

International comparison of road infrastructure investment

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1 Introduction

It has been argued that transport infrastructure in New Zealand is consistently under-funded and is restricting economic growth arising from gains in productivity. This paper compares recent investment levels and funding mechanisms for road infrastructure in New Zealand with those in Ireland and Norway. The findings are that New Zealand road transport investment is comparable in relation to other countries, while the available information suggests the road transport network is performing well. In the light of this and other evidence, it is suggested that there are questions over whether the level of investment in transport infrastructure is restricting economic growth in New Zealand. The discussion identifies a number of issues, which are likely to impact upon the outcomes of road infrastructure investment.

The following section briefly reviews the significance of transport infrastructure investment and policy. Section 3 compares international data on transport investment and makes other relevant comparisons. Section 3 also includes an investigation of similarities and differences between New Zealand, Ireland and Norway. Section 4 sets out some conclusions based on the evidence.

2 Investment in infrastructure

2.1 Investment in transport infrastructure

“Key drivers of land transport infrastructure (capital stock and new construction) are the relationships between, on the one hand GDP and population growth ... and on the other measures of road use, vehicle ownership and paved-road capital stock. Measures which are embodied in the elasticity between infrastructure (road and rail) capital stock and GDP per capita.”

(OECD, 2007, Ch. 4.5, p. 215)

There is a strong theoretical basis connecting infrastructure improvement to economic development. For example, transport network improvements should lead to reductions in transport costs and improved access to markets, amongst other benefits, consequently improving business performance (SACTRA, 1999). Despite correlation, the empirical evidence specifying the scale of the effect and its causal direction is mixed. Early studies suggested a strong and directional relationship. In this view, investment in infrastructure such as roads plays an active part in economic development (e.g. Aschauer, 1989 cited in SACTRA, 1999). Later studies found the relationship to be complex and varied in the scale of its effect. Thus, Fernald (1997) suggests that the positive effect of transport infrastructure on productivity constitutes benefits to some industries (such as those with high vehicle use),

¹ This paper does not necessarily represent the views of the Ministry of Transport.

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while having a low or negative impact on other industries. Furthermore, it appears that investment has a passive role, acting as an enabler rather than a driver of development. Of greater importance to achieving economic growth is the presence of drivers of economic progress, such as the availability of labour and investment capital.

For a given level of funding, effective targeting of transport investment is crucial to the outcomes in terms of achieving transport policy objectives (OECD, 2008a). There are a broad range of factors, such as the quality of the infrastructure, maintenance, management and institutional oversight, which relate to the efficiency of investment. In 'Transport Infrastructure Investment', the OECD (2008a) points to efficiency as a starting point for effective investment in infrastructure. One aspect of this refers to allocative efficiency, in terms of setting priorities and assessing value for money within these priorities in competition with other sectors. Within this they discuss the significance of including private sector finance and road pricing in promoting efficiency of investment. The other aspect of efficiency discussed is productive efficiency, which relates to effective project and asset management. The report suggests that the involvement of the private sector can result in improved efficiency (OECD 2008a). This conclusion highlights the importance of other factors in investment, which will have a substantial impact on the outcomes.

Infrastructure development is itself an economic activity, making a significant input to the economy. For example in the years 2000-02, the Irish Government invested an average of 7% of GNP in infrastructure provision. This is significant, both for economic growth and for the growth in costs of construction when a large increase in investment is made. Predictability and consistency of investment are likely to improve efficiency by supporting growth and investment in the construction industry.

A concern with transport infrastructure investment is whether infrastructure improvements result in additional trips, which otherwise would not have been made (induced travel). Research suggests that there is an effect of induced travel as a result of road capacity increases and network improvements, although the strength of these effects is varied (e.g. SACTRA, 1994). Induced travel may be positive or negative, but it should be suitably accounted for in project appraisal. Currently, induced travel is not included in the appraisal process in New Zealand, and this could lead to over-estimation of benefits, especially on a congested network. In developed countries, congestion is an increasing part of the total cost of motoring.

The question of the adequacy or otherwise of the road network is not just an internal issue nor an academic one. As pointed out by the New Zealand Treasury, "*the perception of overall infrastructure performance in New Zealand is relatively low ... there is a risk that such perceptions could reduce the attractiveness of New Zealand as a place to do business*" (Treasury, 2008). This risk of reduced attractiveness is somewhat separate from the reality of the performance of New Zealand's roads. It is important that the perception of transport infrastructure be based on information, which accurately reflects the ongoing performance of the network. Information is important, both for the perception of the network and for the ability to provide effective governance and administration.

The perception of the road network is given further significance for external markets and foreign investment. New Zealand is dependent on strong international connections, and external markets have a strong influence. While New Zealand is rated highly by the World Bank for ease of doing business, its small domestic market and small size make for particular challenges, such as achieving internal economies of scale and other benefits of agglomeration.

3 Investment trends and cross-country comparisons

3.1 Comparisons with OECD countries

An attempt was made to use OECD data to compare investment in New Zealand with other countries. The International Transport Forum (ITF) requests data from all its member countries on a range of factors, including investment in road infrastructure. The road transport investment information is broken down into 'new construction and major maintenance', and 'operation and routine maintenance'. ITF (2007) published data on new construction and major maintenance as a percentage of GDP. In new construction and major maintenance, New Zealand invests less than the average of ten Western European countries. In general, road construction in New Zealand is relatively low cost, with ongoing maintenance requirements. Thus, it might be expected that New Zealand would spend less on new construction while possibly investing a larger proportion on maintenance.

Comparison of different countries' investment in construction with their investment in operation and maintenance reveals very large differences. Some of this variability may be a real difference as discussed above. However, some of the variability between countries is likely to be a different definition of 'new construction' as compared to 'routine maintenance'. A further issue is whether or not a country's investment figures include toll revenue and private financing. The data collected by the ITF enable us to see a trend within a country over time. More detail is required to allow us to compare countries with any confidence. Therefore a more in-depth consideration was targeted at two countries with some relative similarities but which, usefully, are doing much better than New Zealand in terms of the size of their economies.

3.2 Comparisons with similar countries

Norway and Ireland are similar to New Zealand in many ways (see Table 1). There are similarities in population, geography and also in characteristics of the transport network such as vehicle kilometres travelled (VKT) and network length. Each country's largest city (Auckland, Dublin and Oslo) contains a significant proportion of the country's total population. This has a flow-on effect, such that these cities attract a significant proportion of total national transport funding. Overall, these similarities are likely to contribute to similar needs for investment in infrastructure.

Table 1 – Comparative figures for Norway, Ireland and New Zealand in 2006

	<i>Ireland</i>	<i>New Zealand</i>	<i>Norway</i>
Population (million)	4.2	4.2	4.6
Area ('000 km ²)	70	269	324
Population density (persons/km ²)	60	15.6	14.2
Total road network length ('000 km)	97	94	93
Road network density (km/km ²)	1.37	0.35	0.28
Total vehicle km travelled (billion VKT)	41	39	37
GDP (billion €)	161	81	270
GDP PPP (billion US\$)	187	111	247

The three countries evidently also have some differences. Due to its lower total land area, Ireland's road network density and population density are much higher than Norway's and New Zealand's, although still below the OECD average. Given the higher population density, this may result in a greater opportunity for public transport use in Ireland than in New Zealand or Norway. However, with regard to urbanisation, it appears that Ireland has a lower proportion of its population in urban settlement. A 2007 report by the United Nations suggests that New Zealand and Norway have high proportions of their populations in urban settlement (86% and 78%, respectively). The equivalent figure for Ireland is lower, at 61% (UNFPA, 2007, OECD, 2008c). Despite these differences, all three countries face significant congestion and the challenge to meet demand for road infrastructure.

As discussed later in this report, the most significant difference between New Zealand, Norway and Ireland is their respective GDPs. Throughout the 1960s and 1970s, Ireland, Norway and New Zealand were similar in terms of the size of their GDPs. More recently the three countries' economies have taken different paths. Norway's economic fortunes diverged from New Zealand in about 1980. Ireland's economic success has been more recent, realising large increases in GDP since the mid-1990s. Currently, Norway and Ireland have amongst the highest GDPs per capita in the world. In Table 1, GDP Purchasing Power Parity (PPP) is presented in addition to the nominal GDP which was used in the analysis. This reflects the relative cost of living in each country, as with the nominal GDP figures, the difference between New Zealand and the other countries is evident.

There are many determinants of economic performance, both long and short term. It is not the aim of this paper to review or analyse these. The analyses that follow make conclusions relating to the significance of transport infrastructure in the economic growth of these three countries.

It is suggested that the similarity between the three countries allows a valid cross-country comparison to be made at a broad level.

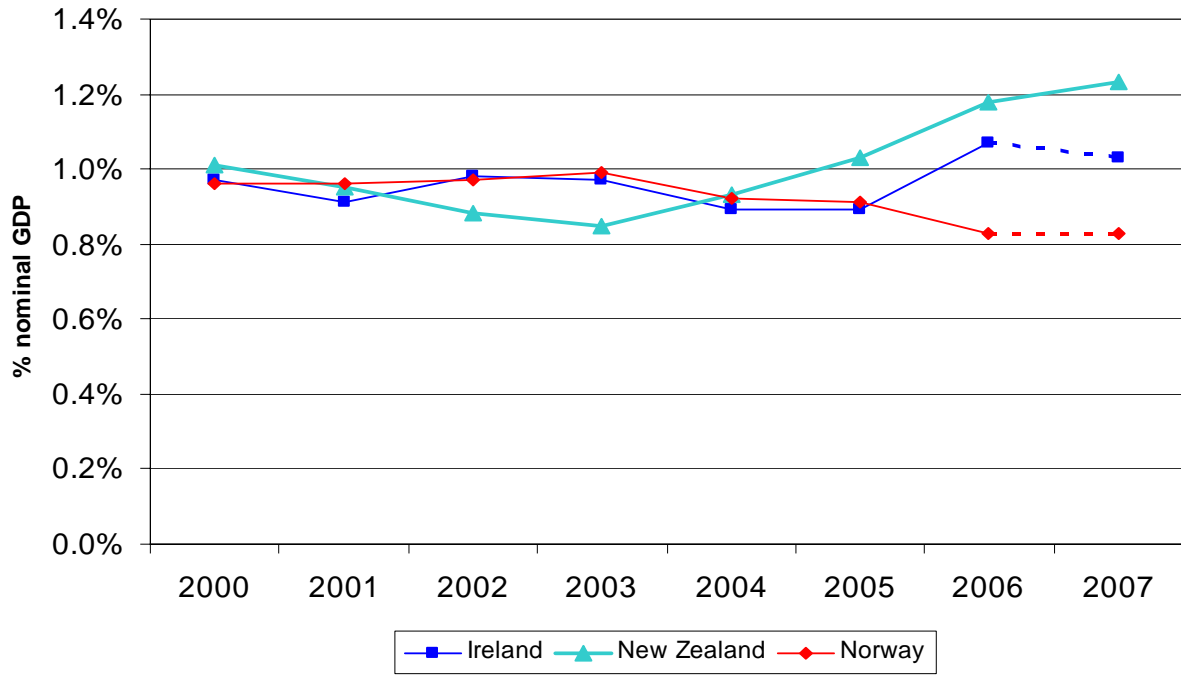
3.3 Investment trends in Ireland, Norway and New Zealand

Figure 1 documents transport infrastructure investment as a percentage of GDP. Figures 2 and 3 show changes in investment and in GDP using growth indices to allow a closer look at separate trends. Following this there is a discussion of differences in absolute spending and other comparisons between the countries included in the analysis. Comparisons per VKT and per capita would show a similar pattern to that in Figure 4, given the similarities between the three countries.

Figure 1 shows that the three countries have similar investment profiles relative to the size of their respective GDPs. This holds, despite the differing sources of funding, including tolls, private finance and EU investment, as discussed further below. The data do not include spending on public transport, which may show a different pattern. The indices in Figures 2 and 3 are indicative of the separate trends since 2000.

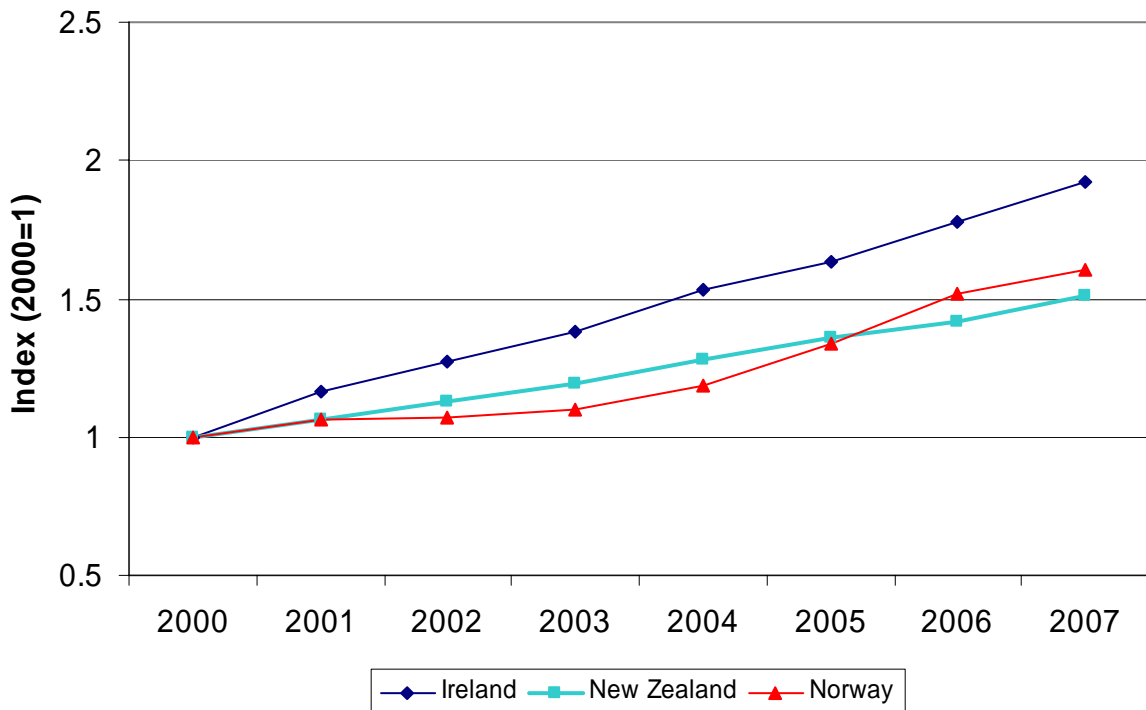
These graphs reveal some quite different trends for the three countries. Ireland has made large increases in investment, roughly in line with high economic growth. New Zealand made increases in investment lower than the rate of economic growth up to 2003, after which increases were larger than economic growth. Norway has had moderate economic growth with lesser increases in investment.

New Zealand has invested a similar amount compared to the other countries as a factor of GDP. However, New Zealand's GDP is smaller than that in the other two countries. In terms of absolute expenditure on road infrastructure, New Zealand is investing less (Figure 4).



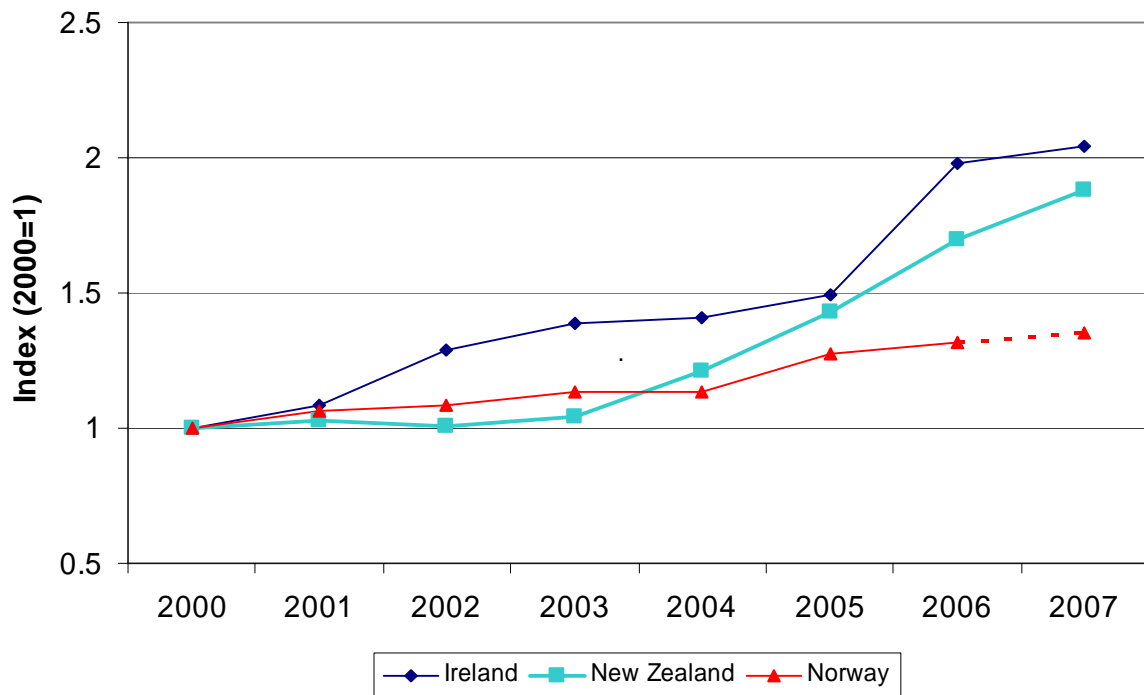
Dashed lines indicate an estimate based on GDP growth and budget forecasts.
Sources in Appendix 1

Figure 1 – Total national investment in road construction and maintenance as a percentage of GDP (nominal).



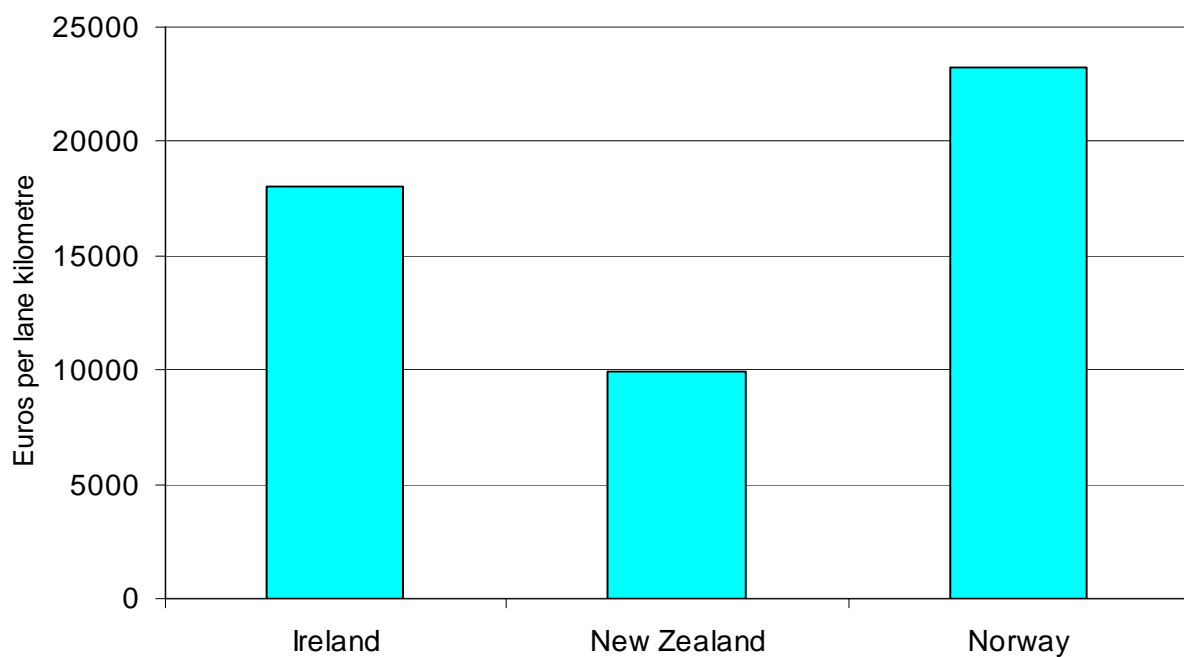
Sources in Appendix 1

Figure 2 – GDP growth indexed to 2000



Dashed lines indicates estimates based on budget
Sources in Appendix 1

Figure 3 – Growth in total investment in road construction and maintenance indexed to 2000



Note: Prices in 2006 Euros
Sources in Appendix 1

Figure 4 – Investment in road construction and maintenance per network kilometre in 2006

Table 2 raises some interesting questions about the relationship between economic development and transport, especially around the effectiveness and targeting of New Zealand's transport investment. VKT might be expected to increase in line with network length, yet there are differences between countries. New Zealand's lower GDP per capita might be expected to correlate with a lower car ownership, yet car ownership in New Zealand is higher than most countries in the world and more than a third higher than the two comparators. The higher level of urbanisation in New Zealand suggests a role for public transport currently not realised. Such differences may merit further investigation, with a view to identifying those aspects of New Zealand's transport network which would generate the most significant returns.

Table 2 – Comparisons between New Zealand, Norway and Ireland. Sources in appendix 1

	<i>Ireland</i>	<i>New Zealand</i>	<i>Norway</i>
Passenger car ownership 2006 (per 1 000 pop.)	420	620	450
Passenger car ownership (% increase 2000-06)	21%	8%	9%
Traffic growth (VKT) – % increase 2001-06 ¹	26%	9%	15%
Total road network length (% increase 2000-06)	0.9%	1.5%	1.6%
Population growth (avg. annual % 1970-2008)	1.1%	1.2%	0.5%

¹. The collection methodologies were not available for the VKT statistics, which may account for some of the difference between countries.

3.4 Finance and appraisal in Ireland, Norway and New Zealand

This section focuses on the funding sources and mechanisms in each of the three countries before evaluating the impact of each country's investment programmes in achieving their objectives. It concludes by discussing the significance of this comparison for New Zealand.

3.4.1 Ireland

Ireland's recent road infrastructure investment profile is characterised by strong growth in both investment and the economy. Since 1998, Ireland's economy has benefited from very large inflows of foreign direct investment, peaking in 2002 at nearly US\$30bn (OECD, 2008c). Price increases have accompanied economic growth and, in some areas, these are outpacing increases in income so that Ireland is becoming less affordable.

Ireland's transport investment strategy is contained within a six-year National Development Plan (NDP), whose current period is 2007-2013. The NDP is a coherent strategy for overall government infrastructure investment, required as a result of receiving funding from the EU. Over the period 2000-2006, Ireland's investment in infrastructure was boosted by EU funds. Although the value was high, €1.7bn over six years, this represented only 8.6% of the total amount invested under the NDP (€19.8bn). Contribution of EU funds has not often been accompanied by the kind of change seen in Ireland (Fitzgerald, 1998). Portugal has not experienced growth of the same scale, while Spain has realised substantial economic growth only in recent years.

A large part of Ireland's road infrastructure investment is for the upgrade of the National road network to dual carriageway. The National roads are strategic roads linking Dublin to Ireland's other principal cities, accounting for approximately 6% of the total network length with more than a third of the total vehicle kilometres travelled (VKT).

Since 2004, Ireland has engaged in public-private partnerships (PPP), with 35-year operating leases for a number of projects. After a slow initial uptake, the value of these is now approaching €2 billion (O'Neill, 2008).

Independent evaluation of the NDP (ESRI, 2003; Indecon, 2005) identified benefits of the investment in the order of 2-3% of GDP. These benefits were realised at the time of investment, and remain over the long term, but further benefit was not evident.

The Indecon report also reflected on the efficiency of the investments. It found that returns on investment were reduced by two factors: the high cost of construction and possible over-investment in a small number of roads. Regarding the first point, increases in construction costs have been relatively small compared to other countries throughout the period 2000-2006. However, looking back to the mid-1990s, construction costs increased more than 50% between 1996 and 2001 (Indecon, 2005). With regard to the second point (investment efficiency) the report suggested that, despite significant traffic growth (VKT), road capacity may not be met on some parts of the network. In contrast some roads continue to be heavily congested. This highlights the importance of allocating resources efficiently.

3.4.2 Norway

Since the 1970s, Norway's economy has benefited from substantial North Sea oil reserves. As a European country that has not joined the European Union, its price levels are among the highest in OECD countries. Norway's road infrastructure investment profile has been fairly stable over the past few years, with increases in GDP and investment roughly equal. Road construction prices have increased faster than GDP resulting in a decrease in investment in real terms since 2000.

Norway has made substantial use of road tolls to finance road construction. Indeed, for over 70 years, tolls have been used to fund infrastructure. Over the past twenty years, toll cordons around cities have been employed to raise revenue for accelerated road construction. Norway now has over 40 toll schemes around the country, with many cities operating toll cordons. Around a third of the total investment in road construction is from tolls. The two largest cities, Bergen and Oslo, are currently operating toll rings.

Bergen, Norway's second largest city, has had a toll ring since 1986. With a regional population of 340,000 it is similar in size to Wellington. The toll scheme was tied to a road construction package, which focussed on upgrading several arterial routes to the city. No financial support for public transport was included in the first package. Indeed, the opening of the toll ring coincided with a decrease in public transport subsidy and frequency. Consequently public transport use dropped significantly (Lian, 2008). In the short run, the capacity increases were sufficient to remove congestion problems. Car ownership increased to match the national average and VKT increased at above average rates (3-5% per year). More recently congestion has been evident again, and a new toll revenue package has directed substantial amounts towards public transport in an attempt to revive its use.

Waersted (1992, cited in Jeromonachou, 2006) reports that no increase in traffic was attributed to the introduction of the toll ring. However, both car ownership and VKT rose substantially. It is likely that both of these were affected by the investment in construction, the consequent increase in capacity and the reduction in transport costs.

Oslo is a very much larger city than Bergen. With a regional population of over one million in 2007, it is similar in size to Auckland. Oslo, and its adjacent regions, contains more than a third of Norway's total population (Fridstrøm, 1999). The initial scheme for Oslo (Oslopakke1) included a commitment of 20% of the revenue for public transport. Oslo did not experience such significant traffic growth as Bergen, nor did it have a reduction in public transport use.

The overall package allowed very much accelerated road construction. Waersted (2005) suggests that the projects which were completed in ten years of toll charging would have taken thirty-five years if they had depended only on central government funding streams. Toll revenue more than doubled the investment in transport infrastructure for Oslo, increasing the proportion of national funding from 11% to 23% (Lian, 2005). However, the increases in capacity have not solved Oslo's congestion problems as they did in Bergen.

Lian (2008) reports that traffic levels and capacity have increased in parallel. He suggests that this is a factor of significant urban sprawl and strong increases in population, employment and traffic (VKT) outside the toll ring. Lian acknowledges a relationship between these factors. It should be acknowledged that the toll rings were not intended as a traffic management measure. Currently the objective of the toll rings is being reviewed to investigate whether they may be used as a traffic management tool (Ieromonachou *et al.*, 2006). Like Ireland, Norway has begun to engage in public-private partnerships recently, with two completed projects and a third at the planning stage (Norwegian Ministry of Transport and Communications, 2008).

3.4.3 New Zealand

New Zealand's investment profile has been varied over the past few years, with a small decrease as a percentage of GDP for the three years to 2003, followed by a significant increase since then. In the longer term, international evidence suggests the pattern of New Zealand's investment in the period 1985-2000 is a common one throughout the developed world (ECMT, 2003). Despite increases in the costs of construction, there has been a real increase in investment.

A further breakdown of the construction price increases in New Zealand since 1999 reveals that fuel and oil costs have been responsible for a large part of the increase in costs. This presents the possibility that recent increases in road investment and increasing fuel costs could drive construction costs higher still in years to come. This would further erode the gains to be made by increasing investment in road construction.

Priorities for transport are set out in the New Zealand Transport Strategy, which was released in August 2008. The strategy documents the need to move toward more efficient use of the road network, and seek to achieve a range of policy objectives. Indications are for significant moves toward alternatives to the car, such as funding for public transport and active modes (e.g. walking/cycling).

Involvement of private finance through PPPs and tolling is currently being investigated for large projects such as the Waterview connection west of Auckland city. The Alport B2 extension of the Northern Motorway, north of Auckland, is programmed to open as a toll road in 2009 (Transit, 2008).

Despite claims that the road network is under-funded and restraining economic development, several indicators point to its ongoing quality. For example, the national State Highway authority, Transit New Zealand [since August 1st 2008 this function has been part of the New Zealand Transport Agency], carries out ongoing road condition surveys using its road analysis system (RAMM). These show continued performance over time. In terms of network growth, the New Zealand network has increased by a similar amount to Norway's. Congestion indicators are mixed, showing a decrease in delays in Auckland since 2003, but increases in congestion in Christchurch and Tauranga.

3.4.4 Further comparison across the three countries

This section reviews the significance of the similarities and differences identified between the three countries. While the total expenditure relative to GDP in each country has been similar, alternative funding sources such as PPPs and tolling appear to have enabled construction projects which would otherwise have taken much longer or been delayed. Private finance can introduce competition into the process, improving timeliness and performance. There is also the possibility that private investment results in greater security of long term funding.

In many countries, including New Zealand, the resource management and appraisal process has been criticised for delaying construction and increasing costs. The evaluation of the Irish NDP with regard to efficiency, points to the importance of effective targeting of investment based on assessment of costs and benefits. If the appraisal process in New Zealand is to be streamlined, it should not come at the cost of efficient targeting of investment.

Despite significant development of infrastructure in Ireland, the OECD's (2008b) most recent evaluation of restrictions on economic growth identified road infrastructure as one of the major factors in some areas. Yet Ireland's rise in the ranks of GDP per capita has been spectacular. It is by no means clear that an increase in infrastructure provision above a certain level is a necessity or a driver of economic growth.

New Zealand competes favourably in international comparisons of infrastructure. A report by the World Economic Forum has compared New Zealand's ground transport infrastructure with other countries². In a survey of over 120 countries, New Zealand ranked 25th and Norway 22nd, while Ireland was ranked 50th (WEF, 2007).

A notable shift in all three countries is the increasing investment in public transport. For example, Ireland is investing €16bn in public transport in the most recent NDP (2007-2013), while €18bn will be invested in roads. Norway and New Zealand have signalled similar shifts in priorities, which might be interpreted as recognition of the need to invest beyond the road network to provide for other modes. All three countries have experienced increases in the costs of road construction over the past decade, but trends and underlying causes vary.

It has recently been noted that New Zealand has made fewer gains in labour productivity than other countries (New Zealand Treasury, 2008). The Treasury also notes that much of the recent economic growth is from increasing labour participation rather than increased productivity. They argue that future gains should be realised through gains in productivity. Kamps (2004) sheds some light on the likely impact of increasing the value of the road network on productivity. His study reviewed the likely productivity gains from marginal changes to public capital stock (of which the road network is a large part). He finds that productivity in New Zealand is unresponsive to changes in the level of public capital stock relative to the OECD average. Contrary to claims that under-investment is restricting economic growth in New Zealand, this suggests that a marginal investment in physical infrastructure would have less impact on productivity in New Zealand than in other countries.

Also in relation to productivity, NZIER (2005) reviewed trends in capital stock in transport and storage. Figures from 1987 – 2001 show a decline in capital stock as a percentage of transport and storage sector contribution to GDP. The report suggests that a downward trend could indicate productivity improvements in the sector, although it is noted that this conclusion depends on correlation. Thus, the sector of New Zealand industry which is characterised by high vehicle use may be making gains in efficiency of use. This is in

² Ground transport infrastructure in this case is defined as "the quality of roads, railroads, and ports, as well as the extent to which the national transport network offers efficient, accessible transportation to key business centres and tourist attractions" (WEF, 2007)

contrast to other infrastructure-related sectors such as Communication and Gas, Electricity and Water whose ratio of capital stock to sector contribution is showing an upward trend (NZIER, 2005).

Research has highlighted the importance of large cities in the overall economic performance and productivity of a country. This is partly based on the realisation of agglomeration economies such that industrial density tends to correlate with a productivity benefit to all firms. Empirical evidence for New Zealand shows there is a productivity gap such that Auckland has higher productivity and value added per worker, (e.g. Mare, 2008).

4 Conclusions

Some commentators have argued that transport infrastructure in New Zealand is consistently under-funded and is restricting economic growth arising from gains in productivity. This short-term review of road transport infrastructure in New Zealand, Ireland and Norway reveals broad similarities between these countries in the levels of investment. A longer timescale review by ECMT (2003) suggests that the pattern of road infrastructure investment in New Zealand over recent decades is one which has been reflected in many developed countries. This trend may be partly a result of increasing competition for fiscal funding. The comparison with Ireland and Norway also showed underlying differences in both the income stream and the outcomes of investment. A review of the literature and of each country's funding streams points to the importance of investment efficiency and targeting of investment.

Other comparisons between countries reveal important differences which may merit further research. Car ownership in New Zealand is above most other countries, with the exception of the USA. Yet growth has been accompanied by a lesser increase in VKT in New Zealand than in other countries. This might suggest a more car-dependent society in New Zealand, one which may benefit from ongoing attention to public transport provision. Urbanisation and population growth are forecast to continue in some areas of New Zealand, giving greater emphasis to this need. Network maintenance statistics and measures of network growth would suggest that New Zealand is performing on a level comparable to Norway and Ireland. These countries are similar in size and geography to New Zealand but have a much higher GDP per capita.

While other factors that have driven the growth in GDP of these countries are well known, it would seem that infrastructure investment, *per se*, may be only loosely connected to that growth in terms of being either necessary or sufficient.

The conclusions are based on a small number of years of investment data. It is acknowledged that a longer time frame may present a different view. Comparable data was not available for a greater number of years at the time of writing but represents an avenue for further research. Similarly, in obtaining data which was comparable, it was necessary to compare a fairly narrow definition of road investment, including only road construction and maintenance, while excluding investment in public transport for example. Again, this would present an interesting comparison but is difficult in practice due to the involvement of private companies and many agencies. As noted in the previous section, the productivity gap in Auckland makes it important to economic growth. This being the case, a regional analysis of investment, including public transport, could be of particular value.

There is now a shift in priorities toward alternatives to car use and management of demand. In all three countries investigated, these priorities are evident in policies such as those set out in the New Zealand Transport Strategy (NZ Ministry of Transport, 2008). To finance their investment many countries around the world are considering or engaging in alternative finance streams, including PPPs and toll charges. Although this does not appear to have

made substantial differences in the overall level of funding, it changes the dynamic and targeting of investment. In Norway's case, completion of projects was achieved at a much greater pace. Toll charges offer an additional tool in setting appropriate prices for use.

The literature highlights the importance of effective appraisal of costs and benefits, taking into account the priorities of transport policy. The wider set of objectives which transport policy seeks to achieve may require greater investment in alternative modes, and pursuing gains in efficiency with respect to both investment in, and use of, the transport network.

Further research may enable identification of those aspects of the New Zealand transport network which could provide the largest gains in efficiency. Such gains would lead to optimal support for economic growth, and contribute to a clearer understanding of the factors relating transport investment and economic growth in New Zealand.

Appendix 1: Sources for figures and tables

National population data: OECD <<http://www.oecd.org>>.

GDP PPP data: International Monetary Fund listed on <<http://www.wikipedia.org>>.

Norwegian GDP data: Norwegian Statistics <<http://www.ssb.no>>.

New Zealand GDP data: NZ Treasury, personal communication.

Irish GDP data: Irish Central Statistics Office, <<http://www.cso.ie>>.

Irish transport investment data: Irish National Roads Authority <<http://www.nra.ie>>.

Norwegian transport investment: Norwegian Public Roads Administration (NPRA)
<<http://www.vegvesen.no>>.

New Zealand transport investment data: Land Transport New Zealand
<<http://www.landtransport.govt.nz>>.

Norwegian VKT data from Norwegian Public Roads Administration (PRA).
<<http://www.vegvesen.no>>.

Irish VKT data from UN Economic Commission for Europe (UNECE).

New Zealand VKT data from NZ Ministry of Transport.

References

- Allen Consulting (2004). *Benefits of investing in New Zealand's road infrastructure*. New Zealand Council for Infrastructure Development. <http://www.nzcid.org.nz>.
- ECMT (2003). *Trends in transport infrastructure investment 1985 – 2000*. <<http://www.internationaltransportforum.org>>.
- ESRI (2003). *Mid-term evaluation of the National Development Plan and the Community Support Framework*. <<http://www.ndp.ie>>.
- Fernald, J. (1997). *Roads to prosperity?* International Finance Discussion Paper No. 592. Federal Reserve Board.
- Fitzgerald, J. D. (1998). 'An Irish perspective on the structural funds'. *European Planning Studies*, 6(6), pp. 677-694.
- Fridstrøm, L. (1999). 'An econometric model of car ownership, road use, accidents and their severity'. In: *Econometric models of road use, accidents and road investment decisions*, Volume II. Report 457/1999. Norwegian Institute of Transport Economics (TØI): Norway.
- GHD (2005). *Comparing infrastructure in New Zealand and Australia*. <<http://www.nzcid.org.nz>>.
- Ieromonachou, P., Potter, S. and Warren, J. P. (2006). 'Norway's urban toll rings: Evolving towards congestion charging?' *Transport Policy*, 13, pp. 367-378.
- Indecon (2005). *Update evaluation of the ESIOP*. <<http://www.ndp.ie>>.
- Infometrics (2003). *Generating Growth: Infrastructure*. <<http://www.qiab.govt.nz>>.
- ITF (2007). *Inland infrastructure investment*. <<http://www.internationaltransportforum.org>>.
- Kamps, C. (2004). *New estimates of government net capital stocks for 22 OECD countries, 1960-2001*. IMF Working Paper WP/04/67. International Monetary Fund.
- Lian, J. I. (2005). *Impact of main road investments in Bergen and Oslo*. English Summary of TØI report 770/2005. Norwegian Institute of Transport Economics (TØI): Norway.
- Lian, J. I. (2008). 'The Oslo and Bergen toll rings and road building investment – Effect on traffic development and congestion'. *Journal of Transport Geography*, 16, pp. 174-181.
- Mare D. (2008). *Labour productivity in Auckland firms*. Motu Working Paper, June 2008.
- Norwegian Ministry of Transport and Communications (2008). <<http://www.regjeringen.no>>.
- NPRA (2001-06). *Annual reports (Arsmelding/Arssrapporter/Nokkeltall/Key Facts)*. Norwegian Public Roads Administration/Statens Vegvesen. <<http://www.vegvesen.no>>.
- NZIER (2005). *Summary infrastructure benchmarks: Comparing infrastructure provision in New Zealand and other countries*. <<http://www.nzier.org.nz>>.
- NZ Ministry of Transport (2008) *The New Zealand Transport Strategy*. <<http://www.transport.govt.nz>>.

- NZ Treasury (2007). *The risks and opportunities from globalisation*. Working Paper 07/05.
- NZ Treasury (2008). *Putting productivity first*. Working Paper 08/01.
- OECD (2007). *Infrastructure to 2030 (Vol.2): Mapping policy for electricity, water and transport*. Organisation for Economic Co-operation and Development.
- OECD (2008a). *Transport infrastructure investment: Options for efficiency*. OECD Publishing.
- OECD (2008b) *Going for growth: Structural policy indicators, priorities and analysis*. OECD Publishing.
- OECD (2008c). OECD Factbook 2008: Total Population: Population and Migration: Regional Population. <<http://caliban.sourceoecd.org/vl=9835804/cl=13/nw=1/rpsv/factbook/010102.htm>>.
- O'Neill, S. (2008). Head of Communications at Irish National Roads Authority. Personal Communication.
- SACTRA (1994). *Trunk roads and the generation of traffic*. Standing Advisory Committee on Trunk Road Assessment. Report for UK Department for Transport: London, UK.
- SACTRA (1999). *Transport and the economy*. Standing Advisory Committee on Trunk Road Assessment. Report for UK Department for Transport: London, UK.
- Statistics Norway (2008). Statbank information database. <<http://www.ssb.no>>.
- Transit New Zealand (2008). *Waterview connection*. <http://www.transit.govt.nz/projects/waterviewconnection/info_and_documents/>.
- UNFPA (2007). State of World Population 2007. <<http://www.unfpa.org>>.
- Waersted, K. (2005). *Urban tolling in Norway: Practical experiences, social and environmental impacts and plans for future systems*. <<http://www.piarc.org>>.
- World Economic Forum (2007) *The travel and tourism competitiveness report 2007*. World Economic Forum. <<http://www.weforum.org>>.