



**An Roinn Iompair  
Turasóireachta agus Spóirt**

**Department of Transport,  
Tourism and Sport**

**Investing In Our Transport Future: A Strategic Framework for Investment in  
Land Transport**

**Background Paper Seven**

**The Regional Development Impacts of Transport Infrastructure**

*Paper Authored by:*

*Edgar Morgenroth, ESRI*

*Issued by:*

Economic and Financial Evaluation Unit  
Department Of Transport, Tourism and Sport  
Leeson Lane  
Dublin 2  
Ireland

# The Regional Development Impacts of Transport Infrastructure: A Literature Review and Policy Implications

---

**Edgar Morgenroth**  
*Economic and Social Research Institute*



## **1. Introduction**

Infrastructure and particularly transport infrastructure investment is often seen as an important policy tool for regional development. Particularly, policy makers and residents of more peripheral regions tend to lobby strongly for more centrally financed investment in transport infrastructure to overcome the perceived disadvantage due to peripherality. Proponents for such transport infrastructure projects typically assert the accessibility benefits, the increase in employment, economic growth effects and improved social inclusion.

Project evaluation usually encompasses a Cost-Benefit Analysis (CBA), which for projects above €30 million is a requirement by the Department of Public Expenditure and Reform. CBA does not generally consider the wider impacts and instead focuses on the direct costs and benefits of the potential users of the infrastructure. Thus, while there is a common perception of significant wider local and regional impact the analysis carried out to evaluate projects often does not cover these effects. However, the local and regional impacts of transport infrastructure projects have been considered in different strands of the academic literature and there now exists an extensive literature which is relevant to the issue of the nature and scale of local and regional development impacts of transport infrastructure investment.

While many relevant studies have been published internationally, very few studies relating to Ireland area available. Therefore, this paper seeks to outline some of the relevant findings from the international literature and draw important policy conclusions. In addition, as little analysis of transport investment at the regional level in Ireland is available, some facts regarding this are also presented.

The paper is organized as follows. Section 2 gives details of public capital expenditure including expenditure on transport at the regional level in Ireland. It demonstrates some important issues regarding accessibility. Section 3 outlines some relevant findings from theoretical research. Section 4 focuses on the empirical research covering findings regarding transport costs and accessibility, the aggregate impact of transport infrastructure, the impact of some specific projects and the research on the relationship between transport infrastructure, employment density and productivity. Section 5 summarises the findings and offers policy conclusions.

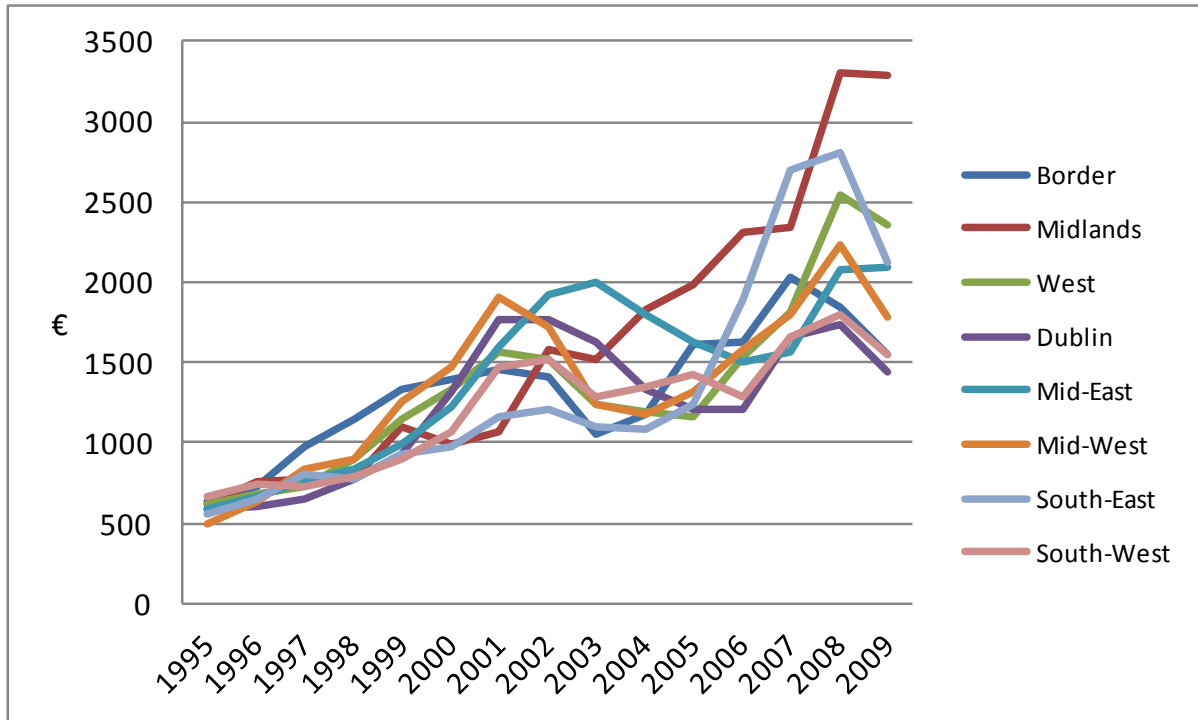
## **2. Regional Transport Investment and Accessibility in Ireland**

It is useful to consider the trends in transport infrastructure investment at the regional level in Ireland. Analysis by Morgenroth (2010) established regional government accounts. The data include public capital expenditure for the eight planning regions in Ireland and also identify expenditure on roads separately. This analysis utilizes data from the Construction Industry Review and Outlook (DKM 2010), which has been discontinued so that the data is only available up to 2009.

Figure 1 shows real per capita public capital expenditure across the planning regions for the period 1995 to 2009. The graph shows the significant increase in capital expenditure for all regions and it also shows that there has been divergence regarding the level of per capita expenditure across the regions with the Midlands

region receiving the highest expenditure in 2009 and Dublin receiving the lowest per capita expenditure. However, the rankings are not constant over time indicating that over the period expenditure is more evenly distributed than in any particular year. Nevertheless, on average Dublin ranked the lowest. In part this reflects the fact that particularly network infrastructure is cheaper to provide on a per capita basis in more densely populated areas (see Büttner et al. 2004, Hortas Rico and Sole-Olle, 2010).

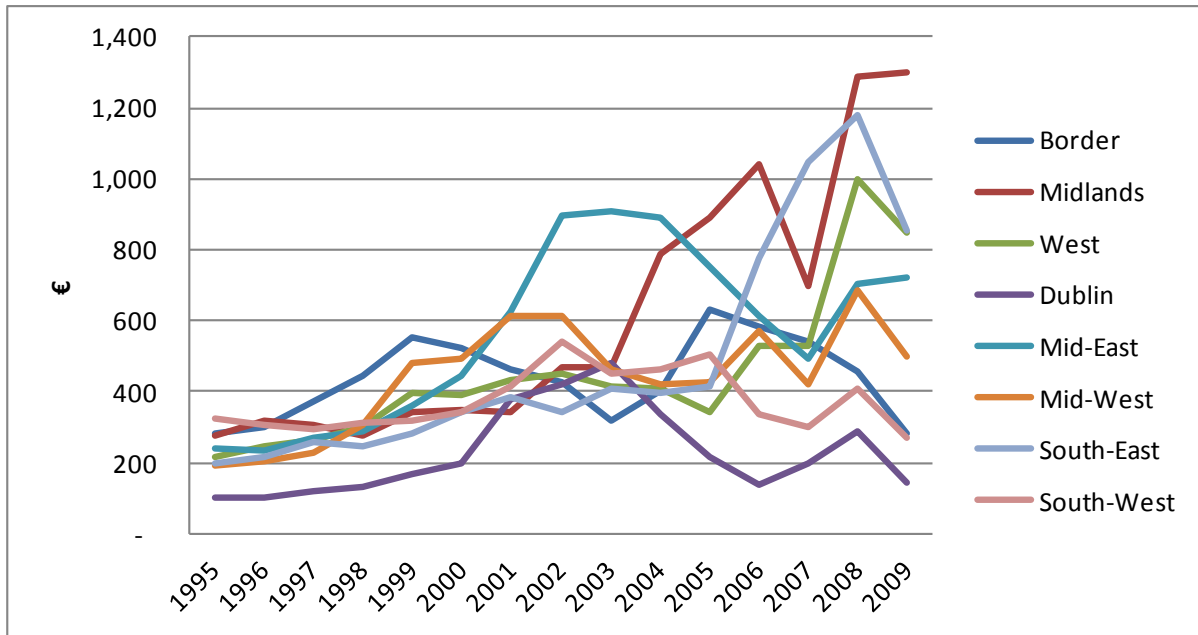
**Figure 1. Real Per Capita Public Capital Expenditure by Region**



Source: Own calculations based on Morgenroth (2010).

Figure 2 shows the per capita real expenditure on roads by region. Again a significant degree of divergence is noticeable. The figure shows that the highest expenditure in 2009 was in the Midlands and the lowest was in Dublin. Furthermore, the data is more volatile reflecting the lumpy expenditure on individual projects. Overall, the two graphs show that public capital expenditure was not disproportionately concentrated in Dublin.

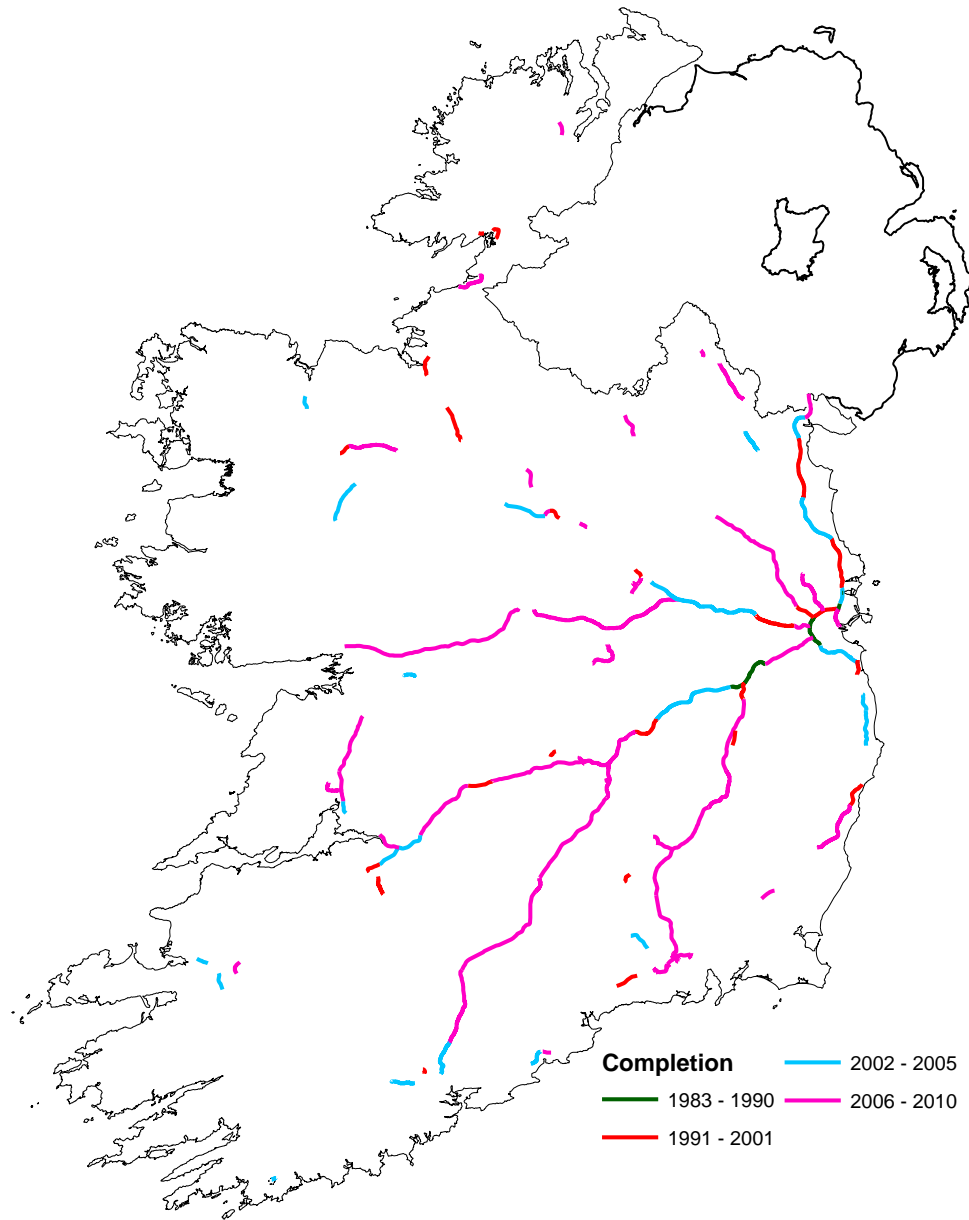
**Figure 2. Real Per Capita Public Capital Expenditure on Roads by Region**



Source: Own calculations based on Morgenroth (2010).

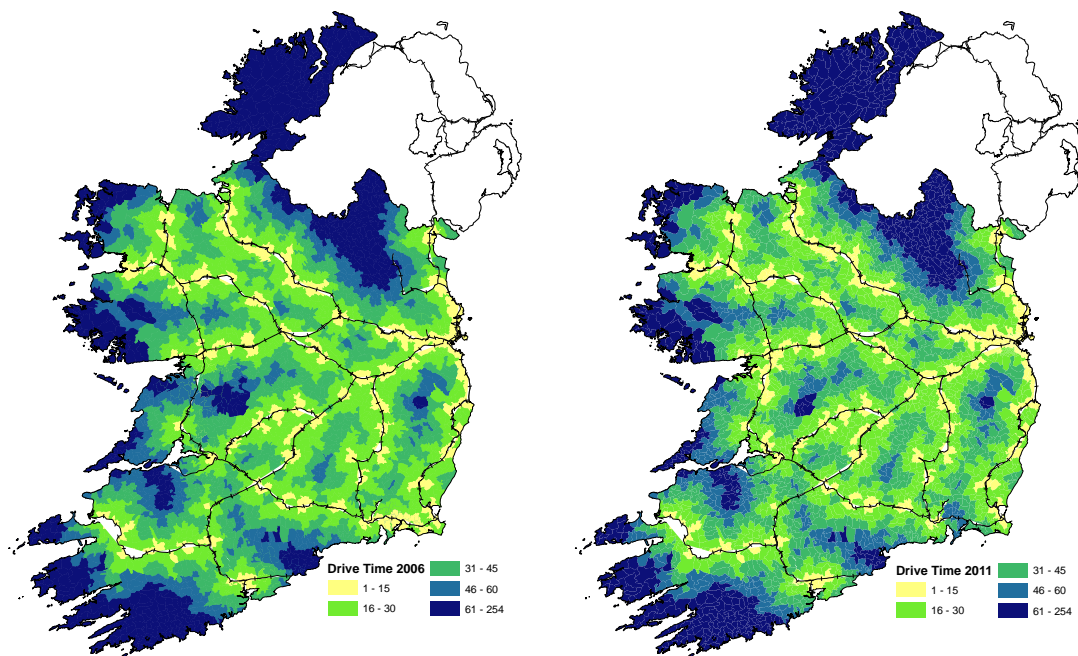
The investment in roads was particularly focused on by-passes on the national road network and the development of the motorway network. Map 1 shows the roads sections completed in the period 1983 to 2010. The map corroborates the data in graph 2 in that it shows that improvements of the major interurban roads have been made across the country. The map shows that the investment was particularly targeted at improving access to and between the major cities, which also implies that this investments benefits more people than if it had been focused on connectivity between other areas. Importantly, this investment has benefitted all regions since for example the improvements in the Midlands also benefits the West when it comes to access to Dublin.

**Map 1. Motorways and By-passes by Period of Completion (1983 to 2010)**



Another way to consider investment in infrastructure is to consider the impact on accessibility which is most readily measured as the time it takes to travel between two places. The travel time to the nearest motorway junction, airport, port or train station can be measured. Here the example of rail accessibility is used, which is sometimes asserted to diminish the development potential of some regions of Ireland. Map 3 shows the time it takes to drive to the nearest rail station for 2006 and 2011. A number of changes to the rail network occurred in the intervening period. Phase 1 of the Western Rail Corridor was completed, the Dublin Docklands to M3 Parkway line was opened and the line between Waterford and Wexford was closed. Careful analysis of the map shows that this has had an impact on accessibility to railway stations in the affected areas. However, the effect is relatively minor which is also borne out by Table 1 which shows the share of the population within drive time intervals for both years. It shows that the changes in rail services increased the share of the population that is within 15 minutes drive time of a railway station by just 1%, mainly due to the introduction of the Docklands-M3 Parkway service. The other two changes had little impact given the low population along those lines. Overall more than two thirds of the population reside within 30 minutes drive time of a railway station and only 15% of the population have a drive time in excess of 45 minutes.

**Map 3. Drive Time to Railway Stations 2006 and 2011**



Source: Own calculations using MS MapPoint.

**Table 1 Percentage of the Population by Drive Time from the nearest Railway Station, 2006 and 2011**

	2006	2011
<b>Under 15 minutes</b>	45.9%	46.9%
<b>15 -30 minutes</b>	27.4%	27.3%
<b>30-45 minutes</b>	12.0%	11.4%
<b>45 -60 minutes</b>	5.7%	5.6%
<b>60 minutes and more</b>	9.0%	8.9%
<b>Total</b>	100%	100%

Source: Own calculations using CSO Census Small Area Population Data.

Another approach to examining the impact of accessibility improvements is to consider the speed required to equalize travel times between different locations. Table 2 shows the road distances between selected larger centres in Ireland. The bottom row shows the average distance for each centre. Athlone is the town in this sample that is located most centrally within Ireland as it has the lowest average distance. Belfast, Letterkenny and Tralee have the highest average distance. While the distance to Dublin is important given its size and function as a capital city, the distance to neighbouring large centres is also important. At a speed of 80 kilometres per hour, the average distance from Dublin takes 127 minutes to drive. To achieve the same average drive time from Letterkenny the average speed would need to be 117 kilometres an hour, which is not achievable without breaking the speed limit even if the roads were improved to motorway standard as some non-motorway travel would reduce the average speed significantly. This example illustrates that it is practically impossible to eliminate peripherality with transport infrastructure investment, although such investment can reduce peripherality. Of course improvements in transport infrastructure will also reduce travel times for intermediate points, for example Monaghan town would benefit from an improvement in the roads between Dublin and Letterkenny, which would give those towns a further advantage over the more peripheral towns. Importantly, if peripherality/centrality were the only factor that differs between centres, then the peripheral centre will always come out second best. This highlights the need to develop other sources of advantage in peripheral places.

**Table 2. Driving Distances Between Major Centres in Ireland**

	Dublin	Dundalk	Belfast	Letterkenny	Sligo	Athlone	Galway	Limerick	Tralee	Cork	Waterford
<b>Dublin</b>	0	85	85.2	240.8	207.7	123.6	216.8	197.8	296.3	251.7	160.8
<b>Dundalk</b>	85	0	83.4	159.1	169.8	151.5	294.8	280.7	379.2	334.6	243.7
<b>Belfast</b>	85.2	83.4	0	150.1	200	284.7	377.8	363.8	462.3	417.7	326.8
<b>Letterkenny</b>	240.8	159.1	150.1	0	110.9	225.7	245.3	332.8	437.7	436.8	400
<b>Sligo</b>	207.7	169.8	200	110.9	0	115.2	134.7	222.2	327.1	326.3	291.3
<b>Athlone</b>	123.6	151.5	284.7	225.7	115.2	0	92.7	121.9	220.4	209.1	175.5
<b>Galway</b>	216.8	294.8	377.8	245.3	134.7	92.7	0	100.6	161.3	201.2	227.4
<b>Limerick</b>	197.8	280.7	363.8	332.8	222.2	121.9	100.6	0	97.7	99.1	126.8
<b>Tralee</b>	296.3	379.2	462.3	437.7	327.1	220.4	161.3	97.7	0	118.4	226.8
<b>Cork</b>	251.7	334.6	417.7	436.8	326.3	209.1	201.2	99.1	118.4	0	123.4
<b>Waterford</b>	160.8	243.7	326.8	400	291.3	175.5	227.4	126.8	226.8	123.4	0
<b>Average</b>	<b>170</b>	<b>198</b>	<b>250</b>	<b>249</b>	<b>191</b>	<b>156</b>	<b>187</b>	<b>177</b>	<b>248</b>	<b>229</b>	<b>209</b>



Source: MS MapPoint

### **3. Theoretical Research**

A number of relevant theoretical papers have been published, and while the focus of this paper is on empirical findings a number of findings from the theoretical literature are worth noting.

Public capital (infrastructure) has been shown to have a number of impacts. In the literature on economic growth the effect of public infrastructure is typically incorporated as an additional input in the production function which raises productivity or reduces costs of production (Barro, 1990, Futagami et. al., 1993). This result should hold not only at the national level but also at the regional level. Without congestion an additional user of infrastructure does not reduce the benefit to other users from that infrastructure, so there is an extra return from that infrastructure which is referred to as a positive externality. However, it should be noted that despite the externalities infrastructure investment can have a low return. Firstly, the relationship between infrastructure investment and growth has been shown to be non-linear, i.e. it is not constant as further infrastructure is put in place, and is dependent on the stock of existing infrastructure (Bougheas et al, 2000). Thus, where the lack of infrastructure is not a constraint additional investment will have a low return. Secondly, even where the infrastructure is a constraint the benefits of investment have to be compared to the costs. In this respect a particular issue for remote regions is the relatively low demand implying lower aggregate benefits. Another relevant finding in Bougheas et al, (2000) is that infrastructure has the highest return when accompanied by low taxes, since taxes reduce the funds available for private investment. An analysis using a regional computable equilibrium model for Finland supports this finding in that it finds growth impacts of infrastructure projects provided they are financed by central government and not local resources, which is implicitly the case in Ireland. This implies a limit to the benefits of infrastructure if it has to be self-financed. Self-financing would imply a significant burden on less developed regions, and hence lobby groups tend to look to central government to subsidise transport infrastructure investment. While such transfers lessen the burden on peripheral regions they increase the burden significantly on more economically central regions and while they contribute to reducing regional differences (see Morgenroth 2010), they may reduce national efficiency.

Transport infrastructure can also have significant trade enhancing effects as this can reduce transport costs as was shown in Bougheas et al, (1999). Kelly (1997) developed a growth model based on the idea put forward by Adam Smith in his book *On the Wealth of Nations* (1776), that the division of labour (specialisation) was limited by the size of the market i.e. with a larger market firms and individuals could specialize in few processes and thereby improve their productivity. In Kelly's model transport infrastructure linkages expand the extent of the market. However only after a particular density of infrastructure linkages is reached (a network is built) will these markets fuse into one large market, and will labour be re-allocated in order to facilitate increased specialisation and output to expand. This model therefore predicts a take off in response to large-scale infrastructure development. Importantly it implies that what matters most is the completion of a network rather than individual unconnected projects, which in turn implies the projects outside of peripheral

areas can have a significant impact on peripheral areas if they reduce transport costs for producers in peripheral areas.

The trade enhancing effects of additional transport infrastructure are often used to justify investment in transport infrastructure for more remote regions. It should however be noted that transport infrastructure not only reduces the transport costs of producers in more remote regions, it also reduces the cost of supplying remote regions for producers located in central regions. Thus, improved transport infrastructure can have a perverse regional development impact where the investment leads to increased competition in a remote region, which could reduce employment in these areas. This issue was investigated by Kilkenny (1998) who demonstrated a non-linear relationship between transport costs and rural development. In her model manufacturing and agriculture face different transport costs. A reduction in manufacturing transport costs results in increased concentration of manufacturing in cities.

## **4. Empirical literature**

The relevant empirical literature on regional development impacts of transport infrastructure encompasses a number of different strands. Firstly, as transport infrastructure is usually aimed at improving accessibility and reducing transport costs a range of papers have considered this. Here it should be noted that it is almost tautological that transport infrastructure investment improves accessibility. Thus, the key issue is whether accessibility improvements have regional development impacts and an improvement in accessibility is just a necessary but not sufficient condition for economic development impacts. Secondly, the aggregate economic impact of investment has been the subject of numerous studies. In this literature the long-run impacts are typically considered rather than the short run impacts which arise during the construction phase of a project. The short run impacts can seem large in a given year but, as these are transitory i.e. they disappear as soon as the project is finished, they are usually considered secondary to the long-run impact. Here it should be noted that if one holds all other factors equal, then the short-run impact of a project is likely to be larger in less developed areas than in more developed regions. For example if the less developed region has high unemployment and the developed region has no unemployment then a project would reduce unemployment in the less developed region while it would just increase prices in the developed regions (assuming no migration). However, the opposite is likely to be true for the long-run impact, as there are fewer beneficiaries. Thirdly, apart from the aggregate studies the specific impact of particular projects has also been assessed by researchers. Fourthly, there is a literature which considers the effect of transport infrastructure on density which increases productivity.

### **4.1 Accessibility and Transport Costs**

The most fundamental purpose of transport investment is to improve accessibility and reduce transport cost.

There appears to have been no recent research on accessibility, but two studies on accessibility in Ireland have been published some time ago. O'Sullivan (1968) showed that there was a relationship between the road network and economic activity in Ireland, with more developed regions having better accessibility. However,

given his study was static i.e. covered only one year it could not establish causality between accessibility and development. Thus, transport infrastructure investment, and with it accessibility, could be developed because of more development rather than drive development. This is an important issue for much of the literature and is often not adequately addressed.

The impact of distance from major urban centres on population growth in Ireland was investigated by Keane (1984). He found that growth in those centres did not spread very far. However, the study was concerned with a period when internal migration was from rural to urban areas. More recent migration patterns ran in the opposite direction suggesting that at least for the recent period Keane's result might be reversed<sup>1</sup>.

Kotavaara et al (2012) considered the effect of accessibility on population change for small geographic scale areas in Finland. They found that higher accessibility is associated with faster population growth. While airport and road accessibility appeared to matter, rail accessibility had no effect. Unfortunately, they did not consider whether transport improvements had any impact.

In an influential study Vickerman et al (1999) develop a measure of high-speed rail accessibility across European regions and consider the likely impact of the development of further high-speed rail lines as part of the EU Trans-European Networks (TENs) programme. They shows that due to the focus of investment in high speed rail on connecting highly populated regions, this investment increases the core-periphery pattern of accessibility and could thus exacerbate economic core periphery patterns.

Combs and Lafourcade (2005) develop a general transport cost (GTC) measure for road transport by truck between employment zones in France incorporating every aspect of cost including insurance and tolls for 1978 and 1998. During this period the motorway network in France was significantly expanded and completed. This generalised transport costs measure shows a strong core-periphery pattern with the lowest transport costs in the central part of France around Paris and high transport costs in the geographically peripheral areas. Indeed they find peripheral transport costs to be twice those in central areas. They also find that a simpler distance measure underestimates the costs of reaching central places while the drive time overestimates the cost although all measures are highly correlated. The generalised cost measure was found to have declined by over 38% in real terms. Importantly 57% of the cost reduction between 1978 and 1998 was found to be due to changes in regulation and only just over 8% was due to the considerable investment in road infrastructure. In other words, a policy change, namely deregulation, that was not aimed at regional accessibility actually had a significantly larger impact on accessibility than road construction which was aimed at improving accessibility.

Accessibility improvements can improve labour market integration i.e. allow people from a wider catchment to access a labour market or alternatively allows a labour market to extend its spatial scale. However, it has been found that simple scale extension in itself does not necessarily bring about benefits but that the degree of

---

<sup>1</sup> The correlation between the net-internal migration across counties for 1996 and 2002 is -0.58 and the correlation between that for 2006 and 2011 is -0.09, which indicates significant changes in the pattern of internal migration. In particular, the change in the late 1990s resulted in counties that previously had experienced positive net-immigration, experiencing significant net-emmigration.

competition for jobs and educational match matters (Geurs and Ritsema van Eck, 2003)<sup>2</sup>. Thus, an improvement in accessibility to a labour market does not necessarily increase the probability of gaining employment as the accessibility improvement increases the number of job seekers in the enlarged labour market. Likewise, if the educational profile of individuals in a remote region do not match those required in the newly accessible central region then accessibility improvements will not improve the labour market outcomes in the remote region.

---

<sup>2</sup> Educational match refers to the match between the available labour force with the available jobs in the labour market. A mismatch between the skills required and those that are available results in unemployment.

## 4.2 Transport Infrastructure and Aggregate Economic Activity

A common approach to testing the effect of infrastructure has been to estimate its aggregate effect on output, employment or productivity, which has been researched in 100s of studies, mostly at the national level and often without disaggregating infrastructure into different types. However, there are many papers which either consider transport infrastructure impacts at the national level and/or consider the impact of infrastructure at the regional or local level. Early contributions to the literature include Blum (1982) and Biehl (1986).

In a meta-analysis of such studies (a study of many studies) Lighthart and Suarez (2011) found the elasticity of private output with respect to public capital (infrastructure) to be 0.14 i.e. a 1% increase in the stock of infrastructure is expected to yield an increase in private output of 0.14%<sup>3</sup>. They also show that the estimated parameters in the literature vary considerably. This is a finding that a quick review of the 100s of papers on this topic would confirm. Thus, while on average a positive impact from investment is expected, no impact or even negative impacts have also been found in many studies. Part of this heterogeneity is explained by differences in econometric specification. Particularly, early papers tended to suffer from poor specification and tended to find larger effects. Once the specification was improved, the estimated effect usually reduced in size. There are also more fundamental reasons why some studies did not find a significant impact. For example, if infrastructure is not a constraint then additional investment is unlikely to yield significant positive effects. This could be the case where significant infrastructure is already in place or where the underlying demand is low.

For network infrastructure such as motorway one would expect the impact of additional investment to be small if the investment only makes a marginal change to a completed network. In this context Iacono and Levinson (2013) analysed the earnings and employment impact of three highway projects in the USA that were aimed at connecting smaller cities. They found no impact which they attribute to the relatively minor travel time savings. They recommend that such projects be assessed on the basis of travel time savings, which if they affect only a relatively small number of travellers are likely to imply that the project is not worth doing.

Another important issue at the regional level is the degree of spillovers i.e. the degree to which investment in one region has an effect on neighbouring regions. For example a bypass will have an effect on the traffic in the by-passed town but will also reduce travel times for traffic that would have previously passed through the town. Furthermore, by inducing additional traffic in another part of the network the by-pass might impose a negative impact (externality) on another part of the network. Improving just one section of road connecting two distant locations will impact not just on the travel time of the area where the road is improved but all other locations along the road.

A particularly interesting study on spillovers is that of Pereira and Roca-Sagales (2003) who use regional data for Spain. They found an aggregate return to infrastructure investment of 5.5% and a positive but smaller impact of infrastructure in most regions. They also identify that spillovers from neighbouring regions account

---

<sup>3</sup> An elasticity is a measure of the response of the target variable due to a one percent change in the policy variable. The elasticity of private output with respect to public capital (infrastructure) is thus measures the responsiveness of private output (the target variable) with respect to infrastructure (the policy variable).

for more than 50% of the total return. The effect of spillovers i.e. the impact of the infrastructure of neighbouring regions, is smaller for geographically central regions of Spain and larger for geographically more peripheral regions.

Another study using data for Spain (del Mar Saolinas-Jimenez, 2004) found infrastructure to have a positive impact on regional productivity but highlighted that higher levels of private capital would have a larger impact on efficiency and productivity growth in less developed regions. Thus, a policy to stimulate private investment would be more effective than one which focuses on infrastructure.

### **4.3 Analysis of Individual Projects**

Apart from the many papers which have considered the impact of transport infrastructure in general, there have also been some studies which have considered specific projects.

An ex-post analysis of 14 road and rail projects by the European Investment Bank (Palanza and S.E.E.E., 1998) found that in four cases (28.6%), where accompanying measures were also implemented, positive regional development impacts could be identified, that one roads project (7.1%) actually had a negative effect and that in the other cases (64.3%) the analysis was inconclusive (EIB, 1998).

An evaluation of the M6 Toll road (by-passing Birmingham) in the UK was carried out by Pugh and Fairburn (2008). They found economic development of industrial land to have been stimulated by the M6 Toll road. Importantly, the development impact was limited to areas within 10 minutes drive time indicating the very localised effect. This would suggest that such developments are unlikely to have wider regional development impact, particularly as displacement effects were not taken account of.

Hedigar (1996) considered the M40 motorway (London to Oxford) and its development impact along with planning issues. He showed that while there had been relatively little development impact in rural areas, this had been largely driven by planning restrictions and not a lack of demand. This highlights that infrastructure development needs to be accompanied by appropriate planning policies to maximise the impact.

The impact of highway bypasses in Kansas was investigated by Babcock and Davalos (2002). Their principle finding was that bypasses did not have an effect on employment in the towns that were bypassed. However, interviews with business owners revealed increased retail sales for travel related businesses.

### **4.4 Density, Productivity and Transport**

Research has established a robust positive link between the density of economic activity, measured by the number of employees per square kilometre of area, and productivity (e.g. Ciccone and Hall, 1996, Ciccone, 2002). An important insight of the implication of the positive relationship between employment density and productivity was put forward by Venables (2007). He showed that an additional worker raises the productivity of all other workers. Additional workers generate a positive externality by reducing production (or consumption) costs up to a point where the negative effects of congestion outweigh these positive effects. Thus anything that facilitates an additional worker including transport infrastructure generates this externality and that a reduction in commuting costs increases the size of the city. Thus transport infrastructure can increase productivity for all workers and allows additional workers to work in the city. This results in an increase in tax revenue i.e. some of the benefits of the transport infrastructure accrue to the State. This tax effect had up to that point not been considered in the cost-benefit analysis of transport projects, but this finding stimulated the development of measures of the wider economic impact of transport infrastructure in cost-benefit analysis particularly in the UK (see DFT, 2014).

Related research (Graham, 2007) found that the productivity impacts differ across sectors and are particularly strong for services and much smaller for manufacturing. Furthermore research shows that agglomeration

economies are subject to rapid spatial decay i.e. they are very localised. For example Graham (2009) found that such externalities are confined to a small radius (10 kilometers) which implies that the contiguously dense part of the agglomeration matters for these density benefits. Recent results for the USA (Melo et al, 2013) showed the productivity effects to be strongest within a 20 minute drive time zone of the central business district and that they decline rapidly in a non-linear fashion. These findings imply that transport investment should be focused on facilitating high density i.e. to reduce congestion associated with high density. This is consistent with the finding by Hymel (2009) that reducing congestion has strong employment growth effects. Another related finding by Sweet (2014) shows that while firms relocate away from locations with region wide congestion they tend to be drawn to places with high local congestion, as they indicate local amenities.

The research on the relationship between transport infrastructure, density and productivity has largely focused on the benefits of projects in regions where the project takes place. However, if a project changes land use (density) then it is possible that this arises through displacement i.e. by drawing firms away from other areas which implies a cost to these areas.. Furthermore, the benefits need to be considered in the light of the incurred costs (see Kanemoto, 2013).

## **5. Summary and Policy Implications**

This paper has considered some of the evidence on the effect of transport infrastructure on regional development. It first outlined some key data for Ireland, which shows that the total investment in roads was not overly concentrated in Dublin. Almost all parts of the country have benefitted from major roads projects and given its central location, the Midlands region has benefitted most. The changes in rail services were shown to have only a marginal impact on rail accessibility, and overall accessibility to rail stations was shown to be high. It was also shown that peripherality is difficult to eliminate, suggesting that peripheral parts of the country will need additional advantages over more central locations other than transport infrastructure. Other factors that determine regional development include the educational attainment and skills of the local labour force, other infrastructure, natural resources, local amenities and other factors determining the quality of life and the profitability of investment in a particular location. In this respect it is worth noting that in relation to educational attainment there has been significant divergence in third level attainment rates over the last 50 years, and this factor better explains the divergence in economic development across regions than differential investment in infrastructure.

The paper reviewed various strands of the literature on the effect of transport infrastructure on economic development. The theoretical literature highlights a number of channels by which transport investment can impact on growth and some conditions which might reduce this impact. The latter include high taxes, low demand, good initial stock of infrastructure, incomplete networks, and increased competition. The empirical literature also shows some mixed results. For example while increased accessibility was found to impact on population growth, that only held for airport and road accessibility and not rail accessibility. While on average, studies find a positive return on transport infrastructure investment, the return is smaller than sometimes assumed and at the regional level spillovers are important. Indeed, some results suggest that investment in



neighbouring regions can have a bigger positive effect on peripheral regions than investment in the region itself. The evaluation of individual projects has also shown mixed results. However, by facilitating greater densities in urban areas, transport infrastructure has been found to generate significant productivity gains.

These results suggest a number of policy implications for the targeting of transport infrastructure investments and their role in regional development:

1. While transport infrastructure investment improves accessibility, such investment cannot eliminate relative peripherality. This implies that a singular focus on transport infrastructure investment for regional development is likely to fail. Rather the focus should be on identifying the key constraints that can be removed and the potential comparative advantage that can be exploited in particular regions.
2. Given that spillovers generate significant benefits particularly in more peripheral areas, these should be identified and acknowledged more explicitly.
3. The highest return on investment appears to be in density facilitating infrastructure that deals with region wide congestion. Particularly in the context of an almost complete network of interurban major roads in Ireland, the analysis suggests that investment should be focused on urban areas and their immediate hinterland.
4. Agglomeration benefits are restricted to the contiguously built up area of an agglomeration. Linking centres that are some distance apart such that they do not form a contiguous conurbation is therefore unlikely to result in any additional scale benefits. Thus, transport infrastructure linking two centres will not generate additional agglomeration economies but will allow for reduced transport costs and thus increased commercial links between the centres.
5. There has been relatively little research on the impact of transport investment on (regional) economic development in Ireland. Given the significant scale of investment over the last 20 years the effect of this should be evaluated at the aggregated level and also in relation to regional development and land-use.

## 6. References

- Barro, R. J. (1990), "Government Spending in a Simple Model of Endogenous Growth," *Journal of Political Economy*, Vol. 98(5), pp. 103-26.
- Biehl, D. (1986) *The Contribution of Infrastructure to Regional Development*. Brussels: European Commission
- Blum, U. (1982) "The Effects of Transportation Investment on Regional Growth: A Theoretical and Empirical Investigation", *Papers of the Regional Science Association*, Vol. 49, pp.169-184.
- Bougheas, S. Demetriades, P., and E. Morgenroth (1999) "Infrastructure, Transport Costs and Trade." *Journal of International Economics*, 1999, Vol. 47, 169-189.
- Bougheas, S., Demetriades, P.O., and Mamuneas, T. (2000) "Infrastructure, Specialisation and Economic Growth." *Canadian Journal of Economics*, Vol. 33, No. 2, pp 506-522.
- Büttner, T., Schwager, R., and D. Stegarescu (2004) "Agglomeration, Population Size and the Cost of Providing Public Services: An Empirical Analysis for German States", *Public Finance and Management*, Vol.4(4), pp. 496-520.
- Ciccone, A., and R. Hall (1996) "Productivity and the Density of Economic Activity", *American Economic Review*, Vol. 86(1), pp. 54-70.
- Ciccone A., (2002) "Agglomeration Effects in Europe", *European Economic Review*, Vol. 46(2), pp. 213-227.
- Del Mar Salinas-Jimenez, M., (2004) "Public Infrastructure and Private Productivity in the Spanish Regions", *Journal of Policy Modeling*, Vol. 26, pp. 47-64.
- DfT (2014) *TAG UNIT A2.1: Wider Impacts*. London: Department for Transport.
- DKM (2013) *Construction Industry Review 2009 and Outlook 2010-2013*. Dublin: DKM Economic Consultants.
- Palanza, F., and S.E.E.E. (1998) "Contribution of Major Road and Rail Infrastructure to Regional Development" *EIB Evaluation Report*. Luxembourg: European Investment Bank
- Geurs, K., and J. Ritsema van Eck (2003) "Evaluation of Accessibility Impacts of Land-Use Scenarios: The Implications of Job Competition, Land-Use and Infrastructure Developments for the Netherlands", *Environment and Planning B*. Vol. 30, pp. 69-87.
- Graham D., (2009) "Identifying urbanisation and localisation externalities in manufacturing and service industries", *Papers in Regional Science*, Vol. 88(1), pp. 63-84.
- Hortas Rico, M., and A. Sole-Olle, (2010). "Does Urban Sprawl Increase the Costs of Providing Local Public Services? Evidence from Spanish Municipalities", *Urban Studies*, Vol. 47(7), pp. 1513-1540.
- Hymel, K., (2009) "Does Traffic Congestion Reduce Employment Growth?" *Journal of Urban Economics*, Vol. 65(2), pp. 127-135.
- Iacono, M., and D. Levinson (2013) "Rural Highway Expansion and Economic Development: Impacts on Private Earnings and Employment", Working Paper 000101, University of Minnesota: Nexus Research Group.
- Kanemoto, Y., (2013) "Pitfalls in Estimating "Wider Economic Benefits" of Transportation Projects", *GRIPS Discussion Paper* No. 13-20.

- Keane, M., (1984) "Accessibility and Urban Growth Rates: Evidence for the Irish Urban System" *Economic and Social Review*, Vol. 15(2) pp. 125-139.
- Kelly, M. (1997) "The Dynamics of Smithian Growth", *Quarterly Journal of Economics*, Vol. 112 (3), pp. 939-964.
- Kilkenny, M., (1998) "Transport Costs and Rural Development", *Journal of Regional Science*, Vol. 38(2), pp. 293-312.
- Kotavaara, O., Antikainen, H., Marmion, M., and J. Rusanen (2012) "Scale in the effect of accessibility on population change: GIS and a statistical approach to road, air and rail accessibility in Finland, 1990–2008" *The Geographical Journal*, Vol. 178(4), pp. 366–382.
- Ligthart, J., and R. Martin Suarez (2011) "The Productivity of Public Capital: A Meta-Analysis" in Jonkhoff, W., and W. Manshanden (eds.) *Infrastructure Productivity Evaluation*. Heidelberg: Springer.
- Melo, P., Graham, D., and D. Levinson (2013) "Agglomeration, Accessibility, and Productivity: Evidence for Urbanized Areas in the US" paper presented at the 92<sup>nd</sup> Transportation Research Board Annual Meeting.
- Morgenroth, E., (2010) "The Regional Dimension of Taxes and Public Expenditure in Ireland". *Regional Studies*, Vol. 44(6) pp. 777-789.
- OECD (2002) *Impact of Transport Infrastructure Investment on Regional Development*. Paris: OECD
- O'Sullivan, P., (1968) "Accessibility and the spatial structure of the Irish Economy", *Regional Studies* Vol. 2(2), pp. 195-206.
- Pereira, A., and O. Roca-Sagales (2003) "Spillover Effects of Public Capital Formation: Evidence from Spanish Regions", *Journal of Urban Economics*, Vol. 53(2), pp. 238-256.
- Sweet, M. (2014) "Do Firms Flee Traffic Congestion?" *Journal of Transport Geography*, Vol. 35, pp. 40-49.
- Vickerman, R., Spiekermann, K., and M. Wegener (1999) "Accessibility and Economic Development in Europe" *Regional Studies*, Vol. 33(1), pp. 1-15.