Employment Effects of Road Construction

Working Paper

The Bureau of Transport and Communications Economics (BTCE) is examining a number of issues in measuring the benefits of transport infrastructure investment. The issue examined in this paper is how to estimate the employment effects of road construction activity. Other papers from the same project have examined regional development effects, and certain tools for evaluating benefits.

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EMPLOYMENT EFFECTS OF ROAD CONSTRUCTION

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FOREWORD

The Bureau of Transport and Communications Economics (BTCE) is examining a number of issues in measuring the benefits of transport infrastructure investment. The issue examined in this paper is how to estimate the employment effects of road construction activity. Other papers from the same project have examined regional development effects (BTCE 1994, 1996a), and certain tools for evaluating benefits (BTCE 1995, 1996b).

Corey Dykstra conducted the research reported in this paper under the supervision of Dr David Luskin, each of whom contributed to the drafting. The Research Managers overseeing the research were Russ Reynolds initially, followed by David Luck and then Dr Leo Dobes. Dr Mark Horridge, of the Centre of Policy Studies at Monash University, ran the ORANI simulations and advised on their interpretation.

The BTCE acknowledges assistance in the provision of information by the Queensland Department of Transport, the Roads and Traffic Authority (NSW), Vicroads, Main Roads Western Australia, the Department of Transport and Works, Northern Territory and the Department of Urban Services in the Australian Capital Territory.

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ABSTRACT

The effects of road construction activity on employment and other economic indicators are estimated with the ORANI model of the Australian economy. ORANI goes beyond the input–output framework that underlies most other estimates of employment effects of road construction activity. Among the additional features are short-run constraints on the availability of capital, real exchange rate pressures, and substitution possibilities between capital and labour. The ORANI database was supplemented by information on road construction costs supplied by the State road authorities.

The theoretical framework used in this paper has significant limitations, like the omission of labour supply constraints, as do the data. The estimated short-term gain in employment from road construction expenditure may well be optimistic as a result. Comparisons are made to estimates obtained using input–output analysis.

SUMMARY

Road construction expenditure has mixed effects on employment during the construction phase. An increase in such expenditure will boost employment in the road construction industry itself and in some related industries that supply inputs to road construction. The usual technique for estimating the employment effects of road construction, input–output (IO) analysis, picks up these positive effects. However, it misses the negative effects by omitting limitations on the availability of labour and other resources. Even in recessions, some types of labour will be in limited supply, so that using more employment for road construction may divert employment from some other industries.

Moreover, even with high unemployment, a fiscal stimulus could place some upward pressure on wages, which would make for smaller employment gains than would be predicted by an IO analysis.

The present analysis of the employment effects of road construction relies on a general equilibrium model of the Australian economy, ORANI, which extends the IO framework. Although the analysis omits constraints on labour supply, it includes constraints on availability of capital inputs (equipment and structures).

The focus of this paper is on the contemporaneous effects of road construction; the effects after construction, during the road's operational phase, are not examined. For illustration, we consider how the economy would have looked in 1994–95 if governments had spent an extra $630 million in that year on road construction. The ORANI analysis indicates, probably optimistically, the following effects from this additional expenditure:

- an increase in real GDP of about $401 million;
- employment gains of 2633 jobs in the road construction industry and 8324 jobs in other industries;
- total employment gains of 17 jobs per million dollars of road construction expenditure during the construction phase (as distinct from the employment effects of roads after construction) and
- a slight appreciation of the real exchange rate causing a fall in the volume of export demand and a rise in import volumes.

These estimates depend very much on the assumptions of the ORANI analysis, some of which are restrictive. Assumed to be unaffected by the increase in road

construction expenditure were average hours per worker, real wages, levels of inventories, and capital inputs in all industries apart from road construction.

Input–output analysis can suggest much larger employment gains from road construction than does the ORANI analysis. This occurs when induced-consumption effects are modelled. An increase in aggregate employment raises labour income and thus stimulates demand for consumer goods. In the IO framework, the increased consumer demand stimulates a second round of employment gains. In our ORANI analysis, the increased consumer demand displaces demand for exports and for some import-competing products by raising the real exchange rate; the displacement effect swamps the direct employment stimulus from increased consumer demand, making the 'second-round' effect on employment slightly negative.

Overall, the ORANI simulations would seem to describe the effects of increased road construction expenditure with greater realism than would an IO analysis, and certainly in more detail. *Nevertheless, extreme care must be taken in using the ORANI estimates reported here for policy analysis.* Although we cannot be sure whether the estimates of employment gains are too high or too low, the absence of labour supply constraints makes overestimation a distinct possibility. Reinforcing this suspicion is the absence from the simulations of any mechanism for producers to meet additional demand by reducing inventories or by increasing hours per worker, rather than by increasing employment.

CHAPTER 1 INTRODUCTION

Unemployment rates have been high in Australia for over two decades.

Capital works projects are often advocated as a means of expanding demand within the economy and inducing higher levels of employment and growth. This paper considers the employment creation ability of an increase in road construction expenditure. The effects on the national economy during the construction phase are the focus; regional and post-construction effects are not examined.

For illustration, we consider how an extra $630 million in road construction expenditure would have affected the economy in 1994–95. The temporary increase in Federal road spending under the 'One Nation' statement of 1992 was a similar amount ($600 million).[1] However, the additional road funding was expended over several years under the One Nation program, whereas in the present scenario, it is all spent within one year, 1994–95. Requiring such a large increase in funding to be spent within a year may not be realistic, but it simplifies the presentation of findings without changing their thrust.[2]

Input–output (IO) analysis is the usual method of modelling the employment effects of road construction or other public works activity. It is based on a number of simplifying assumptions, which, while enhancing its practicality, lack a theoretical basis. Perhaps the most striking are the availability of unlimited land, labour and capital and the assumption that inputs are used in constant proportions.

An alternative approach, applied in this paper, is to use a general equilibrium model. Such a model incorporates input–output tables and imposes additional constraints on responses of industries to changes in output demand. These constraints include the availability of capital inputs, and exchange rate

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1. CPI-adjusting for inflation, we calculated $630 million in 1994–95 as the real equivalent of the $600 million One Nation expenditure. Most of the latter was disbursed in 1992–93, when the CPI was 4.8 per cent lower than in 1994–95.

2. The assumption is more realistic than may appear: it does not require that roads be built within a year. A one-year increase in road expenditure can be allocated to multi-year projects; if the future funding requirements for such projects are offset by reductions in other future road expenditures, the net increase in expenditure can remain limited to one year.

pressures. The short-run version of the ORANI model that is used here is essentially the same as the model documented in Dixon, Parmenter, Sutton and Vincent (1982).

Some of the assumptions in ORANI have been criticised by Cronin (1985) and Toohey (1994) among others. However, when correctly used and interpreted, the ORANI framework provides a more comprehensive analysis than do input–output techniques.

CHAPTER 2 INPUT–OUTPUT AND GENERAL EQUILIBRIUM MODELS

Economic models can help predict the effects of government policies, or other 'shocks' to the economy. Partial equilibrium models consider the effects on particular segments of the economy such as an industry sector. However, it is often important to estimate the effects on the whole economy. Will gains in one sector be offset by losses in other sectors of the economy, and possibly even result in a reduction in Australia's GDP? To model the effects that a change in government policy might have on the economy, and the distribution between sectors, one needs to consider the interaction between domestic industries. This is the field of input–output analysis and general equilibrium models.

2.1 Input–output analysis

Interactions between industries are often modelled through IO analysis. The economy is treated as an interrelated system of industry sectors and final consumers; and demands and supplies of goods and services are equated (IAC 1989).

Australian IO analyses use the input–output tables composed by the Australian Bureau of Statistics (ABS). These show transaction flows, in dollars of goods and services, within the economy in a given year. IO tables include four quadrants, which describe intermediate usage, final demand, primary inputs to production and primary inputs to final demand (ABS 1994a). Figure 2.1 illustrates a typical IO table.

FIGURE 2.1 A SIMPLIFIED INPUT–OUTPUT TABLE

	USAGE / SUPPLY	Intermediate Demand					Intermediate usage (sub-total)	Final Demand				Final demand (sub total)	Total supply
		Agriculture	Mining	Manufacturing	Construction	Services		Consumption	Capital expenditure	Change in stocks	Exports		
Intermediate inputs	Agriculture Mining Manufacturing Construction Services	QUADRANT 1 INTERMEDIATE USAGE						QUADRANT 2 FINAL DEMAND					
Primary inputs	Wages, salaries and supplements Gross operating surplus Commodity taxes (net) Indirect taxes n.e.c. (net) Sales by final buyers Complementary imports and duty Australian production Competing imports and duty Total usage	QUADRANT 3 PRIMARY INPUTS TO PRODUCTION						QUADRANT 4 PRIMARY INPUTS TO FINAL DEMAND					

Source ABS (1994a).

Quadrant 1 of an IO table contains information on intermediate usage of Australian produced materials and services. It shows the amount of each industry's output that a particular industry uses for its own current production. For example, it would show the motor vehicle industry's purchases from other Australian industries of inputs, like steel and paint, that are used up in current production.

Quadrant 2 shows the final demands for an industry's output from households, the government, foreigners, and business investors. For the motor vehicle industry, this would include the value of cars demanded by each of these sectors.

The third quadrant details the 'primary' inputs to each Australian industry. These are the costs of current production, aside from the costs of domestically sourced intermediate inputs. They include the costs of labour and imports, and the returns to land and capital.

The fourth quadrant shows the primary input content of each final demand category, including both direct and indirect usage of primary inputs. For example, the primary input content for motor vehicles would include not only the labour costs of the motor vehicle industry, but also the labour costs embodied in material inputs to motor vehicle production.

The key assumption of IO analysis is that supply meets demand. After determining the interrelationships between industries, and having specified the final demands for each industry's output, one can calculate the total demand for each industry's output including both final and intermediate demand. Additionally, one can calculate the total employment level required, and total income generated by the sum of total final demand.

IO analysis can be used to consider a change in the level of final demand for an industry's output. The results would show the effect on the sums of final demands and employment throughout the economy. The process is based on a number of simplifications that increase the practicality of IO analysis, but lack theoretical ground (IAC 1989).

An implicit assumption of IO analysis is that industries face a constant cost structure. That is, the proportion of costs represented by particular inputs, such as materials, labour and capital, remains constant and is independent of the level of demand. If the IO tables reveal, say, that motor vehicle production required $50 worth of steel on average for every $1000 worth of output, it would be assumed that each additional $1000 worth of motor vehicle production, without limit, would require another $50 worth of steel.

The constant cost structure assumption implies the existence of unlimited quantities of labour and capital, at fixed prices. If the availability of these inputs were limitless then the prices might indeed be fixed and constant. However, even in a recession, some types of labour are in limited supply and some capital items will be used at near capacity. Hence, as firms increase their demand the price of these inputs increases. This in itself precludes a constant cost structure for all levels of output.

IO analysis also assumes that the amount of an input which an industry uses is directly proportional to the industry's output. Under this fixed coefficient technology, an industry which increases its output by 10 per cent will use 10 per cent more of all inputs. This is a stronger assumption than constant returns to scale, since it precludes input substitution. Constant returns simply means that changing all inputs by the same proportion yields an equal proportional change in output. In reality, producers can generally vary the input mix to some extent and it often pays them to do so. When catering to a temporary increase in demand, producers will favour inputs that can be cheaply adjusted downwards once demand returns to normal. Producers can incur substantial losses on the resale of capital items, and this sometimes inclines them towards more labour as a means of raising output temporarily.

Still other simplifications of IO analysis are the omissions of features of the economy, in addition to the constraints on labour and capital supply, that influence the economy's response to a fiscal stimulus. The real exchange rate and its effects on imports and export demand are not modelled, but this and other price effects missing from IO analysis feature in general equilibrium models.

2.2 General equilibrium modelling

General equilibrium (GE) models go beyond IO analysis by recognising economy-wide constraints such as the size of government deficits, the balance of trade and the availability of labour, capital and land (Dixon 1993). They represent quantitatively the behaviour of household consumers, export customers and other final demanders (Dixon and Parmenter 1994). Importantly, this includes the responses of such agents to changes in prices (for example, effect on export demand for Australian wool of a change in that commodity's price). The absence of such price effects is a significant shortcoming of IO analysis. The use in this paper of a general equilibrium model of the Australian economy, the ORANI model, allows a more realistic analysis of the effects of road construction than would be possible with IO analysis.

2.3 The ORANI model

ORANI appears to have been used more widely than any other general equilibrium model of the Australian economy. Powell (1991) counted over 190 applications on public record in the decade after 1977, when the first version of ORANI became operational. Dee (1994) describes the contribution to policy-making of ORANI and related models developed more recently.

The ORANI model incorporates links between industries that arise from the purchase of one another's output, as in IO analysis, and from competition for available resources like labour and capital, and from other constraints that operate generally, such as the government's fiscal policy settings and the trade balance (IAC 1987). Additionally, ORANI depicts producers as being able to substitute between labour and capital, in contrast to the fixed input–output coefficients of IO analysis. But ORANI retains the fixed coefficient assumption for intermediate inputs (material and service inputs used up in current production).

Comparative static models, such as ORANI, examine the state of the economy with and without the occurrence of some 'shock', such as an increase in government spending. Comparisons are between alternative possible states of the economy in the same period, not between different periods. The present analysis considers the economy as it was in 1994–95, and as it would have been in that year with additional expenditure on road construction .

The ORANI database is updated periodically after the release of new IO tables by the ABS. When the research for this paper was conducted, the ORANI database year was 1986–87. (The incorporation of IO tables released in March 1994 was in still progress.) Hence, the present use of ORANI to estimate the effects of road construction in 1994–95 required supplementary assumptions (which are explained in chapter 5).

ORANI can be applied to two broad time horizons: the short run and the long run. A persisting shock to the economy will affect investment plans, gradually leading to changes in the accumulation of capital in various industries. The 'short run' is the period before capital stocks have had time to respond significantly to the shock being modelled. In short-run ORANI simulations, the capital stock of each industry is therefore assumed fixed. The long run refers to the period once adjustments of the capital stock are completed. When the short run ends and the long run begins will depend on the nature of the shock and the state of the economy, and cannot be specified exactly.

ORANI imposes diminishing marginal returns on capital and labour, as do many other economic models. For labour, this means that the amount that each additional worker contributes to output declines as the ratio of labour to capital increases. As discussed later, this assumption plays an important role in the present simulations, which relate to the short run. Diminishing marginal returns to capital are analogously defined but are not directly relevant to short-run ORANI simulations, where capital inputs are held constant.

ORANI is a particularly well documented model, which makes it easy for critics like Cronin (1985) to spot weaknesses. The transparency also makes the model easy to understand and to adapt for particular applications.

CHAPTER 3 COST STRUCTURE OF THE ROAD CONSTRUCTION INDUSTRY

3.1 Industry cost structures

The ORANI model used here distinguishes 130 commodities, which may be produced in Australia or imported, and 122 industries. The construction industry is split into 'residential building' and 'other construction'.

The 'other construction' industry accounted for an output of $26.7 billion in 1986–87 (the year to which the ORANI database related at the time of our research). This industry includes road construction, which accounted for almost 16 per cent of its output, or $4.16 billion (ABS 1990).[3]

Since the ORANI database does not distinguish between road construction and other non-residential construction, information on the cost structure of road construction was obtained from State road authorities for use in the current analysis.[4] The information revealed significant differences in cost structure between road construction and the 'other construction' industry in ORANI. Table 3.1 indicates the broad differences; appendix 1 provides details on the estimated cost structure of road construction and its derivation.

'Intermediate usage items' in table 3.1 refers to materials and services used in the production process. These may be from any of the 122 industries detailed in ORANI, and can be produced locally or overseas. 'Taxes' are those taxes payable on intermediate usage items, such as sales and wholesale taxes. 'Margins' are inputs involved in the transfer of commodities from producers to consumers, such as transport and wholesale and retail trade. 'Payments to non-labour factors' are the costs of fixed and working capital, land, and taxes such as property taxes that are levied neither on commodities nor income.

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3. 'Road construction' refers here to the ABS Australian and New Zealand Standard Industrial Classification (ANZSIC) Class 4121, which covers road and bridge construction and maintenance.

4. The BTCE undertook a separate collection of data on road construction and maintenance costs after the completion of the research reported in this paper. The results were consistent with the information obtained for the present analysis (see appendix 1).

TABLE 3.1 COSTS BY INPUT CATEGORY IN ROAD AND NON-RESIDENTIAL CONSTRUCTION

(per cent of total cost)

Cost input	*Non-residential construction* [a]	*Road construction*
Intermediate usage items	43.9	51.0
Taxes	0.8	1.8
Margins	6.5	11.7
Wages	41.7	28.4
Payroll tax	0.5	0.5
Payments to non-labour factors	6.6	6.6

a. The ORANI industry 'other construction', which includes all construction except residential building.

Source BTCE estimates based on the 1986–87 ORANI database (Kenderes and Strzelecki 1991) and information supplied by state road and traffic authorities in 1993–94.

Road construction is less labour-intensive than non-residential construction as a whole, but has a greater proportion of costs attributable to intermediate usage items (table 3.1). For road construction as distinct from maintenance, the labour cost share may be somewhat higher than reported in table 3.1 because road maintenance is more labour-intensive, and the state road authorities did not always distinguish between construction and maintenance expenditures in the information they provided to the BTCE.

Examining more detailed categories of inputs reveals further differences in cost structure between 'other construction' and road construction.

3.2 *Detailed cost structure of inputs*

The patterns of material input usage differ significantly between road construction and the broader ORANI industry, 'other construction' (table 3.2).[5] Non-metallic mineral products are a major input to road construction but not 'other construction'. The reverse is true for electronic and other electrical equipment, and for structural metal products.

The industries also differ in their occupational mix, measured at the major-category level in the Australian Standard Classification of Occupations (ASCO). Compared with the 'other construction' industry, road construction has a much larger percentage of its workers in the 'plant and machine operators' category, and a much smaller percentage counted as 'tradespersons' (table 3.3). The occupations that might be termed 'blue-collar' comprise these two categories

5. Information supplied by state road authorities was not detailed enough to derive the percentage usage for all 130 commodities in the ORANI model. We have therefore derived the cost structure of road construction for the 10 largest reported material inputs.

plus 'labourers and related workers'; they account for 66 per cent of employment in road construction and 69 per cent of employment in 'other construction'.

TABLE 3.2 TOP FIVE MATERIAL INPUTS FOR ROAD AND NON-RESIDENTIAL CONSTRUCTION

Rank	*Non-residential construction* [a]	*Road construction*
1	Structural metal products	Non-metallic mineral products
2	Electronic equipment	Ready mixed concrete
3	Other electrical equipment	Petrol and coal products
4	Basic iron and steel	Concrete products
5	Ready mixed concrete	Other minerals

a. The ORANI industry 'other construction', which includes all construction except residential building.

Source BTCE estimates based on information supplied by state road and traffic authorities in 1993–94; for 'other construction', the 1986–87 database in the ORANI E-2.2.1 model maintained at the Centre of Policy Studies (Monash University).

TABLE 3.3 OCCUPATIONAL EMPLOYMENT DISTRIBUTION IN CONSTRUCTION SECTORS AND ECONOMY-WIDE

(per cent of employment)

ASCO category	*Non-residential construction* [a]	*Road construction* [b]	*Economy-wide* [a]
1 Managers and administrators	5.0	5.0	7.3
2 Professionals	5.7	8.8	13.0
3 Para-professionals	7.5	9.5	7.3
4 Tradespersons	42.8	10.0	14.5
5 Clerks	11.3	10.1	20.0
6 Salespersons and personal services workers	1.2	0.5	13.0
7 Plant and machine operators and drivers	8.5	34.5	9.1
8 Labourers and related workers	18.1	21.5	15.8

Note The percentages in each column may not add to 100 due to rounding.

a. Distribution in 1986–87. Non-residential construction corresponds to the ORANI industry 'other construction', which includes all construction except residential building.

b. Distribution in 1991.

Sources ABS (1994a); Kenderes and Strzelecki (1991).

CHAPTER 4 THE ECONOMIC ENVIRONMENT OF THE ORANI SIMULATION

ORANI simulations presuppose a certain environment under which shocks to the economy have their effect. In ORANI terminology, the economic environment is the 'closure' of the model.

The closure of the model specifies the variables to be exogenous, that is, determined outside the model, and those that ORANI is to solve for, the endogenous variables. As discussed above, ORANI simulations can be conducted for two broad time frames, short-run and long-run. The selection of the time frame will to some extent determine which variables are exogenous and which are endogenous (Dixon et al. 1982).

The standard short-run closure has been chosen for the simulations reported here because of the temporary nature of the program of increased road construction being analysed. The following variables are assumed to be unaffected by road investments during the construction period (in this sense, fixed):

- real household consumption;
- real private investment;
- real government consumption;
- real wages;
- capital inputs;
- the world economy;
- nominal exchange rate; and
- tax rates and technological changes.

4.1 Real household consumption

The assumption that real household consumption remains fixed accords with Modigliani's life-cycle theory of consumption (Sheffrin, Wilton and Prescott 1988). This theory highlights the differences in consumption responses to temporary versus permanent increases in income. It predicts that people consume only part of a temporary increase in income immediately. Since they will want to spread the benefits of a temporary boon over their lifetime, they initially save much (or most) of the additional income for later consumption. In the present context of a one-off increase in road construction expenditure, any stimulus to the economy from the construction activity will be temporary (abstracting from the benefits once the road is in place). The life-cycle theory of consumption would thus predict little immediate effect on household consumption.

The life-cycle theory of consumption remains controversial, however. If road construction activity increases aggregate employment, some of the people gaining employment might substantially increase their consumption at once. An alternative ORANI simulation reported in chapter 6 allows for this possibility by forcing household consumption to increase by the same percentage as labour income.

4.2 Private investment

Investment can refer to additions of inventories or fixed capital (equipment, and structures). The omission of inventory adjustments is a significant limitation of short-run ORANI. However, in the present analysis, where the road construction program is temporary, private investment in fixed capital can be assumed constant fairly plausibly. Just as with households, firms' reactions to an increase in road construction expenditure depend on their expectation of its duration. If the increase is temporary, they will favour other methods of meeting the increase in demand for their output, such as drawing on inventories or increasing labour input, rather than increasing the stock of fixed capital. Firms would be likely to increase investment significantly only if the increase in output demand is expected to persist.[6]

4.3 Government consumption

It is assumed that government spending on other goods and services remains unaffected by the increase in road construction expenditure. If, in order to spend more on roads, the government needs to spend less on other items, the impact could be much different. Chapter 6 presents a simulation featuring this sort of fiscal constraint.

4.4 Real wages

Our labour market scenario probably gives overly optimistic estimates of employment gains. Real wages are fixed and there are no limitations on labour

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6. The anticipation of improved road transport might stimulate some investment in fixed capital while a road is being constructed—say, farmers expecting better transport for their products start building new storage facilities. However, these effects are probably not that important for an analysis of outcomes during the construction phase; in any case, attempting to incorporate them into the present analysis would be a major exercise.

supply at prevailing wage levels. The scenario best fits an economy in deep recession.

ORANI analyses conducted during the recession of the early to mid-1980s found some justification for the fixed real wage assumption in the Accord between the Federal Government and the Australian Council of Trade Unions (ACTU). The Accord required increases in wages to be indexed to the consumer price index (CPI). Hence, for a time, real wages growth was tightly constrained to promote growth in labour demand. Subsequent moves toward deregulation of wage-setting and other aspects of the labour market have reduced the realism of the fixed real wage assumption. Decentralised bargaining, including negotiation of contracts between individual workers and their employers, is a centrepiece of the major reforms to the industrial relations recently proposed by the Federal Government.

In reality, an increase in road construction expenditure could well place some upward pressure on real wages to the extent that it stimulates aggregate labour demand. The increase in real wages would moderate the increase in labour demand and employment.[7] Also, there may be limitations on labour supply in some occupations that prevent some of the increase in labour demand being met.

Penalty costs associated with hiring and firing workers are absent from the ORANI framework (as Cronin 1985 notes), and can discourage hiring of workers to meet a temporary increase in output demand. Employers may find it more advantageous to draw on inventories or increase hours among existing workers. A temporary program of road construction may therefore have smaller employment effects than indicated by the present ORANI analysis.

4.5 Capital

Capital stocks are accumulations of past investment. So a temporary program of road construction that has no effect on private investment, as assumed here, will also have no effect on private capital stocks. Likewise, to assume no changes in government spending other than on road construction implies no change in public capital stocks other than roads.

Another assumption is that capital stocks are fully utilised, meaning that more input of capital services cannot be obtained from existing stocks. Ignoring the reality of some underutilisation of capital (particularly during recessions) introduces two opposing biases into our estimates of employment gains.

If producers can meet the additional demand for output partly by increasing their utilisation of capital, they will not have to rely as much on an increase in

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7. Conceivably, some of the increase in real wages would lag the road construction activity, in which case some of the dampening effect on aggregate employment would be delayed.

labour input. In this respect, the employment gains from road construction have been overestimated.

The opposing bias arises from the short-term effect of road construction on the real exchange rate. In the simulation reported in chapter 5, the road construction expenditure causes the real exchange rate to appreciate, leading to a decline in export demand and some displacement of domestic production by imports. The resulting employment losses in trade-exposed sectors reduce the overall gain in employment from road construction. If the construction leads to an increase in capital utilisation, contrary to what is assumed here, the pressure on the real exchange rate is reduced. (Increased capital utilisation increases the supply of Australian output, which reduces the price of Australian output relative to overseas prices—exactly what the real exchange rate measures.) Taken alone, this consideration implies underestimation of employment gains.

Machinery input to road construction has been excepted from the assumption of fixed capital inputs. Increasing annual road construction output by $630 million, even temporarily, would probably require additions to the economy's stocks of capital inputs like pavement layers, which are specific to road construction (unless there is ample spare capacity in the road construction industry). The same may be true for capital inputs that are used more generally, but for which road construction is a major customer. (Perhaps bulldozers fall in this category.) To allow for this outcome without laborious reprogramming of ORANI, machinery inputs to road construction are represented as intermediate inputs rather than as capital inputs as such.

4.6 *The world economy*

Economic conditions in the rest of the world are assumed fixed. Australia is, in economic terms, a small country and changes in the domestic economy do not significantly affect the world economy. This means that the conditions underlying foreign demand for our exports remain constant, although export volumes will respond to price changes. Likewise, we assume that the price of imports remains constant. Again, the actual volume of imports will depend on the real exchange rate.

4.7 *The nominal exchange rate*

The real exchange rate is defined as the nominal exchange rate times the domestic price level (P^d), divided by the foreign price level (P^f), or

$$\theta = \frac{eP^d}{P^f}$$

where θ is the real exchange rate, and e is the value of the Australian dollar in foreign currency.

An appreciation of the real exchange rate means that our exports have become dearer relative to overseas prices, and this reduces export demand. Likewise, imports increase as the exchange rate appreciates, since they become cheaper relative to domestically produced substitutes.

The nominal exchange rate is assumed fixed, since its level has no real implications in the ORANI model, so long as Australian prices are flexible. In the model, a 10 per cent depreciation of the Australian dollar would simply cause a 10 per cent increase in all Australian prices, including prices for labour and other factors of production. All real variables in the economy would stay the same: the real exchange rate, real wages, and so on.

4.8 Taxes and technology

Road investments can have complex effects on government budgets. In addition to increasing the budget deficit through construction expenditure, they can affect tax revenues by changing levels of economic activity both during construction and afterward. Governments may adjust tax rates in light of the changed budgetary situation, but the timing and nature of the adjustments are too hard to predict to be modelled here. An increase in tax rates would make for a smaller stimulus to the economy.

Although the tax schedule is assumed fixed, an increase in road construction expenditure can push people into different tax brackets through changes in their incomes. Average tax rates are thus endogenous in this analysis.

Finally, we assume that the road construction expenditure will not affect the level of available technology.

CHAPTER 5 RESULTS FROM THE ORANI SIMULATION

The present simulation indicates, we repeat, the contemporaneous effects of a 'one-off' increase in road construction expenditure in 1994–95. It indicates neither changes over time nor the effects after the roads are built. In addition, government spending on goods and services apart from road construction remained fixed.

The historical nature of the ORANI database complicated the analysis and reporting of findings. The database year was 1986–87 at the time of research, whereas the $630 million road construction expenditure being considered would have occurred in 1994–95. CPI-adjusting for inflation, this expenditure equates to $450 million in 1986–87. The first step was thus to simulate with ORANI the effects in 1986–87 of $450 million extra expenditure on road construction. Simulation results for dollar variables, like real GDP, were then CPI-adjusted back to 1994–95. Simulation results for employment (numbers of persons) were left unadjusted on the assumption that $450 million of road construction expenditure in 1986–87 would have the same employment effects as $630 million of road construction expenditure in 1994–95. [8]

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8. To illustrate the CPI adjustment, consider the findings for real GDP. The ORANI simulation indicated that, in 1986–87, $450 million more road construction expenditure would have raised that year's GDP by $282 million, measured at constant 1986–87 prices. Inflating this by the 42 per cent increase in the CPI from 1986–87 to 1994–95 gave the figure of $401 million in table 5.1.

   The updating procedure only partly resolved the problems of using a relatively old database, but the remaining problems are unlikely to have distorted the results significantly. The biases affecting the employment results, which are the focus of this paper, oppose each other, and the net bias may well be small. One bias arises from use of the CPI to find the 1986–87 equivalent of 1994–95 expenditure on road construction. Apparently, the cost of road construction grew more slowly than the CPI over the period in question, so that the true 1986–97 equivalent was more than the $450 million assumed here. A BTCE index of road construction costs that was unavailable at the time of research implies a slightly higher figure of $465 million (BTCE 1996c). Using this alternative figure in the ORANI simulation would have increased the estimates of employment gains. Moreover, the true figure was probably larger because the BTCE index is merely an input-price index that ignores improvements in road construction productivity. Assuming that productivity was lower in 1986–87 than in

The simulation was run with a version of ORANI developed at the Centre of Policy Studies at Monash University (ORANI E-2.2.1). Results can be scaled to estimate the effects of increases in road construction expenditure differing in magnitude from that modelled here.

5.1 *Macroeconomic impacts*

The simulation indicates that in 1986–87, an extra $450 million of road construction expenditure would have increased real GDP by 0.11 per cent. That suggests that in 1994–95, an extra $630 million of road construction expenditure would have increased real GDP by $401 million (table 5.1).

TABLE 5.1 ESTIMATED SHORT-RUN MACROECONOMIC EFFECTS OF ONE-OFF INCREASES IN ROAD CONSTRUCTION EXPENDITURE

Macroeconomic variable	*$450M in 1986–87: percentage effect*	*$630M in 1994–95: absolute effect*
Real GDP ($M, at constant same-year prices)	0.11	401.10
CPI	0.12	na
Balance of trade ($M)	na	–217.55
Value of export ($M)	–0.14	–77.83
Value of imports ($M)	0.22	139.72
Aggregate employment	0.16	10 957

na Not applicable

Source BTCE ORANI estimates; ABS (1995, 1996). Base 1986–87 values for dollar variables like GDP came from the ORANI database (extracted by the Centre of Policy Studies), and differ from those published by the ABS. The ORANI database includes adjustments to ABS estimates to eliminate certain patterns in the database year that are atypical of other years. The typicalisation procedure mainly applies to agriculture, where conditions are highly variable.

Another finding is that the road construction expenditure would increase the overall price level in the Australian economy, due to the increase in aggregate demand for Australian output. The upward pressure on the price level is indicated by the estimated 0.12 per cent rise in the consumer price index (CPI). Nominal wages are fully indexed to the CPI, by assumption, so that real wages remain constant. The findings are also shaped by other assumptions of the ORANI short-run framework, such as fixed and fully utilised capital stocks, perfectly competitive product markets, diminishing marginal returns to labour,

later years would increase the estimate of the 1986–87 equivalent of future road construction expenditure.

The opposing bias also arises from the failure to consider productivity improvements. Because of these improvements, the same amount of road work would tend to require less labour the more recently the work is undertaken. Taken alone, this would suggest that use of a 1986–87 database has resulted in overestimation of employment gains from road construction in 1994–95.

and no adjustments to inventories (see chapter 4). As in all economic models, the assumptions are only meant to approximate reality and their realism can be debated. Cronin (1985) argues that, contrary to ORANI short-run results, changes in aggregate demand do not significantly affect prices in the industrial sector.

The increase in expenditure on road construction, though amounting to less than a 1 per cent increase in aggregate demand, leads to a deterioration in the balance of trade of $217.6 million. The increase in real GDP from road construction is therefore not a 'free lunch', since trade deficits result in a transfer of assets overseas.

The increase in aggregate demand leads to an appreciation of the real exchange rate through higher domestic prices. (Recall that the nominal exchange rate is constant in this analysis). The volume of imports rises due to both the increase in the level of output demand and the higher real exchange rate, which makes imports cheaper relative to domestic substitutes. Export volumes fall as the real exchange rate appreciates. The effects of changes in the real exchange rate are not modelled in the IO framework.

5.2 Impact on industry sectors

An increase in government expenditure on road construction will have mixed effects on other industry sectors.

Road construction requires material inputs that are supplied by other domestic industries, which, in turn, demand inputs from their suppliers. An increase in road construction spending thus induces a chain reaction through input linkages with other industries. Reflecting this, an IO analysis would indicate that road construction expenditure raises output in all industries.

Unlike IO analysis, however, ORANI also models negative effects on industry outputs which operate through the real exchange rate. The ORANI simulation indicates that road construction expenditures cause the real exchange rate to appreciate, reducing demand for Australian exports and displacing some domestic production with imports. (In reality, the increase in the real exchange rate could be less than indicated if some capital is underutilised.)

Because of the real exchange rate effect, the ORANI simulation indicates declines in output in several industry sectors. This is shown in table 5.2, which aggregates the ORANI industries into 15 sectors. (Appendix II presents the estimates at the detailed industry level.) The adversely affected sectors are particularly export focused, or face strong competition from imports. Demand for output from these industries is therefore highly sensitive to changes in the real exchange rate. A good example is the sector comprising agriculture, forestry and fishing. Output from this sector would have fallen by almost 0.1 per cent had road construction increased by $450 million in 1986–87. Other industries, such as mining, and textiles, clothing and footwear, would have also suffered reduced output demand because of the higher real exchange rate.

TABLE 5.2 ESTIMATED SHORT-RUN EFFECTS ON INDUSTRY SECTOR OUTPUTS OF EXTRA ROAD CONSTRUCTION EXPENDITURE: $450 MILLION IN 1986–87

Industry sector	*Percentage change in sectoral output*
Agriculture, forestry and fishing	–0.10
Mining	...
Food products	–0.08
Textiles, clothing and footwear	–0.05
Wood and paper products	0.03
Chemical and oil products	...
Non-metallic ore products	2.10
Metal products	0.07
Transport equipment	–0.08
Other machinery[a]	0.19
Other manufactured goods	–0.04
Utilities	0.02
Construction industries (excluding road construction)	...
Trade, transport and communications	0.06
Service industries	0.31

... Between +0.005 and –0.005 per cent

a. Machinery and equipment other than transport equipment, including construction machinery.

Source BTCE ORANI estimates.

The industry sectors that gain the most from increased road construction expenditure are the major suppliers of inputs to road construction and sectors less vulnerable to real exchange rate appreciation. The sector supplying non-metallic ore products, proportionately the largest gainer, accounts for an estimated 12 per cent of road construction cost (table I.1). Among other gaining sectors, 'other machinery' is also indicated to be a major supplier to road construction, particularly of specialised construction machinery.[9]

9. Admittedly, the reliability of this indication is uncertain. Machinery does account for a significant share of road construction costs, but much of it is imported. In the absence of data providing a better indication, the present analysis assumes the import share to be the same as for machinery input to all non-residential construction (see appendix I). Some machinery inputs to road construction, like pavement layers, appear to be almost wholly imported. If the import share of machinery input is greater for road construction than for non-residential construction as a whole, table 5.2 may overstate the effect of road construction on output of the 'other machinery' sector.

The service sector is also indicated as receiving a relatively strong output stimulus from road construction. It suffers less from an exchange rate appreciation than do the resource and manufacturing sectors, which face more foreign competition. The exchange rate effect would also have more benign consequences the more heavily a sector depends on import-intensive inputs.

5.3 Employment effects

Spending $630 million more on road construction in 1994–95 would have increased aggregate employment by nearly 11 000 jobs, according to the ORANI simulation. The road construction industry would absorb only a modest share of this increase in employment—on a rough calculation, about 24 per cent (table 5.3), with the remainder occurring in industries supplying road construction (directly or indirectly). An extra $630 million would have increased 1994–95 government spending on roads by 11 per cent (BTCE 1996c); we have assumed in table 5.3 that road construction employment in each occupation would have increased in the same proportion. The calculation is rough because the estimate of actual employment in road construction relates to 1991, rather than 1994–95, and comes from the Population Census. The usual absence of an interviewer in the Population Census basically leaves accuracy and completeness to the respondent, which raises questions about the quality of employment estimates based on the Census, particularly at a detailed industry level. (The ABS Labour Force Survey, the source of our data on aggregate employment, is conducted by interview, but samples too few people to provide estimates for road construction.)

While most of the extra road construction employment is in the 'blue-collar' occupations—tradespersons, labourers and related workers, and plant and machine operators and drivers—the aggregate employment gain is shared more widely. For example, salespersons and personal services workers account for only 0.5 per cent of the employment gain within road construction, but 5.0 per cent of the employment gain economy-wide.

However, the blue-collar occupations still get 61 per cent of the increase in aggregate employment, whereas their current share of aggregate employment is only 39 per cent (table 5.3). Hence, increasing expenditure on road construction may be a better way of reducing unemployment in these occupations than a similar expansion in government expenditure in some other areas. Unemployment in blue-collar occupations can be a particular concern during recessions which, in the past, have usually hit these occupations the hardest.

Men account for a large majority of workers in the road construction industry and in the blue-collar occupations favoured by an increase in road construction expenditure (table 5.4). To estimate the effects of the road construction

TABLE 5.3 ESTIMATED SHORT-RUN EFFECTS OF ROAD CONSTRUCTION EXPENDITURE ON EMPLOYMENT IN ROAD CONSTRUCTION INDUSTRY AND ALL INDUSTRIES BY OCCUPATION: EXPENDITURE INCREASE OF $630 MILLION IN 1994–95

	Road and bridge construction			*Aggregate economy*		
ASCO category	*Base-level employment*[a]	*Change*[c] *(%)*	*Change in employment*	*Base-level employment*[b]	*Change*[c] *(%)*	*Change in employment*
Managers and administrators	1 199	11.0	132	513 600	0.08	411
Professionals	2 110	11.0	232	917 000	0.11	1 009
Para-professionals	2 261	11.0	249	515 200	0.15	773
Tradespersons	2 396	11.0	264	1 019 100	0.11	1 121
Clerks	2 428	11.0	267	1 410 600	0.11	1 552
Salespersons and personal services workers	126	11.0	14	916 100	0.06	550
Plant and machine operators and drivers	8 255	11.0	908	641 700	0.50	3 208
Labourers and related workers	5 154	11.0	567	1 110 800	0.21	2 333
Total	23 929		2 633	7 044 100		10 957

a. Based on 1991 Census of Population and Housing (ABS 1994a).

b. Employment in 1986–87; the aggregate employment figure was taken from the ABS labour force survey (ABS 1995); occupational shares of aggregate employment were taken from the 1986–87 ORANI database (Kenderes and Strzelecki 1991).

c. Relative to the specified base level. Estimates for the aggregate economy rest on the assumption that road construction expenditures of $630M in 1994–95 and $450M in 1986–87 will have the same effects on employment (numbers of persons). The percentage effect will depend on the base year being used (see above notes). By assumption, increased road construction expenditure has the same percentage effect by occupations within the road construction industry (hence, the uniform 11.0 per cent recorded in column 3).

Sources BTCE ORANI estimates; ABS (1994a, 1995, 1996); Kenderes and Strzelecki (1991).

TABLE 5.4 ESTIMATED SHORT-RUN EFFECTS OF ROAD CONSTRUCTION EXPENDITURE ON EMPLOYMENT IN ROAD CONSTRUCTION INDUSTRY AND ALL INDUSTRIES BY OCCUPATION AND SEX: EXPENDITURE INCREASE OF $630 MILLION IN 1994–95

	Road and bridge construction employment					*Aggregate employment*			
	Base level			*Increase*		*Base level*		*Increase*	
ASCO category	*Male* [a]	*Female* [a]	*Change* [c] *(%)*	*Male*	*Female*	*Male* [b]	*Female* [b]	*Male*	*Female*
Managers and administrators	1 065	134	11.0	117	15	426 200	87 400	348	63
Professionals	1 932	178	11.0	213	20	544 900	372 100	674	336
Para-professionals	2 099	162	11.0	231	18	291 700	223 500	527	246
Tradespersons	2 360	36	11.0	260	4	908 400	110 700	1 024	97
Clerks	1 029	1 399	11.0	113	154	399 600	1 011 000	477	1 075
Salespersons and personal services workers	85	41	11.0	9	5	359 700	556 400	219	331
Plant and machine operators and drivers	8 203	52	11.0	902	6	537 800	103 900	2 825	383
Labourers and related workers	4 973	181	11.0	547	20	711 500	399 300	1 676	657
Total	21 746	2 183		2 392	242	4 179 800	2 864 300	7 770	3 188

a. Based on 1991 Census of Population and Housing (ABS 1994a).

b. Employment in 1986–87; the aggregate employment figure was taken from the ABS labour force survey (ABS 1995); shares of aggregate employment by occupation and sex were taken from the 86–87 ORANI database (Kenderes and Strzelecki 1991)

c. Relative to the specified base level. By assumption, increased road construction expenditure has the same percentage effect by occupation within the road construction industry (hence, the uniform 11.0 per cent recorded in column 3).

Sources BTCE ORANI estimates; ABS (1994a, 1995, 1996); Kenderes and Strzelecki (1991).

expenditure on total male and female employment, we have assumed constant the female share of employment within each occupation, calculated separately for road construction and for the rest of the economy. In reality, few jobs belong specifically to men or women, so the estimates are only rough indications.

The results suggest that road construction does favour male employment to some extent. Men are estimated to get 71 per cent of the additional jobs, compared with their 59 per cent share of existing jobs.

5.4 *Unemployment effects*

The ABS counts as unemployed those persons who are not employed but want to work, are actively looking for work and would be available to start work within the week (ABS 1993). Persons who are neither unemployed under this definition, nor employed, are counted as outside the labour force.

In 1994–95, employment stood at 8.09 million and unemployment at 794 600, summing to a labour force of 8.89 million (ABS 1996). Thus, the unemployment rate (the ratio of the number of unemployed to the labour force) was 8.9 per cent.

However, the official unemployment rate may understate the problem of joblessness. There are many people who desire work but who are classified by the ABS as outside the labour force rather than unemployed. These include people who are actively looking for work but would not be available to start work within the week. Also classified as outside the labour force are discouraged job seekers, who are not actively seeking a job because they believe that they would be unable to find one.

A government expenditure program that increases aggregate employment will attract people into the labour force by improving employment prospects. This expansion of the labour force moderates the measured reduction in the level and rate of unemployment. By definition, the number of unemployed persons equals the size of the labour force minus aggregate employment. If the size of the labour force stays the same, unemployment declines by the amount that aggregate employment increases. Unemployment declines by a lesser amount, however, if the increase in aggregate employment attracts more people into the labour force, as it normally would.

Lack of reliable information for estimating the labour force response has led to the assumption of a constant labour force in the present analysis. The estimated effects of road construction on the level and rate of unemployment are optimistic in this respect.

According to table 5.3, the road construction expenditure modelled would create an additional 10 957 jobs in aggregate. If, as assumed, the size of the labour force stayed the same, the total number of unemployed would decrease to 783 643, and the unemployment rate would fall to 8.81 per cent, a decline of just under 0.1 percentage points.

The indication is that even a large increase in road construction expenditure would reduce unemployment only slightly. The estimated reduction from a $630 million increase in road spending is small, despite assumptions that bias the estimate upwards: that the size of the labour force remains constant plus assumptions that exaggerate the increase in aggregate employment (those identified in chapter 4).

CHAPTER 6 COMPARISON OF RESULTS

The ORANI simulation in this chapter provides estimates of the short-run effects of road construction for scenarios somewhat different from that assumed in chapter 4. In one scenario, the increase in road construction expenditure is offset by a matching reduction in other government expenditure on goods and services. In another scenario, increases in aggregate employment are allowed to affect real household consumption. Also examined, in a third scenario, are the short-run effects of government expenditure on welfare services, for comparison with expenditure on road construction. In all scenarios, the additional road construction expenditure remains at $630 million in 1994–95 (which enters the ORANI model as $450 million in 1986–87).

Table 6.1 shows the estimated effects on macroeconomic variables for the three scenarios just described. Corresponding estimates for the scenario in chapter 5, now termed the 'base case', are reproduced in column 1. (The results in column 1 are thus identical to those in table 5.1.)

6.1 Government fiscal constraint

Column 2 reports the results from the simulation with the added constraint on government spending. In this scenario, the increase in road construction spending displaces an equal amount of other government spending.

The reallocation of government spending toward road construction would result in an almost constant real GDP. The estimated effect is actually to reduce real GDP slightly—by just over $48 million. The balance of trade is estimated to decline by nearly the same amount, with export volumes declining marginally. The estimated increase in imports may indicate that inputs to road construction have a higher import content than do inputs to other industries toward which government expenditures are directed.

The results also suggest that, in the short run, government spending on road construction increases employment by less than does other government spending on goods and services. The modelled reallocation of expenditure toward road construction would reduce aggregate employment in the short run, along with real GDP. Aggregate employment would decline by 2943

TABLE 6.1 ESTIMATED SHORT-RUN MACROECONOMIC EFFECTS OF INCREASED ROAD CONSTRUCTION EXPENDITURE AND OTHER CHANGES TO FINAL DEMAND

	Column 1		*Column 2*		*Column 3*		*Column 4*	
	Base case: increased road construction expenditure[a]		*Base case + matching reduction in other government expenditure*[b]		*Base case + induced increase in household consumption expenditure*[c]		*Increase in government spending on welfare services*[d]	
Macroeconomic variable	*Absolute effect*	*Percentage effect*	*Absolute effect*	*Percentage effect*	*Absolute effect*	*Percentage effect*	*Absolute effect*	*Percentage effect*
Real GDP ($M)[e]	401.10	0.11	–48.20	–0.01	397.90	0.11	437.30	0.12
CPI	na	0.12	na	–0.03	na	0.47	na	0.17
Balance of trade ($M)	–217.55	na	–47.50	na	–503.17	na	–178.56	na
Value of exports ($M)	–77.83	–0.14	–1.77	0.00	–241.57	0.42	–90.21	–0.16
Value of imports ($M)	139.72	0.22	45.73	0.07	261.60	0.41	88.35	0.14
Aggregate employment	10 957	0.16	–2 943	–0.04	9 729	0.14	13 182	0.19

na Not applicable

a. A one-off increase of $630 million in 1994–95 (absolute effects) or $450 million in 1986–87 (percentage effects).

b. Government expenditure on all goods and services decreases in equal proportion. Government assistance, like unemployment benefits, are 'transfer payments' rather than payments for goods or services, and are excluded from the modelled spending cut.

c. Household consumption expenditure increases in proportion to the increase in labour income estimated in the base case.

d. 'Welfare services' include employment-related services, police and fire protection, research, prisons and garbage collection. They do not include health or education.

e. GDP measured at constant same-year prices. The effect of the hypothetical changes in 1994–95 final demands on that year's GDP, measured at the actual prices in 1994–95, in the case of the absolute effects. Likewise for the percentage effects, except that they relate to 1986–87. (See note a).

Source See source note to table 5.1.

despite the addition of 2632 workers in road construction, due to an employment loss of 5575 in other sectors. The interpretation is that other goods and services consumed by the government are generally more labour-intensive and may also be less import-intensive than road construction.

6.2 *Household consumption endogenous*

Column 3 reports the results of a simulation where household consumption increases by the same percentage as labour income, which increases due to gains in aggregate employment. The assumptions are otherwise unchanged from the base case in chapter 4.

Contrary to what one might expect, the ORANI estimates do not reveal a greater stimulus to the economy in this scenario than in the base case where real household consumption was assumed fixed. Real GDP increases by $398 million, which is some $3 million less than under the base case. Likewise, the number of jobs created at the aggregate level is 9729, again slightly less than that estimated under the base case. The paradoxical indication from these results is that increased consumer demand causes slight economic contraction.

How could an increase in consumer demand cause economic contraction? ORANI provides the following explanation. Housing accounts for a large share of consumer spending and the stock of housing is relatively fixed in the short run. With the housing stock fixed, an increase in demand for dwellings will simply bid up their price. To a lesser extent, the increase in consumer demand will also push up the prices for non-housing consumables, which are less fixed in supply. Wages rise to compensate workers for the increased consumer prices, since real wages are fixed in the short run as well. The wage increase, in turn, makes Australian products more expensive, which discourages exports and stimulates imports. These indirect contractionary effects can be strong enough to outweigh the direct expansionary effect of increased consumer demand.

Increased government demand for road construction also has these opposing effects. However, for two reasons, it creates less inflationary pressure than does an increase in household consumption demand. First, wages are indexed to consumer prices, which depend less on demand for inputs to road construction than on consumer demand. Second, increased supply relieves upward pressure on prices and, in the short run, the supply of inputs to road construction responds more readily to increased demand than does the supply of dwellings (which is assumed fixed). The difference in inflationary effect is manifest in the CPI increase being so much smaller in column 1 than in column 3. Since higher prices for Australian products reduce export demand and increase import demand, an increase in household consumption demand stimulates the economy by less than does an increase in expenditure on road construction.

The important point is that IO analysis greatly exaggerates the employment created by an increase in household consumption demand. Whether ORANI shows any employment created by this change or, as in the simulation reported here, a net loss of employment, may depend on the database year. The effect is in any event likely to be much smaller than an IO analysis would show, according to advice from Dr Mark Horridge of the Centre of Policy Studies.

6.3 Increase in expenditure on welfare services

Governments in Australia spend a lot on 'welfare services' as defined by the ABS. These services include police and fire protection, research, prisons, garbage collection, and employment-related services. They do not include health and education.

In 1994–95, an extra $630 million spent on welfare services would have increased real GDP by just over $437 million, or $36 million more than would the same increase in road construction expenditure, according to the ORANI results in columns 1 and 4.

While the real exchange rate appreciates by more than in the base case (as indicated by the CPI results), this does not translate to a greater deterioration of the balance of trade, which actually falls by some $39 million less than the base case. It could be that welfare services are less import-intensive than road construction, so that more of the government's outlays go to domestic, rather than foreign, suppliers.

The increase in expenditure on welfare services creates an estimated 13 182 additional jobs, which is 20 per cent more than the corresponding estimate for road construction. This reflects the labour-intensive nature of welfare services.

Care should be taken in interpreting these results. They indicate that for a 'one-off' outlay of $630 million, welfare services may create more employment in the short run than does road construction. However, the short-term employment effect is but one consideration in evaluating government expenditure programs. Other considerations include the benefits from better road transport and increased provision of welfare services.

6.4 ABS input–output multipliers

Input–output analysis is the most common method of estimating the employment effects of an increase in final demand for an industry's output (as was discussed in chapter 2). The ORANI findings in this paper invite comparison with ABS estimates of employment multipliers for non-residential construction, which are based on the 1989–90 input–output tables (ABS 1994c). The comparison is inexact, since the non-residential construction industry—'other construction' in the IO terminology—includes activity beside road construction. The ABS does not have a separate employment multiplier for road construction.

The multipliers obtained from the ABS measure employment in 'full-time equivalents' and exclude jobs created overseas (being based on the direct allocation of competing imports; see ABS 1991b for detailed description of the several types of multipliers.)

The multiplier relevant to our base-case simulation is the simple multiplier, which incorporates only the initial effects plus the production-induced effects. It excludes consumption-induced effects, as does our base-case simulation (where household consumption is assumed to remain constant; see chapter 4).

The simple ABS employment multiplier for 'other construction' is 16. This means that, in 1989–90, a $1 million increase in government demand for non-residential construction would increase aggregate employment by the equivalent of 16 full-time workers. For a $630 million increase in such expenditure, this equates to 10 080 more full-time workers.

The base-case ORANI simulation indicates an employment multiplier of 17.4 for 1994–95 (the increase in aggregate employment of 10 957 divided by the $630 million of road construction expenditure). This multiplier differs from the ABS employment multiplier in the year to which it relates and in the measure of employment (workers versus full-time equivalent workers), but these differences distort comparison only slightly. (The small biases they introduce are offsetting.)[10] Rather, the ORANI-based multiplier being larger appears to reflect the different outcomes for the ratio of employment to output: in the ORANI simulations, achieving a given increase in output requires a more than proportionate increase in employment, given the assumptions of fixed capital input and constant returns to scale; in the IO framework, employment per unit of output in each industry is fixed.

When consumption-induced effects are modelled, the ORANI simulation indicates much smaller employment gains than does the ABS employment multiplier. For each industry, the ABS calculates a total multiplier for employment that adds consumption-induced effects to the simple multiplier. The consumption-induced effects are positive in the IO framework: an increase in final demand for the output of 'other construction' boosts employment; the additional workers have more income to spend, which raises their demand for consumer goods and services; which in turn increases employment. For 'other construction', the ABS total multiplier is 27, or about 40 per cent larger than the

10. CPI-adjusting for the difference in year reduces $630 million in 1994–95 to $554 million in 1989–90. Adjusting for the difference in measure of employment requires data on employment by full- and part-time status. In 1986–87, the year to which the ORANI database related, 80.1 per cent of workers were full-timers (ABS 1995). Since the ABS counts two part-timers as equivalent to one full-timer, this means that full-time equivalent employment amounted to 90 per cent of total employment. Taking 90 per cent of the employment gain indicated by our base-case simulation gives an estimated gain of 9861 in full-time equivalent employment. Dividing this employment gain by $554 million gives a multiplier of 17.8, compared to the value of 17.4 before adjustment.

simple multiplier of 16, meaning that consumption-induced effects account for about 40 per cent of the overall increase in (full-time equivalent) employment. A totally different picture emerged from the ORANI simulation where household consumption increased proportionately with labour income: the consumption-induced effect on aggregate employment was small and negative (as discussed above.) Hence, the employment multiplier implied by this simulation (15.4) is slightly smaller than that implied by the base-case simulation (17.4), and much smaller than the ABS total multiplier (27).

CHAPTER 7 CONCLUDING COMMENTS

The employment effects of road investment during the construction phase are very hard to estimate.

The usual method, input–output analysis, ignores resource constraints and the possibilities for substitution between inputs. National economic models can potentially add some realism in these and other respects, and provide better estimates of the aggregate employment effects of major road construction expenditures.

The ORANI model of the Australian economy imposes resource constraints in the form of capital inputs being fixed in the short run, and allows for substitution between labour and capital. In addition, it recognises that government fiscal measures (like road construction expenditures) can affect the real exchange rate, causing changes in demand for imports and exports. However, the realism of key assumptions in ORANI and other national economic models can also be challenged. The modelling of product prices and other aspects of the short-run version of ORANI used in this paper have provoked some criticism. Many of the criticisms of ORANI—such as the failure to account for changes in inventories and in hours per worker—apply equally to standard IO analyses.

It is probably fair to say that models of the Australian economy, including ORANI, provide too simplistic a picture of the labour market to reliably estimate the employment effects of road construction and other government expenditures. ORANI leaves it up to users of the model to make assumptions about wage determination. Generally, these are extreme assumptions. Short-run analyses with ORANI often assume, as in this paper, that real wages are exogenous (unaffected by the shock being modelled), in which case aggregate employment is affected.[11] Another extreme case is where wages adjust freely to neutralise any pressures on aggregate demand for labour. This is the usual scenario in ORANI analyses of long-run effects. Since it assumes away effects on aggregate employment, it was not suitable for the present analysis, although some short-run applications of ORANI have adopted it. The truth is somewhere

11. A variant of this in some ORANI-based studies is to assume nominal wages exogenous, leaving both real wages and aggregate employment variable.

between these extreme cases. A government expenditure program would induce *some* change in aggregate employment and *some* change in real and nominal wages.

Some models of the Australian economy attempt to explain wage determination through econometric analysis of past experience. How well they explain what drove wages in the past is an open question; econometric analyses have failed to produce reliable findings about some other issues despite massive efforts.[12] More fundamentally, past patterns of wage determination in Australia may be a poor guide to the future, especially with major reforms to the labour market pending under the current Federal Government.

Overall, the ORANI simulations would seem to describe the effects of increased road construction expenditure with greater realism than would an IO analysis, and certainly in more detail. *Nevertheless, extreme care must be taken in using the ORANI findings reported here for policy analysis.* Although we cannot be sure whether these ORANI estimates of employment gains are too high or too low, the absence of labour supply constraints makes overestimation a distinct possibility. Reinforcing this suspicion is the absence from the simulations of any mechanism for producers to meet additional demand by reducing inventories or by increasing hours per worker, rather than by increasing employment.

Without a better understanding of the labour market, the employment effects of government fiscal measures will remain largely unknown. Hopefully, enhanced models of the Australian economy will capture the realities of the new industrial relations system, though this will be a formidable task. With the emphasis in the new system on enterprise agreements, the economic literature on 'internal' labour markets might provide some insights. This literature focuses on the firm-level arrangements for wages, employment security and career paths. It incorporates certain features of labour markets that have often been ignored in economic models: in particular, the acquisition by workers of skills that are specific to their current workplace, and the difficulties in obtaining information (for example, about prospective job applicants and about employee performance). However, Baker and Holmstrom (1995), speaking of the US experience, note that the empirical underpinnings for models of internal labour markets are weak. From two case studies of company personnel records, they found much more flexibility in compensation practices than models of internal labour markets typically allow. Their call for more case studies might well be heeded in Australia. (IC 1993 presents a useful survey of labour market models from an Australian perspective.)

Lastly, while national economic models may shed some light on the employment effects of road construction and other government expenditures, their use for this purpose has inherent limits. Given the broad range of

12. For example, the macro-econometric literature on infrastructure payoffs has yielded no firm conclusions; see BTCE (1996b) for a review.

applications for which these models are designed, they will invariably omit some detail that would be desirable for a particular application—say, information on supply constraints in occupations closely linked with road construction. Hence, for accurate estimation of employment effects, national economic models should be supplemented with information from other sources where possible.

APPENDIX I DERIVATION OF THE ROAD CONSTRUCTION COST MATRICES IN ORANI

BTCE has combined information on road construction costs with the ORANI database (which subsumes road construction within the broader industry 'other construction'). The detailed cost information was entered in six matrices, one for each of the broad cost categories in table 3.1. The matrix for 'payments to non-labour factors' was derived as a residual after calculation of the other matrices. The derivation of the other matrices is outlined below.

After completion of the present analysis, the BTCE obtained more comprehensive information on road construction and maintenance costs from a survey of state road authorities, local government agencies, and contractors (BTCE 1997). The data suggested about the same labour share of costs as did the information obtained for the present analysis: an estimated 26 per cent versus 29 per cent.

Intermediate usage matrix

Standard ORANI industries have their intermediate inputs classified between 260 categories. There are 130 commodity types, each of which may be produced domestically or imported. The scope of this project did not allow collection of information to this degree of detail for the road sector. From the information supplied by the state road authorities, it was estimated that approximately 51 per cent of the total cost of road construction is attributable to intermediate usage items. Several states also provided further details regarding the split of materials into sub-categories. From this data we derived an intermediate usage matrix, detailing percentage of total costs allocated to the ten largest intermediate usage items.

We have assumed that the percentage split between imported and locally produced materials is the same for road construction as for 'other construction'.

Taxes on intermediate usage

An implied taxation rate was derived from the ORANI 'other construction' data set. This was done by dividing the dollar tax payment by the dollar cost of the materials. The implied tax rate was then multiplied by the intermediate usage matrix to obtain the tax paid on intermediate usage items as a percentage of total cost.

Margins

Margins were calculated in the same way as taxes on intermediate usage. ORANI has a total of nine margin matrices. For our derivation of the margins paid in the road construction industry, we have only taken into account the first four margin categories, as these seem to be the most significant in absolute terms. The implied margin rates were then multiplied by the intermediate usage matrix to obtain the margins paid on intermediate usage in the road construction industry.

Labour cost matrix

Unpublished employment numbers based on the 1991 Population Census were obtained from the ABS.[13] The information gave total employment in road construction by the eight major ASCO categories. Using information from Kenderes and Strzelecki (1991), and assuming that relative wages and hours worked remain constant between the 'other construction' and the road construction industry, we derived matrices for the wage bill and number of hours worked by ASCO category.

Our treatment of payroll tax is similar to that of taxes on intermediate usage and that of margins. Implied taxation rates were calculated for each ASCO category and then applied to the labour cost matrix of road construction.

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13. The information pertained to ANZSIC Category 4121: Non-Building Construction—Road and Bridge Construction. Miscellaneous construction included in this category, like construction of aerodrome runways, probably accounts for a very small share of the estimated employment. It is likely that the vast majority of workers in this category are employed on road construction.

TABLE I.1 INTERMEDIATE INPUT COSTS IN ROAD CONSTRUCTION: BASIC COSTS, MARGINS AND TAXES BY INPUT CATEGORY

(per cent of total road construction costs)

	Basic costs		Margins		
Material inputs	*Local*	*Import*	*Local*	*Import*	*Taxes*
Other minerals	1.5	0.03	1.09	0.02	0
Petrol and coal products	4.73	0.37	1.3	0.1	1.83
Ready mixed concrete	5.1	0	0.82	0	0
Concrete products	4.08	0	1.07	0	0
Non-metallic mineral products	12.45	2.85	2.49	0.57	0
Structural steel products	3.48	0.09	0.3	0.01	0
Construction machinery	3.67	6.53	1.23	2.2	0
Other machinery [a]	1.95	0.6	0.36	0.11	0
Road transport	2.04	0	0	0	0
Other business services	1.5	0.03	0	0	0
Total	40.52	10.48	8.66	3.02	1.83

a. Miscellaneous items that do not fit into other ORANI categories of machinery and equipment, such as transport equipment or construction machinery. For a list of all categories, see table II.1 (industries 72–82).

Source BTCE estimates based on the 1986–87 ORANI database (Kenderes and Strzelecki 1991) and information supplied by state road and traffic authorities in 1993–94.

TABLE I.2 LABOUR COSTS IN ROAD CONSTRUCTION

(per cent of total road construction cost)

ASCO category	*Wage cost*	*Payroll tax*	*Labour cost*
Managers and administrators	1.76	0.01	1.77
Professionals	3.28	0.06	3.33
Para-professionals	3.02	0.05	3.08
Tradespersons	2.57	0.03	2.6
Clerks	2.1	0.03	2.13
Salespersons and personal services workers	0.01	0	0.01
Plant and machine operators and drivers	10.11	0.18	10.28
Labourers and related workers	5.56	0.09	5.64
Total	28.41	0.45	28.85

Source BTCE estimates based on the 1986–87 ORANI database (Kenderes and Strzelecki 1991) and unpublished information from the ABS 1991 Population Census.

TABLE I.3 PAYMENTS TO NON-LABOUR FACTORS IN ROAD CONSTRUCTION

Description	Per cent of total road construction cost
Fixed capital	3.94
Working capital	2.33
Land	0.00
Non-commodity indirect taxes nec	0.36
Total	6.63

nec Not elsewhere classified

Source See source notes to table I.1.

APPENDIX II INDUSTRY OUTPUT EFFECTS FROM INCREASING ROAD CONSTRUCTION EXPENDITURE

Chapter 5 presented estimates of output effects for broad industry groups. Table II.1 shows corresponding estimates for each of the 122 industries, apart from road construction, that are detailed in the ORANI model.

TABLE II.1 ESTIMATED SHORT-RUN EFFECTS ON INDUSTRY OUTPUTS OF EXTRA ROAD CONSTRUCTION EXPENDITURE: $450 MILLION IN 1986–87

Industry		*% change in output*	*Industry*		*% change in output*
1	Pastoral zone	–0.11181	28	Confectionery and cocoa	–0.02219
2	Wheat–sheep zone	–0.10383	29	Other food products	–0.22629
3	High rainfall zone	–0.13222	30	Soft drinks, cordials	0.004437
4	Northern beef	–0.16816	31	Beer and malt	–0.00266
5	Milk cattle and pigs	–0.0457	32	Other alcoholic drinks	–0.06389
6	Other farming export	–0.1229	33	Tobacco products	–0.00577
7	Other farming import	–0.06167	34	Cotton ginning, etc	–0.20632
8	Poultry	–0.10738	35	Man-made fibre, yarns	–0.11093
9	Services to agriculture	–0.05147	36	Cotton yarns, fabrics	–0.11048
10	Forestry and logging	0.005324	37	Wool, worsted fabrics	–0.05546
11	Fishing and hunting	–0.04659	38	Textile finishing	–0.0284
12	Ferrous metal ores	–0.06522	39	Textile floor coverings	–0.01242
13	Non-ferrous metal ores	–0.09895	40	Other textile products	–0.01242
14	Black coal	–0.12468	41	Knitting mills	–0.03017
15	Crude oil	0.021298	42	Clothing	–0.02662
16	Liquefied petroleum gas	0.007543	43	Footwear	–0.10516
17	Natural gas	0.022629	44	Sawmill products	–0.0386
18	Brown coal (briquettes)	0.014198	45	Veneers and wood boards	–0.01331
19	Brown coal (lignite)	0.002219	46	Joinery and wood products	–0.00488
20	Other minerals	0.728999	47	Furniture and mattresses	–0.02396
21	Services to mining nec	–0.0284	48	Pulp, paper, paperbound	0.144203
22	Meat products	–0.17526	49	Bags and containers	0.134441
23	Milk products	–0.00444	50	Paper products nec	0.006212
24	Fruit and vegetable products	–0.00976	51	Newspapers and books	0.006656
25	Margarine, oils, fats nec	–0.02707	52	Commercial printing	0.038158
26	Flour and cereal products	–0.00843	53	Chemical fertilisers	–0.08608
27	Bread cakes and biscuits	0.002662	54	Other basic chemicals	–0.02307

Continued on next page

Industry		% change in output
55	Paints and varnishes	0.000444
56	Pharmaceutical goods	–0.05147
57	Soap and detergents	–0.00399
58	Cosmetics and toiletries	–0.02751
59	Other chemical goods	0.017748
60	Petrol and coal products	0.200996
61	Glass and glass products	–0.00976
62	Clay products, refractories	–0.02751
63	Cement	1.505474
64	Ready mixed concrete	2.091602
65	Concrete products	2.006411
66	Non-metallic mineral prods	9.054586
67	Basic iron and steel	0.126455
68	Non-ferrous metals	–0.12779
69	Structural metal products	0.510699
70	Sheet metal products	–0.01597
71	Other metal products	0.02041
72	Motor vehicles and parts	–0.12557
73	Ships and boats	0.001331
74	Railway rolling stock	–0.00177
75	Aircraft	–0.0213
76	Scientific equipment	–0.07853
77	Electronic equipment	–0.06123
78	Household appliances	–0.02751
79	Other electrical goods	–0.00355
80	Agricultural machinery	0.022185
81	Construction machinery	3.195527
82	Other machinery	0.25424
83	Leather products	–0.07676
84	Rubber products	–0.01864
85	Plastic products	–0.02219
86	Signs, writing equipment	–0.00843
87	Other manufacturing	–0.14154
88	Electricity generation, steam turbine	0.012867
89	Electricity generation, hydro	0.007987

Industry		% change in output
90	Electricity generation, gas turbine	0.026622
91	Electricity generation, combined cycle	–0.01375
92	Electricity generation, other fossil fuel	0.012424
93	Power station services, other renewable	0.103382
94	Electricity end-use supply	0.012867
95	Gas	0.0528
96	Water, sewerage, drainage	0.028841
97	Residential building	0
98	Other construction (excludes road construction)	0.000887
99	Wholesale trade	0.133554
100	Retail trade	0.014198
101	Mechanical repairs	0.031946
102	Other repairs	0.050138
103	Road transport	0.306153
104	Rail and other transport	0
105	Water transport	0.022185
106	Air transport	–0.01109
107	Services to transport	0.018192
108	Communication	0.030172
109	Banking	0.020854
110	Non-bank finance	0.043039
111	Investment and services	0.026178
112	Insurance	0.016861
113	Other business services	0.087853
114	Ownership of dwellings	0
115	Public administration	0.008874
116	Defence	0
117	Health	0
118	Education, libraries	0.000444
119	Welfare services	0.003993
120	Entertainment, leisure	0.012867
121	Restaurants, hotels	0.006656
122	Personal services	–0.00089

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Abbreviations

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AGPS	Australian Government Publishing Service
BTCE	Bureau of Transport and Communications Economics
IAC	Industries Assistance Commission
IC	Industry Commission

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACTU	Australian Council of Trade Unions
ANZSIC	Australian and New Zealand Standard Industrial Classification
ASCO	Australian Standard Classification of Occupations
BTCE	Bureau of Transport and Communications Economics
CPI	Consumer price index
GDP	Gross domestic product
GE	General equilibrium
IAC	Industries Assistance Commission
IO	Input–output
na	Not applicable
nec	Not elsewhere classified
RBA	Reserve Bank of Australia