

*Confidential*

# **Summary Infrastructure Benchmarks**

**Comparing infrastructure provision in  
New Zealand and other countries**

**Updated Summary Report to  
New Zealand Council for  
Infrastructure Development**

**6<sup>th</sup> September 2005**



## Preface

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## Authorship

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## Executive Summary

Infrastructure is important to economic and social development, providing services that support modern industrial production, trade and lifestyles. But many constraints currently appearing in infrastructure – evident in concerns over transport congestion, energy security, water quality and broadband reach – raise questions about whether New Zealand infrastructure is sufficient to meet current and future needs, and whether the country is spending enough relative to other countries with which it competes.

Benchmarking is one of several methods used to estimate the likely scale of “deficit” in infrastructure provision required to meet expected economic growth. It usually entails comparing across countries simple statistical relationships between infrastructure spending and GDP or population.

There are no comprehensive sources of benchmarks or datasets on infrastructure across countries that allow widespread international comparison. But inferences can be drawn from:

- Detailed studies of particular countries, extrapolated to other countries;
- Public capital investments, which include some items that are not infrastructure, and exclude infrastructure provided by the private sector;
- Investment in infrastructure sectors in particular countries.

Infrastructure investment has declined in OECD countries since 1970 in face of growing demands on public funds for other expenditures and debt repayment. The OECD, World Bank and International Monetary Fund tell consistent stories on aggregate figures of capital formation and capital consumption, but they do not isolate the proportion attributable to infrastructure.

The OECD is currently undertaking a study of global infrastructure issues, opportunities and challenges which would develop appropriate data sets. New Zealand is not (although it could be) one of the participating countries.

Studies that relate infrastructure stock levels to economic activity generally indicate additional infrastructure has positive effects on economic activity, but there is no consensus as to how much. They also show that there is considerable disparity across countries in the ratios of capital stock to GDP, implying that the efficiency with which capital is used also varies widely.

New Zealand’s infrastructure provision can be inferred from changes in the capital stock in infrastructure industries (Utilities supplying electricity, gas and water; Transport and Storage; Communications) and by spending on the public road system (which is subsumed within Government Administration in the national accounts). This shows infrastructure investment declining as

a share of GDP over the past 35 years, as in other developed countries. (Figure 1).

Combining historical data with forecasts,<sup>1</sup> Figure 2 shows total road spending (road maintenance and capital improvements, excluding spending on public transport subsidy and other non-road items) declined as a share of GDP from 1960 to 1990 before levelling off. Current and forecast allocations provide for a slight rise in spending as a percentage of GDP, but this share is still well below the levels prevailing in the 1960s. Road expenditure in New Zealand is forecast in the range of 1.1-1.3% of GDP through to 2015, about the same level as in Australia in the late 1990s.

The ratio of capital stock to sector GDP in New Zealand has been relatively flat for the Utilities, Communications and Transport sectors since the early 1990s (Figure 3), in contrast to the experience in Australia where the corresponding ratios in the infrastructure sectors continue to decline (see Figure 4). The continuing decline in Australia is indicative of continuing productivity improvements in the use of capital in these sectors, whereas the flat profile in New Zealand suggests that capital productivity improvement has stagnated. Possible causes include insufficient investment in new efficiency raising technologies, ineffective investment choices, or inefficient operation of infrastructure, but more detailed studies would be required to decompose the causes of this apparent stagnation in each sector.

Most countries New Zealand commonly compares itself with have significant differences in size, wealth, industrial structure or political arrangements that affect their infrastructure provision. There are no close comparators for New Zealand and international benchmarking at aggregate level is only likely to give broad indication of whether New Zealand is an outlier compared to countries it seeks to emulate or compete with.

The amount that a country needs to spend on infrastructure depends on its industrial structure, configuration and geography, and stage of development. A long term decline in infrastructure's share of GDP need not be cause for concern if it reflects more efficient provision and operation of infrastructure over time, or a substantial shift to more productive sectors in the economy.

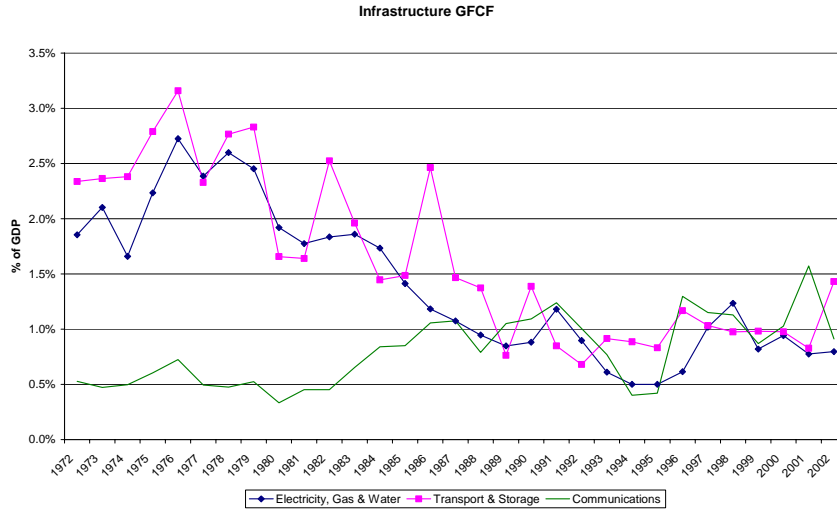
However, the New Zealand figures do show there has been long term decline in infrastructure spending as a share of GDP, and less productivity improvement than in Australia. This is suggestive of deficiencies in infrastructure provision in New Zealand, but more detailed assessments than benchmarking that better account for varying quality of infrastructure and its management are needed to explain the reasons for this situation.

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<sup>1</sup> Forecasts from the National Land Transport Programmes to 2015, local authority road expenditures at current contribution levels and NZIER forecasts of nominal GDP over the same period.

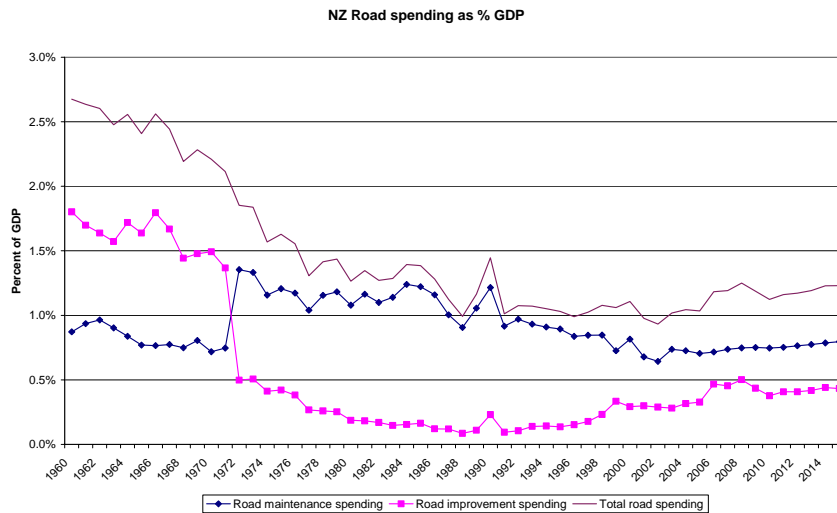
**Figure 1 Gross Fixed Capital Formation in Infrastructure Industries in New Zealand 1972-2002**

Percentage of GDP



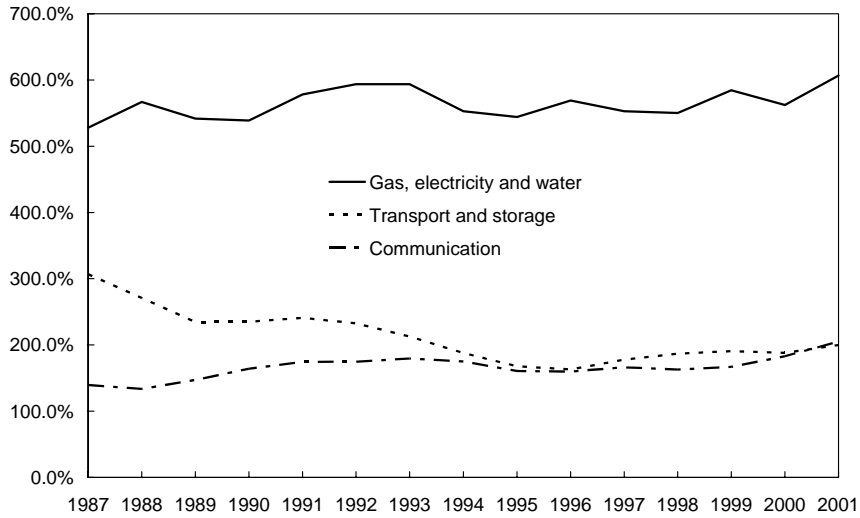
Source: NZIER; Statistics New Zealand

**Figure 2 Road spending as percentage of GDP**



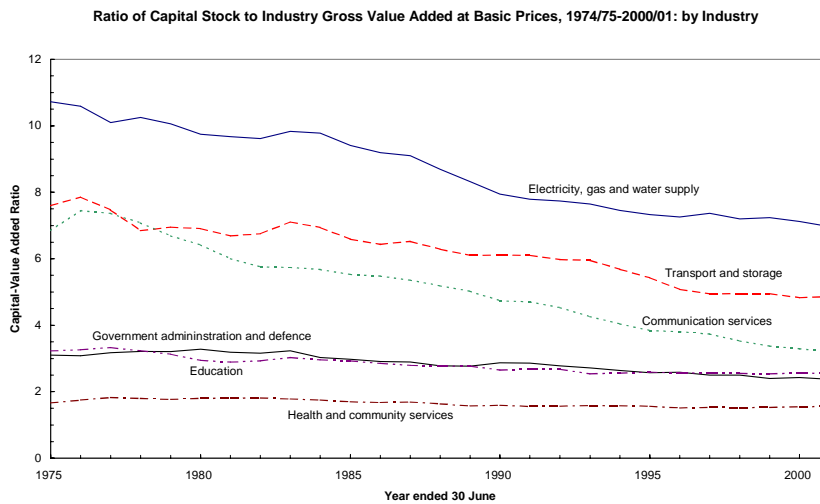
Source: NZIER, Statistics New Zealand, Land Transport New Zealand

**Figure 3 Capital stock as percentage of sector GDP in NZ**  
 NZ\$ value of sector capital stock against sector contribution to GDP



Source: NZIER; Statistics New Zealand

**Figure 4 Capital Stock to Industry Gross Value Added in Australia**  
 Basic Prices



Source: Makin

## 1. Introduction

Infrastructure is important to economic and social development, providing services that support modern industrial production, trade and lifestyles. But many constraints currently appearing in infrastructure – evident in concerns over transport congestion, energy security, water quality and broadband reach – raise questions about whether New Zealand infrastructure is sufficient to meet current and future needs, and whether the country is spending enough relative to other countries with which it competes.

Benchmarking is one of several methods used to estimate the likely scale of “deficit” in infrastructure provision required to meet expected economic growth. It usually entails comparing across countries simple statistical relationships between infrastructure spending and GDP, or infrastructure spending and population.

There are no comprehensive datasets on infrastructure across countries allowing widespread international comparison. Comment on the international experience with infrastructure is drawn from:

- Detailed studies of particular countries, with inferences extrapolated to other countries;
- Studies of investments in public capital stock, which include some items that are not infrastructure, and exclude infrastructure provided by the private sector;
- Studies of investment in infrastructure sectors in particular countries, which may also include non-infrastructure items (machinery, vehicles).

## 2. Definition of infrastructure

There is no universally recognised definition of infrastructure, although descriptions include “the basic services or social capital of a country, or part of it, which make economic and social activities possible by providing transportation ...[and other facilities]... in which community activities can take place.”<sup>2</sup> Definitions may variously encompass:

- Economic infrastructure, including physical assets such as roads, railways, airports, ports, telephones, energy, water and sewerage systems;
- Social infrastructure, including such assets as medical, educational and judicial facilities, and sometimes public housing, parks and amenities.
- Functional infrastructure, including institutions of governance, software platforms etc.

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<sup>2</sup> . The Routledge Dictionary of Economics (1995)

Government's infrastructure audit reports in 2004<sup>3</sup> covered four broad categories of infrastructure – transport, energy, water and wastewater, and communications. These are all economic infrastructure and share characteristics such as economies of scale that favour capacity adjusted in large, lumpy increments, high sunk costs and risk of asset stranding as market conditions change, long lead times for installing new capacity due to scale and regulatory hurdles (e.g. with respect to environmental impacts).

### 3. International trends in infrastructure

Infrastructure investment has declined in OECD countries since 1970 in face of growing demands on public funds for other expenditures and debt repayment. However, comparable data across countries to support this observation are elusive in the public domain, although some studies of selected countries do demonstrate the general proposition.

An ideal aggregate measure of infrastructure would capture changes in the stock of infrastructure over time, with new investment sufficient to cover depreciation and provision for growth. Published data on capital stocks rarely identify infrastructure separately, leaving the infrastructure stock to be inferred from flow measures of Gross Fixed Capital Formation and Fixed Capital Consumption.<sup>4</sup>

Information from the OECD, World Bank and International Monetary Fund tell consistent stories on these aggregates, but they do not isolate the proportion of capital formation and consumption attributable to infrastructure. The OECD is currently undertaking a study of global infrastructure issues, opportunities and challenges with a view to enhancing infrastructure's contribution to economic and social development, but New Zealand is not (although it could be) one of the selection of countries participating in this study.<sup>5</sup>

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<sup>3</sup> See [www.med.govt.nz/irdev/econ\\_dev/infrastructure/reports](http://www.med.govt.nz/irdev/econ_dev/infrastructure/reports)

<sup>4</sup> **Gross Fixed Capital Formation** is the term used in the System of National Accounts to refer to gross investment in tangible assets. It comprises the outlays of producers on durable real assets, such as buildings, motor vehicles, plant and machinery, roading, and improvements to land (e.g. clearance, contouring, drainage etc), although it excludes the purchase value of land itself. GFCF includes the value of construction work done by a firm's own employees. The term 'gross' indicates that **Fixed Capital Consumption** (depreciation) has not been deducted from the value of the outlays: so gross investment encompasses both replacement investment and net new investment.

In aggregate, over the long term, a sector's or economy's GFCF needs to roughly keep pace with its fixed capital consumption if it is to sustain growth. If GFCF comprises only replacement of capital consumed in the previous period, the sector/economy can only grow to the extent that technology change increases productivity of capital as it is replaced. To raise growth above this level requires net new investment in excess of capital renewal, to increase capacity of assets to provide more services.

<sup>5</sup> OECD Advisory Unit on Multi-Disciplinary issues: Futures Project on Global Infrastructure Needs: Prospects and Implications for Public and Private Actors (July 2005)

The amount that a country needs to spend on infrastructure depends on its industrial structure, configuration and geography, and stage of development. A long term decline in infrastructure's share of GDP need not be cause for concern if it reflects more efficient provision and operation of infrastructure over time, or a substantial shift to more productive sectors in the economy (such as services) with smaller inputs of infrastructure services per unit of value added.

Studies that relate infrastructure stock levels to economic activity generally indicate additional infrastructure has positive effects on economic activity, but there is no consensus as to how much. They also show that there is considerable disparity across countries in the ratios of capital stock to GDP, implying that the efficiency with which capital is used also varies widely. Such efficiency differences may stem from the institutions within which infrastructure is managed, as well as the level and quality of investment.

Three firm conclusions can be drawn from the existing international literature on infrastructure's contribution to economic activity:

- Infrastructure is a necessary and vital prerequisite to private production, but it alone will not drive growth if other conditions are not favourable (like open markets and flexible labour supply), so issues around infrastructure quality, management and institutional oversight need consideration alongside infrastructure quantity.
- Investment in public infrastructure has generally positive effects on growth, but it is also subject to the law of diminishing returns, and at some point further additions may be counter-productive.
- Across all countries a majority of studies indicate an under-investment in public capital to date, but there is little agreement as to the magnitude of that under-investment.

Some studies illustrating New Zealand's relative performance include:

- A UNIDO study of 89 countries shows New Zealand's ranking on infrastructure slipping from 13<sup>th</sup> in 1985 to 17<sup>th</sup> in 1998, using an infrastructure index narrowly based around the number of phone connections and energy use in each country.<sup>6</sup>
- An IMF study of 22 OECD countries shows New Zealand has one of the highest rates of public capital per head (including infrastructure) but also an elasticity of output with respect to new public capital of 0.087, substantially lower than the average for the group of countries (0.221).<sup>7</sup>
- A World Bank study of global infrastructure needs to 2010 found developed countries (including New Zealand) needed on average to

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<sup>6</sup> UNIDO (2002) *Industrial Development Report 2002/03 - Competing through innovation and learning*

<sup>7</sup> Christophe Kamps (2004) "New estimates of Government Net Capital Stocks for 22 OECD countries 1960-2001" IMF WP/04/67

spend 1.18% of GDP per year on infrastructure, including 0.42% of GDP on new infrastructure (not maintenance).<sup>8</sup> But New Zealand (and Australia) already spend more than this share of GDP on infrastructure (2-3%), raising questions about this study's data and assumptions.

An example of international benchmarking is given by the UK's Commission for Integrated Transport (CIT), which notes the UK spent 0.9% of GDP on transport infrastructure in 1996 compared to an EU average of 1.2%, and that UK spending per head of population fell from 89% of the EU average in 1990 to 71% in 1994.<sup>9</sup> However, CIT notes major difficulties in interpretation caused by spending varying according to weak economic growth and budget constraints, the distorting effects of large one-off infrastructure projects, and poor data for private investment and infrastructure maintenance. It concludes that further work needs to be done to overcome limitations of aggregate level benchmarking, and the need to supplement it with other assessments of infrastructure quality and deficiencies.

## 4. New Zealand's infrastructure record

New Zealand's infrastructure provision can be inferred from changes in the net capital stock in infrastructure industries (Utilities supplying electricity, gas and water; Transport and Storage; Communications) and by spending on the public road system (which is subsumed within Government Administration in the national accounts). This shows investment declining as a share of GDP over the past 35 years, as in other developed countries.

Figure 1 shows gross fixed capital formation in Utilities (Electricity, Gas and Water) and the Transport and Storage sectors declining as a share of GDP over the period from 1972, but the Communications sector has had a slightly rising share. This pattern is similar to that in Australia, where the share of GDP spent on Transport and Storage has been markedly higher than in New Zealand since 1990.<sup>10</sup> Net fixed capital formation (after allowing for capital consumption) for the three New Zealand sectors combined has been less than 1% of GDP for most years since 1990 (average 0.6% per year).

A recent rise in communications investment has been a common experience in New Zealand, Australia and other OECD countries. There is an element of technology-push implicit in these worldwide patterns, with the emergence of new telephony services, internet data requirements and the

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<sup>8</sup> Fay M & Yepes T (2003) "Investing in infrastructure: what is needed from 2000 to 2010?"; World Bank Policy Research Working Paper 3102

<sup>9</sup> UK Commission for Integrated Transport (2003) "European Best Practice in Transport – Benchmarking".

<sup>10</sup> Makin T (2002) "Infrastructure in Australia: Estimates, Effects and Issues" Paper to the Pacific Economic Outlook, Structural Issues Group, Japan (March)

rapid spread of cellular phones since the early 1990s. In both New Zealand and other countries, this has coincided with a period of regulatory change and increased competition on the domestic market. A combination of expanding demand, new service possibilities, competition and disputes over access to common networks and gradual increase in regulatory certainty have led to conditions for infrastructure investment. However, precisely attributing this to technology, ownership or demand drivers is an exercise that has yet to be done.

The other utilities sectors have not enjoyed such favourable conditions for investment. Water offers little scope for new services other than improvements in quality and reliability, and is still largely under the influence of local government ownership and legal restrictions on the charging for water and wastewater services. Investment in energy infrastructure has been slow to expand after deregulation and the creation of competitive suppliers. Contributory factors to this include concerns over long term gas supply, protracted Resource Management Act processes for large projects, and the increased risk of asset stranding in a regulatory environment which is still subject to periodic change.

Spending on the road network is readily identifiable because of its transparent funding through central and local government bodies. Figure 2 is drawn from National Land Transport Programmes to 2015, Statistics New Zealand figures on local authority road expenditures and NZIER forecasts for nominal GDP over the same period. The NLTP figures are those released in August 2005, after allowing for an announced increase of \$500 million, which raises the profile of total spending in the period to 2010.

Total road spending (road maintenance and capital improvements, excluding spending on public transport subsidy and other non-road items) declined as a share of GDP from 1960 to 1990 before levelling off (Figure 2). Spending on road improvements and new roads also declined relative to maintenance spending, but recovered after 1990. Current allocations provide for increases in road improvements and total road spending, which represents a slight rise in spending as a percentage of GDP, but this share is still well below the levels prevailing in the 1960s. Road expenditure in New Zealand is forecast in the range of 1.1-1.3% of GDP through to 2015, about the same level as in Australia in the late 1990s.<sup>11</sup>

Nominal GDP grew faster than road spending through to the early 1980s, since when road spending has moved somewhat erratically but generally kept pace with growth in GDP in most years until 2005-2007, when the growth in road spending is expected to outstrip GDP.

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<sup>11</sup>Allen Consulting Group (2004) *“Benefits of Investing in New Zealand’s Road Infrastructure”*  
Report for the New Zealand Automobile Association

The rate of productivity improvement from infrastructure in New Zealand (as indicated by the ratio of capital stock in the infrastructure sectors per unit of sector contribution to GDP) has slowed compared to countries like Australia. This may be because the infrastructure investment is lower than it needs to be, or it is not being managed as efficiently as it could be.

Figure 3 shows the ratio of capital stock to sector GDP in New Zealand to have been relatively level for Utilities, Communications and Transport sectors since the early 1990s. This contrasts with the experience in Australia where the corresponding ratios in the infrastructure sectors continue to decline (see Figure 4).<sup>12</sup> The flat profile in New Zealand suggests that improvement in capital productivity has stagnated. Possible causes include insufficient investment in new efficiency raising technologies, ineffective investment choices, or inefficient operation of infrastructure, but more detailed studies would be required to decompose the causes of this apparent stagnation in the different sectors.

The corresponding ratios of Capital Stock to Gross Value Added (GDP) for the infrastructure sectors in Australia are presented in Figure 4. There is a long term decline in these ratios for each of the Utilities, Transport and Communications sectors which is continuing up to the present. The consistent decline in Australia is indicative of continuing productivity improvements in the use of capital in these sectors, which in turn may reflect more appropriate investment in these sectors than is being achieved in New Zealand.<sup>13</sup> Establishing the reasons for the apparent differences between the countries, however, would require more detailed investigation than a comparison of aggregate indicators, and may depend on data that is not available in the public domain in a consistent form across countries.

As a share of GDP, Gross Fixed Capital Formation in the Utilities, Transport and Communications sectors has been slightly higher in Australia than in New Zealand over most recent years.

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<sup>12</sup> Figure 3 and Figure 4 are from different sources and use different scales and terminology but are depicting similar features of each country. For New Zealand each sector's capital stock is shown as a percentage of the sector's contribution to GDP: the capital stock figure is much larger than the GDP flow figure. In Australia the same relationship is expressed as a ratio. Industry value added is essentially the same as sector GDP. The differences in ratios in the two countries suggests there may be differences in the way capital stock or value added are being measured across the two countries, but such measurement issues would not explain the differences in the direction of trend.

<sup>13</sup> The flat ratios in Figure 4 for Government Administration, Education and Health sectors in Australia do not necessarily imply a lack of productivity improvements: as much of the output of these sectors is not provided at market prices, in the national accounts their outputs and value added are calculated through costs of supply rather than value of outputs, so the flat ratios simply imply that for these sectors capital stock is in relatively constant proportion to the level of activity.

## 5. Comparison with other countries

Overall New Zealand's history of infrastructure investment over the past 35 years shows a similar pattern of declining share of GDP as is found in other developed countries, but no other country has the size, industrial structure and political characteristics to provide a close comparison of performance. Most countries New Zealand commonly compares itself with have significant differences in size, wealth, industrial structure or political arrangements that affect their infrastructure provision.

As a share of GDP, Gross Fixed Capital Formation in Australia has been higher in Transport and Storage, and about the same in Utilities and Communications, as in the corresponding New Zealand sectors since the early 1990s. The apparent difference in productivity across the two countries reflects more than just investment levels. Australian spending on road infrastructure has been higher throughout the same period.

Ireland is a country that is sometimes compared to New Zealand, with a similar sized population and an enviable recent record of climbing up the OECD rankings by per capita GDP. It currently has a National Development Plan investing 3% of GDP in infrastructure, including transport, water services, housing and health facilities. But Ireland's infrastructure has also benefited from substantial transfers from the EU's structural funds, and there is some evidence it may be over-investing in some areas.<sup>14</sup>

Norway is another country similar in population size and elongated geography to New Zealand, but it has also consistently been one of the OECD's highest ranked countries by per capita GDP over the past two decades. With substantial revenues from oil and gas exports it has invested heavily in transport infrastructure, but some of this has an explicit social motivation of improving accessibility and retaining population in remote rural areas. Thanks to the ease with which electricity can be exported to neighbouring countries in Europe, it has 27,000 megawatts of installed generation capacity, three times that in New Zealand, providing generous headroom and resilience against variability in its mainly hydro-based system. These characteristics cannot be replicated in New Zealand, where energy can only be exported "embedded" in products.

International studies provide some evidence that the decline in investment in infrastructure sectors has been steeper, and levelled off later, in New Zealand than in other OECD economies.<sup>15</sup> However, these studies do not fully explain the reasons for this difference in experience.

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<sup>14</sup> Kamp's (2004) study of 22 OECD countries referred to above, found Ireland's elasticity of output with respect to new public capital spending to be -0.068 over the period 1960-2001. If correct, this would imply that new public capital spending (including on infrastructure) has a negative effect on economic output, but what is driving this result is unclear from the study.

<sup>15</sup> Kamp's (2004) study, referred to above.

## 6. Conclusions

International benchmarking of infrastructure provision at aggregate level is only likely to give broad indication of whether New Zealand is an “outlier” compared to other countries it seeks to emulate or compete with. It needs to be complemented by more bottom up approaches to assessing infrastructure needs that can better account for varying quality of infrastructure and its management.

However, the New Zealand figures do show there has been a long term decline in road spending as a share of GDP, with some recovery since the late 1990s. They also show less productivity improvement from capital in infrastructure sectors than is apparent in Australia. This is suggestive of relatively inefficient provision of infrastructure in New Zealand, but benchmarking alone will not establish what causes these differences.