MODELLING THE ECONOMIC EFFECTS OF OVERCOMING UNDER-INVESTMENT IN AUSTRALIAN INFRASTRUCTURE

This report was prepared for the Australian Council for Infrastructure Development by Econtech Pty Ltd.

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Executive Summary

The Australian Infrastructure Report Card for 2001 evaluated the state of Australia's infrastructure by assigning ratings, ranging from "A" to "F", across 13 sectors. An "A" rating indicated that infrastructure in 2001 was fit for current and future use, whereas an "F" rating indicated that infrastructure in 2001 was inadequate for current and future use.

The highest rating returned in the Report Card was a "B" for the airports, ports and telecommunications sectors. In comparison, the ratings assigned to the electricity, gas, rail, road and water sectors ranged from a "B-" down to a "D-". This means that a significant boost to the 2001 level of investment is required in each of these five sectors so that infrastructure reaches a reasonable standard.

The Australian Council for Infrastructure Development (AusCID) has commissioned Econtech to examine the economy-wide and industry effects of addressing this under-investment in infrastructure. Specifically, Econtech's task is to examine the economic effects of overcoming infrastructure under-investment in the sectors that returned poor ratings in the Infrastructure Report Card. As mentioned above, these sectors are the electricity, gas, rail, road and water sectors.

The first step is to identify the current gap in infrastructure in each of the five sectors and estimate the infrastructure investment required to close this gap. These estimates of infrastructure under-investment were supplied to Econtech by AusCID and focus on the inadequacy of the country's infrastructure to meet current demand, not future demand. Thus, for this report, under-investment has been defined as "the infrastructure investment that should be in place today but is not".

The second step is to use the estimated infrastructure under-investment, in each of the five sectors, as inputs to Econtech's Murphy Model 600 plus (MM600+). MM600+ is a computable general equilibrium (CGE) model of the Australian economy that models a long-term equilibrium. The second step involved creating two scenarios.

- The first scenario (or "baseline scenario") reflects a situation where infrastructure under-investment is not addressed. This means that the capital stock under the baseline scenario does not change from its existing level.
- The simulated (or "reform scenario") reflects a situation where the infrastructure under-investment is overcome. This means that the capital stock in the five areas of electricity, gas, rail, road and water is expanded from its existing level.

The reform scenario entails a significant upgrading of the nation's infrastructure. This involves an expansion of capital of 65 per cent in the rail sector and 18 per cent in both the gas and road sectors. The water sector experiences a boost to capital of 10 per cent, while there is a smaller boost in the electricity sector of 2 per cent.

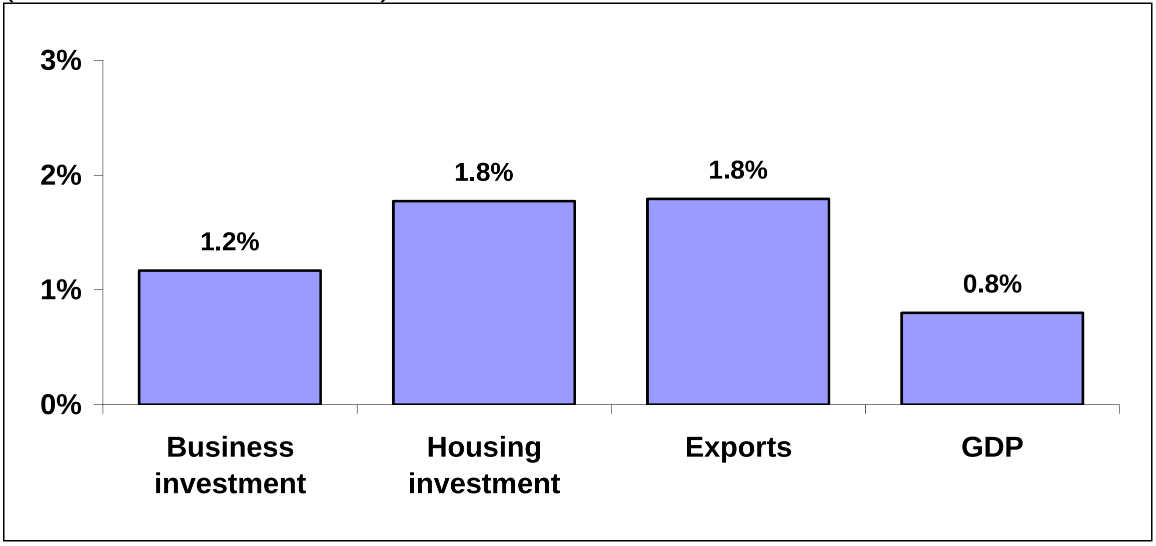
These increases in industry capital stocks boost the productive capacity of the five affected industries, leading to a gain in GDP of 0.8 per cent. This represents the GDP dividend from expanding the stock of the nation's infrastructure by an estimated 6.2 per cent. This implies an output elasticity of 0.13 (calculated as 0.8 divided by 6.2). This is similar to the previous studies that are surveyed in section 2, which gave a central estimate for this elasticity of 0.17.

This gain in GDP can also be seen in GDP's expenditure components, including business investment and exports, as shown in Chart A and explained below.

The additional infrastructure investment in the three utility industries of electricity, gas and water represents a rise in business investment. Thus, the modelling results show a significant gain in business investment of 1.2 per cent under the reform scenario compared with the baseline (see Chart A). The additional infrastructure investment in the two transport industries is assumed to be undertaken by government and so leads to a gain in general government investment – in principle the modelling results would be similar irrespective of who undertakes the additional investment. Furthermore, upgraded water infrastructure facilitates an expansion in housing investment of 1.8 per cent.

Upgraded utility services and freight transport reduce the cost of doing business. The resulting improvement in international competitiveness boosts exports by 1.8 per cent.

Chart A
Estimates of Macro-economic Effects
(% deviation from baseline)



In the long run, lower costs to industries for infrastructure services (road and rail freight transport, water, gas and electricity) are passed on to consumers in the form of lower prices for consumer goods and services, as shown in Table A. In addition, consumers benefit more directly through lower prices for the infrastructure services that they purchase themselves. Hence the biggest savings are in the Housing category, which includes gas, electricity and water services, and the Transportation category, which includes rail passenger transport.

Table A
Estimates of Impact on Consumer Prices (CPI)
(% deviation from baseline)

	Reform Scenario
Food	-2.1%
Alcohol and Tobacco	-1.4%
Clothing and Footwear	-1.6%
Housing	-8.0%
H/hold Furnishings, Supplies etc	-1.8%
Health	-1.7%
Transportation	-2.2%
Communication	-1.3%
Recreation	-1.8%
Education	-0.3%
Miscellaneous	-1.3%
All Groups CPI	-3.2%

Chart B shows that the lower consumer prices from of an upgrading of Australia's transport and utility services translates into higher living standards. The improvement in consumer welfare (or living standards) is 0.4 per cent.

Chart B
Estimates of Living Standards and Price Effects
(% deviation from baseline)

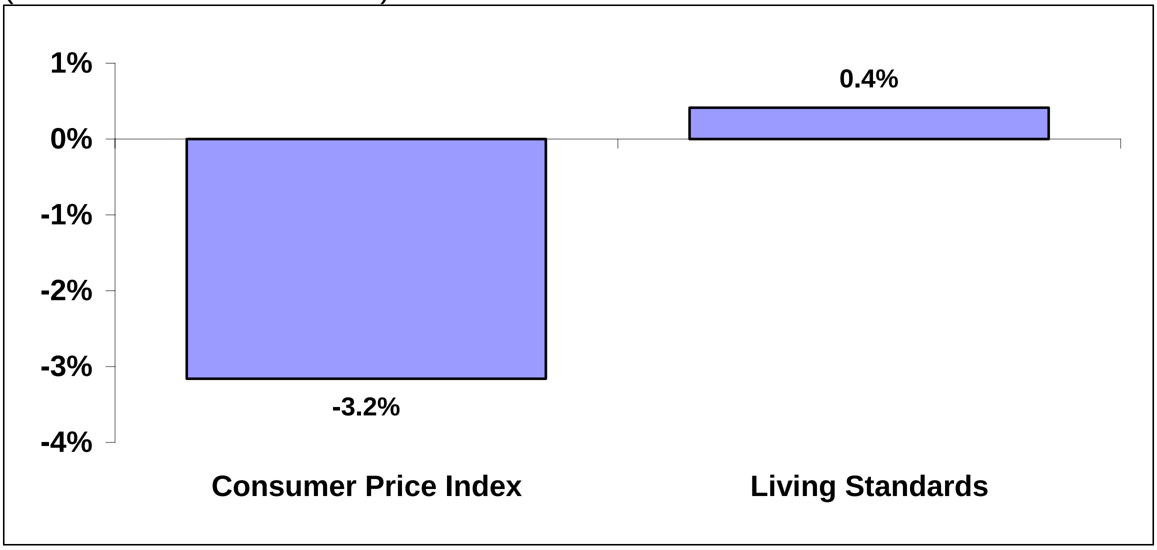


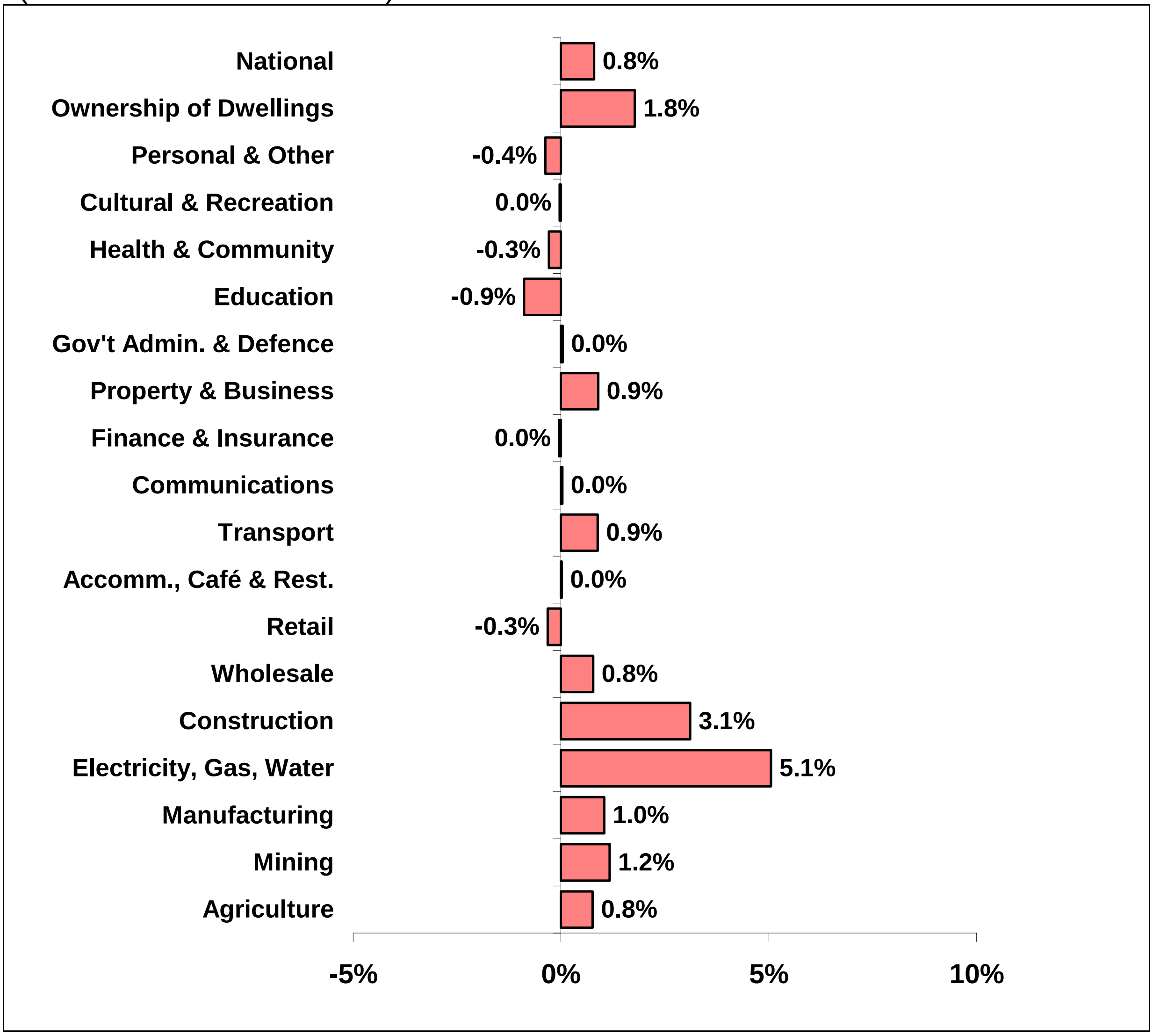
Chart C shows the gains in GDP by industry. As reported earlier, the overall gain in GDP is 0.8 per cent. While most industries gain, Chart C shows that the biggest gains are concentrated in the construction industry and the electricity, gas and water industry.

The construction industry benefits directly from the boom in infrastructure investment across road, rail, gas, electricity and water. This leads to a gain in construction activity of 3.1 per cent.

The electricity, water and gas industry experiences an even larger gain in activity of 5.1 per cent. The additional infrastructure investment in these industries boosts their supply of electricity, gas and water. Similarly, the additional infrastructure investment in road and rail boosts the supply of transport services by 0.9 per cent.

As explained earlier, the reform scenario also boosts housing investment. This boosts the housing services industry, known by the ABS as the "Ownership of Dwellings" industry.

Chart C
Estimates of Effects on GDP by Industry
(% deviations from baseline)



1 Introduction

The Australian Infrastructure Report Card for 2001 evaluated the state of Australia's infrastructure by assigning ratings, ranging from "A" to "F", across 13 sectors. An "A" rating indicated that infrastructure in 2001 was fit for current and future use, whereas an "F" rating indicated that infrastructure in 2001 was inadequate for current and future use.

The highest rating returned in the Report Card was a "B" for the airports, ports and telecommunications sectors. In comparison, the ratings assigned to the electricity, gas, rail, road and water sectors ranged from a "B-" down to a "D-". This means that a significant boost to the 2001 level of investment is required in each of these five sectors so that infrastructure reaches a reasonable standard.

The Australian Council for Infrastructure Development (AusCID) has commissioned Econtech to examine the economy-wide and industry effects of addressing this under-investment in infrastructure. Specifically, Econtech's task is to examine the economic effects of overcoming infrastructure under-investment in the sectors that returned poor ratings in the Infrastructure Report Card. As mentioned above, these sectors are the electricity, gas, rail, road, and water sectors.

The first step in analysing the economic effect of infrastructure under-investment is to identify the current gap in infrastructure in each of the five sectors and estimate the infrastructure investment required to close this gap. These estimates of current infrastructure under-investment were supplied to Econtech by AusCID and are based both on previous reports that identified infrastructure deficiencies and also on expert opinion. AusCID also put forward reasons for under-investment in each sector.

The estimates of infrastructure under-investment, used in this report, focus on the inadequacy of the country's infrastructure to meet current demand, not future demand. Thus, for this report, under-investment has been defined as "the infrastructure investment that should be in place today but is not".

The second step is to use the estimated infrastructure under-investment, in each of the five sectors, as inputs to Econtech's Murphy Model 600 plus (MM600+). MM600+ is a computable general equilibrium (CGE) model of the Australian economy that models a long-term equilibrium. It includes a detailed treatment of the stock of infrastructure by industry. Its results show the effects of varying the capital stock in the five sectors on economy-wide variables such as GDP, prices, investment, as well as production in individual industries.

This report is structured as follows.

- Section 2 examines previous work on the relationship between infrastructure investment and economic output.
- Section 3 contains estimates of the likely infrastructure under-investment in each of the five sectors of electricity, gas, rail, road and water.
- Section 4 describes the modelling approach.
- Section 5 sets out the model results at a national and industry level.

While all care, skill and consideration has been used in the preparation of this report, the scope of this report is based on the strict instructions of AusCID and it is designed to be used only for the specific purpose set out below. If you believe that your instructions are different from those set out below, or you wish to use this work or information contained within it for another purpose, please contact us.

The specific purpose of this report is to model the economic impact of overcoming infrastructure under-investment in Australia. These effects are assessed at the economy and industry level.

The findings in this report are subject to unavoidable statistical variation. While all care has been taken to ensure that the statistical variation is kept to a minimum, care should be taken whenever using this information. Should you require clarification of any material, please contact us.

2 Literature Review

This section reviews previous studies on the relationship between infrastructure investment and economic output. The purpose of this section is to distill existing knowledge on how infrastructure investment impacts the economy and the magnitude of this impact.

The debate on the relationship between infrastructure and economic output began with a study by Aschauer in 1989. He found that public infrastructure investment in the United States is an important input to private production because it leads to cost savings resulting in a reduction in overall business costs. Aschauer found that a 1 per cent increase in public infrastructure spending resulted in a 0.4 per cent increase in economic output.

Some commentators claimed that the direction of causality in Aschauer's study was incorrect. They argued that an increase in private production causes an increase in public infrastructure spending and not the other way around. Other commentators questioned the size of the effect on the economy. However, many other studies since Aschauer's work, using different data sets and methodologies, have also found that public infrastructure investment has a direct and positive effect on economic output - but the magnitude of this effect varied significantly from study to study.

In Australia, there are a number of studies that have estimated the economic benefits from investing in infrastructure. The results of some of these studies are summarised in Table 1.

Table 1
Australian Studies on the Output Elasticity of Infrastructure Investment

Author	*Output Elasticity**
Otto and Voss (1996)	0.17
Pereira (2001)	0.17
Kam (2001)	0.10
Song (2002)	0.27-0.39

*The increase in economic output from a one per cent increase in infrastructure investment

One of the earlier studies, by Otto and Voss (1996), examined the economic benefits of public spending on different types of infrastructure. There are two main results from this study.

- First, investing in public infrastructure generates a positive impact on economic output. Specifically, they found that a one per cent increase in spending on public infrastructure in Australia leads to an increase in economic output of 0.17 per cent (this is known as the elasticity of output with respect to capital and is referred to as the output elasticity).

- Second, economic infrastructure services contribute more to economic output than other types of public expenditure. For example, road investment generates a higher return than investing in social security and welfare services.

In a later study, Kam (2001) found that infrastructure investment generated smaller economic benefits than those estimated by Otto and Voss. Specifically, the output elasticity was estimated at 0.10 per cent, that is, a one per cent increase in infrastructure investment translates to an increase in economic output of 0.10 per cent. Kam found that the accumulation of public capital has a permanent effect on the economy, not only by increasing output directly, but also by also encouraging private investment in capital.

In a more recent study, Song (2002) discovered that the economic benefits from an increase of one per cent in public infrastructure ranged from 0.27 to 0.39 per cent. These estimates are higher than the estimated output elasticities from the previously mentioned studies, but this can be explained by the different time frames of the studies. Song used more recent data and explained that "*The higher estimates from more recent data indicate a higher marginal product of public capital, and thus may suggest that public capital is not provided in the recent period as sufficiently as in early periods*".

Other studies have compared the economic benefits of infrastructure investment across countries. For example, Pereira (2001) compared the output elasticity across 12 OECD countries (including Australia). All countries reported a positive economic benefit from infrastructure investment, with the output elasticity ranging from 0.17 to 1.4. Pereira estimated an output elasticity for Australia of 0.17, which is the same as Otto and Voss's earlier estimate and lower than that estimated for the other countries. Pereira explains that infrastructure investment is strongly correlated with economic achievement. The data for the study is based on the 1960-1980 period for most countries. During this period economic growth in Australia was lower than for other countries. Australia's low economic performance was associated with a low responsiveness of the private sector to public investment, which reduced the economic benefits from public investment in infrastructure.

In addition to variations across countries, some studies have found that investment in particular sectors have greater positive effects on output than investment in other sectors. Variations in the adequacy of infrastructure across industries can help explain patterns in comparative advantage across industries. Yeaple and Golub (2002) found that infrastructure has a positive effect on output across all industries, with investment in roads having the biggest impact across industries. The authors also find that changes in the availability of infrastructure are associated with industry specialisation. For example, an increase in road infrastructure and electricity generating capacity causes a shift away from manufacturing towards the service sectors. A recent "Public Infrastructure Bulletin" echoed the observation from the studies mentioned above that investment in transport services have greater positive effects on output than investment in other sectors.

In summary, previous studies on the relationship between infrastructure and economic growth are consistent in that all studies show that infrastructure has a positive and permanent effect on economic output. While the magnitude of this effect varies between the studies within a range of 0.10 to 0.39, a reasonable central estimate is 0.17. This implies that a 1 per cent increase in infrastructure leads to a 0.17 per cent increase in output. Moreover, investment in infrastructure in some sectors in the economy generates higher returns than for investment in other sectors.

These previous studies rely on aggregate analysis of the relationship between infrastructure capital and GDP. This is useful in providing a general idea of the responsiveness of GDP to infrastructure investment. In this report the central estimate of the output elasticity from the existing literature of 0.17 serves as a useful cross-check on our modelling results. However, the existing literature has three significant limitations.

First, as noted above, correlation between higher infrastructure capital and higher GDP does not necessarily imply causation. Second, aggregate analysis does little to assist understanding of the actual mechanisms through which infrastructure investment boosts GDP.

To overcome these first two limitations, this report analyses the impact of overcoming under-investment in infrastructure using a detailed structural model of the Australian economy. Such a model shows the detailed causal mechanisms linking infrastructure investment to GDP by industry. The modelling approach is described in detail in section 4.

The third limitation of the previous studies is that, as noted above, in practice the GDP dividend from infrastructure investment is likely to vary from one type of infrastructure investment to another. To overcome the third limitation, this report confines itself to proposed infrastructure investments that are know to be viable, as detailed in section 3.7.

3 Estimates of Infrastructure Under-investment

The deficiencies in Australia's infrastructure were identified in the National Infrastructure Report Card for 2001 (hereafter referred to as "the Report Card"). The Report Card rated infrastructure services in 13 sectors covering electricity, gas, rail, roads, airports, telecommunications and ports. The ratings for the 13 sectors are presented in Table 2.

The Report Card rated the country's infrastructure on scale from "A" to "F". An "A" rating indicated that the level of infrastructure in 2001 was sufficient for current and future purposes, whereas an "F" rating indicated that the level of infrastructure in 2001 was inadequate for current and future purposes.

At the broad level, this national infrastructure assessment did not return any "A" ratings. In fact, the highest rating was a "B" for the ports, airports and telecommunications sectors, which indicated that minor changes were required so that infrastructure in this sector was fit for current and future use. In comparison, the water, rail, road, electricity and gas sectors were each assigned lower ratings, ranging from "B-" down to "D-". Of the most concern were the rail and road sectors. These two sectors scored poorly on the Report Card, achieving only a "D-" and "D" respectively, and were assessed as being in a "disturbing state".

Table 2
Infrastructure Ratings in the 2001 Australian Infrastructure Report Card

Infrastructure	Rating
Ports	B
Airports	B
Telecommunications	B
Electricity	B-
National Roads	C
Potable Water	C
Gas	C
State roads	C-
Wastewater	C-
Local roads	D
Storm water	D
Irrigation	D-
Rail	D-

Source: Institution of Engineers, Australia (2001).

The purpose of this section is to provide estimates of under-investment in sectors that returned less than a “B” rating in the Report Card. As mentioned above, these are the electricity, gas, rail, road and water sectors. The estimates of under-investment presented in this section were provided to Econtech by AusCID. AusCID identified infrastructure projects that should be in place today but are not because of inhibiting factors such as regulatory failure, planning delays and lack of government fiscal commitment. As such, the estimates of under-investment take into account the amount of investment required so that infrastructure is fit for current use only; it does not examine the issue of future use.

In assessing the current level of under-investment in the economy, AusCID drew on a number of professional reports and also on advice from experts in each of the five sectors. The estimates of under-investment include the land transport projects announced in the “Auslink” white paper by the Department of Transport and Regional Services (2004). This is because these projects are designed to correct current deficiencies in infrastructure. As such, these projects are included in the definition of under-investment used in this report – “infrastructure projects that should be place today but are not”.

This section now turns to the AusCID estimates of under-investment in each of the sectors that scored poorly on the Report Card.

3.1 Electricity

In comparison to other sectors, the electricity sector fared well under the Infrastructure Report Card, scoring a “B-” rating. There has been considerable reform in the electricity in recent years with the privistisation of the electricity generation, transmission and distribution assets in Victoria and South Australia. In the other states and territories, the state governments control the electricity market. The electricity market is subject to regulation so many of the issues relating to under-investment in this sector are regulation issues.

The infrastructure for the electricity sector can be divided into three parts: distribution, transmission and generation. These parts are analysed in turn below.

Electricity Distribution

The distribution of electricity from the grid is carried out by distribution utilities. The distributors own and operate the electricity network that delivers electricity to premises. The price the distributors charge is subject to price controls or tariffs which is set by an independent regulator. The information on the under-investment in electricity is based on recent submissions to the regulator's review of electricity prices.

IPART (Independent Pricing and Regulatory Tribunal) has recently completed its review of electricity distribution tariffs in NSW. The submission from Energy Australia (2003) indicates that the capital under-spend (relative to what the regulator allowed) on asset replacement over the current regulatory period will be around $71 million. It can be estimated from its submission to IPART that the corresponding figure for Integral Energy (2003) is $58 million. It was not possible to construct an estimate for either Australian Inland or Country Energy.

Other major jurisdictions (Victoria, Queensland and South Australia) are currently reviewing distribution tariffs but are in the early stages of that process. However, it does appear that capital expenditure, and probably renewal expenditure, may have been higher in Victoria than New South Wales. That said, it is almost certain there is a backlog of renewal in country NSW and other jurisdictions and assuming it might be the same as what is required by the two largest distributors in NSW does not seem excessive. Therefore, AusCID estimates that the balance of distribution under-spend to be $131 million.

Electricity Transmission

The transmission of electricity covers the transmission of electricity from the generation source to distribution centres. According to the Infrastructure Report Card, the main issue with electricity transmission is the interconnection between states because each state developed its own transmission infrastructure in isolation over the years.

In relation to interconnectors, the development of the South Australian-New South Wales interconnector (SNI) still remains in dispute but really should be in place. Transgrid reported the cost of the project in 2000 would be $110 million.

According to a recent article in "The Age" (Myer, 2003) which quoted documents tabled in the Tasmanian Parliament, Basslink (the interconnector between Tasmania and Victoria) would have been in place today but for excessive delays in gaining planning approval and related issues. The project has only just commenced and has a current forecast cost of around $780 million.

Electricity Generation

A Review of the National Electricity Market Management Company (NEMMCO) 2003 Statement of Opportunities and the January 2004 update indicate there is no current lack of generation capacity. As a general proposition, peaking capacity does appear to be coming on line as required although there clearly is a major question going forward about the development of future base load capacity that is not currently required. Thus, the estimate of the under-spend on electricity generation is zero.

Table 3
Estimates of Under-investment in the Electricity Sector
($ billion)

	Value	Projects
Electricity distribution	0.071	Capital under-investment on asset replacement by Country Energy in NSW
	0.058	Capital under-investment on asset replacement by Integral Energy in NSW
	0.131	Under-investment in other jurisdictions
Electricity transmission	0.110	South Australia-New South Wales interconnector
	0.780	Basslink
Total	1.150	

Source: AusCID

Table 3 shows the estimated under-investment in each of the three parts of the electricity sector. As shown in the last row of this table, the total under-investment in electricity is estimated at $1.12 billion. This under-investment is largely the result of planning delays and regulatory issues.

3.2 Gas

The gas sector was assigned a “C” rating in the Infrastructure Report Card. The report card assessed the condition of the assets in this sector as good but pointed out that many pipelines do not have the capacity to meet demand.

This sector has also undergone significant reform. Previously, a monopolistic market existed with a single source and transmission pipeline delivering gas in each of the major gas markets. Now, the transmission and distribution of gas is almost fully privatised. The market is also characterised by regulation with the implementation of the National Gas Code. The National Gas Code determines the price third parties pay for access to the pipelines for the transmission and distribution of gas.

Gas Transmission

Significant investment has occurred in gas transmission pipelines and distribution networks over the last decade and there is significant debate as to whether the Gas Code has impeded investment. Whilst the Productivity Commission (2003) has concluded that the Code has impeded investment, plausible arguments and evidence have been advanced to the contrary.

According to AusCID there is little or no reliable estimate of this under-investment in the transmission of gas with one notable exception – the Dampier to Bunbury pipeline. Had Epic received the tariff it had expected it would have preceded with the $870 million upgrade of the pipeline. Of this amount, $125 million has been expended and approximately another $300-400 million would have been provided by around this time with the remainder spent in the future. It has been assumed that the missing part of this asset today would cost $400 million.

Discussions with industry participants have indicated that issues associated with market risk and development and tax have also had a significant impact on transmission pipeline development and if policy settings had of been different, some $2 billion would have been spent on the PNG to Queensland pipeline and $0.1 billion on the Central ranges pipeline. These investments would open up significant new markets for gas, especially in Queensland, and would greatly enhance competition in both upstream and downstream energy markets.

Gas distribution

There is also evidence to suggest that there has been under-investment in gas distribution because of poor policy and regulatory settings. However there are competing views that incremental distributional systems, especially in regional areas, are simply uneconomic. This is reflected in the Victorian Government's regional reticulation program of $70m. The truth almost certainly lies somewhere in between these two positions.

It does seem appropriate to include something for gas distribution although it is noted that projects are relatively small in scope (all of Tasmania was estimated only to cost $200 million) and limited in geographical range (Tasmania and southeast corner). The total estimated under-spend in gas distribution is $100m.

Putting together the above estimates for under-spend for gas transmission and distribution, the total gas infrastructure under-spend is estimated to be $2.6 billion (see Table 4).

The reasons for this situation are:

- regulatory failure (especially in relation to the Dampier-Bunbury pipeline); and
- failure to properly develop markets.

Table 4
Estimates of Under-investment in the Gas Sector
($ billion)

	Value	Projects
Gas transmission	0.40	Dampier-Bunbury pipeline
	2.00	PNG to Queensland pipeline
	0.10	Central ranges pipeline
Gas distribution	0.10	
Total	2.60	

Source: AusCID

3.3 Water, sewerage and drainage

Sewerage, drainage and potable water scored poorly on the Report Card (C-, D and C). No credible estimates of investment shortfall could be found relating to these largely urban issues. Discussions with industry participants and their representative organisations led to a range of estimates from zero to $20 billion. However, the general view was that urban water infrastructure was lacking.

A number of major projects were identified that a number of discussants believed should already have been completed: these projects are set out in Table 5.

Given Adelaide's high dependency on the Murray for drinking water, clearly there would be worthwhile recycling projects in that city. It is also known that there is a serious shortage of catchment capacity developing in a number of Coastal Queensland cities are a result of population growth. Other examples of under-investment in urban water infrastructure almost certainly exist.

The total under-spend for water, sewerage and drainage is estimated to be $3.0 billion (See Table 5). Reasons for this situation are:

- regulatory failure (National Competition Policy and regulatory price setting);
- lack of fiscal commitment; and
- failure to properly develop markets.

Table 5
Estimates of Under-investment in the Water Sector
($ billion)

Projects	Value
Sydney sewerage	2.00
Perth desalination plant	0.25
Additional recycling for Brisbane suburbs/Gold Coast	0.40
Melbourne storm water and grey water recycling	0.30
Other projects	0.05
Total	3.00

Source: AusCID

3.4 Roads

Road infrastructure also scored poorly in the Report Card with rating of “C”, “C-” and “D” for national, state and local roads respectively. These ratings have not changed from the 2000 Report Card.

With the exception of a number of private sector funded tollways, the Australian road system is funded by all three levels of government from recurrent expenditure.

In its submission to the Federal Government in the context of the 2004 Budget, the Australian Automobile Association (2003) stated that there existed a backlog of over $10 billion in Australia’s road network covering all levels of government. This estimate is based on a study undertaken by Allen Consulting, which calculated a backlog for New South Wales ($4.4 billion), Victoria ($3.8 billion) and Western Australia ($2.2 billion) of $10.4 billion.

Given the scope of the road network in Queensland, and the known problems with the Ipswich Motorway and the Bruce Highway, plus smaller issues in South Australia and Tasmania, a national figure of around $13 billion would not be unreasonable. However, given the standing of the AAA and its recently stated view, $10 billion has been used.

The total under-spend for road construction is estimated to be $10.0 billion.

Reasons for this situation are:

- fiscal failure; and
- the taxation regime obstructing private sector involvement

3.5 Rail

The Infrastructure Report Card returned a “D-“ for the rail sector in Australia. Apart from the irrigation sector this was the lowest rating across the 13 sectors. The Report Card pointed out that performance in the rail sector varies across regions from an “A+” for the Pilbara region iron ore trains to an “F” for the Melbourne-Sydney-Brisbane interstate rail track.

The rail sector can be categorised into rail freight and urban passenger rail, which are described in turn below.

Rail freight

It is well known that there have been decades of chronic under investment in Australia’s rail system and in particular the interstate rail network and the Sydney urban network.

In 2002 AusCID commissioned National Economics (2002) to undertake a study on the potential of transport infrastructure to contribute to economic growth. That study found that the following interstate rail projects could be readily justified and given the returns to these projects were so high, one could conclude these projects should have already been undertaken and completed.

- Melbourne to Brisbane inland rail link ($1.8 billion)
- Melbourne to Sydney ($1.3 billion)[1]
- Sydney to Brisbane ($1.1 billion)

[1] These Sydney related projects include expenditure on improving terminals in Sydney

In addition, there are known to be serious problems with rail access to a most capital city ports and important regional ports (such as Port Kembla and Portland). Identifiable projects are listed below.

1. Fremantle ($40 million)
2. Port Kembla ($400 million)
3. Portland ($30 million)[2].
4. Port Adelaide ($80 million).
5. Melbourne-Mildura track upgrade ($20 million)
6. Melbourne-Albury Wodonga ($45 million)
7. Tottenham yard bi-directional standard gauge ($40 million)
8. Rail access to the Port of Melbourne ($110 million)
9. Hunter Valley rail links ($450 million)
10. Technology improvements and bridge strengthening ($145 million)

Estimates under (1) and (2) above were obtained from a National Economics (2002) report, while estimates under (4)-(10) were obtained from the recent Auslink paper from the Department of Transport and Regional Services (2004).

Urban passenger rail

The principal problems with the urban rail system seem to be in Sydney. It was reported in the "Sydney Morning Herald" (Goodsir, 2003) that $1.5 billion was required to fix an immediate maintenance backlog in the Sydney network. This was denied by the NSW Government. In the Mini-budget of 6 April 2004, $1.0 billion was announced for infrastructure projects and $1.5 billion for new rolling stock. Certainly, part of the rolling stock expenditure is to replace rolling stock that will be due for retirement in future years but a large amount would be due to a back log. In addition, there are certainly other projects in Sydney that should have been undertaken by now but have not yet been funded, as well as other projects around the nation.

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[2] Personal communication with AusCID.

The estimate for total under-investment in the rail sector in Australia is presented in Table 6. This table shows that the total estimate of under-investment is $8.060 billion, with under-investment in both rail freight and rail passenger transport.

Reasons for this situation are:

- fiscal failure; and
- pricing of road access impeding private sector involvement.

Table 6
Estimates of Under-investment in the Rail Sector
($ billion)

Projects	Value
Melbourne-Brisbane inland rail link	1.800
Melbourne- Sydney rail link	1.300
Sydney-Brisbane rail link	1.100
Rail access to Port Adelaide	0.080
Rail access to Fremantle	0.040
Rail access to Port Kembla	0.400
Rail access to Portland	0.030
Melbourne Mildura track upgrade	0.020
Melbourne-Albury Wodonga	0.045
Tottenham yard bi-directional standard guage	0.040
Rail Access to the Port of Melbourne	0.110
Hunter Valley Rail Links	0.450
Bridge Strengthening	0.145
Sydney infrastructure projects	1.000
New rolling stock in Sydney	1.500
Total	8.060

Source: AusCID

3.6 Summary of Under-investment

The total estimated value of infrastructure under-investment in Australia in the five areas of electricity, gas, rail, road and water is $24.8 billion (see Table 7). As mentioned this under-investment covers the deficiency in infrastructure in meeting current demand. Previous estimates of infrastructure under-investment are as high as $150 billion because they take into account the inadequacy of current infrastructure services in meeting future demand as well as current demand. Further, AusCID has been careful to ensure that these estimates are justifiable, as far as possible, from external sources wherever possible, although this has not been possible in some cases. In adopting this approach the estimates given here should be seen as representing the bottom end of the range for deficiencies in the infrastructure capital stock.

3.7 Return on investment

AusCID have also identified the rate of return from infrastructure projects in each of the five sectors. The estimated rate of return is based on the nominal pre-tax rate of return from current projects as indicated by experts in each area validated against various sources such as analysts' reports and regulatory decisions. The rates represent those for which private sector investors would be prepared to advance capital.

It should be noted that sector contains a broad range of activities which have widely varying risk profiles – regulated electricity transmission has a very different risk and return profile to peaking plant generation. As such, the rates of return presented here are broad sectoral averages and do not apply to any particular project.

An indication of the rate of return is important because it determines whether a project is commercially viable. If projects are not commercially viable then investment would not be forthcoming and so the current infrastructure deficiencies would not be corrected. The rate of return should cover cost of risk-free borrowing plus a risk premium reflecting the riskiness of the asset. The government 10-year bond rate at the time of writing was 5¾ per cent and the risk premium for commercial property and utilities is generally in the range of 3 to 8 per cent, depending on the asset. Thus, as a general guide, a rate of return in the range of 8¾ to 13¾ per cent would indicate that investment is commercially viable.

On this basis, Table 7 shows that infrastructure projects would generally be commercially viable. While, the rate of return for the water sector is towards the bottom of the indicated range, the risk premium for investing in the water sector is relatively low, so a rate of return of 9 per cent is likely to be acceptable. Thus the projects summarised in Table 7 would be likely to proceed if the inhibiting factors identified in this section were removed.

Table 7
Estimates of Under-investment and Rate of Return* by Sector

Sector	Under-investment	Rate of Return
	($bn)	%
Electricity	1.15	10.5
Gas	2.60	12.5
Road	10.00	12.5
Rail	8.06	12.5
Water	3.00	9.0
Total	24.81	

*The rate of return is the nominal pre-tax rate of return.
Source: AusCID

4 Modelling Approach

This section describes the modelling approach used to model the economic benefits of overcoming under-investment in infrastructure in Australia. Under this approach, the estimates of infrastructure under-investment outlined in the previous section are first transformed into model inputs suitable for the MM600+ model. These inputs are then fed into MM600+ and results are collected at both the national and industry levels. This section begins with a description of the MM600+ model and ends with a description of the model inputs (or scenarios).

4.1 Nature of MM600+ Model

MM600+ is a long-term CGE model of the Australian economy. MM600+ has many features that are important for analysing the economic impacts of infrastructure investment, including the following.

- MM600+ has 108 industries that produce 672 products, making it six times more detailed than any comparable model. The high level of product detail means that a wide variety of policy changes can be analysed, and the effects on very specific industries and products can be distinguished. This makes it suitable for distinguishing between the effects of infrastructure investment in different sectors of the economy.

- In particular, MM600+ distinguishes the five industries of infrastructure under-investment: water, gas, electricity, road and rail. Investment in each of these industries can be adjusted independently. This is important because the estimated extent of under-investment varies between each of these industries.

- Further, the model distinguishes between the different products produced by each infrastructure industry. For example, the model distinguishes between the supply of passenger and freight transport services by both the road transport and rail transport industries. This means that the model can take into account that the split of the benefits of additional investment in, say, rail transport between passenger and freight services depends upon the nature of that additional investment.

- Overcoming infrastructure under-investment will improve the price competitiveness of rail transport relative to road transport. MM600+ allows for substitution by industry between road and rail freight transport in response to such changes in their relative price competitiveness. In most cases the elasticity of substitution is set to 2.

- Overcoming infrastructure under-investment will also affect the pattern of passenger fares faced by consumers. MM600+ allows for substitution by consumers between the different modes of passenger transport: bus, taxi, rail, water and air.

- Finally, overcoming infrastructure under-investment in utilities will affect the various energy costs faced by consumers. MM600+ comprehensively allows for substitution by consumers within the broad consumption category of “gas, electricity and fuel”.

- The model produces comprehensive results for all of its 672 products, including effects on production, employment and trade flows.

- The model also produces results for all of key broad economic aggregates such as consumption, business investment, government investment, exports, gross domestic product (GDP) and consumer welfare.

The simulations in this report are based on the standard long-run closure of the MM600+ model. Thus they estimate what the Australian economy would be like in the long run if Australia’s current under-investment in infrastructure were overcome. This is fitting because economic policies should be judged against their lasting effects on the economy, not just their effects in the first one or two years.

MM600+ models a long-run equilibrium. Some of the key assumptions involved are as follows.

- *external balance*: in MM600+, the balance of trade is at a sustainable level. Specifically, a trade surplus is run equal to the amount required to service foreign-owned capital. The real exchange rate needed to achieve this trade surplus is determined by MM600+. Thus shocks to international trade affect the real exchange rate, not the trade surplus.

- *budget balance*: the government budget is also assumed to be at a sustainable level. Specifically, it is assumed to be in balance. Labour income tax is varied to balance out the effects on the government budget of any shock to the budget.
- *private saving*: the level of private sector saving and associated asset accumulation are sustainable in the long run. Specifically, private saving is held constant in MM600+ by fixing the quantity of capital that is owned locally, and changes in capital are only in the foreign-owned portion. This implies that the additional infrastructure investment is financed by foreigners, so that the full cost of financing that investment is fully taken into account through increased payments to foreign owners. The modelling therefore shows the net benefits of overcoming infrastructure investment.

More information on MM600+ is available in Appendix B.

4.2 Modelling Scenarios

The basic modelling approach used in this report is to transform the estimates of under-investment contained in Section 3 of this report into inputs suitable for the MM600+ model. This involves creating two scenarios.

- The first scenario (or “baseline scenario”) reflects a situation where infrastructure under-investment is not addressed.
- The simulated (or “reform scenario”) reflects a situation where the problem of under-investment in each sector is overcome.

Differences in economic outcomes between the reform scenario and the baseline scenario are then calculated to determine the economic benefits of overcoming the current level of under-investment in infrastructure.

As mentioned above, the MM600+ model contains a detailed treatment of the capital stock in each industry. Under the baseline scenarios, the infrastructure under-investment in the five sectors of electricity, gas, rail, road and water is not addressed. This means that the capital stock under the baseline scenario does not change from its existing level.

In contrast, the problem of under-investment infrastructure is overcome under the reform scenario. This means that the capital stock under the reform scenario is expanded from its existing level in each of the five sectors. The model inputs for this scenario are presented in Table 8.

There were two steps to developing these inputs.

- First, the estimates of under-investment were represented in 1998/99 prices, because MM600+ is based on the 1998/99 values.
- Second, changes in the capital stock under the reform scenario are calculated by boosting the capital stock by the level of under-investment in each sector.

The previous section showed that the main factors impeding investment in the electricity, gas and water sectors are mis-pricing issues associated with regulation. Specifically, the regulated price is set too low to induce supply in these sectors. So, Econtech used the modelling device of a production subsidy to stimulate production and capital stock under the reform scenario in these sectors. This has the same economic effect as increasing the price the regulated industries can charge.

The under-investment in the road and rail sectors was mainly related to inadequate government spending. For these sectors, Econtech increased general government investment spending. It then worked through the benefits from this increase by lifting capital efficiency in the road and rail industries, and then directed the benefits of this cost saving between passenger and freight transport through the modelling device of re-balancing production taxes.

The change in the capital stock under the reform scenario is presented in Table 8. As would be expected, the pattern of change in the capital stock reflects the ratings pattern in the Report Card. For example, the electricity sector was assigned the highest rating in the Report Card and so you would expect the capital stock adjustment required for this sector under the reform scenario to be relatively small. Conversely, the rail sector was assigned the lowest rating, so you would expect the capital stock adjustment required for this sector to be larger relative to the other sectors. The adjustments presented in the table below reflect this.

Table 8
Model Inputs
(% change in capital stock)

Sector	% increase in Capital Stock
Electricity	2.3%
Gas	18.1%
Road	18.0%
Rail	65.2%
Water	9.8%

Source: Econtech

Table 8 shows that capital stock in the Electricity industry has been boosted by 2.3 per cent in the reform scenario (compared to the baseline scenario). This boost is equivalent to the estimated under-investment in the electricity sector discussed in Section 3.

Similarly, the other four industries also receive a boost to their capital stock under the reform scenario. Of these, capital stock in Gas, Road and Water increase by up to 20 per cent of their baseline levels. These increases are also in line with the estimated under-investment for each sector, which was presented in Section 3. The capital stock in the rail sector is over 65 per cent higher in the reform scenario than in the baseline. This massive expansion in the rail sector reflects the aged nature of the capital stock in this industry so a significant amount of investment is required to improve the existing capital stock as well as expanding the capital stock.

5 Economic Impacts of Overcoming Under-investment

As discussed previously, there are two steps in modelling the economic benefits of infrastructure under-investment in Australia. Section 3 presented the results for the first step, which was to identify the current gap in infrastructure in each of the five sectors and estimate the infrastructure investment required to close this gap. Section 4 described the second step, which was to convert the raw inputs into model inputs that can be used in the MM600+ model. The simulated long-term effects on the Australian economy were then assembled from the modelling results. These effects are described in this section. We begin with the national results and then report the industry results.

5.1 National Effects

This section describes the economy-wide economic impacts of addressing infrastructure under-investment in Australia. Chart 1 shows the impact of overcoming infrastructure under-investment on investment, exports and production (GDP), while Chart 2 shows the impact on prices and living standards. Further details are provided in Appendix A.

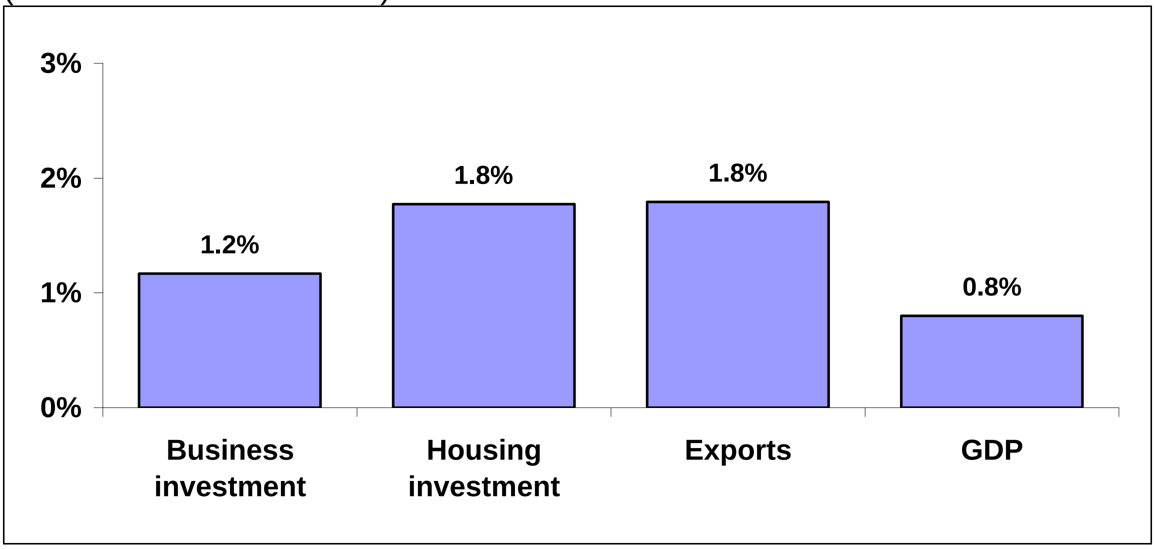
These increases in industry capital stocks boost the productive capacity of the five affected industries, leading to a gain in GDP of 0.8 per cent. This represents the GDP dividend from expanding the stock of the nation's infrastructure by an estimated 6.2 per cent. This implies an output elasticity of 0.13 (calculated as 0.8 divided by 6.2). This is similar to the previous studies that were survey in section 2, which gave a central estimate for this elasticity of 0.17.

This gain in GDP can also be seen in GDP's expenditure components, including business investment and exports, as shown in Chart 1 and explained below.

The additional infrastructure investment in the three utility industries of electricity, gas and water represents a rise in business investment. Thus, the modelling results show a significant gain in business investment of 1.2 per cent under the reform scenario compared with the baseline (see Chart 1). The additional infrastructure investment in the two transport industries is assumed to be undertaken by government and so leads to a gain in general government investment – in principle the modelling results would be similar irrespective of who undertakes the additional investment. Furthermore, upgraded water infrastructure facilitates an expansion in housing investment of 1.8 per cent.

Upgraded utility services and freight transport reduce the cost of doing business. The resulting improvement in international competitiveness boosts exports by 1.8 per cent.

Chart 1
Estimates of Macro-economic Effects
(% deviation from baseline)



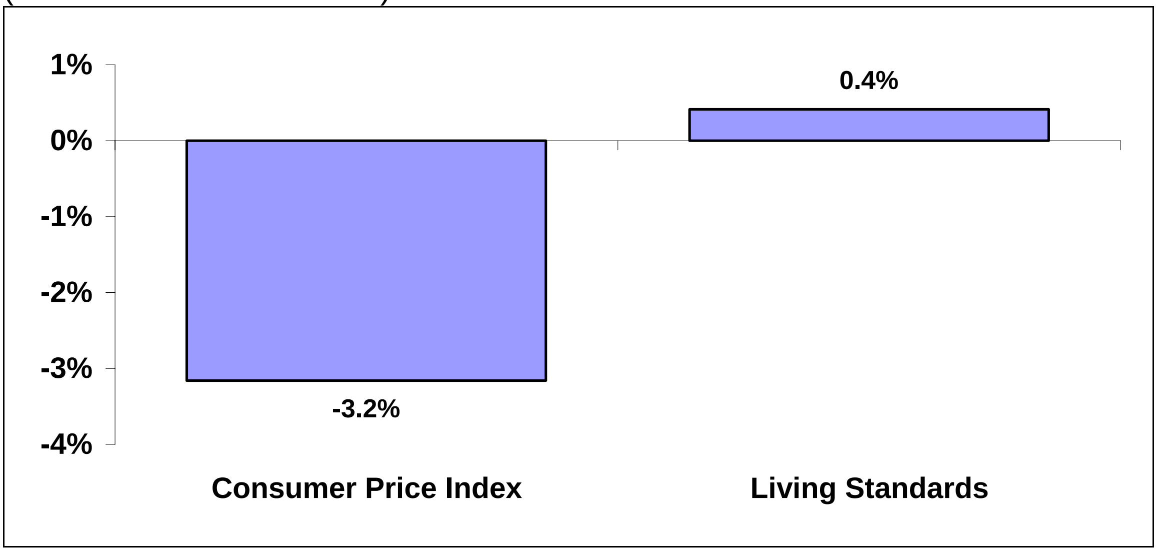
In the long run, lower costs to industries for infrastructure services (freight transport, water, gas and electricity) are passed on to consumers in the form of lower prices for consumer goods and services, as shown in Table 9. In addition, consumers benefit more directly through lower prices for the infrastructure services that they purchase themselves. Hence the biggest savings are in the Housing category, which includes gas, electricity and water, and the Transportation category, which includes rail passenger transport.

Table 9
Estimates of Price Effects (CPI Groups)
(% deviation from baseline)

Sector	Reform Scenario
Food	-2.1%
Alcohol and Tobacco	-1.4%
Clothing and Footwear	-1.6%
Housing	-8.0%
H/hold Furnishings, Supplies etc	-1.8%
Health	-1.7%
Transportation	-2.2%
Communication	-1.3%
Recreation	-1.8%
Education	-0.3%
Miscellaneous	-1.3%
All Groups CPI	-3.2%

Chart 2 shows that the lower consumer prices from of an upgrading of Australia's transport and utility services translate into higher living standards. The improvement in consumer welfare (or living standards) is 0.4 per cent.

Chart 2
Estimates of Price and Living Standard Effects
(% deviation from baseline)



5.2 Industry Effects

This section describes the industry-wide economic impacts of addressing infrastructure under-investment in Australia.

Chart 3 shows the gains in GDP by industry. As reported earlier, the overall gain in GDP is 0.8 per cent. While most industries gain, Chart 3 shows that the biggest gains are concentrated in the construction industry and the electricity, gas and water industry.

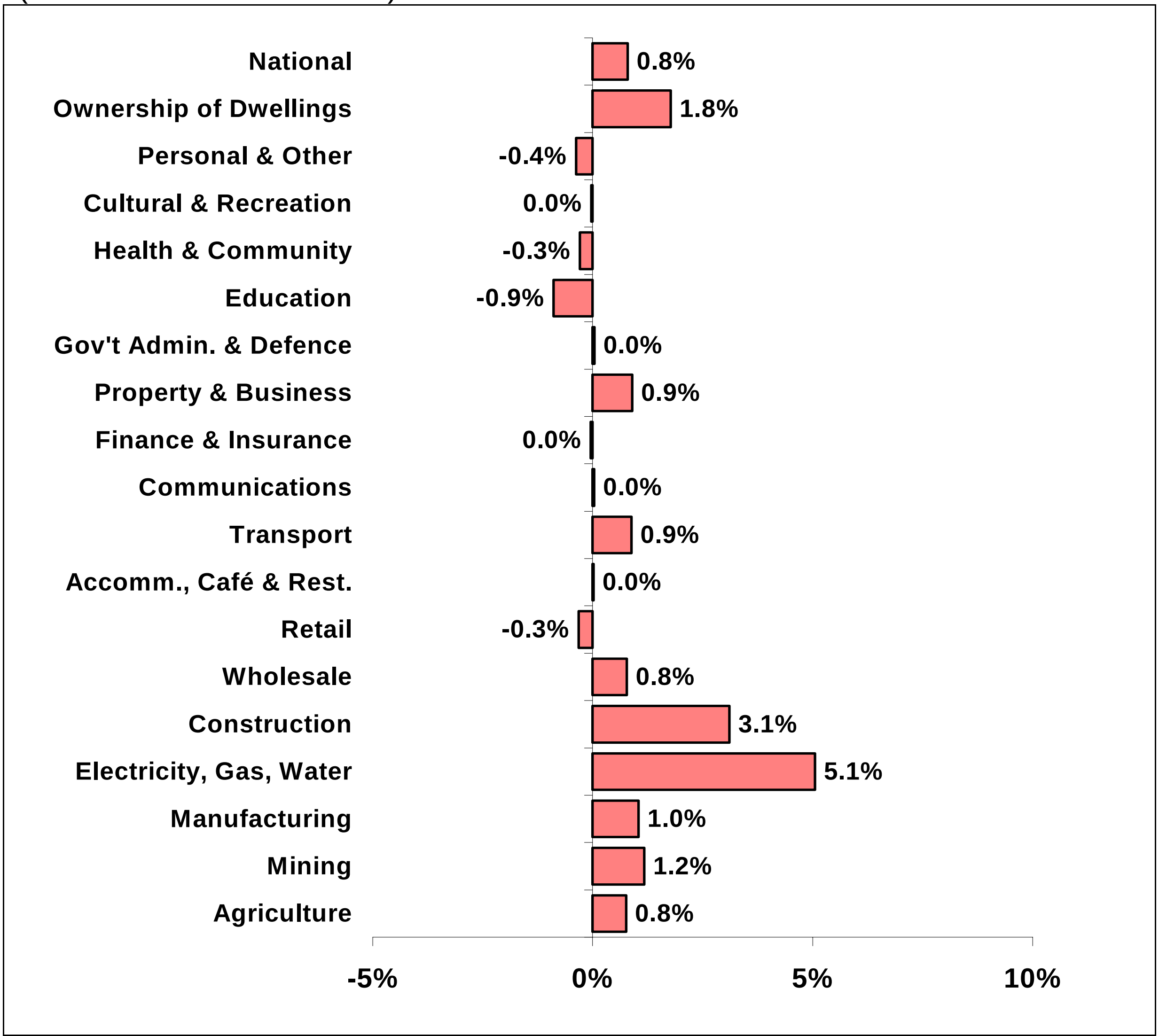
The construction industry benefits directly from the boom in infrastructure investment across road, rail, gas, electricity and water. This leads to a gain in construction activity of 3.1 per cent.

The electricity, water and gas industry experiences an even larger gain in activity of 5.1 per cent. The additional infrastructure investment in these industries boosts their supply of electricity, gas and water. Similarly the additional infrastructure investment in road and rail boosts the supply of transport services by 0.9 per cent.

As explained earlier, the reform scenario also boosts housing investment. This boosts the housing services industry, known by the ABS as the “Ownership of Dwellings” industry.

Further details can be found in Appendix A.

Chart 3
Estimates of Effect on GDP by Industry
(% deviations from baseline)



Appendix A: Detailed Model Simulation Results

Table A1
Infrastructure Capital and Investment
(% deviation from baseline)

	Reform Scenario
Industry Capital:	
Electricity supply	2%
Gas supply	18%
Water supply; sewerage and drainage services	10%
Government Annual Expenditure:	
Roads	18%
Rail	65%

Table A2
Estimate of the Change in the Volume of Production in the Transport and Utility Services Industries
(% deviation from baseline)

	Reform Scenario
Electricity supply	2%
Gas supply	18%
Water supply; sewerage and drainage services	9%
Rail, pipeline and other transport	5%
Road transport	2%

Table A3
Estimates of Price Effects by Industry
(% deviation from baseline)

	Reform Scenario
A. Agriculture, Forestry & Fishing	-1.9%
B. Mining	-1.9%
C. Manufacturing	-2.2%
D. Electricity, Gas & Water	-27.8%
E. Construction	-1.6%
F. Wholesale Trade	-1.7%
G. Retail Trade	-1.5%
H. Accomm., Cafes & Restaurants	-2.2%
I. Transport	-4.5%
J. Communication Services	-1.3%
K. Finance and Insurance	-1.1%
L. Property & Business Services	-3.1%
M. Government Admin. & Defence	-1.7%
N. Education	-0.4%
O. Health & Community Services	-1.7%
P. Cultural & Recreational Services	-1.9%
Q. Personal & Other Services	-1.4%
R. Ownership of Dwellings	-4.4%

Table A4
Estimates of Production Effects by Industry
(% deviation from baseline)

	Reform Scenario
A. Agriculture, Forestry & Fishing	0.8%
B. Mining	1.2%
C. Manufacturing	1.0%
D. Electricity, Gas & Water	5.1%
E. Construction	3.1%
F. Wholesale Trade	0.8%
G. Retail Trade	-0.3%
H. Accomm., Cafes & Restaurants	0.0%
I. Transport	0.9%
J. Communication Services	0.0%
K. Finance and Insurance	0.0%
L. Property & Business Services	0.9%
M. Government Admin. & Defence	0.0%
N. Education	-0.9%
O. Health & Community Services	-0.3%
P. Cultural & Recreational Services	0.0%
Q. Personal & Other Services	-0.4%
R. Ownership of Dwellings	1.8%
GDP	0.8%

Table A5
Estimates of Impact on Consumer Prices (CPI)
(% deviation from baseline)

	Reform Scenario
Food	-2.1%
Alcohol and Tobacco	-1.4%
Clothing and Footwear	-1.6%
Housing	-8.0%
H/hold Furnishings, Supplies etc	-1.8%
Health	-1.7%
Transportation	-2.2%
Communication	-1.3%
Recreation	-1.8%
Education	-0.3%
Miscellaneous	-1.3%
All Groups CPI	-3.2%

Table A6
Estimate of Macro-economic Effects

(% deviation from baseline)

	Reform Scenario
annual consumer living standards ($million):	
change in living standards - measure 1 (a)	1,529
change in living standards - measure 2 (a)	1,588
annual consumer living standards (% change):	
change in living standards - measure 1 (a)	0.4%
change in living standards - measure 2 (a)	0.4%
general effects:	
Real After-tax Wage	0.2%
Exchange Rate	2.0%
Consumer Price Index	-3.2%
national accounts:	
private consumption	0.1%
housing investment	1.8%
business investment	1.2%
exports	1.8%
imports	0.7%
GDP	0.8%

(a) change in living standards can be measured using either the compensating variation or equivalent variation

Appendix B: A Guide to Econtech's Murphy Model 600 Plus (MM600+)

This Appendix provides a guide to Murphy Model 600 Plus (MM600+), which is Econtech's industry model.

Type of Model

MM600+ can be compared with MM2, Econtech's economic forecasting model. Econtech first forecasting model was MM, developed in 1987/88, followed by two versions of MM2, the first in 1994 and the second in 1996. These models are based on quarterly data. Comprehensive dynamic structures are used in generating quarter-by-quarter forecasts of the economy extending nine years into the future. Econtech distributes MM2 in MM Simulator for Windows software, which is widely used by businesses and governments to produce their own forecasts and scenarios for the Australian economy.

Econtech's first industry model, MM303, was developed in 1997/98. It was then upgraded to MM600+ in 1999/00 under a contract to the Australian Competition and Consumer Commission. These models are based on a very detailed picture of the industrial structure of the economy that can only be found in the input-output tables published by the ABS. MM600+ uses the unpublished version of these tables to distinguish the production of 672 products by 108 industries. MM600+ is currently implemented in Excel and is used by Econtech in project consulting engagements for businesses and governments.

In developing two different types of economic models for forecasting and industry work, Econtech has followed a "horses for courses" approach. The forecasting model, MM2, provides quarter-by-quarter results but only distinguishes 18 industries. The industry model, MM600+, distinguishes 672 products, but only provides short-term and long-term results. It is not practicable to integrate both models into a single "super" model that provides quarter-by-quarter results for 672 products because quarterly ABS data are not available at that fine level of product detail.

MM600+ can be compared with other industry models such as the PRISMOD model of the Department of the Treasury and the Monash Model of the Centre of Policy Studies at Monash University in three key areas:

- detail;
- coverage; and
- time dimension.

MM600+ has a high level of detail in terms of both products and indirect taxes.

In MM600+, 108 industries produce 672 products. The other two models distinguish about 110 products.

MM600+ distinguishes 24 types of existing indirect taxes plus a GST of any design. This is similar to PRISMOD, while Monash has less tax detail with three types of existing indirect taxes and no GST.

Turning to economic coverage, MM600+, like Monash, is a computable general equilibrium (CGE) model, giving it wide coverage of the Australian economy. While PRISMOD covers only industry costs and prices, MM600+ and Monash also cover industry production and employment.

The third and final area of model comparison is the time dimension. As explained in sections 6 and 7, MM600+ provides estimates of both short-term and long-term effects. By comparison, PRISMOD provides estimates of long-term effects only. While Monash does not provide estimates of long-term effects, it does provide estimates of year-by-year effects.

Table 1.1

Model Comparison

Model	MM600+	PRISMOD	Monash
Products	672	107	about 110
Indirect taxes	25	similar	3
Coverage	prices, production	prices	prices, production
Time dimension	short & long term	long-term	annual

CGE modelling is well-established in Australia due mainly to the pioneering work of Peter Dixon in developing the ORANI model and then the Monash Model.

While some Australian CGE models are adaptations of Dixon's ORANI model, MM303/MM600+ was developed from scratch. At the same time, there are similarities between the models.

This is partly because ORANI and MM600+ are both in the CGE family, and therefore model computable, market-clearing outcomes under optimising behaviour. Similarly they both inevitably rely on input-output tables published by the ABS.

It is also because Dixon's work, as reported in Dixon, Parmenter, Sutton and Vincent (1982) and Dixon, Parmenter, Powell and Wilcoxen (1992), was an important source of ideas for MM600+ such as:

- import demand for each commodity is modelled in three categories: intermediate goods, consumption goods, and investment goods; and
- there is a detailed treatment of distribution margins.

The ORANI model also has some ideas not found in MM600+, including some refinements specific to agriculture. Equally, MM600+ has some ideas not found in ORANI/Monash, including an extended range of economic choices or behavioural responses, as discussed in section 5.

Beyond these similarities and differences in ideas, the main differences between the two models are in the areas of detail and time dimension, as already summarised in Table 1.1.

Implementation of Model

Implementing MM600+ involved constructing a database, choosing a software environment, setting up a baseline simulation, and then putting the model into action performing simulations of actual or proposed economic shocks.

Econtech obtained a special series of the input-output tables from the ABS. In these unpublished tables, 107 industries produce about 1,000 products, compared with the published tables which only distinguish 107 products i.e. one product per industry. The unpublished tables also include a series of special tables containing extra detail on indirect taxes.

In constructing the database for MM600+, the ABS input-output data were manipulated to give an exactly-balanced, economically meaningful database. This included the following adjustments:

- aggregating from about 1,000 products to 672 products;
- treating "Sales by Final Buyers" as sales of used cars;
- constructing a travel composite commodity, used in modelling export demand for inbound travel in Australia;
- identifying household and business import demand for Australian travel overseas.
- balancing industry usage with product supply;
- imputing labour income to employers and self-employed; and
- allocating inventory investment.

Turning to the topic of software environment, MM600+ is implemented in Excel. The database is constructed in a series of workbooks linked backed to raw ABS data, which is also in the form of Excel workbooks. This implementation gives easy access to all model inputs, outputs and equations. Thus all inputs and equations can be altered and all outputs can be viewed.

MM600+ is specified in levels as a non-linear system, not in changes as a linear system, so model solutions are always exact. It is solved iteratively in Excel using Excel's standard iterative method for resolving "circular references". A model simulation in Excel under a very tight convergence criterion[3] takes about 30 minutes and involves about 500 iterations of the model.

Simulations of economic shocks involve varying the values of one or more model inputs relative to their baseline values. With open access to all model inputs, a wide variety of shocks can be conducted. These can involve virtually any shift in technology, tastes, foreign demand or taxation.

To enable more sophisticated analysis of the welfare effects of taxation and other reforms, the model provides for positive/negative externalities in consumption for each product, the values for which can be set by the model user.

Product Detail

As noted in the previous section, in the input-output tables published by the ABS, 107 industries produce 107 products. These industries/products, which are the basis for other economic models, are listed in the left-hand column of the Table Appendix (attached).

In building MM600+, Econtech decided to incorporate a higher level of product detail than found in the published input-output tables. This is available in unpublished input-output tables that we obtained in electronic form from the ABS. The ABS derives the published tables by aggregating from these more detailed unpublished tables.

While the unpublished tables include about 1,000 detailed products, some aggregation was necessary because some data for detailed products are censored by the ABS to protect the confidentiality of individual companies. However, aggregation was kept to a minimum. This gave the 672 products that appear in MM600+ and are listed in the second column of the Table Appendix (attached). This is the maximum achievable level of product detail.

The high level of product detail in MM600+ has many advantages. In commissioning MM600+ as a further development of Econtech's earlier CGE model, MM303, the ACCC

[3] For example, for convergence, annual GDP, which is about $500,000,000,000, can change by no more than

requested the high level of product detail so that model estimates could serve as a more useful point of comparison in the ACCC's price monitoring work.

The high level of product detail also means that many policy changes can be analysed without the need for further disaggregation. For example, petrol and diesel are distinguished from other petroleum products, making it easier to accurately model the changes in fuel taxation under the New Tax System, as these tax changes are different for petrol, diesel and other fuels.

It also means that the gains from some micro-economic reforms can be more fully captured. For example, a finer level of disaggregation better reveals the diversity in rates of customs duty, leading to more reliable estimates of the gains from tariff reforms that produce benefits by reducing this diversity.

$1,000 from the previous iteration, implying a precision of 1 in 500,000,000.

Tax Detail

The treatment of taxation is particularly detailed in MM600+. The model distinguishes 24 different indirect taxes on industry production and products, as listed below. These can each be varied either universally, or as they apply to each industry or product or end purchaser. In addition, MM600+ provides for a GST, under which each product/industry can be classified as taxable, input-taxed or GST-free.

Production Taxes	Product Taxes
Land Tax	GST
LGA Rates	Sales tax
Liquor & Gambling Taxes	Stamp Duty
Payroll Tax	Gambling Taxes; Former State Licence Fees
Taxes on Insurance	Primary Production Taxes
Motor Vehicle Taxes	Regulatory Service Fees
Stamp Duties	Excise Taxes
Taxes on use of goods etc	Motor Vehicle Taxes
Fringe Benefits Taxes	Financial Institution Duties
Departure Tax	Customs Duty on Exports
Other Indirect Taxes nec	Other Commodity Taxes
Total Subsidies	Commodity subsidies
	Customs Duty on Imports

This high level of indirect tax detail is only possible because MM600+ uses the unpublished input-output tables. While these unpublished tables distinguish 24 categories of indirect taxes, the published tables distinguish only three categories.

In modelling the changeover to the New Tax System, it was important to accurately represent the application to industries and products of sales tax, GST and fuel taxes.

The ABS input-output tables have significant shortcomings in their application of sales tax to products. For example, they do not allow for the “aids to manufacture” exemption on sales tax on inputs into the agriculture, mining, manufacturing and utilities industries. They also overstate sales tax collections on motor vehicles.

Also, obviously the input-output tables do not incorporate the just-introduced GST.

To address these sales tax and GST areas, Econtech commissioned a review by KPMG of the wholesale sales tax and GST treatments of each of the 672 products appearing in the model. We also built in the "aids to manufacture" exemption form sales tax. These tax assumptions were in turn reviewed by the ACCC in conjunction with the ATO.

The remaining significant complication in accurately modeling the changeover to the New Tax System is the complex nature of the changes to fuel taxation. MM600+ takes into account that changes in diesel fuel tax are different in each on the following areas:

- qualifying road use;
- non-qualifying road use;
- rail and marine transport;
- agriculture and fishing use;
- mining use; and
- other non-transport use.

MM600+ also takes into account that *ANTS* does not include any cuts to taxation of fuel used in air transport, including both aviation turbine fuel and aviation gasoline.

Economic Choices and Elasticities

MM600+ models how changes in relative prices affect economic choices, leading to changes in the industry pattern of production and employment. The main price-sensitive choices in the model involve:

- business choice between labour and capital;
- business choice between different types of capital;
- business choice between different forms of energy;
- business choice between road and rail freight transport;
- business choice of its size;

- choice between import and local sources of supply;
- business choice between local and export destinations for sales;
- consumer choice between broad commodity groups;
- consumer choice within broad commodity groups; and
- demand for Australian exports.

In modelling economic choices, values need to be assigned to the elasticities that govern the sensitivity of each choice to changes in relative prices. The following explains each of the economic choices listed above in more detail and also gives the associated values for the elasticities. The only elasticities not presented below are trade elasticities as these are provided separately in the Table Appendix.

Substitution between labour and capital

The elasticity of substitution between labour and capital in production in each of the 108 industries is set to 0.75 in MM600+, consistent with Econtech's econometric research for MM2.

Substitution between different types of capital inputs

MM600+ provides for substitution between different types of business capital e.g. motor vehicles, computers, buildings etc. Business holdings of motor vehicles and computers are price sensitive, making it important to allow for substitution between different forms of business capital.

In MM600+ the elasticity of substitution between different forms of business capital is set at 0.5. In modelling this substitution, the user cost of each form of capital is calculated by applying a required rate of return plus a depreciation rate to the price of new investment, where both the depreciation rate and the price of new investment vary from one form of capital to the next.

Substitution between different forms of energy

MM600+ allows for substitution by business between different forms of primary energy, including black coal, brown coal, LPG and natural gas. Allowing for these substitution possibilities is vital when assessing the economic effects of energy development projects, or in examining greenhouse gas emission issues.

For most industries, the elasticity of substitution between forms of primary energy is set to 4.5. The exception is the electricity industry, where the elasticity has been set to 6, to reflect the high sensitivity of the choice of type of electricity generation to the relative cost of different forms of energy.

Substitution between road and rail freight transport

MM600+ allows for substitution by industry between road and rail freight transport. It does this by drawing on earlier work by the Industry Commission, incorporated in the ORANI-HILMER model, on the elasticity of substitution between road and rail freight transport. For most products this elasticity is set to 2, but lower values are used for some products. Substitution between freight transport modes is modelled both for transport from business to business (or importer to business) and from business to export wharves.

Business choice of its size

In MM600+, the representative business in each industry selects its size to minimise unit costs. The small business exemption from payroll tax distorts this choice so that in each industry the selected size is less than the technically efficient size.

In modelling the technically efficient size, it is assumed that for the representative business in each industry the need for primary factors (i.e. capital and labour), F, depends on its level of output, Q, according to the following equation.

$$F = Q + a.(QC - Q) + a.Q.\ln(Q/QC)$$

For technical efficiency, Q=QC. The sensitivity of efficiency to variations in Q away from QC is given by the parameter a. Fuss and Gupta, analysed 91 Canadian manufacturing industries and found that there was an average loss of efficiency of about 4 per cent from operating at one-half of the technically efficient scale. Using that result, in MM600+ the parameter a has been set to equal 0.13 in each industry.

In most states, payroll tax is calculated by applying the payroll tax rate to the business wage bill net of a tax-free threshold. This threshold provides a larger reduction in unit cost for smaller businesses than for larger businesses, distorting the choice of business size.

The technically efficient business size, QC, was then set separately for each industry so that the model correctly predicts industry payroll tax collections. This involves using the corollary of the fact that industries dominated by small businesses do not pay much payroll tax because of the tax-free threshold.

The model has been used to examine the distorting effect of the small business exemption from payroll tax on business size in an Econtech report of 23 June 1998 for the Australian Chamber of Commerce & Industry on "Payroll Tax: Is it as Good as a VAT or as bad as sales tax?".

Substitution between imports and local supply

As in the Monash Model, allowance is made for substitution between imported and local sources of supply for each importable commodity for each of three categories of end use. The categories of end use are: recurrent inputs; business investment; and other components of final demand. The values of the Armington elasticities governing this substitution were originally based on those used in the Monash Model in 1997, but some have been modified in the light of experience with MM600+. All trade elasticities used in MM600+ are reported in the Table Appendix.

Substitution of local producers between supplying the export and home markets

In modelling export supply, MM600+ distinguishes between the production of a commodity for the home market and production for the export market. For each commodity, an elasticity of transformation links production for the two markets.

To the extent that a commodity's transformation elasticity is set to less than infinity (the value implicit in the ORANI model), an allowance if made for some friction in switching supply between the two markets. This friction may arise because some exported commodities are tailor made for export, or are more narrowly defined than the corresponding home commodity e.g. Australian consumers may eat all types of apples while we may only export Fuji apples to Japan — this affects the ability to switch supply between the two markets.

Based on model simulation experiments, the exports elasticity of transformation has been set to 0.5 for water transport and black coal, 1.5 for other minerals, and 2.5 for all other exports. These and all other trade elasticities in MM600+ are reported in the Table Appendix.

Substitution between broad consumption groups

Substitution between broad consumption groups is modelled in a linear expenditure system of consumer demand. The parameters of this system were estimated by Econtech using quarterly national accounts data extending from 1974-75 to 1996-97 and are set out in Table 1. Implied price and income elasticities are also presented in Table 1.

As expected, consumer demand for the following groups is income inelastic: food; cigarettes & tobacco; gas, electricity & fuel; fares; and operation of motor vehicles. Equally, consumer demand for the following groups is income elastic: financial services; other services; and personal travel imports (i.e. overseas holidays);

Table 1

Consumption Group Parameters and Elasticities

Estimation Period: 1974.3-1997.2

		β	γ	Budget share	Income elast.	Price elas.	ν
A	Food	0.078	1320	14.5%	0.54	-0.34	-1.0
B	Cigarettes and tobacco	0.011	164	1.9%	0.57	-0.39	-0.5
C	Alcoholic drinks	0.040	187	4.1%	0.97	-0.65	-1.0
D	Clothing, fabrics and footwear	0.041	342	5.2%	0.78	-0.52	-0.5
E	Household appliances	0.031	93	2.9%	1.10	-0.73	-0.5
F	Other household durables	0.032	233	3.8%	0.83	-0.55	-0.5
G	Health	0.084	268	7.8%	1.08	-0.68	-0.5
H	Dwelling rent	0.208	531	18.4%	1.13	-0.62	-0.5
I	Gas, electricity and fuel	0.012	205	2.2%	0.52	-0.36	-1.0
J	Fares	0.010	160	1.8%	0.54	-0.37	-1.0
K	Purchase of motor vehicles	0.042	119	3.8%	1.11	-0.73	-0.5
L	Operation of motor vehicles	0.045	440	6.2%	0.72	-0.48	-0.1
M	Postal and telephone services	0.019	72	1.8%	1.03	-0.70	-0.5
N	Entertainment and recreation	0.038	314	4.9%	0.79	-0.52	-0.75
O	Financial services	0.054	1	3.9%	1.40	-0.92	-0.5
P	Other goods	0.093	67	7.1%	1.31	-0.82	-0.5
Q	Other services	0.130	-161	8.2%	1.59	-0.96	-0.5
R	Personal Travel Imports	0.032	-103	1.6%	2.03	-1.36	-0.5

Substitution within broad consumption groups

MM600+ also allows for substitution within broad consumption groups. Alcoholic drinks serves as an example. Clements et al. conclude that “the price elasticity of alcohol as a whole is about -1/2” (p.77). However, because of substitution between different forms of alcohol, price elasticities for individual alcoholic beverages are larger at –0.8, –0.7 and –1.9 for beer, wine and spirits respectively (p. 78). Thus it is important to allow not only for substitution between broad consumption groups, but also for substitution within consumption groups.

To allow for substitution within consumption groups, the consumer demand system in MM600+ is derived from a generalisation of the indirect utility function associated with the linear expenditure system. In this two-level generalisation, an intra-group substitution parameter,

ν,

appears which can take different values for different groups, as shown in the last column of Table 1. This parameter is set to –0.5 for most groups (zero equates to no intra-group substitution, as in the Monash model). This value implies that the price elasticity for an individual consumption commodity is up to 1.5 times the size of the price elasticity for the consumption group in which it belongs.

Under this approach, consumer demand for consumption of commodity *k* in group *i* is given by the following equation.

$X_{ik} = \alpha_{ik}.\gamma_i + \phi_{ik}.(\beta_i/P_{ik}).(C - \Sigma P_j.\gamma_j).(Q_i/P_{ik})^{-\nu i}$

where:

$P_i = \Sigma \alpha_{il}.P_{il}$ for all i

$Q_i = [\Sigma \phi_{il}.P_{il}^{\nu i}]^{1/\nu i}$ for all i

$\Sigma \alpha_{il} = 1$ for all i

$\Sigma \phi_{il} = 1$ for all i

$\Sigma \beta_i = 1$

Export demand

Export demand elasticities in MM600+ range from -4 for wool, where Australia has market power, and tourism, where product differentiation is important, to -12 for a broad range of exports. The pattern of elasticities for minerals and minerals processing were developed in 1998 in consultation with Malcolm Gray, a commodities consultant engaged by the Minerals Council of Australia. All trade elasticities used in MM600+ are reported in the Table Appendix.

Long-term Closure

MM600+ has two different closures frames — a short-term closure and a long-term closure — so that it can provide results from an economic shock for two different time frames. The long-term closure is described in this section while the short-term closure is described in the next section.

The long-term closure models a long-run equilibrium. For most economic shocks, the long run is likely to be attained in five to ten years.

In the long-run, economic agents optimise, all markets are in equilibrium, and assets and liabilities follow sustainable paths. Some of the key assumptions involved are:

- *profit maximisation*: the representative business in each industry chooses inputs and outputs to maximise profit subject to prices and a production function exhibiting constant returns to scale. This involves choosing inputs of capital and labour and outputs for the local and export markets;

- *labour market equilibrium*: in the long-run the labour market is assumed to attain equilibrium, so that an economic shock has no lasting effect on total employment. This assumption is implemented by fixing the level of total employment;

- *external balance*: in the long-run net liabilities to the foreign sector must follow a sustainable path. This assumption is implemented by setting the trade balance equal to the cost of servicing payments on foreign-owned capital — the real exchange rate needed to achieve this outcome is determined by the model;

- *budget balance*: in the long-run the budget balance must be sustainable. Specifically, in MM600+ the government budget is assumed to be in balance. It is necessary to designate a swing fiscal policy instrument to achieve that outcome. Generally, the rate of tax on labour income is used as the swing fiscal policy instrument; and

- *private saving*: in the long-run the level of private sector saving and associated asset accumulation must be sustainable. Further, one potential problem with long-run models is that saving (i.e. sacrificing present consumption for future consumption) can appear artificially attractive, because the model results show the gain in future consumption but not the sacrifice of present consumption. To address both of these issues, saving is held constant in MM600+ by fixing the quantity of capital that is owned locally.

MM600+ pays particular attention to the correct measurement of changes in national economic welfare. It uses the compensating variation and equivalent variation from welfare economics. These are alternative measures of the gain in real consumer spending.

More specifically, under a linear expenditure system model of consumer demand, these measures of welfare change virtually equate with changes in real supernumerary (or non-essential) consumption. Real supernumerary consumption is calculated by subtracting nominal “essential” consumption from nominal total consumption to obtain nominal supernumerary consumption, before deflating using the ideal price index for supernumerary consumption.

In MM600+ effects on vertical equity can also be measured. This is done by calculating movements in real supernumerary consumption for consumers at different income levels. In the results, the benefits of an economic reform are tilted towards low-income earners if the ideal price index for essential consumption falls by more than the ideal price index for supernumerary consumption.

Short-term Closure

The long-term closure factors in full adjustment of industry capital stocks to economic shocks, which is a protracted process that may take five to ten years.

Because of this lengthy capital stock adjustment process, short-term closures have been developed for economic models. These short-term closures hold industry capital stocks fixed.

In the case of MM600+, the short-term closure is different because it was developed under a contract to the ACCC to mimic the price exploitation guidelines issued by the ACCC in March 2000. Under these guidelines, businesses:

> "should not increase the net dollar margins on their goods and services as a result of the New Tax System changes alone".

While this rule applies to June 2002, the short-term closure is only designed for the introduction year of the New Tax System, 2000/01.

Under this short-term closure, the long-term closure is modified by holding fixed the price of capital services in each industry. This means that changes in the cost of non-capital inputs flow through fully into prices, but changes in the cost of capital inputs have no effect on prices.

This is a reasonable representation of the ACCC guidelines as they apply in 2000/01.

Under the guidelines, savings in the cost of capital inputs only need to be passed on into prices as existing capital is replaced. This would not occur to a significant extent in 2000/01, so it is reasonable to model the guidelines by holding fixed the cost of capital inputs.

Equally, the ACCC guidelines require that savings in the cost of non-capital inputs are passed on fully into prices, and this is also captured in the short-term closure.

The short-term closure is only designed to mimic the ACCC guidelines, not other short-term applications, where a more conventional short-term closure based on fixed capital stocks would need to be used.

A conventional short-term closure is similar in that changes in the cost of capital inputs would have no effect on prices. However, it differs in that only part of changes in the cost of non-capital inputs would flow through into prices, with the proportion varying from one product to the next depending on supply and demand elasticities in each market.

Applications

MM303/MM600+ has been used in modelling the changeover to the New Tax System as well as many other applications.

The changeover to the New Tax System has been modelled for:

- companies
- industry associations
- governments; and
- the ACCC.

Companies

MM303/MM600+ is the most widely used model for estimating the effects of the New Tax System on company costs. MM600+ services have been supplied to companies by Econtech itself as well as through Ernst & Young, KPMG and Firmstone & Feil. These taxation services have been used by major companies in each of the following industries.

- mining
- pharmaceuticals
- other manufacturing
- media
- water
- retailing
- hotels
- road transport
- rail transport
- communications
- banking
- insurance
- professional services

Industry Associations

Econtech has used MM303/MM600+ to analyse the effects of the New Tax System for the following industry associations.

- Australian Automobile Association
- Australian Chamber of Commerce & Industry
- Australian Bankers Association
- Australian Hotels Association
- Australian Pharmaceutical Manufacturers Association
- Distilled Spirits Industry Council of Australia
- Housing Industry Association
- Master Builders Australia
- Minerals Council of Australia
- Plastics and Chemicals Industry Association
- Printing Industry Association of Australia
- Water Services Association of Australia

Governments

Econtech developed the Econtech ANTS Savings Calculator, which has been used by the following governments for estimating the effects of the New Tax System on the costs of their agencies.

- Commonwealth Government
- New South Wales Government
- Victorian Government
- Queensland Government
- WA Government
- SA Government
- Tasmanian Government
- ACT Government
- NT Government

ACCC

- Under contract to the ACCC, Econtech further developed its MM303 model to produce MM600+.

- The ACCC has used the results from MM600+, together with industry information, in its Shopping Guide covering the likely effects of ANTS on about 200 consumer prices.

- The ACCC Small Business Cost Savings Estimator - a tool to help small business comply with the ACCC price exploitation guidelines - was developed for the ACCC by Econtech.

Other Applications

MM303/MM600+ was also used in the following industry policy consultancies.

- a study for Chevron of its proposed natural gas pipeline from PNG to Gladstone

- a study for a major corporation of a proposed shale oil project

- a study for an oil company of a possible business decision with major implications for the oil industry

- a study for the Australian Greenhouse Office on National Average Fuel Consumption

- a study for two oil companies of a proposed merger of their oil refining operations

References

Aschauer, D A (1989), “Is public expenditure productive?” *Journal of Monetary Economics*, 23, pp.177–200.

Australian Automobile Association (2003), *2004-05 Budget Submission*, October 2003. www.aaa.asn.au/submis/ 2003/2004-05_Budget_Submission.pdf

Australian Centre For Public Infrastructure (2004), “Measuring Up: Dimensions of the Australian Infrastructure Sector”, *Public Infrastructure Bulletin*, Issue three, March 2004.

Clements, K.W., Selvanathan, A. and Selvanathan, S. (1996), “Applied Demand Analysis: A Survey”, *The Economic Record*, Vol. 72, No. 216.

Department of Transport and Regional Services (2004), *Auslink: Building our National Transport Future*. http://www.dotrs.gov.au/auslink/whitepaper.aspx

Demetriades, P O and T P Mamuneas (2000), “Intertemporal output and employment effects of public infrastructure capital: Evidence from 12 OECD countries”, *The Economic Journal*, 110 (July), pp.687–712.

Dixon, P B, Parmenter, B R, Sutton, J and Vincent, D P (1982), *ORANI: A Multisectoral Model of the Australian Economy*, North-Holland, Amsterdam

Dixon, P B, Parmenter, B R, Powell, A A and Wilcoxen, P J (1992), *Notes and Problems in Applied General Equilibrium Economics*, North-Holland, Amsterdam.

Energy Australia (2003), *Energy Australia Submission to IPART*, April.

Fuss and Gupta (1981), "A Cost Function Approach to the Estimation of Minimum Efficient Scale, Returns to Scale, and Suboptimal Capacity: With an Application to Canadian Manufacturing", *European Economic Review*, 15(2), pp. 123-35.

Goodsir D (2003), “Safer rail: the $1.5 billion secret”, *Sydney Morning Herald*, April 28.

Kam, T C Y (2001), *Public infrastructure spillovers and growth: Theory and time series evidence for Australia*, Department of Economics, University of Melbourne. http://www.economics.unimelb.edu.au/research/workingpapers/wp00_01/wp00_01.htm

Institution of Engineers, Australia (2001), *2001 Australian Infrastructure Report Card*, www.ieaust.org.au/library/ publications/2001ReportCard.pdf

Intelligent Energy Systems (2000*), Application of ACCC Regulatory Test to SNI: Report to Transgrid*, November.

Integral Energy (2003), *2004 Electricity Network Review Submission to the Independent Pricing and Regulatory Tribunal*, April.

Myer R (2003),"Tassie magic needed to make Basslink pay its way", *The Age*, July 28.

National Economics (2002), *Transport Infrastructure: a perspective and prospective analysis of its role in Australia's economic growth*, Melbourne, December.

NEMMCO (2003), *2003 Statement of Opportunities*, http://www.nemmco.com.au/publications/soo/soo2003.htm

NEMMCO (2004), *2004 Statement of Opportunities*. http://www.nemmco.com.au/publications/soo/soo2004.htm

Otto, G D and Voss, G M, (1996*), The Macro-economic Benefits of Public Infrastructure Investment*, NRMA, Sydney.

Pereira, A M, (2001)*, Public investment and private sector performance –international evidence*, http://www.spaef.com/PFM_PUB/v1n2/1_2/1_2_7_pereira.pdf.

Productivity Commission (2003) *Review of the Gas Access Regime: Draft Report*.

Song L L (2002), *Public Capital, congestion and Private Production in Australia*, Melbourne Institute of Applied Economic and Social Research, the University of Melbourne, November.

Yeaple, S and S Golub, 2002, *International productivity differences, infrastructure, and comparative advantag*e, http://www.columbia.edu/cu/economics/infrastructure.pdf.