



ESRI

www.esri.ie

Working Paper No. 301

June 2009

Estimating the Impact of Metro North

Edgar Morgenroth

Subsequently published as D. Jacobson and D. Ó Broin (eds.) [Local Dublin, Global Dublin: Public Policy in an Evolving City Region](#). Dublin: DCU Press/ Glasnevin Publishing. 2010.

Abstract: The single largest project under the Irish National Development Plan (NDP) 2007-2013, is the construction of a Metro system. Despite the fact that this is the largest project under the NDP and the government's transport strategy, Transport 21, no cost benefit analysis on the project has been published. This paper aims at addressing this lack of published analysis by considering the likely economic impact one of the Metro projects, Metro-North. In doing so the paper implements two novel methods namely the use of estimates from hedonic house price models and the results from macroeconomic studies instead of the conventional cost-benefit analysis. The two methods come up with contradictory results in that the hedonic pricing methodology would suggest that the Metro-North project should not proceed while the macroeconomic approach suggests the investment should go ahead. These results are dependent on the underlying assumptions, excluded benefits and parameters used, but given the analysis in the paper alternatives can be implemented readily.

Key Words: Metro North, impact assessment

JEL Code: H43, H54, R42, R53

Corresponding Author: edgar.morgenroth@esri.ie

ESRI working papers represent un-refereed work-in-progress by members 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.

Estimating the Impact of Metro North

1. Introduction

The single largest project under the Irish National Development Plan (NDP) 2007-2013, is the construction of a Metro system, made up principally of two metro lines – Metro-North and Metro-West along with an interconnector. Metro-North which may well be the only part of the system that will actually be built is expected to cost somewhere in the region of €3 billion and €6 billion¹. According to the Rail Procurement Agency, Metro North is going to consist of underground, surface and elevated tracks over a total length of 18 kilometres. Initially there will be 15 stops along the route with a further two to be added later. Furthermore there will be park and ride facilities enabling multimodal commutes. Metro North is expected to carry 35 million passengers per year, which is larger than the current usage of the LUAS (both lines) usage which carried 29 million passengers in 2007, with trains every 4 minutes.

Despite the significant expected expenditure, no cost benefit analysis on the project or any other evaluation has been published². This paper aims at filling the information gap by assessing the impact of Metro-North. In doing so it does not follow the conventional cost-benefit analysis (CBA) methodology but instead utilises a novel approach using the results of hedonic analysis along with the application of a macroeconomic approach. In relation to the application of the hedonic estimates the paper considers the dynamic benefits in terms of changed land use. In both cases the analysis is carried out in the context of a review of the international literature.

The usual approach to the ex-ante evaluation of a project such as Metro-North is to carry out a Cost Benefit Analysis (CBA). The usual approach in CBA is to estimate the expected change in accessibility as measured by distance or time from employment and other amenities. A given location is likely to benefit from higher accessibility after the transport investment which should thus result in a reduction of

¹ The expected cost of Metro-North has not been made public by the Rail Procurement Agency (RPA), apparently for commercial reasons so as not to give the potential bidders for the project the benefit of knowing the budget that is available for the project. While the range of costs is quite wide one would expect the project to cost closer to €3 billion than €6 billion.

² Evaluations have been carried out by the RPA but these are not publicly available.

travel time. This in turn can be translated into a monetary value by applying a cost of time. A further direct impact, which is typically considered as part of a CBA is the reduction in accidents and thus injuries and fatalities. In doing so it relies on a range of assumptions about the direct impacts on travel times, the number of travellers, the value of time and the value of prevented accidents. Furthermore, CBA analysis requires assumptions regarding the appropriate discount rate which is used to discount future benefits and costs. As such the CBA approach is more readily applied by the agencies sponsoring the investment or their consultants since they will have more detailed knowledge regarding some of these aspects.

However, the ex-post benefits of transport infrastructure have also been assessed using a number of alternative approaches. One is to consider the impact of the investment on property prices, comparing the before investment prices with the after investment prices, accounting for all other relevant factors. This methodology is attractive since it encapsulates all impacts, positive and negative, in the analysis. Another method that has been applied is the estimation of aggregate function of economic activity in response to changes in a range of inputs including infrastructure. Again this method captures a wider set of benefits than is captured by cost benefit analysis. Finally, some research has also considered the derived or dynamic benefits of transport infrastructure in terms of land-use as expressed in population and employment changes. This paper uses the results of these approaches to assess the ex-ante benefits of Metro-North.

This paper is organised as follows. The next section considers the impact of public transport infrastructure investment on population density and employment which can be considered the dynamic benefits of investment. Section three review the published literature regarding the impact of transport infrastructure on property prices and utilises this to estimate the likely impact of Metro-North on property values. Finally section four reviews the literature on the macroeconomic impact of public infrastructure investment and utilises these results in order to derive a return of the investment in Metro-north. Finally section 5 summarises the results and draws conclusions.

2. Population and Employment Density

A common argument against rail based public transport infrastructure in Ireland is that population densities are too low so that the level of usage will not justify the higher fixed costs of the rail system as opposed to a bus based system. This argument ignores the possibility that the introduction of a rail based system will in itself change the population density along the rail corridor, which constitutes a dynamic effect³. Likewise the construction of a Metro line is likely to impact on the distribution of economic activity and thus employment. These issues are considered in the this section.

Population Density

The potential impact of rail based systems on population density are at the heart of the ‘new urbanism’ movement, which argues that additional road infrastructure leads to increased use of cars and sprawl while rail leads to higher densities and more sustainability⁴. However it may also be argued that since transport costs have reduced significantly as a proportion of overall expenditure the connection between transport infrastructure and the distribution of the population has weakened. These issues are explored in a paper by Handy (2005) that reviews the existing literature. Her review concludes that light rail infrastructure can increase densities over time, but that this increase in densities is contingent on other factors also being in place. These include the implementation of supportive planning policies, underlying economic buoyancy, the complementarity of the rail system with other transport infrastructure and restrictions on parking.

Levinson (2008) considered the impact of the development of the rail system in London in the 19th and 20th Centuries on population and employment densities. By considering such a long period the paper can account for the lagged effects of infrastructure development as well as the endogeneity. In addition the paper separately considers the impact on different types of areas by classifying all areas into two categories – core and peripheral. The paper reports that rail development is a precursor to population increase but that this population increase leads to subsequent

³ These issues have been considered in Indecon (2008) but without reference to the international literature or an explicit model, but with assumptions and projections largely based on external sources, which were adopted without much questioning.

⁴ The latter is also sometimes referred to as ‘smart growth’.

additional rail investment. Thus, rail developments have led to suburbanisation with an increasing proportion of the population resident in suburban areas. This trend of suburbanisation was found to have accelerated due to the construction of the underground system. More formally a 10% increase in underground capacity (0.3 stations per km²) leads to 2.2% increase in population density. Interestingly there are spillover effects in the suburban area whereby neighbouring areas to those that have rail and underground services also experienced an increase in population density. Finally, the introduction of the underground in particular has led to significantly higher employment concentration in the core central business districts.

Another recent study which considers the impact of transport infrastructure on population and employment is that of Duranton & Turner (2008). They found that a 10% increase in a city's stock of roads leads to a 2% increase in population and employment. A 10% increase in the stock of large buses leads to a 0.8% increase in population.

Translating these estimated impacts into actual projected impacts for the Metro-North line is not straightforward since it introduces a new service rather than improving the service. It is however, not unreasonable to expect an increase in densities of 5% or 10% concentrated in the electoral districts in which the Metro line is being built. The actual (ex-post) impact will of course depend on planning decisions and the level of future development, and these factors will also determine the time horizon over which the impacts take place.

Given that the evidence suggests that impact is likely to be limited to a relatively narrow corridor around the Metro line it is necessary to consider just portions of the EDs⁵. Following the literature we allow for the highest impact of the Metro to extend 500 metres from the line in either direction, with a more modest impact for area located between 500 metres and 1,000 meters from the line. By using a spatial buffer in a GIS package it is possible to calculate the fraction of each ED that is within this

⁵ It is important to keep in mind that Metro-North is at this point not part of complete system of underground lines and the public transport system in Dublin is not well integrated so that Metro-North should be considered more as a stand alone project than a part of a larger network. In time the integration with a range of transport modes with in the Dublin area may improve in which case the benefits are likely to greater.

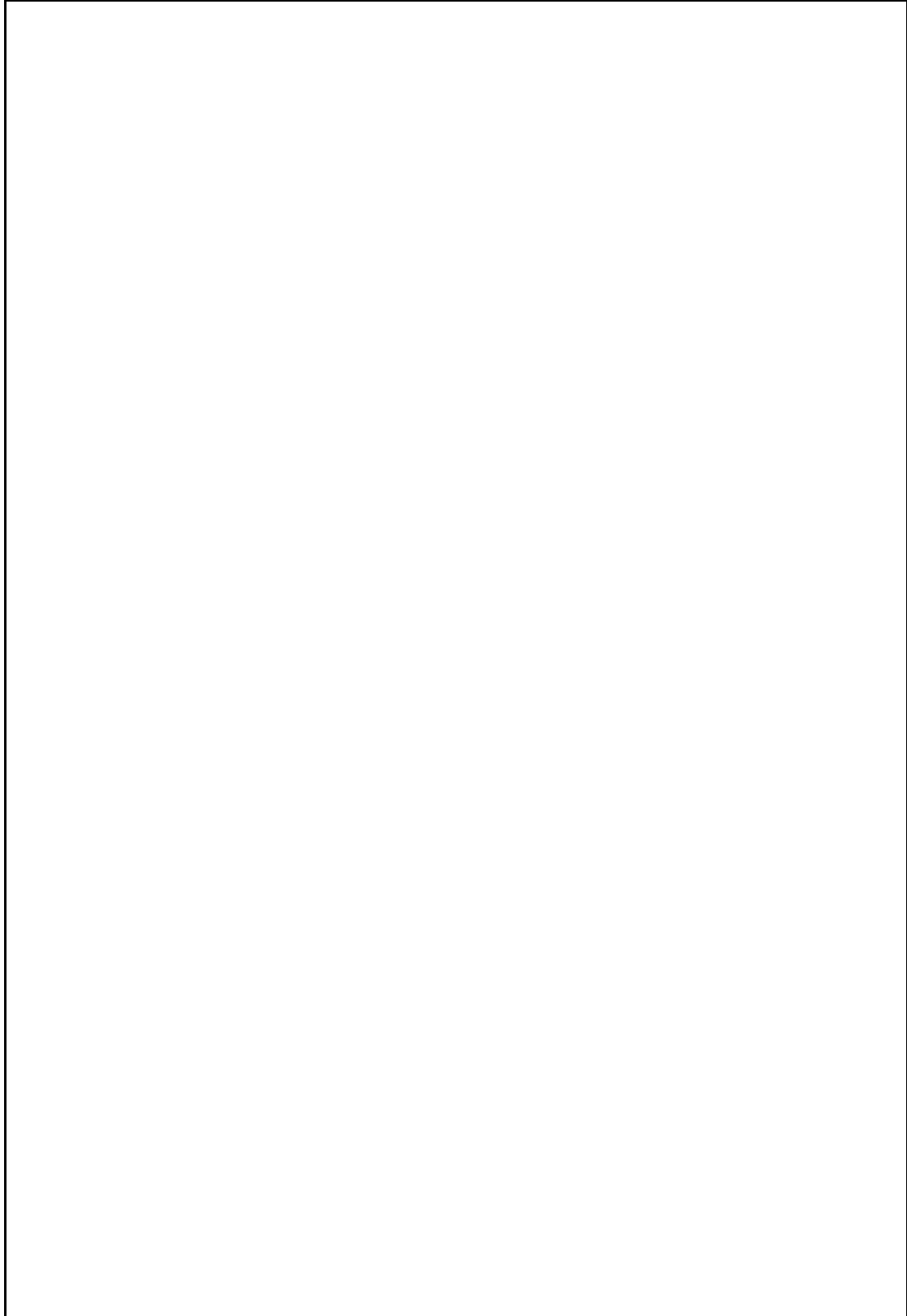
500 metre buffer and beyond that in the 500 to 1,000 meter buffer. Secondly, since the impacts are more likely to accrue only to properties located closer to Metro stations rather than the line per se we also apply buffers around the stations. Again it is possible to derive buffers for this and use them to calculate the impact. The Metro line along with the stations and buffers is shown in Map 1. The Map shows the difference between the two approaches to buffering for the 500 meter buffers, with the station buffer covering a smaller area than the line buffer.

If one assumes that the population is spread evenly within each electoral division (ED) it is straightforward to calculate the population contained within the buffers, and it is then also simple to calculate the impact of the assumed 5% and 10% increases of the population. Subject to the validity of the assumptions, in 2006 some 59,000 and 45,000 persons resided in the line buffer and station buffer respectively. Along the line buffer the population would increase by 3,000 or 6,000 respectively for the 5% or 10% assumed increase, while along the station buffer the respective increase is 2,200 and 4,400. For the 500 to 1,000 meter buffers we assume 2.5% and 5% increase respectively, which yields approximately 1,500, 3,000, 1,700 or 3,400 additional persons.

One important point to note is that the projected impact of Metro-North outlined above does not include the natural increase in the population. While Fingal experienced very rapid population growth during the period 2002 to 2006, Dublin County Borough experienced only very modest growth. This reflects the nature of current land-use, where development land had been available in Fingal but not in Dublin County Borough. Going forward the likely population growth is somewhat uncertain. While it is still likely that the trend growth in Dublin County Borough will continue at low rates, the previous high growth in Fingal may not be replicated in the short- to medium-term. This will be due to the likely effects of the economic downturn which is likely to turn net immigration into net emigration and since it will take some time before the internal migration pattern returns to the traditional pattern of migration towards the large cities and particularly Dublin. This could leave Dublin in a situation with rapidly falling population share, and thus impact on the population growth in Fingal. In the absence of firm predictions of these patterns, the analysis here

excludes population growth that is exogenous to the Metro-North investment decision.

Map 1 Proposed Route of Metro North, Stations and 500 metre buffers.



Employment Density

Button et al. (1995) conducted a large survey of new commercial premises to analyse the importance of transport access to the location decisions of firms. They found that different transport infrastructures had different effects. Roads were found to be an important locational determinant, where firms seek to have ready access to the parent company and where the new firm comes from outside the local area and are thus found to be more important for inward investment. This link was found to be even stronger in the case of airports. Bus connections were found to be more important for larger firms, perhaps reflecting the fact that they can service a larger catchment than fixed line rail.

In a microeconomic study of locational factors affecting firm startups and relocation in Portugal, Holl (2004) found that transport infrastructure and market access was particularly important for firm relocation. This has important implications since it implies that new transport infrastructure will lead to a relocation of firms rather than startups so this investment may not create additional jobs and indeed may lead to a relocation away from one part of the network to another part.

Regeneration implies population and employment growth. In that context it is interesting to note that in a study of Sheffield the impact of transport investment on regeneration was not found to be particularly strong. However, this was related to the lack of co-ordination and fragmentation in urban governance (see Lawless and Gore, 1999).

Overall this research suggests that new rail infrastructure is likely to increase the population particularly outside of the city centre while also increasing employment. The latter is likely to be more prominent in central areas and might be due to employment relocation rather than through the generation of new jobs. It is therefore difficult to assess the precise impact the Metro will have on job location and it is even more difficult to estimate the benefits since one needs not only to identify the number of net new jobs but also the sectors these are in and the level at which these jobs are.

3. Property Values

There have been numerous studies on the impact of major transport investments on property values. These encapsulate a range of impacts including the direct impact from improvements of accessibility, reduction in congestion, improvement in the environment. In addition to these positive impact there may be negative impacts such as noise, additional traffic, safety and aesthetics. All of these effects as well as the discounting allowed for by individuals are captured in the house price and this effect can be recovered using a hedonic regression model.

Hedonic models estimate property values as a function of the characteristics of the property and the indicators of the amenities and disamenities in the vicinity of the property. One amenity is of course the presence of various transport infrastructure including Metro/underground stations. An important aspect of the model is that (dis)amenities are assumed to only affect property values over a limited distance. The rationale for this is clear – amenities that are far away are more costly to access (either in time or money terms) and thus matter less to the property value. The degree to which this is true is typically assessed using a sensitivity analysis where models with alternative distance decay assumptions are estimated. In effect the hedonic model compares property values for properties close to the transport infrastructure being analysed and those that are not close to this infrastructure, taking out all other effects. The model is estimated using regression techniques and the coefficients that are recovered from this estimation can then be used to derive a value of the presence of infrastructure as a fraction of the property value.

One such analysis is that of Gibbons and Machin (2005) who analysed the impact of the Jubilee Line extension of the London Underground and the Lewisham extension to the London Docklands Light Railway. New lines increased property values by 9.3% on average. They found that the impact vanished at a distance of two kilometres from a station.

In contrast Bae et al. (2003) found that the construction of an additional Metro line in Seoul added very little to property values. However, their analysis was limited to properties built before the additional Metro line was constructed. Supply of properties has significantly increased since the construction which is likely to have resulted in a

downward pressure on prices at least in relative terms. An interesting finding of the study was that the new line had a significant impact on the overall usage of the Metro system in Seoul which increased by almost 15%. This highlights the significant network effects in terms of usage that can be achieved in an integrated system.

Armstrong and Rodriguez (2006) estimated hedonic models for the impact of commuter rail in eastern Massachusetts. They found that the proximity to commuter rail services increased property values by approximately 10%. Similarly, Strand and Vagnes (2001) found a 10% impact for properties located within 100 meters of the railway line.

A smaller impact was estimated by Hess and Almeida (2007) for the value of a property being located close to rail transit stations in Buffalo, New York, in that they found that such a location increases property values by 2-5%. Interestingly they found a larger impact for properties in high income areas.

In a very recent Irish study Mayor et al. (2008) considered the impact of the LUAS on property prices. They found that the new light rail transit system in Dublin (LUAS) has had a significant impact on property values. For example along a 500 metre buffer in Zone 2 and 3 of the Green Line the LUAS has increased property values by 12% accounting for all other factors. Again there is significant distance decay in the impact which vanishes at a distance of 2 kilometres from LUAS stations. Interestingly this study found a smaller impact of both the Dublin Area Rapid Transit (DART) and mainline rail stations on property values. This is likely to be explained by the frequency differences of the different rail based systems. LUAS has higher frequencies than DART which in turn has higher frequencies than mainline rail.

The results reported here mirror those found in a meta-analysis by Debrezion et al. (2007). That study considered not just residential property but also commercial property. Interestingly, the premium for commercial property located close to rail transit stations was found to be over 12% higher than that for residential property, which received a premium of just over 4%. For every 250 metres that a commercial property is located closer to a station it gains 2.3% in value. This result clearly highlights the benefits for commercial development from the construction of transit

rail systems to the local areas in which the stations are located, which will be further addressed below.

This review of the literature clearly highlights that a new METRO line will bestow significant increases in property values of about 10% to those properties located relatively close to MTERO stations, with a distance decay so that along an outer buffer the impact on property values is 5%.

In order to predict the impact on house prices it is necessary to consider first the number of households and thus housing units that are likely to be affected. In order to do Small Area Census of Population data is utilised. This is available at the Electoral District (ED) level. By assuming that the population is evenly distributed within each ED one can calculate the number of households, housing units and persons that will benefit from the Metro in terms of property values.

Using the 2006 Census as the basis for the calculations then approximately 20,000 households were resident in the 500 metre line buffer and just over 15,000 households were resident in the 500 metre station buffers. For the 500 to 1,000 buffer the corresponding figures are 22,000 and 25,000 households respectively.

Of course not all properties are privately owned and in so far as they are owned by local authorities or other public bodies, these will benefit from the property value increase. Around a quarter of households reside in rented accommodation rented from local authorities and voluntary bodies, which means that about 5,000 households in the 500 meter line-buffer or 4,000 households for the 500 meter station-buffers are renting such accommodations. A similar proportion is also renting from the private sector so that about 50% of households along the Metro-North route are renting. A similar 50:50 split emerges in relation to the types of housing units with just over 47% of housing units being accounted for by houses, 48% accounted for by apartments and bedsits and with the rest being accounted mobile homes or those where the housing unit is not stated.

The department of Environment Housing statistics indicate that the average new house in Dublin cost €350,000 during the third quarter in 2008, while second hand

houses cost just over €410,000. New apartments in Dublin cost just over €310,000 while second hand apartments were making just below €310,000. According to the Permanent TSB/ESRI house price index, house prices in Dublin in January 2009 averaged just short of €350,000. However, house prices in north Dublin are lower than in the southern part of Dublin. This difference is somewhere in the region of €60,000 or 17%.

According to the findings from the literature it is reasonable to expect housing units to within the 500 meter buffers along the Metro line to gain approximately 10% in value, with properties located further away to gain 5%. Taking the figures for house and apartment prices and adjusting the average downwards by 17% yields an average house price of €290,000 and an apartment price of €257,300. Using just the identified number of houses and apartments with these prices it is straightforward to work out the impact of a 10% increase of values, assuming the current prices prevail⁶. Using the 500 metre line buffer this impact amounts to a gain of €34 million, while using the 500 meter station buffer a gain of €96 million would be realised. For the 500 to 1,000 metre €287 million and €25 million so that the totals €22 million or €720 million for the combined 500 metre and 500 to 1,000 metre buffers.

In section 2.1 the induced change in population due to the completion of a Metro was outlined. These are essentially the dynamic benefits of the infrastructure investment which should be included in the impact assessment. If one applies the existing household size to this population one can derive an estimate of the number of households and using the split between house and apartment derive the number of additional properties which might also benefit from the increase in property values. Assuming a 5% increase in the population would add just over 1000 households to the 500 metre line buffer and 760 to the 500 metre station buffer. The associated gain in property values for the housing units for these additional households would be €26.7 million and €19.8 million respectively. This would increase to €33.4 million and €29.6 million if one assumes a population increase of 10%. Allowing for a population increase of 2.5% or 5% in the 500 to 1,000 meter buffer adds 530, 1,060, 600 or 1,200 households respectively, which results in a further property value gain of €7.2 million €14.4 million €8.1 million €6.2 million.

⁶ Perhaps a somewhat heroic assumption in the current economic environment.

Thus, if one allows for the impact of the induced population density the valuation would reach almost €90 million. It should be noted that in these calculations no allowance is made for an increase in the population that might take place in the absence of the investment in Metro-North. However, the implications are readily calculated given the numbers set out above. For example if through integrated planning the population in the buffers were to double then the benefit still would only be €1.64 billion which would only cover about half of the lower range expected cost of Metro-North.

While the above calculations account for all the benefits accruing to the residential property owners along the Metro line, these may underestimate the clearly underestimate the total benefits. While the results of the hedonic models suggest that properties not located in close proximity to the Metro line are not subject to an increase in values indicating that the benefits of Metro will not be different zero the method does not account for externalities that are not priced by the market such as some environmental benefits as well as the benefits enjoyed by individuals who use the service infrequently, such as holiday makers flying into Dublin airport.

Immediate environmental effects such as the reduction in congestion or noise and the improvement of air quality are of course accounted for by the method, but for example in the absence of carbon taxes reductions in carbon emissions may not be properly accounted for by the method. Relative to the benefits assessed as part of the above analysis these omitted benefits are likely to be small relative to the overall impact on property prices.

The benefits to persons who do not reside in proximity to the line that not reflected in the hedonic analysis are largely time savings, which are more properly assessed as part of a cost-benefit analysis⁷.

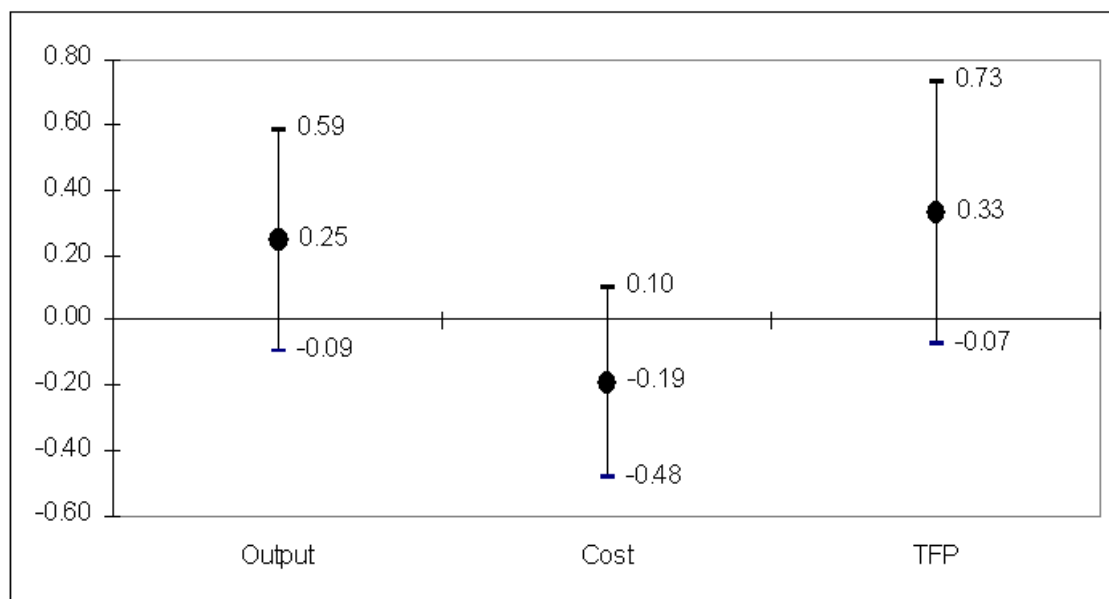
⁷ If one assumes that one third of the passengers (7 million) from Dublin airport are going to use the Metro with a time saving of 20 minutes the benefit valued at the value of time proposed in Goodbody (2004) of €4.7 per hour would be just short of €1 million. Obviously these are recurring benefits so if one assumes a 30 year time horizon and ignores discounting then the value would be just under €30 million. Using the Goodbody figures along with the projected passenger numbers it is simple to establish that, assuming these numbers are correct, a benefit to cost ration in excess of one is likely to result.

Finally, the above analysis only considered residential properties, omitting commercial properties. The degree to which these gain in value depends on the impact on employment which as was noted above is somewhat ambiguous. If for example an increase in employment close to Metro-North is simply due to relocation then a consequent drop in property values in the areas where the employment moved from is likely, cancelling out the benefit.

4. Economic Aggregates

One problem with the microeconomic approach to assessing the benefits of Metro-North is that it is difficult to measure all the benefits and indeed all the costs of the project. One way to get around this problem is to apply a macroeconomic approach. It turns out that a large literature considers the impact of transport infrastructure on economic aggregates such as GDP. However, most of these studies focus on the macroeconomic effects or at best the regional effects, rather than local impacts. They studies are typically estimating models to identify the impact on aggregate output, costs and total factor productivity (growth not accounted for by inputs). Overall infrastructure tends to have a positive impact on output and total factor productivity and decrease costs. The results of a large number of studies for Greece, Ireland, Portugal and Spain have been summarised in Bradley et al. (2004). They did a quasi meta-analysis, which is shown in Figure 1, where the mean elasticities for each type of approach is shown along with the two standard deviations confidence interval. For example the figure shows that on average a one percent increase in the stock of infrastructure results in a one quarter percent increase in output, but this is likely to fall in the range between just a negative and as high as 0.59%. The TFP elasticities are even larger while the cost elasticities are smaller such that a one percent increase in infrastructure stock would result in a decline of costs of 0.19%.

Figure 1 Average elasticities and confidence intervals



Source: Bradley et al. (2004).

The size of the impact at the macro level depends on a range of factors. These include the initial level of infrastructure (e.g. a country only needs only one road network and not two), the type of infrastructure that is build and sectors that are investigated (in the case of Figure 1 all sectors together). The results at the regional level are more patchy. This is likely to be explained by the fact that the benefits may spill out of the region, that there are important interactions between infrastructure and other growth drivers and that there may be excess capacity/lack of demand for further infrastructure. For example, in a recent paper Crescenzi and Rodriguez-Pose (2008) find that while a good infrastructure endowment in European regions along with a good endowment in neighbouring regions results in higher growth rates, additional investment does not seem to have a positive impact. As such a good transport infrastructure is a necessary but not sufficient condition for growth at the regional level.

At a more local level a few studies have considered the impact of transport infrastructure on shopping patterns and turnover. For example Crampton (2003) reports that rail infrastructure terminating in the centre of towns increases the number of shoppers in the centre resulting in significantly higher turnover. However, this results in sharp increases in rents for shops which in turn changes the nature of shops located in central areas as smaller local shops are priced out of these locations. Blum

(1982) found that road infrastructure had a positive growth effect at the local authority level in Germany while railroads were found to have at best a marginal impact. In a meta-analysis, Button (1995) finds that at the local level road infrastructure investment has a negative impact while other transport infrastructures have a small positive impact on economic activity.

In summary the literature yields somewhat contradictory results. At the aggregate macroeconomic level infrastructure is found to have significant positive impacts, but at the more disaggregated local or regional level the evidence of a strong link between transport infrastructure and the key economic aggregates such as output and growth is less pronounced. Interestingly this lesser impact at the regional level appears to persist even if spatial spillovers are taken account of.

Utilising the results from the macro economic studies one can assess the impact of Metro North on the economy as a whole and calculate a rate of return. In order to do this it is first necessary to establish the level of the public capital stock. Using this and the elasticities from the literature it is relatively trivial to calculate the return on the investment⁸. Our crude estimate of the public capital stock for 2008 is €250 billion⁹. While a precise costing has not been published by the government Metro North is expected to cost somewhere in the region of €3 to 6 billion. In other words it would add 1.2% to 2.4% to the capital stock. Using the average elasticity this would add between 0.3% and 0.6% to GDP which using the figures for 2007 would amount to €600 million to €1.2 billion. This would be a significant immediate return on the investment, which is however significantly driven by the choice of elasticity. The average elasticity of 0.25 given the current public capital to GDP ratio implies a marginal product (return) of almost 19% which is quite high. An implied return of 13% was identified for roads investment in a paper by Keeney (2007). This given the capital to GDP ratio would imply an elasticity of 0.17, which in turn would result in an increase of GDP in the range of €390 million to €775 million.

⁸ All calculations presented here are based on a Cobb-Douglas production function.

⁹ This was calculated using real gross fixed capital formation by central and local government for the period 1970 to 2008 with the last two data points taken from the department of finance estimates and the other data taken from the national accounts. A depreciation rate of 2% was assumed and the starting value was constructed using Harberger's formula with a real growth rate of investment of 5.6%.

One interesting feature of using this approach is that the higher the ‘addition’ to the capital stock the bigger the return to the investment. In other words if the cost of Metro North doubles then the return also doubles. However, paying double the cost does not imply double the benefit, especially if the higher cost merely reflects higher profits for the construction companies, rather than a higher specification. This reflects the theoretical foundations of the method which assume competitive markets and hence competitive pricing by bidders for projects. In practice these might not hold¹⁰. In a statistical ex-post analysis inefficient investments would reduce the size of the elasticity and indeed one can find examples where this is not statistically different from zero. Ex-ante however, the application of this aggregate approach is very sensitive to the investment values that are used and to the assumption that the marginal product of the proposed investment is equal to that of other infrastructures used to derive the estimates.

6. Conclusions

This paper has analysed the impact of Metro North using two novel methods, namely the hedonic pricing models and the macroeconomic returns to infrastructure literature, rather than the standard Cost Benefit Analysis. It was shown how the dynamic benefits from the construction of Metro-North can be incorporated into the estimation of the impact using the hedonic property valuation models. This analysis addresses an important information gap for any discussions around the decision to proceed with the construction of Metro-North. The results are quite interesting in that contradictory results are found.

The application of the hedonic pricing model results suggests that the benefits are likely to significantly smaller than the cost of the project, suggesting that the project should not proceed. However, that methodology does omit some benefits such as the potential for net additions to employment, global environmental externalities and direct benefits to individuals not living in proximity to the Metro line. It is argued that these omitted benefits would not be sufficiently large to change the overall recommendation from this approach.

¹⁰ As Pritchett (1996) notes, in terms of the productive capacity of an economy there is a big difference between investing in roads or rail and investing in a presidential palace. In the same sense there is a big difference between and investment in Metro that is achieved at competitive cost as compared to one that is achieved at over-inflated costs.

The application of the results from the macroeconomic returns to infrastructure literature on the other hand found a return that would exceed that of a private sector investment suggesting that the project should proceed. This result is highly dependent on the elasticities used and the marginal product of the investment considered. Here we assumed that Metro-North will have a similar impact on output as the average infrastructure already in place in a range of countries that suffer an infrastructure deficit.

While the results are dependent on a range of assumptions they should provide a useful starting point for discussions about the merits of the Metro-North. While the assumptions utilised here are based on sound arguments other researchers may dispute these, but can use the methods proposed here to readily calculate alternative benefits.

Overall, the proposed methodology should prove useful for the evaluation of a range of projects not just in Ireland and should form part of a suite of evaluation methodologies applied before any large investment decision is made. Both methodologies used here have the advantage (over CBA) of incorporating effects that are otherwise difficult to evaluate.

7. References

- Armstrong R., and D. Rodriguez (2006) "An evaluation of the accessibility benefits of commuter rail in Eastern Massachusetts using spatial hedonic price functions" *Transportation*, Vol. 33, pp. 21-43.
- Bae, C-H, Jun M-J and H. Park (2003) "The Impact of Seoul's Subway Line 5 on Residential Property Values", *Transport Policy*, Vol. 10, pp.85-94.
- Blum, U., (1982) "Effects of Transportation Investments on Regional Growth: A Theoretical and Empirical Investigation", *Papers in Regional Science*, Vol. 49(1), pp. 169-184.
- Bradley, J., Gacs, J., Morgenroth E., and G. Untiedt (2004) "A Study of the Macroeconomic Impact of the Reform of EU Cohesion policy", Report to DG Regional Policy.
http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/3cr/macro_impact.pdf
- Button, K., (1995) "What Can Meta-Analysis Tell us about the Implications of Transport?", *Regional Studies*, Vol. 29(6), pp .507-517.
- Crampton, G., (2003) "Economic Development Impact of Urban Rail Transport", Paper presented at the European Regional Science Association (ERSA) conference held in Jyväskylä, Finland.
- Crescenzi, R., and A. Rodriguez-Pose (2008) "Infrastructure Endowment and Investment as Determinants of Regional Growth in the European Union", *European Investment Bank (EIB) Papers* Vol. 13(2), pp. 62-101.
- Goodbody Economic Consultants (2004) *Cost Benefit Parameters and Application Rules for Transport Project Appraisal*. Report to the Department of Transport.
- Handy, S., (2005) "Smart Growth and the Transportation-Land Use Connection: What Does the Research Tell Us?" *International Regional Science Review*, Vol. 28(2), pp. 146-167.
- Mayor, K., Lyons, S., Duffy, D., and R. Tol (2008) "A Hedonic Analysis of the Value of Rail Transport in the Greater Dublin Area" ESRI Working Paper No. 264.
- Duranton G., and M. Turner (2008) "Urban Growth and Transportation" CEPR Discussion Paper No. 6633.
- Gibbons, S., and S. Machin (2005) "Valuing Rail Access Using Transport Innovations", *Journal of Urban Economics*, Vol. 57, pp. 148-169.
- Hess, D., and T., Almeida (2007) "Impact of Proximity to Light Rail Rapid Transit on Station-area Property Values in Buffalo, New York", *Urban Studies*, Vol. 44(5/6), pp. 1041-1068.
- Holl, A., (2004) "Start-ups and Relocation: Manufacturing Plant Location in Portugal", *Papers in Regional Science*, Vol. 83(4), pp 649-668.
- Indecon (2008) *Economic Development Strategy for the Metro North Economic Corridor*. Dublin: Fingal County Council.
- Keeney, M. (2007) , *Economic and Social Review*, Vol. Pp.

- Lawless, P., and T. Gore (1999) "Urban Regeneration and Transport Investment: A Case Study of Sheffield 1992-96", *Urban Studies*, Vol. 36(3), pp. 527-245.
- Levinson (2008) "Density and Dispersion: The Co-development of Land Use and Rail in London", *Journal of Economic Geography*, Vol. 8(1), pp. 55-78.
- Pritchett, L., (1996) "Mind your P's and Q's: The Cost of Public Investment is Not the Value of Public Capital", World Bank Policy Research Working Paper No. 1660.
- Strand, J., and M. Vagnes (2001) "The Relationship Between Property Values and Railroad Proximity: A Study Based on Hedonic Prices and Real Estate Brokers' Appraisals", *Transportation*, 28, pp. 137-156

Year	Number	Title/Author(s) ESRI Authors/Co-authors <i>Italicised</i>
2009		
	300	Explaining Structural Change in Cardiovascular Mortality in Ireland 1995-2005: A Time Series Analysis <i>Richard Layte, Sinead O'Hara and Kathleen Bennett</i>
	299	EU Climate Change Policy 2013-2020: Using the Clean Development Mechanism More Effectively <i>Paul K Gorecki, Seán Lyons and Richard S.J. Tol</i>
	298	Irish Public Capital Spending in a Recession <i>Edgar Morgenroth</i>
	297	Exporting and Ownership Contributions to Irish Manufacturing Productivity Growth <i>Anne Marie Gleeson, Frances Ruane</i>
	296	Eligibility for Free Primary Care and Avoidable Hospitalisations in Ireland <i>Anne Nolan</i>
	295	Managing Household Waste in Ireland: Behavioural Parameters and Policy Options <i>John Curtis, Seán Lyons and Abigail O'Callaghan-Platt</i>
	294	Labour Market Mismatch Among UK Graduates; An Analysis Using REFLEX Data <i>Seamus McGuinness and Peter J. Sloane</i>
	293	Towards Regional Environmental Accounts for Ireland <i>Richard S.J. Tol, Nicola Commins, Niamh Crilly, Sean Lyons and Edgar Morgenroth</i>
	292	EU Climate Change Policy 2013-2020: Thoughts on Property Rights and Market Choices <i>Paul K. Gorecki, Sean Lyons and Richard S.J. Tol</i>
	291	Measuring House Price Change <i>David Duffy</i>
	290	Intra-and Extra-Union Flexibility in Meeting the European Union's Emission Reduction Targets <i>Richard S.J. Tol</i>
	289	The Determinants and Effects of Training at Work: Bringing the Workplace Back In <i>Philip J. O'Connell and Delma Byrne</i>
	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 Julia 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
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 Maitre
- 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
- 207 Distributional Effects of Public Education Transfers in Seven European Countries
Tim Callan, Tim Smeeding and Panos Tsakloglou