gratefully acknowledged. All errors and opinions are ours.

References

Bazilian, M., O'Leary, F., O'Gallachoir, B., Howley, M., 2006. Security of Supply in Ireland. Sustainable Energy Ireland, Cork.

Beenstock, M., Goldin, E., Haitovsky, Y., 1998. Response Bias in a Conjoint Analysis of Power Outages. Energy Economics, 20, 135-156.

Bergin, A., FitzGerald, J., 2009. The ESRI Data Bank. Economic and Social Research Institute, Dublin.

CER and NIAUR, 2007. The Value of Lost Load, the Market Price Cap and the Market Price Floor -- A Response and Decision Paper. Commission for Electricity Regulation and Northern Ireland Authority for Utility Regulation, Dublin.

CER and NIAUR, 2009. The Value of Lost Load in 2010 Decision Paper. Commission for Electricity Regulation and Northern Ireland Authority for Utility Regulation, Dublin.

Corwin, J., Miles, W., 1978. Impact Assessment of the 1977 New York City Blackout. US Department of Energy, Washington, DC.

CSO, 2010. National Accounts. Central Statistics Office, http://www.cso.ie/statistics/nationalacc.htm.

de Nooij, M., Koopmans, C., Bijvoet, C., 2007. The value of supply security: The costs of power interruptions: Economic input for damage reduction and investment in networks. Energy Economics, 29, 277-295.

de Nooij, M., Lieshout, R., Koopmans, C., 2009. Optimal blackouts: Empirical results on reducing the social cost of electricity outages through efficient regional rationing. Energy Economics, 31, 342-347.

DECC, 2008. Sub National Electricity Figures. Department of Energy and Climate Change, http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx.

DETI, 2010. Employment Statistics. Department of Enterprise, Trade and Investment, http://www.detini.gov.uk/deti-stats-index/stats-labour-market/stats-labour-market-employment.htm.

Eirgrid, 2009. Generation Adequacy Report 2010-2016. Eirgrid, http://www.eirgrid.com/media/Generation%20Adequacy%20Report%202010-2016.pdf

Elexon, 2007. Load Profiles and their Use in Electricity Settlement. Elexon, http://www.elexon.co.uk/documents/Participating_in_the_Market/Market_Guidance_-_Industry_Helpdesk_faqs/Load_Profiles.pdf.

ESBI, 2009. Electricity Profiles 2001. ESB International, www.esbi.ie.

ESRI, 2005. Irish National Time Use Survey 2005. Economic and Social Research Institute, www.esri.ie.

GGDC, 2010. Total Economy Database. Groningen Growth and Development Centre, http://www.ggdc.net.

HM Treasury, 2010. GDP Deflators. Her Majesty's Treasury, http://www.hm-treasury.gov.uk/d/gdp_deflators.xls.

Lyons, S., Fitz Gerald, J., McCarthy, D., Malaguzzi Valeri, L., Tol, R.S.J., 2007. Preserving Electricity Market Efficiency while Closing Ireland's Capacity Gap. Quarterly Economic Commentary, Autumn, 62-82.

Malaguzzi Valeri, L., Tol, R.S.J., 2006. Electricity Shortages in Ireland: Probability and Consequences. Quarterly Economic Review, Winter, 1-7.

NIAUR, 2010. Electricity. The Northern Ireland Authority for Utility Regulation, http://www.niaur.gov.uk/electricity.

NISRA, 2008. Demography. Northern Ireland Statistics and Research Agency, http://www.nisra.gov.uk/archive/demography/population/midyear/NI_Home_Pop_5yrbds(1961-2008).xls.

OECD, 2009. Taxing Wages 2008. Organisation for Economic Co-operation and Development, Paris.

ONS, 2009. NUTS1 GVA (1989-2008) Data. Office for National Statistics, http://www.statistics.gov.uk/downloads/theme_economy/CRC2008ALL.pdf.

ONS, 2010a. ASHE Results. Office for National Statistics, http://www.statistics.gov.uk/statBase/product.asp?vlnk=13101.

ONS, 2010b. Consumer Price Indices. Office for National Statistics. http://www.statistics.gov.uk/statbase/Product.asp?vlnk=868

SEAI, 2009. Energy Balance Statistics, Sustainable Energy Authority of Ireland, http://www.cso.ie/px/sei/database/SEI/Energy%20Balance%20Statistics/Energy%20Balance%20Statistics.asp

Tol, R.S.J., 2007. The Value of Lost Load, in: O'Leary, F., Bazilian, M., Howley, M., O’Gallachoir, B. (Eds.), Security of Supply in Ireland 2007 Report, Sustainable Energy Ireland, Cork, pp. 63-66.

Walker, N., Scheer, J., Clancy, M., Ó Gallachóir,B., 2009. Energy Forecasts for Ireland to 2020. Sustainable Energy Ireland, Cork.

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2010		
	356	Public Policy Towards the Sale of State Assets in Troubled Times: Lessons from the Irish Experience *Paul K. Gorecki, Sean Lyons* and *Richard S. J. Tol*
	355	The Impact of Ireland's Recession on the Labour Market Outcomes of its Immigrants *Alan Barrett* and *Elish Kelly*
	354	Research and Policy Making *Frances Ruane*
	353	Market Regulation and Competition; Law in Conflict: A View from Ireland, Implications of the Panda Judgment Philip Andrews and *Paul K Gorecki*
	352	Designing a property tax without property values: Analysis in the case of Ireland *Karen Mayor, Seán Lyons* and *Richard S.J. Tol*
	351	Civil War, Climate Change and Development: A Scenario Study for Sub-Saharan Africa *Conor Devitt* and *Richard S.J. Tol*
	350	Regulating Knowledge Monopolies: The Case of the IPCC *Richard S.J. Tol*
	349	The Impact of Tax Reform on New Car Purchases in Ireland *Hugh Hennessy* and *Richard S.J. Tol*
	348	Climate Policy under Fat-Tailed Risk: An Application of FUND *David Anthoff* and *Richard S.J. Tol*
	347	Corporate Expenditure on Environmental Protection *Stefanie A. Haller* and *Liam Murphy*
	346	Female Labour Supply and Divorce: New Evidence from Ireland Olivier Bargain, Libertad González, *Claire Keane* and Berkay Özcan
	345	A Statistical Profiling Model of Long-Term Unemployment Risk in Ireland *Philip J. O'Connell, Seamus McGuinness, Elish Kelly*
	344	The Economic Crisis, Public Sector Pay, and the Income Distribution

Tim Callan, Brian Nolan (UCD) and *John Walsh*

	343	Estimating the Impact of Access Conditions on Service Quality in Post *Gregory Swinand, Conor O'Toole* and *Seán Lyons*
	342	The Impact of Climate Policy on Private Car Ownership in Ireland *Hugh Hennessy* and *Richard S.J. Tol*
	341	National Determinants of Vegetarianism *Eimear Leahy, Seán Lyons* and *Richard S.J. Tol*
	340	An Estimate of the Number of Vegetarians in the World *Eimear Leahy, Seán Lyons* and *Richard S.J. Tol*
	339	International Migration in Ireland, 2009 *Philip J O'Connell* and *Corona Joyce*
	338	The Euro Through the Looking-Glass: Perceived Inflation Following the 2002 Currency Changeover *Pete Lunn* and *David Duffy*
	337	Returning to the Question of a Wage Premium for Returning Migrants *Alan Barrett and Jean Goggin*
2009	336	What Determines the Location Choice of Multinational Firms in the ICT Sector? *Iulia Siedschlag, Xiaoheng Zhang, Donal Smith*
	335	Cost-benefit analysis of the introduction of weight-based charges for domestic waste – West Cork's experience *Sue Scott* and *Dorothy Watson*
	334	The Likely Economic Impact of Increasing Investment in Wind on the Island of Ireland *Conor Devitt, Seán Diffney, John Fitz Gerald, Seán Lyons* and *Laura Malaguzzi Valeri*
	333	Estimating Historical Landfill Quantities to Predict Methane Emissions *Seán Lyons*, Liam Murphy and *Richard S.J. Tol*
	332	International Climate Policy and Regional Welfare Weights Daiju Narita, *Richard S. J. Tol*, and *David Anthoff*
	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, Se*án 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 Maître*

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 Maître*

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 Maître*

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 Maître*
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 Maître*
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. Fuglestvedt, 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 Maître*

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 Carton 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 Maître*

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
Laura Malaguzzi Valeri

231 Is FDI into China Crowding Out the FDI into the European Union?
Laura Resmini and *Iulia Siedschlag*

230 Estimating the Economic Cost of Disability in Ireland
John Cullinan, Brenda Gannon and *Seán Lyons*

229 Controlling the Cost of Controlling the Climate: The Irish Government's Climate Change Strategy
Colm McCarthy, *Sue Scott*

	228	The Impact of Climate Change on the Balanced-Growth-Equivalent: An Application of *FUND* *David Anthoff*, *Richard S.J. Tol*
	227	Changing Returns to Education During a Boom? The Case of Ireland *Seamus McGuinness*, *Frances McGinnity, Philip O'Connell*
	226	'New' and 'Old' Social Risks: Life Cycle and Social Class Perspectives on Social Exclusion in Ireland *Christopher T. Whelan* and *Bertrand Maître*
	225	The Climate Preferences of Irish Tourists by Purpose of Travel *Seán Lyons, Karen Mayor* and *Richard S.J. Tol*
	224	A Hirsch Measure for the Quality of Research Supervision, and an Illustration with Trade Economists *Frances P. Ruane* and *Richard S.J. Tol*
	223	Environmental Accounts for the Republic of Ireland: 1990-2005 *Seán Lyons, Karen Mayor* and *Richard S.J. Tol*
2007	222	Assessing Vulnerability of Selected Sectors under Environmental Tax Reform: The issue of pricing power *J. Fitz Gerald*, M. Keeney and *S. Scott*
	221	Climate Policy Versus Development Aid *Richard S.J. Tol*
	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*