Investment in transport infrastructure

Effects on economic and demographic outlook

NZIER report to Horowhenua District Council

November 2015

About NZIER

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

NZIER is also known for its long-established Quarterly Survey of Business Opinion and Quarterly Predictions.

Our aim is to be the premier centre of applied economic research in New Zealand. We pride ourselves on our reputation for independence and delivering quality analysis in the right form, and at the right time, for our clients. We ensure quality through teamwork on individual projects, critical review at internal seminars, and by peer review at various stages through a project by a senior staff member otherwise not involved in the project.

Each year NZIER devotes resources to undertake and make freely available economic research and thinking aimed at promoting a better understanding of New Zealand's important economic challenges.

NZIER was established in 1958.

Authorship

This paper was prepared at NZIER by John Ballingall, Geoff Parr and John Stephenson.

L13 Grant Thornton House, 215 Lambton Quay | PO Box 3479, Wellington 6140
Tel +64 4 472 1880 | econ@nzier.org.nz

Key points

The objective: explore how the Wellington Northern Corridor (WNC) could transform the Horowhenua economy

Horowhenua District Council (HDC) has asked us to provide a scenario of how the Horowhenua economy will perform given infrastructure improvements as part of central government's investments in the Roads of National Significance (RoNS).

The literature provides some insights into how improved transport links affect economic outcomes

A review of international and domestic literature highlights that improved transport links tend to deliver economic benefits through various channels:

- widening businesses' possibilities
- new external investment
- increased productivity following a 'thickening' in local markets for labour and goods and services
- increasing population dispersion.

Various case studies use these channels to estimate expected gains to regional economies from large transport projects (i.e. ex ante studies), and we have drawn on their findings to inform our analysis. But we found very little relevant ex post analysis (analysis after the projects are completed) to inform this study.

Significant impact on Horowhenua

Based on our review of the literature, we posit that investment in State Highway 1 between Wellington and Levin is expected to reduce freight costs and travel times and thereby make Wellington and Manawatū-Whanganui more desirable and more productive. This a free hit to the regional economy – in that this is investment in new capacity for the region that does not cannibalise other investment.

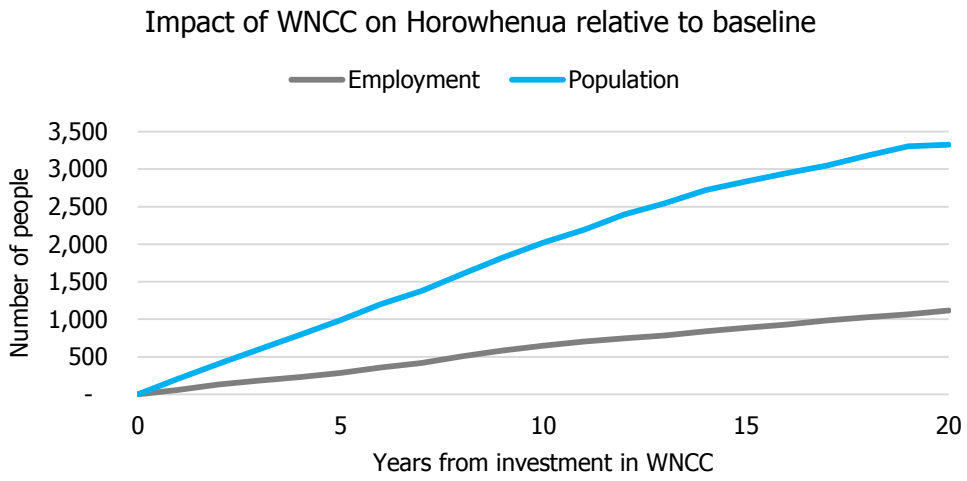
Using empirical models that examine these growth drivers, we find that, if the investment works as intended, population growth, employment and economic activity will be significantly higher than otherwise expected.

850 additional jobs in 2030 and faster population growth

By our estimation, WNC investment will see 850 extra jobs in the Horowhenua District in 15 years, and over 1,000 in 20 years. This is shown as the cumulative difference in jobs in the region relative to our baseline (or without the impact of WNC investment) in Figure 1.

Figure 1 Projected employment and population shocks in Horowhenua District

Number of persons



Source: NZIER

These estimates of job gains are larger than in previous modelling exercises. The main reason our numbers differ is because our analysis combines the effects of rising employment and economic activity with increased migration in-flows and then accounts for the second round effect that this has on jobs.[1] Our analysis also assumes employment gains are proportionate to the size of the labour force – which is growing over time – as opposed to measuring employment impacts in terms of one off absolute changes.

Population growth will increase, rising to 1.2% annual growth, on average over the next 15 years, compared to annual growth of 0.4% in the past 10 years. This will translate into 1.7% annual growth in number of households over the next 10 years, compared to 0.7% annual growth on average in the last decade. This will lift Horowhenua's population by nearly 10,000 people in 20 years.

Maximising the potential gains from WNC

that HDC's economic development focus to take advantage of the WNC might usefully be directed towards:

- leveraging comparative advantages (including cheap land and attractiveness to land intensive industry)
- planning for required infrastructure needs
- intensive cooperation with neighbouring districts which, on some issues, are essentially part of the Horowhenua
- lifting firms' and households' openness to change.

[1] More people (immigrants) generally means more jobs. This sort of effect is not usually used in state highway investment assessments because NZTA takes a national-level approach while some of the changes we are estimating are 'transfers' of people and economic activity within New Zealand. NZTA (2013 pp. 2-4) notes that their 'Social cost-benefit analysis considers the cost and benefits to the nation as a whole. This viewpoint is appropriate in the cast of transport activities, which are undertaken on behalf of the nation and are publicly funded.'

Contents

Appendices

Figures

Tables

1. Objectives and approach

The brief

Horowhenua District Council (HDC) has asked us to provide a credible scenario of how the Horowhenua economy will perform given infrastructure improvements as part of central government's investments in the Roads of National Significance (RoNS).

The RoNS includes an investment in State Highway 1 between Wellington and Levin, known as the Wellington Northern Corridor (WNC). This will likely reduce freight costs and travel times, making Wellington, Manawatū-Whanganui and the Horowhenua District more desirable and more productive. This is likely to mean population and economic activity will be significantly higher than otherwise. We have been asked to quantify these potential gains.

We have also been asked to assess Horowhenua's economic connections with surrounding regions and how widely HDC should think about in considering the potential economic impacts of the WNC. The WNC is an investment spanning multiple administrative regions. This raises questions about whether the investment will have different impacts in different parts of the Wellington and Manawatū-Whanganui regions. Indeed, one might reasonably ask whether administrative (council) boundaries bear a reasonable resemblance to economic or functional boundaries.

Our approach

1. Review literature on how transport affects regional economic activity (develop a framework).
2. Identify relevant case studies of transformational change resulting from improved transport links (identify parameters for modelling).
3. Build empirical simulation models to estimate potential gains in population and employment, and implications by broad industry.
4. Describe the wider connections of the Horowhenua economy in the context the potential economic impacts of the WNC.

2. The framework: how WNC might deliver benefits

This section draws on the literature review in Appendix A and pulls out the key themes.

2.1. How transport infrastructure affects economic development

Investment in transport infrastructure can boost economic activity by:

1. **widening businesses' access to workers and inputs** and markets (i.e. expanding production possibilities)
2. **increasing population dispersion** – i.e. widening the geographical scope of an economy
3. new production possibilities attracting **new external investment** (possibly foreign direct investment)
4. **'thickening' local markets** for labour and goods and services, which can boost productivity by
    a. increasing competitive pressures

improving information exchange, including helping people to find the right job or find the right staff. The first three channels lift economic activity and employment by either utilising existing under-employed resources (people and land) or attracting new people to an area.

The fourth effect raises wages and living standards, through convergence with surrounding regions.

All of the above effects can combine to cause structural change in an economy, such as by making different kinds of industries viable because of improved access to knowledge-intensive skills. This further raises growth potential.

The positive benefits are likely to disproportionately accrue to larger population centres. This is because already large and dense centres can take advantage of the benefits unlocked by better infrastructure, with an advantage from having a larger and more productive economy to start with.

At the same time, increased productivity is also likely to cause living costs to increase through higher land prices. This can then cause positive 'spill-overs' where some people migrate to neighbouring areas where land prices are lower.

3. The modelling

Our modelling draws on the framework described above, uses some key parameters from the most relevant studies and is calibrated using relevant data from Statistics New Zealand.

There are numerous options for analysing the costs and benefits of infrastructure projects. These are summarised in Appendix A.2.

For this paper, we use demographic- and industry-based simulation modelling. Further information on simulation modelling is provided in Appendix C.

3.1. Channels of effect: employment, migration and productivity

3.1.1. Direct effects on employment, migration and productivity

Three effects have been modelled:

- a reduction in the long run unemployment rate (-0.01%)
- productivity gains (+0.1%) due to an increased economic mass in the wider lower North Island
- an increase in the propensity of people to migrate to Horowhenua (0.4%) given changes in economic activity and opportunities in Horowhenua and surrounding regions.

The first shock assumes that conventional employment gains (as in Saha, 2010) manifest themselves as a reduction in unemployment – or improved utilisation of local resources already residing in Horowhenua.[2]

The productivity gain assumption is informed by estimates from the UK suggesting that productivity gains from transport infrastructure for a smaller town sitting between two larger centres are likely to be in the order of 0.5% and up to 2.65% if the structure of the town's economy changes.[3] These effects are one-off effects over an unspecified period. We, however, want to model specific annual productivity growth changes.

We have chosen to model an additional 0.1% on annual rate of productivity growth by way of example.

A 0.1% productivity improvement is not large in the context of existing indicators of productivity in Horowhenua. Horowhenua has persistently low average incomes for similar occupations when compared to neighbouring districts (see Figure 2 and

[2] Mckay to Foxton investment expected to cause a 0.1% increase in employment. This is approximately equivalent in this case to a 0.1 percentage point reduction in unemployment.

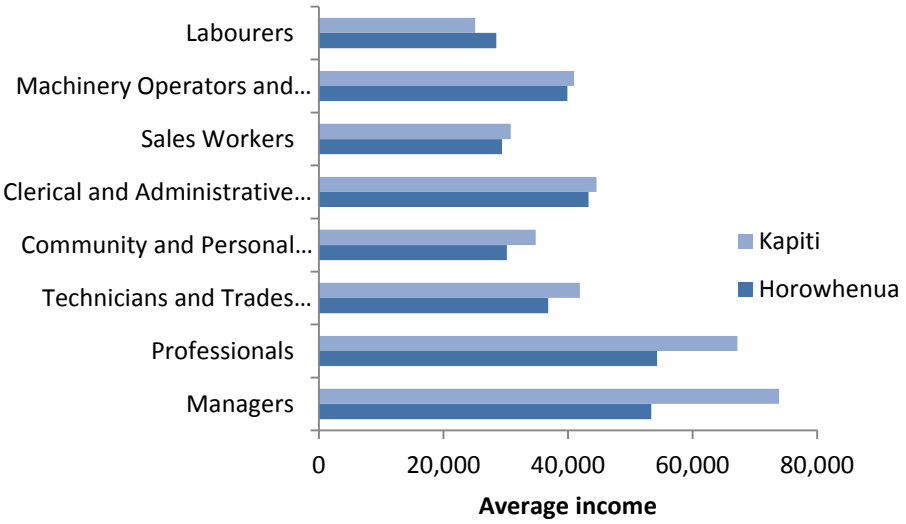
[3] Overman et al (2012) suggest a 20 minute accessibility improvement in travel between Leeds (715,000 people) and Manchester (2.5 million people) would lift wages in the town of Wakefield (70,000 people) by 0.5%.

discussion in section 4 on labour markets). This suggests considerable scope for productivity gains and associated wage increases.[4]

That said, we do not expect complete closure of productivity and income gaps. This is because people tend sort themselves into higher wage and lower wage locations based on preferences and productivity. That being so, convergence will be 'conditional', which means income gaps are likely to persist.

Figure 2 Gaps in incomes suggest scope for productivity gains

Mean income by occupation group



Source: Statistics New Zealand census 2013

The migration response is based on an estimated relationship between GDP and migration of a 0.69% increase in migration rates for every 1% increase in GDP (see Appendix A).[5] The size of the shock is fairly small, as shown in Figure 3 below, but the impacts in terms of population size do accumulate over time.

3.1.2. Spillover effects from neighbouring regions

Sitting behind these effects are other positive effects that arise from gains outside Horowhenua, particularly the Wellington region.

We have assumed that the employment impact in Wellington from the WNC is twice as large as in Horowhenua (i.e. 0.2% in accordance with official RoNS business case

[4] If people in Horowhenua working as Technicians or in Trades had wages that grew 0.1% faster than people in Kapiti it would take 100 years to close the gap in wages observed at the last census. This reinforces that our productivity gain assumption is modest. This modesty is important because assumptions about productivity growth are very powerful while evidence for what affects productivity growth is, by definition, lacking because it is measured as a 'residual' i.e. what is left over after capital services and quality adjusted labour inputs have been used to explain output.

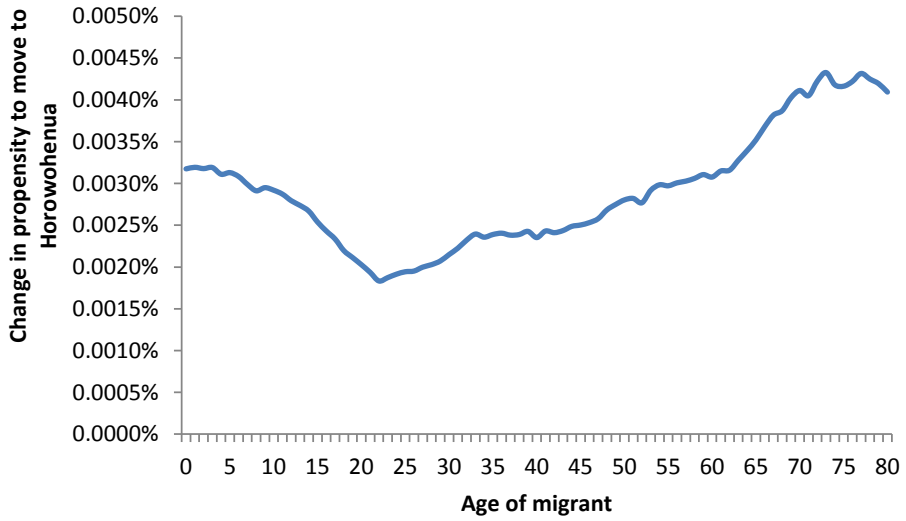
[5] This order-of-magnitude change is modest relative to other research suggesting a one-for-one relationship between employment shocks and migration (see Grimes, Mare, and Morten (2007)).

estimates) and used the same assumptions as for Horowhenua in the case of migration probabilities and productivity growth.[6]

Growth in Wellington then boosts growth in Horowhenua because once in Wellington people have an increased propensity to then move to Horowhenua, perhaps, but not always, in retirement.

Figure 3 A modest shock to inward migration

Change in probability that domestic or overseas migrant will move to Horowhenua District[7]



Source: NZIER

3.2. Results

3.2.1. Economy-wide employment effects

By our estimation, WNC investment will see 850 extra jobs in the Horowhenua District in 2030. This is the difference, in 2030, between the solid line and the dotted line in Figure 1. This is a 0.4% increase in annual growth in the number of jobs in the District, from 0.8% to 1.2%. This is a little lower annual growth rate compared with the past 10 years when the number of jobs in the District grew by 1.4% per year on average – a growth rate that was 1.1% higher than population growth reflecting the extent to which people travel from other districts to work in the Horowhenua District.

These estimates of job gains are larger than in previous modelling exercises. The main reason our numbers differ is because our analysis combines the effects of rising employment and economic activity with increased migration in-flows and then

[6] The reason we chose not to increase productivity and migration rates to reflect larger infrastructure and employment impacts is to keep the simulations from being overly optimistic. Further, Wellington faces greater land constraints that might limit changes in immigration potential in a way that they might not in Horowhenua.

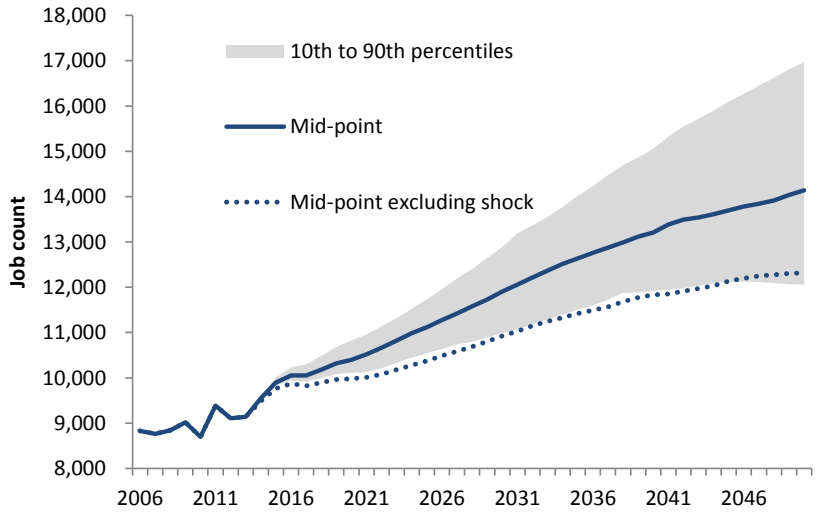
[7] The average probability that a migrant looking to live somewhere in NZ, whether domestic or international, will choose the Horowhenua District is 0.0025 (0.25%).

accounts for the second round effect that this has on jobs.[8] Our analysis also assumes employment gains are proportionate to the size of the labour force – which is growing over time – as opposed to measuring employment impacts in terms of one off absolute changes.

The distribution of outcomes in the shaded area illustrates the uncertainty in long term projections. Economic and demographic changes are path dependant and policy and other shocks tend to accumulate over a long period of time. This means that negative shocks can lead to a persistently worse outcome than the middle-scenario. Similarly, positive shocks can lead to a virtuous cycle of positive outcomes.

Figure 4 Projected employment in Horowhenua District

Job count (not adjusted for FTEs). Projections include range with probabilities.



Source: NZIER

3.2.2. Sector impacts

Sector-wise the biggest increases in growth from the WNC investment are expected in the manufacturing sector. The biggest change in activity (GDP), however, is in the services industry – servicing both tourists and other industries. And the fastest growth rate is in the primary sector, albeit off a comparatively low base.

[8] More people (immigrants) generally means more jobs. This sort of effect is not usually used in state highway investment assessments because NZTA takes a national-level approach while some of the changes we are estimating are 'transfers' of people and economic activity within New Zealand . NZTA (2013 pp. 2-4) notes that their 'Social cost-benefit analysis considers the cost and benefits to the nation as a whole. This viewpoint is appropriate in the cast of transport activities, which are undertaken on behalf of the nation and are publicly funded.'

Table 1 All sectors expected to play a role in growth

GDP estimates are dollar millions ($1995/96)

	Levels			Share of total GDP		
	Primary	Manufacturing	Services	Primary	Manufacturing	Services
2005	82	138	233	18.1%	30.4%	51%
2015	102	148	238	20.9%	30.3%	49%
2030	155	174	348	22.9%	25.7%	51%
2050	245	200	529	25.2%	20.5%	54%

	Change			Compound annual growth rate		
	Primary	Manufacturing	Services	Primary	Manufacturing	Services
2005-2015	20	10	4	2.2%	0.7%	0.2%
2015-2030	52	26	110	2.8%	1.1%	2.6%
2030-2050	91	26	182	2.3%	0.7%	2.1%
2015-2050	143	52	291	2.5%	0.9%	2.3%

Source: NZIER

We assume that the investment does not have a material impact on the industry composition of the Horowhenua District economy. As discussed earlier, these changes, if they do occur, are thought to produce large growth effects (Overman et al 2012). However, we did not find sufficiently convincing evidence to apply such changes in this instance. Furthermore, determining precisely what kind of change and how much to implement would be highly speculative without additional detailed work on successful case-studies.

3.2.3. Demographic changes

Expected population growth of 1.2% per year

WNC is expected to boost the population of Horowhenua District, reaching over 38,000 in 2030 from an estimated 32,300 today. That is an annual growth rate of 1.2% compared to estimated growth of 0.4% in the past 10 years (see Table 2).

A projected growth rate of 1.2% is significantly different to Statistics New Zealand's projection that the Horowhenua District's population will be 3% smaller in 2033 than in 2013, an annual growth rate of -0.1%. However, our view is that population growth in the Horowhenua District would be 0.7% without the WNC investment.

Annual population growth of 1.2% is similar to population growth rates in the past 10 years in similar sized districts, in terms of population, such as Ashburton (1.4% annual growth) and Matamata-Piako (1.1%).

Of that growth, around 3,000 new residents (0.6% in terms of growth rates) are drawn into the region by the WNC investment.

The future is by no means certain, however, with migration being notoriously volatile both nationally and regionally. Our projections take this into account and our projections for population in 2030 include a low end projection (10th percentile) of 34,500 and a high end projection (90th percentile) of 42,700.

Table 2 Demographic projections

	Population		Households	
Levels	Base	With WNC	Base	With WNC
2005	31,057	31,057	11,792	11,792
2015	31,965	32,373	12,543	12,679
2030	35,527	38,576	15,167	16,373
2050	39,258	44,337	17,818	20,092

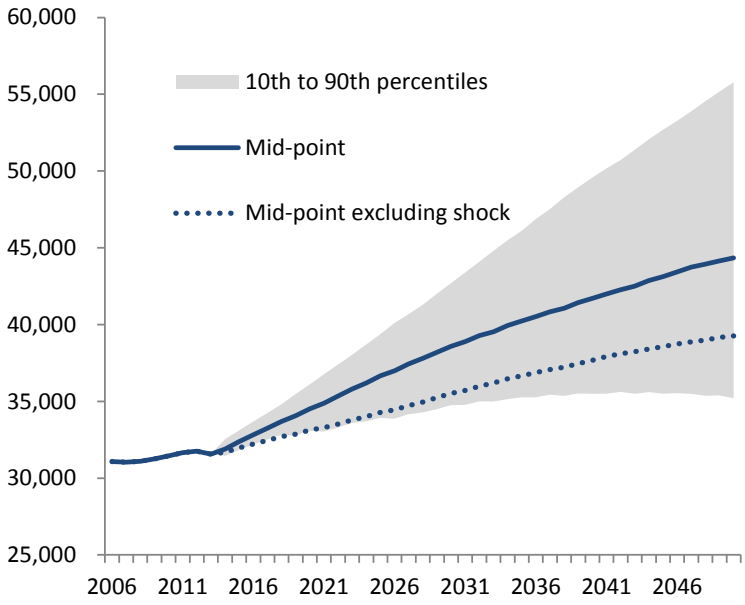
	Population		Households	
Changes	Base	With WNC	Base	With WNC
2005-2015	908	1,316	750	886
2015-2030	3,562	6,203	2,624	3,694
2030-2050	3,732	5,761	2,651	3,718
2015-2050	7,293	11,964	5,275	7,413

	Population		Households	
Annual Growth	Base	With WNC	Base	With WNC
2005-2015	0.3%	0.4%	0.6%	0.7%
2015-2030	0.7%	1.2%	1.3%	1.7%
2030-2050	0.5%	0.7%	0.8%	1.0%
2015-2050	0.6%	0.9%	1.0%	1.3%

Source: NZIER

Figure 5 Projected population in Horowhenua

Projections include range with probabilities.



Source: NZIER

Household numbers expected to grow more quickly than population

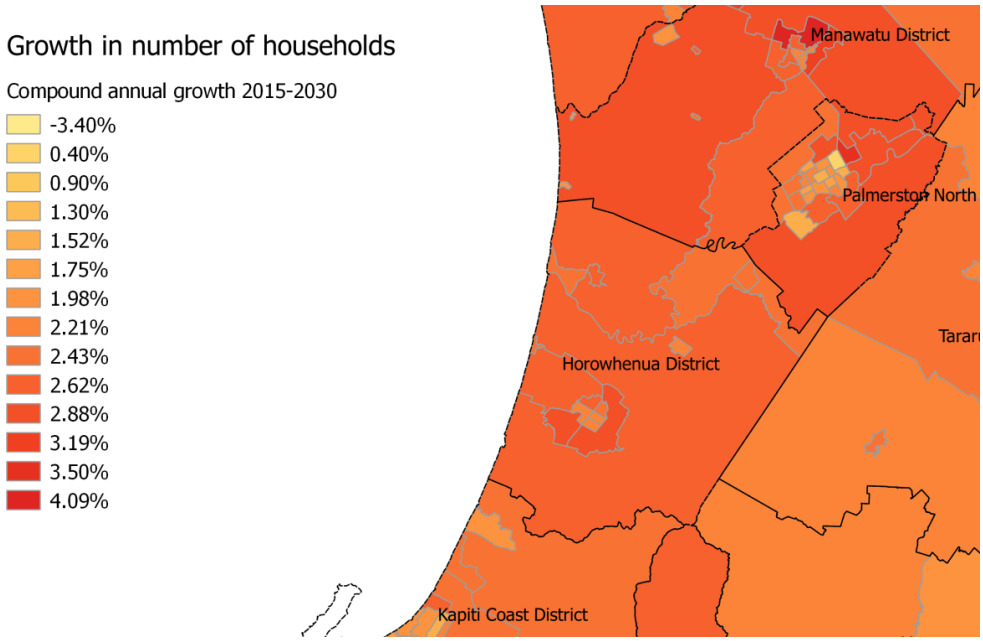
As the population ages (Figure 7), household sizes will begin to decline. This means that growth in households will outpace population growth. We project household numbers to grow by a 1.7% per year in the next 15 years (compound annual growth rate).Our expectation is that the spatial distribution of household growth will be fairly even, albeit slightly faster in areas immediately around Levin.[9]

Connections matter for economic development strategies

The strong connections between Horowhenua and surrounding regions and districts are a key reason to be optimistic about a material change in economic outlook for Horowhenua.

We next discuss how to think about Horowhenua in terms of economic function and to note that in many cases the economic fortunes of Horowhenua are intimately connected to the fortunes of the wider Manawatu-Whanganui region, Wellington region and lower North Island.

Figure 6 Relatively even growth in households in Horowhenua

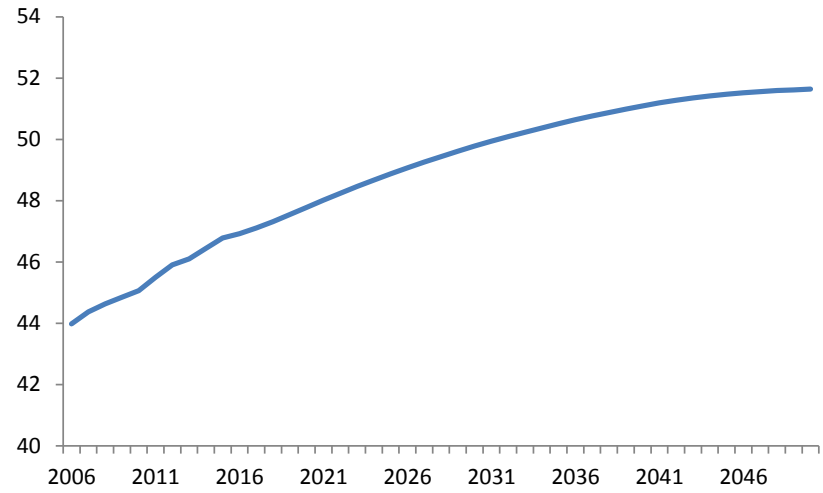


Source: NZIER

[9] Our model of population location is based on simple statistical models of spatial and temporal correlation. They do not account for local regulation and plans.

Figure 7 Horowhenua population expected to age

Median age



Source: NZIER

4. Economic outlook contingent on outside connections

Effective economic development requires understanding the wider economic system within which an economy operates. In the present context this means understanding what the Horowhenua 'economy' is and how it links to other parts of the lower North Island and national economies. These connections represent competition for where the growth will turn up, and also, how growth may spill over from other places.

What's in a name?

The typical unit of measure when it comes to economic analysis of regions, at least in New Zealand, tends to be administrative boundaries (typically territorial authorities or regional council boundaries).

But if the area unit of measure is too narrow, it may show a specialised and volatile economy, missing complementary connections with other areas, which make it a more resilient economy in reality.

Indeed that is part of the rationale for the growth impacts modelled in this report - that Horowhenua is on the border of two larger economic entities and stands to benefit from spill-overs both North and South.[10]

On some measures it does not make a great deal of sense thinking of Horowhenua as an economy, because businesses and other connections span across administrative boundaries. Below we investigate instances where Horowhenua might be considered an economy in some functional sense and suggest that the District would likely be better off if it was better integrated with other Districts' economies in the region.

We start from the perspective that an economy is a set of one or more interdependent markets in which goods or labour are traded. An economy then is a set of markets defined geographically.

From here, the right geographic definition depends on why one wants to define a regional economy in the first place.

The defining question then is around what one is trying to affect. If we are worried about economic progress it is helpful to think about the health and functioning of different kinds of markets or market-like processes. For example:

- **consumer markets:** markets for consumer goods which are very narrow, although often extend (or bleed) beyond administrative boundaries
- **labour markets:** where jobs reside and where people travel to work and other labour market connections
- **migration:** long term connections through people moving for work or retirement
- **tourism:** short term people movements, from New Zealand and overseas.

[10] The idea that there might be particular gains to a small(er) spatial area from increased connection with denser areas may be why some researchers in the United States have found evidence for positive effects of road investment at a county level but not at the state level.

- **housing:** correlations in contiguous housing areas suggests common economic patterns, which tend to be broader than administrative boundaries and closer to labour market regions
- **supply chains and investment and equity (i.e. ownership):** very wide reach with strong links into major urban centres which tend to be the home of financial capital

It is not uncommon to consider transport networks as an additional element. We prefer to see transport networks as embedded within and facilitating all of these. This is because transport is a 'derived demand', meaning that it is of little value in and of itself. Thus transport is best understood in terms of what it enables.

Below we step through each of the different market-level perspectives to see what they imply about the economic extent of the Horowhenua.

4.1. Consumer markets

Consumer markets and spending patterns can be used to define regions how and where people interact and buy and trade good and services on a day-to-day basis.

These measures help capture the extent of economies at a very granular level because, in principle and in general, people limit the length and number of trips they have to make to get what they want. This will generally mean going to the nearest outlet to get what they need but it may also mean going to single spot where many businesses have set up, so supplier density matters.

On the supply-side customer density will have a large impact on whether businesses set up in an area. Customer density dictates the extent to which an area is self-sufficient for a large amount of goods or not.

The interaction of these density effects creates gravity-like relationships. This can be seen in Figure 8 which uses electronic transactions data to map the amount of spending by a person being spent in Levin. The catchment is reasonably small, with most spending coming from within a 5km radius of the centre of Levin.

The consumer catchment in Levin does not exhibit an especially long reach from, for example, people travelling north on State Highway 1. People who live 30km or more away from Levin account for only 0.1% of spending, for example.

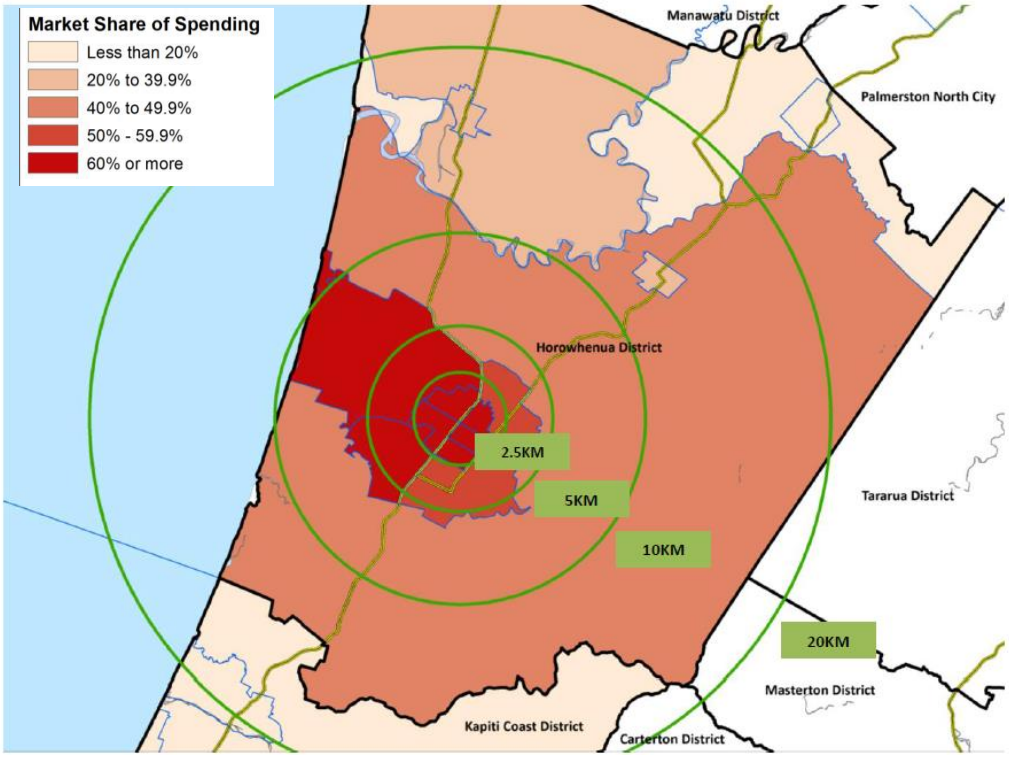
The catchment exhibits a large share of the spending of locals. That is, of the people who live within 2.5km of Levin at least 95% shop in Levin. Those people also do 68% of their total spending in Levin. This compares with, for example, only 44% of total spending being spent in Lower Hutt by people living within 2.5km of Lower Hutt central.

It appears that the north of the Horowhenua district is less closely attached to Levin than the south, with shares of spending in Levin declining the closer someone is to Palmerston North. That mimics what we see in terms of the labour markets we discuss in the next section. This finding is also repeated in other consumer spending catchments where a reasonably high share of spending appears to take place where people work rather than where they reside. That is not to say that local spending will not increase when population grows. It certainly will. But it will not increase

proportionately with population growth if people are travelling out of the District to go to work.

Figure 8 Consumer spending defines small-scale local economies

Catchment for spending in Levin



Source: Market View

4.2. Labour markets

Commonly measured by 'travel to work' areas

The typical measure used to classify labour markets is 'travel to work', captured in surveys and census data. A 'Travel to Work Area' is a natural unit of analysis for studying labour market adjustments and changes to job opportunities.

The basic method involves joining suburbs together by the strength of commuter inflows and outflows.

These measures are also useful inputs for defining internal migration. The idea is that if people move within a labour market area, then they are probably moving for reasons of housing and location preferences. If people move to another labour market area then this is assumed to be a more profound shift, possibly reflecting the need to move for work purposes.

The number of labour markets has been shrinking over time

In New Zealand the 'travel to work' method was first used by Newell and Papps for the Department of Labour in 2001 based on 1991 Census data. That study found that New Zealand was made up of 140 labour market areas.

A 2004 update of the 2001 study, using 2001 Census data suggested that the number of labour market areas in New Zealand had shrunk – from 140 to 104.

We have replicated this analysis using 2013 Census data and identify 66 labour market areas. This result partly reflects shrinking populations in peripheral areas of New Zealand in recent decades.[11] It also reflects the opposite side of that process - densification of major city and urban regions such as Auckland.

As areas densify they increase the intensity of their interactions with neighbouring areas. Over time, as networks expand their influence, what were separate pieces became part of a single market.

In general, we observe the following two types of labour markets:

- dispersed and small labour markets in rural New Zealand
- large single labour market areas of Auckland, Wellington and Canterbury.

Horowhenua District sits somewhere in between. The district straddles two separate labour market areas, but sits on the cusp of being part of other labour market areas including the Wellington (see Figure 9), Palmerston North City, or Manawatu District labour markets.

We contend that Horowhenua stands to benefit a great deal from improved connections to the South.

Recent studies (e.g. Gibbons et al, 2014) have shown most of the spatial variations in labour productivity are caused by people-based effects. Skilled workers relocate themselves into the largest urban agglomerations (see p760):

> *[…] most of the observed regional inequality in average wage in Britain is explained by 'sorting' or 'people' rather than 'places'. Our preferred estimates, which include the individual fixed effects, suggest that the contribution of individual characteristics to variation in wages is between 100 to 850 times larger than the contribution of area effects.*

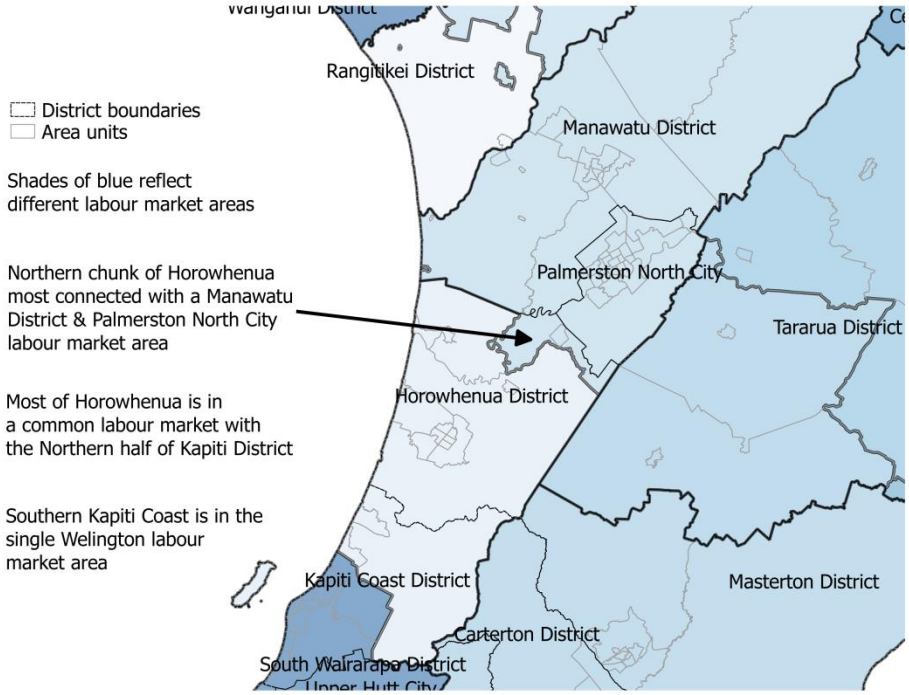
Thus, the residents of the Horowhenua District would benefit considerably from greater access to regional labour markets, creating opportunities for residents of the District to obtain both employment and potentially higher wages by working outside the District. The other side of this coin is that residents in other Districts can work in Horowhenua District or moving to the Horowhenua District becomes more attractive because improved connections between Districts means that they don't have to change jobs.

Cities within the Wellington are particularly high performing on some measures of human capital and labour market success – such as ranking top across a range of income measures. For other regions in New Zealand, how we look at the data gives very different answers.

[11] The travel-to-work method restricts labour market areas to areas with working populations of at least 2000 people.

Figure 9 Horowhenua spans two different labour market areas

Based on 2013 census travel to work



Source: NZIER

Horowhenua, by way of example, has median wages around 9% ($28,000 vs. $31,000) lower than the Kapiti Coast District and at the 90th percentile of wages the difference widens to 40% ($77,000 vs. $107,000).

Table 3 Income by District

Wage and salary earners, 2012

	95th percentile		50th percentile		95th:50th percentiles	
	Income	Rank in NZ	Income	Rank in NZ	Ratio	Rank in NZ
Wellington City	139,760	1	40,810	1	3.4	55
Porirua City	112,500	2	36,640	4	3.1	39
Auckland	111,920	3	35,400	5	3.2	42
Lower Hutt City	108,610	4	37,320	3	2.9	32
Kapiti Coast District	107,330	5	30,980	22	3.5	56
New Plymouth District	105,530	6	31,970	14	3.3	47
Upper Hutt City	104,950	7	38,660	2	2.7	8
Buller District	99,020	8	32,020	13	3.1	41
Hamilton City	98,590	9	34,600	7	2.8	22
Kawerau District	97,290	10	27,210	43	3.6	59

Source: NZIER, Statistics New Zealand (LEED)

On the whole, transport improvements are complementary to other conditions for economic activity and growth, such as the availability of productive land, skilled labour, willing investors, and a supportive planning environment.

An important insight in all of this is that important events for economic development, in terms of job opportunities and living standards of people who reside in the Horowhenua District, may take place in neighbouring districts. That being so, inter-council cooperation is important.

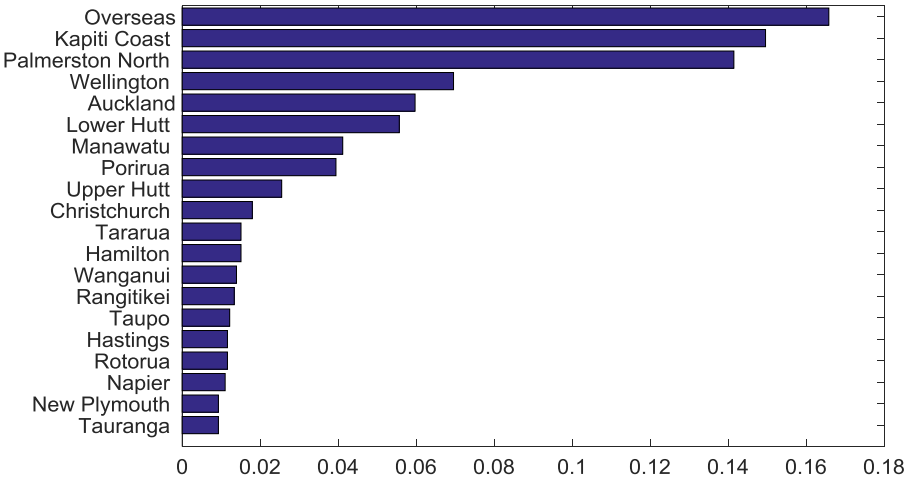
4.3. Migration

Connections between people are also strengthened by migration connections. Here we see that Horowhenua already has very strong connections to the wider Wellington region, as well as into the Manawatu (see **Error! Reference source not ound.**). While the largest share of migrants comes from overseas, a vast majority (when combined) come from neighbouring regions of Kapiti, Wellington, and Palmerston North.

Better transport connections through the WNC, particularly to the south, could increase the propensity of people from the greater Wellington region to migrate to Horowhenua.

Figure 10 Most of Horowhenua's new residents come from nearby

Share (decimal) of migrants by origin, 2008-2013



Source: Statistics New Zealand

4.4. Tourism

Short term tourism connections help to lift the amount of spending in Horowhenua by non-residents – whether day trippers, travelling workers or domestic tourists and bach owners.

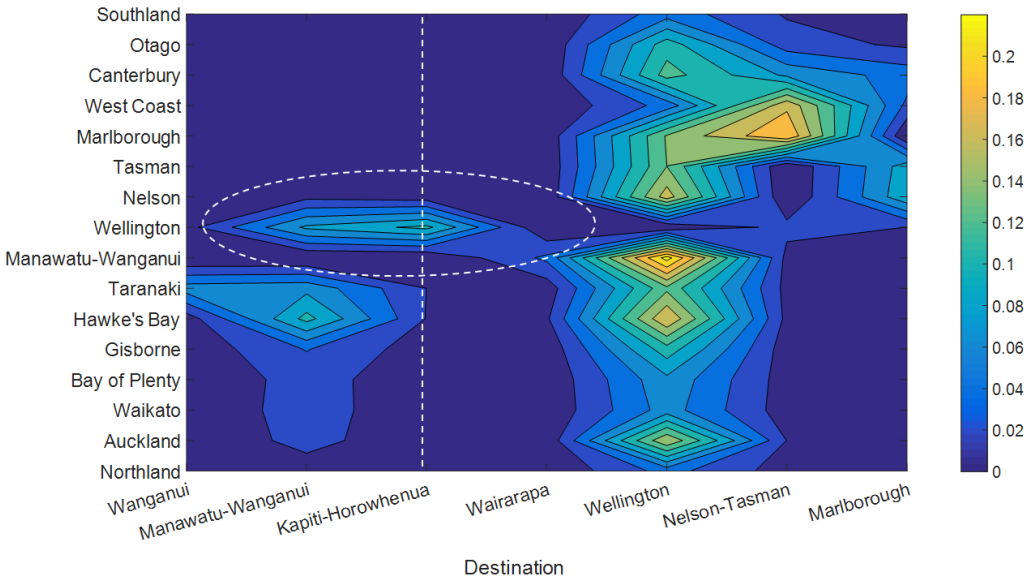
Of all the out-of-town transactions that Wellingtonians undertake, 1 in 10 is carried out in the Kapiti-Horowhenua tourism area. While those numbers are a little tricky to get a fix on from a Horowhenua District perspective – because they include both Kapiti and Horowhenua – they underscore that Horowhenua is closely related to Kapiti and is part of the entertainment market for Wellingtonians.

Out-of-town spending also underscores that physical boundaries and transport links affect the density of economic and social interactions. This can be seen in domestic tourism transactions shown in Figure 11 below. The heat map shows that more money is spent to the North of Wellington by Wellingtonians than to the South. This no doubt reflects a mixture of the physical influence of the Cook Strait as well as social and economic influences.

This generally says that HDC is in a lucky position with respect to its ability to do well if and when Wellington is doing well. However, our earlier observations around consumer markets are an important caveat. With 0.1% of spending currently coming from people living more than 30km away this suggests that local tourism is a 'nice to have' aspect of the HDC commercial environment but not a game changer.

Figure 11 Neighbours are a major source of spending in Horowhenua

Destination share of domestic tourism transactions originating from region on left axis



Source: NZIER, MBIE

4.5. Investment and asset price interdependency

Beyond labour markets and 'people' connections there are investment connections, supply chains and other market interdependencies which are also helpful lenses to better understand economies and integration. These interdependencies operate both locally, at small scales, and more broadly at very wide scales.

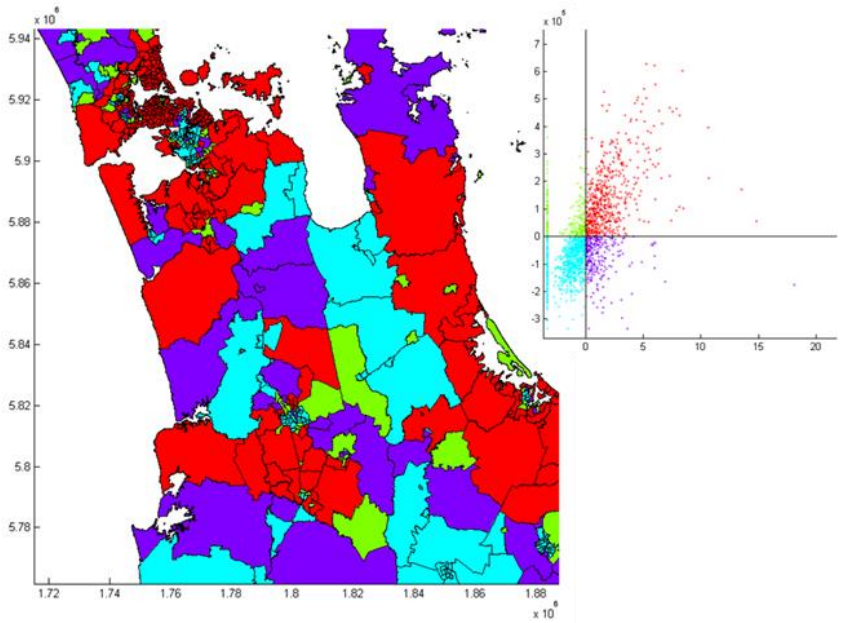
4.5.1. Housing market connections

Investments, which have clearly tracked market prices, can be a timely indicator of economic connections. For example, if there is a shock in the housing market (for example by a sudden reduction in housing supply) then the subsequent price changes in neighbouring areas can hold clues of economic connections.

By way of example, we can see this in Figure 12. In the first figure, we see the areas that are closely correlated with Auckland house prices. Parts of the Auckland, Waikato and Bay of Plenty move closely together. On this measure, the golden triangle is clearly visible (the census area units in red). But it also shows that within the Waikato and Bay of Plenty, not every region participates in this economic connection (those in blue, purple and green).

Figure 12 Spatial cross correlation of house prices – Auckland and surrounding regions

Each colour represents clusters of similar housing market performance (measured in 4 groups)



Source: NZIER

In the case of the Horowhenua District there is no spatial clustering of housing market indicators – at least not across the suburb level or across the wider Lower

North Island or Wellington level. We interpret this as a function of relatively low transactions and local quirks. We also expect that this reflects a bifurcated housing market with coastal property fetching very different prices relative to inland suburbs.

Either way, the Horowhenua District is not part of any particular wider housing market, per se, and this likely reflects relative abundance of land. If this is so, this is a source of comparative advantage for HDC and should be interpreted as a good thing. Steps should be taken to ensure that people can take advantage of comparative abundance such as through avoiding inflexible land use controls.

Horowhenua's housing market could potentially become better integrated with markets in neighbouring districts – perhaps as a result of a widening of labour market areas. If that happens, the outcome will be positive wealth effects for Horowhenua residents through increased land and property prices. However, this may also reduce some of Horowhenua's cost advantage to its neighbours.

4.5.2. Freight connections

Investment connections can be people focussed, rather than economy focussed. One of the key features of economic developments over the past century is the increasingly importance of supply chains.

Very rarely is a product entirely produced in one location and traded in its final form. Instead, a product is now more likely to have services and value added to it in various parts of the supply chain – meaning supply chains not just measure the flow of goods, but economic connections.

We look to measure the economic connections between regions through freight connections – at a regional level given that is the data we have available.

We find that freight clusters around:

- Auckland and the Bay of Plenty in the Upper North Island
- Wellington and Manawatū-Whanganui in the Lower North Island
- Canterbury in the South Island.

Freight flows highlight that secondary urban areas can play a crucial role for regional economies by providing a low(er) cost option for land intensive activities like logistics and freight handling; hence the interdependencies which have developed between Auckland and the Bay of Plenty and Wellington and Manawatu.

In the South Island these interdependencies are less significant because population densities are much smaller.

Ultimately, these economic connections suggest 3 areas of interdependency or 'economies' centred on 3 major urban centres:

- Upper North Island, centred on Auckland
- Lower North Island, centred on Wellington
- South Island, centred on Canterbury.

This, when combined with observations above around abundance of land, might suggest scope for comparative advantage for HDC in terms of Lower North Island logistics chains and warehousing activities.

Table 4 Density of freight flows show trade coalescing around 3 hubs

Millions of tonnes of freight by all mode from origins in rows and destinations in columns, 2012

	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu	Wellington	Tas-Nel-Mar	West Coast	Canterbury	Otago	Southland	Total
Northland	**12.0**	1.9	0.1	0.9	0.0	0.2	0.1	0.0	0.4	0.3	0.0	0.6	0.2	0.2	16.8
Auckland	0.9	**38.3**	2.4	2.9	0.1	0.5	0.5	1.3	1.2	0.1	0.0	1.2	0.1	0.0	49.3
Waikato	0.1	4.3	**23.8**	3.1	0.0	0.2	0.3	0.1	0.1	0.0	0.0	0.1	0.0	0.0	32.0
Bay of Plenty	0.2	1.9	1.8	**20.2**	0.1	0.2	0.1	0.3	0.1	0.0	0.0	0.1	0.0	0.0	25.0
Gisborne	0.0	0.1	0.1	0.2	**3.2**	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	3.8
Hawke's Bay	0.0	0.2	0.2	1.0	0.5	**7.4**	0.1	0.7	0.1	0.0	0.0	0.1	0.0	0.0	10.3
Taranaki	0.1	0.2	0.4	0.3	0.0	0.2	**6.1**	0.3	0.1	0.0	0.0	0.1	0.0	0.0	7.6
Manawatu	0.0	0.3	0.1	0.2	0.0	0.9	1.9	**5.7**	1.5	0.0	0.0	0.1	0.0	0.0	10.6
Wellington	0.0	0.7	0.1	0.0	0.0	0.1	0.1	0.9	**6.4**	0.0	0.0	0.1	0.0	0.0	8.4
Tas-Nel-Mar	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1	**8.0**	0.4	0.5	0.0	0.0	9.3
West Coast	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.6**	2.8	0.1	0.0	5.5
Canterbury	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.9	0.7	**31.0**	1.3	0.6	35.3
Otago	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	**8.5**	0.7	10.0
Southland	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1	**10.1**	11.6
Total	13.3	48.8	29.0	28.8	4.1	9.9	9.3	9.5	9.9	9.3	3.7	37.7	11.3	11.6	**236.0**

Source: Ministry of Transport

4.6. Enterprise connections

It turns out that one of the widest measures of economic connections is enterprise of ownership structures. This looks at whether a business in a particular region also has employees or businesses in other regions. Again the analysis is regional (principally due to confidentiality issues with more detailed data) but it is still useful to the extent that it suggests the existence of a Lower North Island 'economy' at least so far as business connections are concerned.

Our analysis suggests 6 distinct groupings across NZ:

- **Auckland super region:** In some groupings, it appears New Zealand is comprised of Auckland and a series of satellite economies defined by their common connection to Auckland. By virtue of sheer scale and being home to many commercial head-offices Auckland has dense commercial connections with the rest of New Zealand.
- **Metro region:** The larger urban centres tend to be connected on some measures (Auckland, Hamilton, Tauranga, Wellington Christchurch and Dunedin to a lesser extent)
- **Upper North Island:** Northland, Auckland, Waikato and Bay of Plenty form a tight cluster of enterprise connections. This is not surprising given their geographic proximity.
- **Lower North Island:** There is a lower North Island cluster comprising Hawke's Bay, Taranaki, Manawatū-Whanganui and Wellington.
- **Upper South Island:** There is a tight cluster with Nelson, Tasman, Marlborough and West Coast.
- **Lower South Island:** There is cluster with Canterbury, Otago and Southland.

The dominance of large urban centres and the breadth of enterprise connections illustrates the extent to which commerce operates with a very long reach and firms can and do relocate operations quickly and easily. This is both a risk and an opportunity. It implies that more receptive and flexible commercial environments can successfully attract new investment. It also implies that long standing employers cannot be taken for granted.

Table 5 Summarised enterprise connections

Above average strength of regional connections across enterprises (see data in appendix)

Rows are where the main enterprise is located; columns

	NOR	AKL	WAI	BOP	GIS	HB	TAR	MAN	WEL	NEL	TAS	MAR	WST	CAN	OTG	STH
Northland																
Auckland																
Waikato																
Bay of Plenty																
Gisborne																
Hawke's Bay																
Taranaki																
Manawatū-Whanganui																
Wellington																
Nelson																
Tasman																
Marlborough																
West Coast																
Canterbury																
Otago																
Southland																

Source: NZIER, Statistics New Zealand

5. Summary and implications

Integration and competitive advantage key to growth

Our expectation is that the WNC will have significant effects on the Horowhenua District 'economy'. Population growth will increase, rising to 1.2% annual growth, on average over the next 15 years, compared to annual growth of 0.4% in the past 10 years. There will also be 850 additional jobs in the District in 2030 compared with a world in which the WNC did not exist.

Much of the gain will come from greater integration with neighbouring regions, in particular productivity gains from better integrating with the Wellington region and the Wellington labour market.

We find limited evidence that the Horowhenua District is, in and of itself, an economy. Only in terms of labour markets is the District reasonably distinctive or independent in terms of being close to being a self-contained labour market (albeit spanning part of the Kapiti Coast District). That distinctiveness is not positive in the sense that residents of Horowhenua have lower incomes and fewer economic opportunities than their neighbours.

As the economic mass of the Wellington region continues to expand it is likely that further integration, facilitated by the WNC, will enable deeper connections between Horowhenua and the Wellington region. This is likely to happen somewhat autonomously.

The trick for decision makers in the Horowhenua then will be to work with the District's competitive advantages including relatively cheap and available land and labour – and not responding to increased demand or economic activity in the region with measures that undermine the region's competitive cost advantage (by raising cost and prices).

Economic reach matters and differs for different activities

It is important to be aware that different economic activities have different spheres of interdependence and influence. Retail markets, for example, are highly local. Labour markets extend more widely but, at least in the case of Horowhenua, are highly local.

Extending the reach of markets, by making HDC an attractive place for commuters or migrants to live, is a key part of economic development.

Other activities are already very broad, such as freight flows and enterprise connections. It is important to be aware that this means that the HDC does not have a captive market for commercial activity and there will be competition from neighbouring regions and changes in market or regulatory conditions.

Biggest risks and opportunities are in business investment

Firms are relatively foot-loose and the economic power of firms extends across the entirety of the Lower North Island. Working to its comparative advantages, in terms of cheap land and improved access to Wellington, the HDC has the opportunity to

attract business investment. Policy makers should look to retain the cost advantage in land as a key point of comparative advantage over neighbours.

The biggest gains will come if the local economic environment attracts new industries that help to broaden the economic base. Structural change has been shown to be a very important for facilitating large productivity gains and transformational economic changes. But these are likely to accrue to larger centres.

Appendix A Links between transport infrastructure and growth

A.1 The benefits of a transport improvement

A.1.1 User benefits

A transport improvement directly benefits the users of transport services in several ways. There may be savings in travel time, fuel, vehicle maintenance and other costs, reductions in vehicle emissions and delays, or increased service quality. Travellers benefit from reduced fatigue and frustration, and have more time available for work. Workers become more productive and might choose to work longer hours. At the margin, some individuals might decide the reduction in transport costs makes it worthwhile to join the workforce.

A.1.2 Indirect productivity effects

Businesses indirectly benefit from the increased productivity of transport users, because their labour costs fall. They respond by cutting prices, or by procuring more inputs, including labour, in order to increase production. Businesses can also source inputs from further away owing to the fall in transport costs. Therefore the indirect productivity effect of a transport improvement is a mixture of increased output, employment, and lower prices, assuming perfect competition – which includes assuming no economies of scale.

A.1.3 Wider economic benefits

Relaxing the assumption of perfect competition allows for the possibility that industries are oligopolies, with only a few competitors, that production might be subject to economies of scale, and that there could be information externalities. This sets the scene for the recognition of the wider or secondary economic benefits of a transport improvement. The benefits of greater output, reorganisation and specialisation are all wider or secondary benefits, driven by the primary benefits derived to transport users themselves.

There may be re-organisation effects where transport improvements allow for economic concentration and agglomeration, and the exploitation of economies of scale. A smaller number of large, low-cost producers can replace a larger number of spatial monopolies that were previously sealed off from each other by the existence of high transport costs.

A transport improvement improves both backward and forward linkages, providing better access for manufacturers to inputs and consumers, respectively. The resulting concentration creates a ‘thick’ local labour market, so employers and employees can find each other more easily. This agglomeration or concentration also creates information sharing externalities.

Agglomeration is the co-location of economic activity in space, for example in cities. Eberts and McMillen (1999) define agglomeration economies as a form of positive externality in which a firm's production costs are lowered by increases in the output of other unrelated firms. These economies are thought to arise from the shared use of non-excludable inputs, such as labour pools, transportation networks and other types of urban infrastructure.

An improvement in transport in a region increases the competitive threat from firms outside the region. This is the two-way road effect. The net impact on output would depend on whether the transport improvement predominantly favours firms located within the region, or those located in neighbouring regions.

Dispersion is the opposite of agglomeration. Dispersion effects may be present where the resources or factors of production are either immobile (e.g. agriculture, tourism, mining) or dispersed. Transport improvements cannot facilitate the movement of factors that are immobile. And concentration of economic activity that raises the demand for land in the region will increase land rents and encourage dispersion. Concentration of economic activity can also cause congestion, which encourages dispersion.

Of relevance to the appraisal of the benefits of transport improvements in a region such as Horowhenua, the NZ Transport Agency (2013, p 5-407) does not anticipate there will be agglomeration benefits worth evaluating outside the major urban centres:

> *The required spatial concentration of economic activity for realising agglomeration benefits is only likely to occur in the major industrial and urban centres of New Zealand. It is only the large and complex urban transport activities that will provide the relevant conditions that justify an analysis of agglomeration benefits.*

A.1.4 Spatial effects

Clearly, there are spatial dimensions of the output and reorganisation effects of a transport improvement. This is particularly important from a regional perspective. The relocation of economic activity may be within a region, between neighbouring regions, or between countries. As Byett et al (2015, p23) point out:

> *For the first and third categories the perspective is essentially the same: the first is a redistribution within the area while the third is an unambiguous effect on national output. However, the second will be viewed differently by the two tiers of government and is one reason why the regional tier can be more enthusiastic than the national tier about infrastructure investment.*

If there are economies of scale and falling transport costs, then it is often efficient for regions to specialise in certain industries, and engage in inter-industry trade with other regions and/or other countries (Krugman and Venables, 1996). For example, Detroit specialised in cars, Silicon Valley in technology.

Venables (2013) extended the analysis to task specialisation between regions or cities – the phenomenon whereby firms locate business functions in different cities –

headquarters in one city, production in another city. Such specialisation depends on communications, particularly when certain service functions are located offshore.

A.1.5 Regional effects

When modelling the regional benefits of transport improvements, there is a need to account for spatial spill-overs – in other words, benefits beyond the region where the improvement has taken place. This could be on top of the benefits within the region, or at the expense of the region, where a transport improvement has facilitated the movement of resources and production to a neighbouring region.

The empirical evidence of regional spill-overs related to transport projects is mixed and depends on how widely a region is defined. In a recent review of the literature on regional spill-overs, Grimes (2014) reports neither of the studies by Holtz-Eakin and Schwartz (1995), nor Duranton and Turner (2012) found statistically significant spill-over effects of highways across regions in the United States.

By contrast, a general method of moments (GMM) estimate of a dynamic regional production function that includes the spill-over effects of highways in US states found neighbouring states acquire some of the productivity benefits of highway improvements carried out in a nearby state (Jiwattanakulpaisarn et al, 2011). In China, Yu et al (2013) found land transport investment in neighbouring regions has a significant spill-over effect across regions but the magnitude of the effect differs depending on the current productivity of the regional economy. Ding (2013) found positive spill-over effects associated with urban roads and regional roads for Chinese regions.

The implication of the above for the current study is that at the regional level, there are several potential impacts of a transport improvement within Horowhenua. These could be ranked, from most-preferred to least preferred, from the perspective of the Horowhenua region:

- Benefits in Horowhenua plus spill-over benefits to another region;
- Benefits in Horowhenua but no spill-over benefits to another region;
- Benefits in another region but no benefits in Horowhenua; or
- Benefits in another region at the expense of Horowhenua; or
- Benefits in another country at the expense of Horowhenua.

Note that the benefits to a region following a transport improvement could come from inward investments (foreign direct investment, or FDI). FDI can bring more competition into a region, and lead to knowledge spill-overs.

Recent regional studies in the USA (at the county level) have shown very small benefits (e.g. Lacono and Levinson, 2013). This has been put down to the maturity of transport networks, meaning most gains have already been realised, plus the effect of the recession since 2008.

A.1.6 People-based effects

Transport improvements can directly influence the place-based effects discussed above (output effects and re-organisation effects), but indirectly influence people-based effects, for example by causing migration. Recent studies (e.g. Gibbons et al, 2014) have shown most of the spatial variations in labour productivity are caused by

people-based effects. Skilled workers relocate themselves into the largest urban agglomerations (see p760):

> *[…] most of the observed regional inequality in average wage in Britain is explained by 'sorting' or 'people' rather than 'places'. Our preferred estimates, which include the individual fixed effects, suggest that the contribution of individual characteristics to variation in wages is between 100 to 850 times larger than the contribution of area effects.*

On the whole, transport improvements are complementary to other conditions for economic activity and growth, such as the availability of productive land, skilled labour, willing investors, and a supportive planning environment. An improvement in transport will not – in and of itself – lead to economic benefit.

A.2 The appraisal of transport improvements

A.2.1 Weighing up benefits and costs

Up to now, the discussion has concentrated on the potential benefits of a transport improvement project. The appraisal of a project must take into account the costs associated with making the improvement, and weigh them up against the expected benefits.

Here we mainly discuss cost/benefit analyses and the gross value added approach to the appraisal of transport improvements. There are other techniques, and Kernohan and Rognlien (2011) have classified these as top-down versus bottom-up approaches.

Cost/benefit analysis (CBA) is the most common form of appraisal used, although there are many other methods of appraisal. In particular, gross value added (GVA) methods are being used more for the appraisal of transport improvements at the regional level, especially in the UK and the USA.

The NZ Transport Agency has set out its approach to the appraisal of the transport benefits and dis-benefits/costs of proposed projects, in its Economic Evaluation Manual, or EEM (2013).

Generally, CBA only accounts for the costs and the direct user benefits plus the indirect productivity impacts of a transport improvement. GVA methods also include the wider economic benefits of a transport improvement. Wider economic benefits are the result of transport cost reductions alleviating the effects of market failures outside the transport sector:

- A 'spatial monopoly' could arise in a region where high transport costs give market power to a firm serving the area, and constrain competitors from delivering an alternative product to customers in that region. A transport improvement could introduce competition into that market;
- In sectors where firms have market power, this shows up in price/cost margins. A reduction in transport costs increases competition, reduces mark-ups, and increases economic efficiency by eliminating the dead-weight loss associated with price/cost margins;
- Transport improvements could facilitate agglomeration, which allows businesses to exploit economies of scale. It is a sign of imperfect

competition for an industry to have increasing rather than constant returns to scale;

- Agglomeration could also lead to improved sharing of information or expertise. This would be an externality, another instance of imperfect competition.

The Agency considers both direct and wider economic benefits of a transport improvement should be appraised. While it warns against double counting of benefits, the NZ Transport Agency (2013, p5-407) nevertheless recognises the wider economic impacts that are discussed above.

A.2.2 Bottom-up approaches to the appraisal of a transport improvement

Bottom-up methods are usually partial equilibrium approaches, which quantify the impact of an effect in isolation from the rest of the economy, and the measured gains are either on top of – or ignore – the benefits captured elsewhere.

The cost/benefit approach and agglomeration effects

The cost/benefit analysis (CBA) framework is a bottom-up or micro approach to identifying the economic impacts of a transport improvement. CBA methods are commonly used to assess the impact of transport infrastructure projects. CBA focuses on the economic welfare benefits and costs of investment projects.

Net benefits to society can be calculated by the gains made in the transport market, for example from time savings and reduced fuel consumption, assuming conditions of full employment and perfect competition. Ignoring externalities, the costs to society are the marginal capital and operating costs caused by the transport infrastructure project. The calculation and comparison of net benefits, or benefit-cost ratios (BCRs), can help to rank or prioritise the alternative projects being considered.

CBA methodology has been refined to account for imperfectly competitive market structures and to capture the benefits of agglomeration. The CBA approach is well grounded in microeconomic theory, although it requires extensive data. It is often difficult to explain the benefits, which are often stated in abstract terms of consumer surplus, and difficult to know where benefits and costs will fall within society. There may also be benefits and costs beyond those captured by the standard CBA analysis. Although economists view CBA results in a positive way, spatial planners and transport professionals are more sceptical about the role CBA should play in appraisal decision-making, according to Mouter et al (2013).

The social approach to CBA analysis is favoured by NZTA (2013, p2-4) and explained as follows:

> *Social cost-benefit analysis considers the cost and benefits to the nation as a whole. This viewpoint is appropriate in the case of transport activities, which are undertaken on behalf of the nation and are publicly funded.*
>
> *Social cost benefit analysis is a framework in which non-market benefits and costs such as safety improvements, environmental pollution and increased accessibility can be considered alongside commercial benefits and costs.*

Social CBA analysis is not necessarily the best method for regional studies, such as the benefits in Horowhenua of a transport improvement.

Other bottom-up methods of appraisal

Some New Zealand studies have assessed the benefits of agglomeration. For example, Maré and Graham (2009) examined the link between 'effective density' and productivity. Effective density was a measure of accessibility to employment that can be estimated at a local level with and without a transport improvement.

Elasticities were calculated that helped convert the accessibility improvement from a project into a productivity gain from agglomeration. The New Zealand elasticities varied from 0.032 for agriculture to 0.087 for finance and insurance, and averaged 0.069. Therefore a 10% increase in employment accessibility across New Zealand would cause a 0.69% increase in (national) gross value added (GVA). Similar evidence was derived for the UK.

A.2.3 Top-down methods of appraisal

There are also top-down, macro methods relating transport investment to some measure of economic growth. For example, some research has considered how public investment can lead to increased output or productivity. Looking at cross sectional data and/or time series data, this research measures the impact of investment on measures of aggregate economic growth, such as gross domestic product (GDP) or gross national product (GNP).

Aschauer (1989) found a significant positive relationship between transport investment and economic output across states in the USA, but there were problems attributing causality: was productivity higher where there was more infrastructure investment or did more productive areas receive more investment? Further studies corrected for these problems but found less significant links between transport investments and economic output.

The Gross Value Added approach

The gross value added (GVA) approach is another top-down, macro-level method of transport appraisal. GVA methods, as described in Byett et al (2015), involve estimating the gross domestic product (GDP) elasticity to population (or employment) density, based on observed differences in GDP, population mass and other explanatory variables. One then infers that a transport project leads to a change in the accessible population mass, which results in a GDP effect consistent with the elasticity estimates.

The GVA approach entails building a GVA model, producing GVA forecasts, and applying these forecasts to assess or prioritise projects.

GVA models are often applied to derive regional effects. GVA is simply GDP measured on the production side excluding taxes and subsidies on production, and is more readily available than GDP at a regional level. Institutional change in the UK has led to studies on the GVA impacts of transport. The "City Deal" (HM Government, 2012) created a planning context in which decisions on transport investments were devolved to city regions, so economic growth has become a key indicator. City regions in England are now prioritising transport investments to maximise GVA. The

focus is usually on regional growth and regional funding, rather than the wider benefits and costs to the nation.

GVA models have a dependent variable that is some change in economic activity: GDP, GVA, income or employment.

In the US, an economic impact analysis is commonly used to analyse an investment impact. These could include input-output analysis and CGE models.

The UK models are often reduced form equations of wages or GVA or employment density against economic mass, and taking into account labour inputs, sometimes people attributes and occasionally, capital inputs. Changes in economic output that are ignored are those due to injuries or fatalities (safety), damage costs of crashes, carbon emissions and health.

The UK GVA models presented the impact of transport investments in the language of GDP and jobs and put the focus on regions, which enabled the impact to be communicated easily.

The advantages of GVA models are their relative simplicity and ability to isolate a productivity effect. This complements the standard transport appraisal benefits as the productivity gain would not all be captured within a rule-of-half[12] based appraisal of user benefit.

The transmission mechanism between accessibility and GDP can be difficult to determine. The accessible population elasticities vary according to the specification of the model. People attributes are an important confounding influence on productivity, and there could be other confounding effects.

There are many models used, and outcomes are reported variously as jobs or wages or GDP or GVA. Results can be reported for a period of time, or for a point in the future, or as a present value, with various durations and discount rates used. It can be difficult to identify the ultimate beneficiaries of a transport project at a disaggregated level, as it is difficult to identify the origins and destinations of long-distance traffic. With new modelling methods, the GVA approach is becoming more widespread, as they have much to offer.

GVA models produce a richer description of benefits and costs, and for larger projects computable general equilibrium (CGE) GVA models might be needed. Some of these CGE GVA models allow for the incorporation of externalities and agglomeration effects into the analysis. The partial nature of GVA analysis can be overcome by turning to CGE models, or at least by a more widespread understanding of what the partial analysis is measuring, and what it is not measuring. GVA estimated benefits will occur in the future, so their accuracy will always depend on the accuracy of economic growth projections.

Two forecasts are required to assess the likely economic impact of a transport investment: the expected state of the economy after the investment; and the counterfactual without the investment. The difference between the two is a measure of the investment's impact.

[12] A rule-of-half appraisal includes only the direct user benefits of a transport improvement. The user benefits are about half the total benefit: the other half of the benefit from a transport improvement is the decline in deadweight loss associated with mark-up pricing.

The challenge with these forecasts are twofold: the future is unknown so uncertainty about both sets of forecasts creates large uncertainty about the impact of any investment; and a one-year snapshot does not adequately measure the cumulative benefits – and costs – of any investment.

Appendix B Case studies of transport project impacts

This appendix provides case studies of impacts of transport projects. The examples are either ex ante evaluations or meta-level studies using statistical models. We did not find any robust ex-post evaluations of impacts of transport projects on places similar to Horowhenua.

B.1 GVA case studies on the impact of high-speed rail networks

Important examples are the approaches used by KPMG (2010a and 2010b) and the Spatial Economics Research Centre (SERC) (see Overman et al, 2009) to appraise the impact of high-speed rail.

KPMG (2010b, p3) predicted there would be huge benefits of building a high-speed rail network in the UK:

> *By 2040, HSR could leave national economic output up to 2.1 per cent higher than it would otherwise have been, essentially allowing the country to leap ahead one year in its economic growth*

The KPMG model took an aggregate approach, equating sector wages to measures of surrounding economic mass (plus a residual term). There is no modelling of the linkages between people and between firms and how they interact with land availability and the transport system. The model estimates the elasticity of wages to economic mass and (independently) the elasticity of employment density to economic mass, and then applies these elasticities to derive a forecast, by region, of the impact of an effective increase in mass due to lower rail travel costs.

KPMG chose to present their results as a difference at one point in time, sufficiently far ahead to be confident that the investment had been completed and its effects were being fully felt. In the two projects discussed, the forecast years were 2040 and 2037 respectively.

A more recent application (KPMG 2013) was developed to understand the impact of HS2 (a high-speed rail line from London to Manchester and Leeds via Birmingham). GVA was measured by GDP but the explanatory variables in the model were expanded to include labour input and an implied capital input. The density equation included both changes in transport costs and changes in production as determinants of the relocation of labour.

Overman et al (2009) presented some scenarios rather than forecasts in their SERC case study. For example, if train travel time were cut by 20 minutes between Leeds and Manchester then the average wage in Wakefield would increase by 0.50%, rising to 2.65% should the composition of the Wakefield economy also change.

B.2 GVA case study on a proposed additional Waitemata Harbour crossing in Auckland

A case study conducted as part of the report for the New Zealand Transport Agency (NZTA) by Byett et al (2015) relied on a GVA model developed for New Zealand using 2001 and 2006 census data from the 72 sub-national Territorial Authority (TA) areas, to assess a proposed additional Waitemata Harbour crossing in Auckland. The model predicted productivity gains from local agglomeration as well as productivity gains from wider connectivity. There were however difficulties with the measurement of effective densities and the ability to make inferences about regional distribution. The model highlighted the likely benefits of another harbour crossing.

B.3 Case study: Auckland motorway extension from Albany to Silverdale

Grimes and Yuan (2010) examined the impact of the extension of Auckland's Northern Motorway from Albany to Silverdale. Population within three kilometres of new motorway exits increased 57% from 2001-2006, compared with 21% for the rest of the North Shore and 38% for Auckland as a whole. Employment within three kilometres new exits increased 67% compared with 34% in the rest of the North Shore and 55% in Auckland as a whole. Population and employment effects in Rodney District were even more dramatic, especially around Orewa/Whangaparoa and Warkworth.

These first-order benefits are more important than the second-order benefits usually identified in cost-benefit analyses, such as travel time savings, vehicle operating cost savings, accident cost savings, seal extension benefits, driver frustration reduction benefits, vehicle emission reduction benefits, and other external benefits. Albany is now a major commercial, educational, sporting and residential node within Auckland. The improved transport network north of Auckland has allowed the city to expand beyond its limits to Albany and to improve connections with places beyond.

B.4 Case study: upgrade of Auckland's Western Line rail network

Grimes and Young (2013) examined the effects of an upgrade to Auckland's Western Line rail network, announced in 2005. Using a difference-in-difference regression approach coupled with a repeat-sales methodology, they tested the hypotheses that house prices appreciated following the announcement and that the degree of appreciation reflected proximity to rail stations. They also tested whether a specific transport-related urban redevelopment affected house price appreciation. They found statistically significant rises in values of houses located near (but not right next to) stations upon announcement of the upgrades, with rapidly increasing prices near rail improvementrs, reflecting both positive and negative amenity impacts.

B.5 Case study: M7 Motorway, New South Wales, Australia

The opening of the M7 in December 2005 linked the M2, M4 and M5 motorways in the Sydney orbital road network (see: Australian Government, 2010). The M7 is four

lanes and 40km long (Sydney's longest motorway), with dual carriageways in both directions. A wide central median exists to cater for future transport needs. At the time of construction it was Australia's largest urban road project.

The M7 was procured by the NSW Roads and Traffic Authority (RTA) under a PPP. This approach was similar to the method undertaken for other Sydney motorways, and allowed the NSW Government to transfer the majority of the risks of construction and ownership to the private sector.

The benefits of the project focus on the contribution to mobility, freight transit and new employment in Western Sydney. A number of other benefits to the community were projected, including (p24):

- Safer and more efficient road transport for passenger vehicles and freight in Western Sydney
- Better access to employment opportunities in Western Sydney by linking existing and future industrial and residential areas
- Stronger economic growth in Western Sydney, with investment in the area being encouraged by potential savings in transport costs
- Reductions in the number of heavy vehicles using local roads
- Better air quality and less noise in key residential areas
- Faster travel times between key Western Sydney suburbs.

Actual traffic flows on the M7 have fallen below initial forecasts, but the increased average journey length, and a longer ramp-up period than forecast (with traffic still growing at 6–7% per annum, five years after opening) have ensured the motorway achieves its financial objectives.

B.6 Case study: Northern Expressway, South Australia

The Northern Expressway Project (see: Australian Government, 2010) in the northern metropolitan district of Adelaide was the largest road construction project undertaken in South Australia since the 1960s. It is a 23km four-lane road with an associated cycle and pedestrian path. The project was delivered under a Design and Construct contract by a consortium including a design joint venture and a construction joint venture.

It cost $564 million, of which the Australian Government contributed $451 million under the Nation Building Program, and the South Australian Government contributed $113 million. The Northern Expressway opened in September 2010, within budget and three months ahead of schedule.

The economic analysis component of the business case for the project considered road user benefits including travel time savings, accident costs, vehicle operating cost reductions and off-road benefits, including the impact of improving links between industrial zones and growth areas. The analysis found that the project had a net present value of approximately A$461 million and a benefit/cost Ratio of 2.4.

The objectives of the project targeted the following benefits (p36):

- Increasing transport efficiency, particularly freight to the Port of Adelaide

- Improving road safety and reducing heavy vehicle traffic that had been using alternative routes through residential areas to avoid congestion on Main North Road
- Creating a more effective connection with port and rail facilities by linking directly to the Port of Adelaide, facilitating a future road/rail intermodal terminal at Waterloo Corner, and providing improved access to rail terminals
- Reducing the environmental and social impacts of existing heavy vehicle traffic movements by transferring traffic to a new route of an appropriate standard
- Enhancing economic outcomes for the State and reducing the cost of moving freight from the Riverland and Barossa regions to the Port of Adelaide.

Financial management was challenging, as the costs of key inputs were projected to escalate, including steel, oil and construction industry resources. The strategy of the South Australian Department of Transport, Energy and Infrastructure (DTEI) was to bring forward project completion by a year, limiting the scope for cost escalation.

Appendix C Simulation modelling pros and cons

Caveat: simulation not general equilibrium analysis

The analysis in this report is based on a model of regional demographics and economic growth that is a based on simulation. This approach to analysing economic growth is quite different to other approaches such as using computable general equilibrium (CGE) models and analysis.

Simulation and CGE models have very different and complementary strengths and weaknesses.

Simulation methods are useful for answering questions such as: what can I hope to achieve and where should I start looking for it? Once those sorts of questions have been answered CGE models should be used to ask: "how big of an effect can we reasonably expect?" and "is the policy's effect on the economy unambiguous?"

These different uses arise from the key analytical difference between CGE and simulation models: CGE imposes a lot more structure on the analysis, such as explicit adding-up constraints, than simulation models, while simulation models draw much more heavily on estimated empirical relationships which accommodate a more optimistic or unconstrained view of the world.

There are real strengths in emphasising empirics or data over structure of a model, not least of which is that it turns out that some theory is not borne out by the data.[13] A case in point is the observed importance of creative destruction within industries in driving productivity growth, (see OECD (2003)).[14] While such effects are adequately accounted for in neo-Schumpeterian and other endogenous growth theory they don't align well with more conventional neoclassical growth theory which focuses on changes to the structure of an economy (i.e. allocative efficiency) in driving productivity gains. They are also difficult to model.

Potential problems with simulation methods include:

- possible double-counting by applying results from multiple independent studies
- omitted variable bias
- absence of interaction effects e.g. the extent to which simultaneous investment elsewhere constrains growth opportunities in the economy under investigation.

These are not fatal, depending on your perspective, but they do illustrate some of the limitations of this sort of modelling.

[13] This may mean the data analysis is no good (there are identification problems) or it may mean the theory is no good. Either way, what matters for this discussion is that there are gaps between the two.

[14] For a more up to date discussion of the gaps between empirical "facts" and theory see Jones and Romer (2010).

By contrast with simulation models CGE models implicitly apply a rather more sceptical view of the capacity of policy to boost growth – unless those policies are removing some form of rigidity in the economy.

Appendix D References

Aschauer, DA, 1989. Is public expenditure productive? *Journal of Monetary Economics* 23, no.2: 177-200.

Australian Government, 2010. *Infrastructure Planning and Delivery: Best Practice Case Studies.* Canberra: Department of Infrastructure and Transport.

Byett, Anthony, James Laird, Adolf Stroombergen & Stephen Trodd (MWH New Zealand Limited), March 2015. *Assessing new approaches to estimating the economic impact of transport interventions using the gross value added approach.* New Zealand Transport Agency research report 566. Accessed 30 September 2015 http://www.nzta.govt.nz/assets/resources/research/reports/566/docs/566.pdf

Ding, C, 2013. Transport Development, Regional Concentration and Economic Growth. *Urban Studies* 50: 312-328.

Duranton, G & M Turner, 2012. Urban Growth and Transportation. *Review of Economic Studies* 79: 1407-1440.

Eberts, R. W. and D. P. McMillen, 1999. "Agglomeration economies and urban public infrastructure". In E. S. Mills and P. Cheshire (Eds.), *Handbook of Regional and Urban Economics*, Chapter 38, pp. 1455–1495. Elsevier.

Grimes, A., D. Mare, M. Morten (2007) 'Adjustment in Local Labour and Housing Markets', Motu Working Paper 07-10, Motu Economic and Public Policy Research http://motu-www.motu.org.nz/wpapers/07_10.pdf.

Gibbons, S, HG Overman and PO Pelkonen, 2014. Area disparities in Britain: understanding the contribution of people versus place through variance decompositions. *Oxford Bulletin of Economics and Statistics,* 76, no.5: 745–763. Accessed 30 September file:///C:/Users/geoffp/Downloads/Gibbons_et_al-2014-Oxford_Bulletin_of_Economics_and_Statistics.pdf

Grimes, Arthur, Eyal Apatov, Larissa Lutchman & Anna Robertson, October 2014. *Infrastructure's long-lived impact on urban development: theory and empirics.* Motu Working Paper 14-11. Motu Economic and Public Policy Research.

HM Government (2012) *Unlocking growth in cities: city deals – wave 1.* London: HM Government Cabinet Office. Accessed 30 September 2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221009/Guide-to-City-Deals-wave-1.pdf

Holtz-Eakin, D & A Schwartz, 1995. Spatial Productivity Spillovers from Public Infrastructure: Evidence from 85State Highways. *International Tax and Public Finance* 2: 459-468.

Iacono, M & D Levinson, 2013. *Case Studies of Transportation Investment to Identify the Impacts on the Local and State Economy.* University of Minnesota, Department of Civil Engineering, research project 2013-03.

Grimes, Arthur and Yun Liang, 2010. Bridge to Somewhere: Valuing Auckland's Northern Motorway Extensions. *Journal of Transport Economics & Policy* 44(3): 287-315. Earlier version released as Motu Working paper 08-07, Wellington, www.motu.org.nz

Grimes, A & C Young, 2013. Spatial effects of urban rail upgrades. *Journal of Transport Geography* 30(6): 1-6.

Jiwattanakulpaisarn, P, R Noland & D Graham, 2011. Highway infrastructure and private output: evidence from static and dynamic production function models, *Transportmetrica* 7: 347-367.

Kernohan, Duncan and Lars Rognlien, September 2011. *Wider economic impacts of transport investments in New Zealand.* NZ Transport Agency research report 448, Steer Davies Gleave.

KPMG, 2010a. *High speed rail in Great Britain: consequences for employment and economic growth. Technical Report to Greengauge 21.* Accessed 30 September 2015 www.greengauge21.net/wp-content/uploads/employment-methodology.pdf

KPMG, 2010b. *High speed rail in Great Britain: consequences for employment and economic growth.* Report to Greengauge 21. Accessed 30 September 2015 www.greengauge21.net/wp-content/uploads/consequences-for-employment.pdf

KPMG, 2013. *HS2 regional economic impacts.* Report prepared for HS2 Ltd. Accessed 30 September 2015 https://www.kpmg.com/UK/en/IssuesAndInsights/ArticlesPublications/Documents/PDF/Market%20Sector/Building%20and%20Construction/hs2-regional-economic-impacts.pdf

Krugman, P and A Venables, 1996. Integration, specialisation, and adjustment. *European Economic Review,* 40, no. 3: 959-967.

Maré, DC and DJ Graham, 2009. *Agglomeration elasticities in New Zealand.* Motu working paper 09-06. Motu Economic and Public Policy Research.

Mouter, N, JA Annema and B van Wee, 2013. "Attitudes towards the role of cost–benefit analysis in the decision-making process for spatial-infrastructure projects: a Dutch case study". *Transportation Research Part A: Policy and Practice* 58: 1–14

NZ Transport Agency, 2013. *Economic evaluation manual.* Accessed 30 September 2015 http://www.nzta.govt.nz/assets/resources/economic-evaluation-manual/economic-evaluation-manual/docs/eem-manual.pdf

NZ Transport Agency, 2015. *Travel time saving assessment.* NZ Transport Agency research report 570. Accessed 29 September 2015 http://nzta.govt.nz/resources/research/reports/570

Overman, H, 2013. *The regional economic impacts of HS2.* Spatial Economics Research Centre (SERC) Blog. Accessed 30 September 2015 http://spatial-economics.blogspot.co.uk/2013/09/the-regional-economic-impacts-of-hs2.html

Overman, H, S Gibbons, S D'Costa, G Mion, P Pelkonen, G Resende and M Thomas, 2009. *Strengthening the economic linkages between Leeds and Manchester. Report to Northern Way.* Accessed 30 September 2015 http://eprints.lse.ac.uk/43146/1/Strengthening%20economic%20linkages%20between%20Leeds%20and%20Manchester_full%20report(lsero).pdf

Venables, AJ, 2013. *Expanding cities and connecting cities: the wider benefits of better communications.* Discussion paper. University of Oxford.

Yu, N, M de Jong, S Storm & J Mi, 2013. Spatial spill-over effects of transport infrastructure: evidence from Chinese regions. *Journal of Transport Geography* 28(4): 56-66.

Appendix E Migration impact model

The model is similar to a conventional gravity-style model (using distance to predict flows) but is augmented to account for spatial dependence of:

- flows from neighbouring origins (origin-dependence)
  - on the assumption that strength of migration flows from, for example, Auckland to Bay of Plenty may be associated with the strength of flows from Waikato to the Bay of Plenty
- flows to neighbouring destinations (destination-dependence)
  - on the assumption that strength of migration flows to, for example, Auckland from Bay of Plenty may be associated with strength of flows from Waikato to Auckland
- flows from neighbouring origins to neighbouring destinations (origin-destination dependence)
  - on the assumption that strength of migration flows to Auckland from Bay of Plenty may be associated with strength of flows from Gisborne to Waikato (i.e. occur due to similar and correlated drivers).

This kind of model builds on more conventional spatial econometric models and the use of spatial weight matrices to describe relationships across space. The specification used for this model is essentially a spatial autoregression of the form used in for

In this model, weight matrix takes up to 3 different forms – one for each of the above potential sources of spatial dependence.

The model is not an equilibrium model, so this is not a spatial equilibrium model per se, however it does draw on the concepts in urban and regional economics used to establish equilibria.

Following the approach set out in Le Sage and Pace (2008), the model is:

$$m = \rho_1 W o \quad m + \rho_2 W_d m - \rho_1 \rho_2 W_o W_d m + \alpha + X_d \beta_d + X_o \beta_o + D\gamma + \epsilon$$

Where: m is a vector of origin to destination migration flows; X_d is a matrix of destination characteristics; X_o is a matrix of origin characteristics; D is vector of distances between origins and destinations; W_o is an origin-specific spatial weight matrix; W_d is a destination-specific spatial weight matrix. The spatial weights matrices are constructed using distances between origins and destinations with rows normalised to sum to 1.

The data is worker migration between regions according to Statistics New Zealand's Linked Employer Employee Data. The regions in the data are limited to the following groupings:

- Northland
- Auckland
- Waikato

- Bay of Plenty
- Gisborne, Hawke's Bay
- Taranaki, Manawatū-Whanganui
- Wellington
- WestCoast, Tasman, Nelson, Marlborough
- Canterbury
- Otago
- Southland

The model results are summarised in Table 6. Separate models were fitted to each year.

The key result of this analysis is summarised in Figure 13 showing the sharp break in the model intercept in 2008 – indicating that the recession of 2008-09 has had a lasting effect on migration flows.

Table 6 Worker migration model parameters

Linked Employer-Employee Data on interregional migration

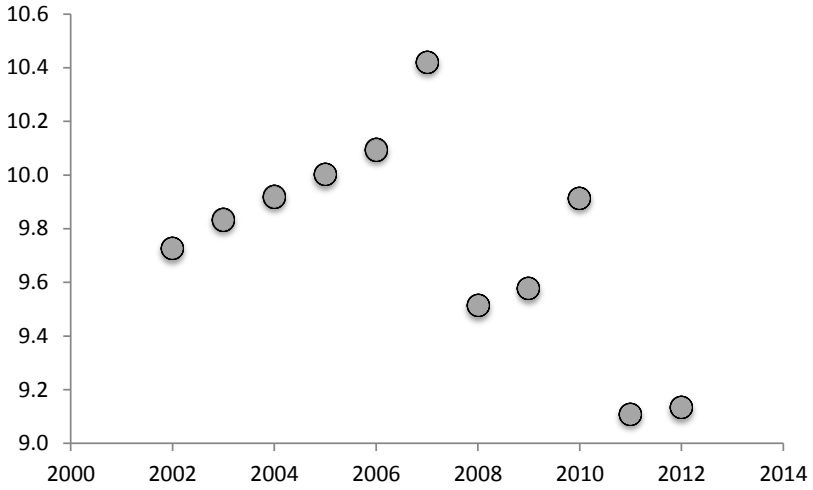
				Origin		Destination	
Year	c	distance	rho[15]	GDP	House price	GDP	House prices
2002	9.73	-0.0014	0.13	0.69	-0.83	0.69	-0.66
2003	9.83	-0.0013	0.11	0.69	-0.80	0.66	-0.60
2004	9.92	-0.0014	0.11	0.67	-0.72	0.60	-0.60
2005	10.00	-0.0013	0.10	0.68	-0.73	0.64	-0.62
2006	10.09	-0.0013	0.10	0.68	-0.72	0.65	-0.63
2007	10.42	-0.0012	0.08	0.72	-0.77	0.69	-0.64
2008	9.51	-0.0013	0.13	0.67	-0.77	0.59	-0.54
2009	9.58	-0.0013	0.13	0.62	-0.63	0.62	-0.69
2010	9.91	-0.0014	0.15	0.59	-0.59	0.55	-0.77
2011	9.11	-0.0014	0.14	0.62	-0.66	0.64	-0.60
2012	9.13	-0.0014	0.16	0.63	-0.74	0.61	-0.57

Source: NZIER

[15] Coefficient on the spatial weight matrix.

Figure 13 Significant decline in migration flows in recent years

Constant values for migrant flows in natural logarithms, each year is a different estimation



Source: NZIER

Appendix F Data tables

Table 7 Auckland is everywhere – when measured by enterprise connections

	There are this many employees working for the same business in...															
For each employee of a business in...	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatū-Whanganui	Wellington	Nelson	Tasman	West Coast	Marlborough	Canterbury	Otago	Southland
Northland	1.0	2.2	0.6	0.4	0.0	0.2	0.2	0.4	1.1	0.1	0.0	0.0	0.1	0.7	0.2	0.1
Auckland	0.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Waikato	0.1	1.1	1.0	0.2	0.0	0.1	0.1	0.2	0.5	0.0	0.0	0.0	0.0	0.3	0.1	0.0
Bay of Plenty	0.1	1.4	0.4	1.0	0.0	0.1	0.1	0.2	0.6	0.0	0.0	0.0	0.0	0.5	0.1	0.1
Gisborne	0.4	4.3	1.1	0.7	1.0	0.5	0.3	0.8	2.5	0.2	0.0	0.1	0.1	1.5	0.4	0.2
Hawke's Bay	0.1	1.7	0.4	0.3	0.1	1.0	0.1	0.3	0.9	0.1	0.0	0.0	0.0	0.6	0.2	0.1
Taranaki	0.2	2.3	0.6	0.4	0.0	0.2	1.0	0.4	1.2	0.1	0.0	0.0	0.1	0.9	0.3	0.1
Manawatū-Whanganui	0.1	1.4	0.4	0.2	0.0	0.2	0.1	1.0	0.8	0.1	0.0	0.0	0.0	0.5	0.2	0.1
Wellington	0.0	0.8	0.1	0.1	0.0	0.1	0.0	0.1	1.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0
Nelson	0.3	4.3	0.9	0.6	0.1	0.3	0.2	0.7	2.3	1.0	0.1	0.1	0.2	1.7	0.5	0.3
Tasman	0.3	2.8	0.9	0.5	0.1	0.2	0.2	0.4	1.4	0.3	1.0	0.1	0.2	1.2	0.4	0.2
West Coast	0.4	3.8	1.0	0.7	0.1	0.4	0.3	0.8	2.6	0.2	0.1	1.0	0.2	2.4	0.7	0.3
Marlborough	0.4	4.2	1.0	0.7	0.1	0.4	0.3	0.8	2.1	0.3	0.1	0.1	1.0	1.7	0.5	0.3
Canterbury	0.0	0.7	0.1	0.1	0.0	0.1	0.0	0.1	0.3	0.0	0.0	0.0	0.0	1.0	0.1	0.1
Otago	0.1	1.4	0.3	0.2	0.0	0.1	0.1	0.2	0.7	0.1	0.0	0.0	0.0	0.6	1.0	0.2
Southland	0.2	2.2	0.6	0.3	0.0	0.2	0.2	0.4	1.2	0.1	0.0	0.1	0.1	1.0	0.6	1.0

Source: NZIER, Statistics New Zealand