Road Construction Price Indexes 1969/70 to 1980/81

Report

This Report presents input-price indexes for national road construction activity for the period 1969-70 to 1980-81.

Report 49

Road Construction Price Indexes 1969-70 to 1980-81

The Bureau of Transport Economics (BTE) is a professional research body undertaking independent studies and investigations to assist the Commonwealth Government in the formulation of policy in all modes of transport. Although formally linked to the Department of Transport, the Bureau has a considerable degree of professional and administrative autonomy and reports directly to the Minister for Transport on its program of research work.

The BTE regularly publishes results and findings of its research work. BTE publications are produced in the following principal series:

- REPORTS — which primarily contain the results of major studies, which are usually referred to the Bureau by the Minister for Transport
- OCCASIONAL PAPERS — which document the major technical research work of the BTE
- INFORMATION PAPERS — which contain details of major systematic data series or information collections
- CONFERENCE PROCEEDINGS — which contain proceedings and papers for conferences organised by the BTE.

A list of recent BTE publications appears on the inside back cover of this publication.

ERRATA

BUREAU OF TRANSPORT ECONOMICS
REPORT 49
ROAD CONSTRUCTION PRICE INDEXES
1969-70 to 1980-81

Page vi

TABLE 2.3 should read
'DMR (NSW): input-price index compared with cost rise index'

TABLE 3.1 should read
'Comparison of input-price and input-cost indexes 1969-70 to 1980-81'

TABLE 4.1 should read
'Variations in composition of expenditure between SRAs and LGAs'

Page 32

The formulae should read
'Laspeyres quantity index' and
'Paasche quantity index'

Road Construction Price Indexes 1969-70 to 1980-81

Bureau of Transport Economics

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE, CANBERRA 1982

ISBN 0 642 07111

Printed by Watson Ferguson and Co., Brisbane

FOREWORD

This report contains a review of various road construction price indexes which have been compiled by the former Commonwealth Bureau of Roads, the Bureau of Transport Economics and State road authorities. In addition, it presents newly compiled input price indexes for national road construction activity.

The overall index relating to Australia as a whole, is made up of three sub-indexes relating to maintenance, State road authority construction and local government authority construction; each of these indexes contains three input components: salaried and other labour; fuel, bitumen and other materials; and plant acquisition and replacement.

The BTE has compiled these indexes for use in its next review of the Australian road system, and to assist others interested in road construction activity who require up-to-date information on price movements for inputs to road construction.

The work involved in preparing this report was undertaken in the BTE's Economic Assessment Branch by Dr R.W. Mellor, Mr J.E. Lane and Mr G. Hewton; the latter two are now with the National Capital Development Commission and the Department of Industrial Relations, respectively.

G. K. R. REID
Director

Bureau of Transport Economics
Canberra
December 1981

CONTENTS

TABLES

FIGURES

SUMMARY

This report presents indexes measuring movements over time in prices for the major input components used by the road construction industry. The indexes relate to the road construction industry in Australia; no disaggregation by States or other geographic areas has been attempted. Separate indexes are presented for road construction activity and for maintenance activity. In addition, separate indexes have been compiled for road construction activity by State road authorities (SRAs) and by local governments (LGAs). The indexes are presented on an annual basis for the period 1969-70 to 1980-81.

The indexes presented are fixed-weight input-price indexes which have been derived by combining price indexes for the major input components used by the road construction industry. The weights reflect estimated expenditure on those inputs in the base year 1979-80.

The index type chosen differs significantly from that previously used by the Commonwealth Bureau of Roads (CBR) and the Bureau of Transport Economics (BTE) in their Road Assessment Studies. The former were output-cost indexes which were derived by deflating an input-price index by an index of productivity; in addition, the inputs were defined in terms of the primary components used in the National Accounts Input-Output Tables (for example, direct and indirect labour, depreciation, taxes). The new indexes are input-price indexes (with no adjustment for productivity) and are based on inputs actually purchased by the industry (for example, wages, salaries, materials, plant).

Because they relate to inputs, the new indexes indicate a faster rate of growth in the price of road related activity than the output indexes used in the earlier BTE study. The new indexes are also considered to have advantages over former indexes with respect to their sensitivity to changes in input prices, timeliness of the weights, ease of updating, and ease of interpretation.

This report also examines the issues involved in measuring productivity changes (and associated changes in the quality and composition of both inputs and outputs), and deriving an output-cost index which reflects changes in input prices and productivity. It is concluded that further substantial work on obtaining comparable data on unit cost movements in the road construction industry would be necessary to estimate productivity changes and output costs in a robust manner.

CHAPTER 1—INTRODUCTION

ORIGINS OF THE STUDY

Road construction price indexes are important tools for assessing the impact of changes in funding levels on the physical level of provision of road infrastructure. Development of such indexes has been undertaken in Australia by a number of agencies and for a variety of purposes. However, perhaps the most significant longer-term work in this field was that performed by the former Commonwealth Bureau of Roads (CBR). The CBR's work was undertaken in support of its broader program of research work relating to road investment needs.

Following amalgamation of the CBR and the Bureau of Transport Economics (BTE) in 1976, the BTE was charged with continuing responsibility for the road investment analysis functions[1] formerly vested in the CBR. The first major exercise of this responsibility involved preparation in 1979 of a report (BTE 1979) which comprised an assessment of the Australian road system. This assessment was basically an evaluation of future road needs and alternative road expenditure patterns for the period 1979-80 to 1982-83. As an input to that 1979 report, the BTE developed and published (Burke 1978) a set of road construction price indexes.

Since publication of the BTE's 1978 work on indexes, there have been considerable movements in the prices of inputs to road construction. As a result, there is widespread interest in obtaining updated indexes. The basic origins of this study lie in this demand for current and nation-wide indexes.

OBJECTIVES OF THE STUDY

The general objective of the BTE study is closely aligned to the origins of the study - that is, to fulfill the demand for up-to-date information on the price movements for inputs to road construction. However, there are also more specific aims within this broad objective, and it is worth examining these in a little more detail.

The first of these aims relates to the fact that the BTE is currently working towards preparation of its next review of the Australian road system. This review is being undertaken in a climate of changing policy objectives and institutional arrangements. The changing environment, in itself, dictates the need for a re-examination of all significant inputs to the review process (irrespective of the desirability of such re-examination for more straight-forward reasons such as updating).

The second specific aim of the study is to provide participants in road construction with a guide to trends in road construction input prices for Australia as a whole. It is recognised that most of those directly involved in road construction require price indexes at a disaggregated level for their normal managerial functions of planning and cost control. Such a requirement will not be fulfilled by the aggregated national indexes developed by the BTE. On the other hand, national price indexes should provide a useful basis of comparison in development and interpretation of more disaggregated indexes.

There are, of course, further aims which apply to the technical characteristics of the indexes which are discussed in this report. Primary amongst these are the important considerations that the indexes should be timely (in the sense of measuring recent

1. In broad terms, these functions cover evaluation of the Australian road system and preparation of reports to the Commonwealth Minister for Transport on the need for financial assistance to the States for roads.

price movements), and that they should, if possible, be suitable for short-term forecasting. In addition, the indexes should be capable of updating with a minimum of delay and effort.

A further aim of this report is to attempt to clarify the concepts and interpretation of a number of available road construction price indexes. This is accompanied by an explanation of how these indexes relate to each other, so that they may be more readily understood and more usefully employed.

TYPES OF INDEXES

A detailed examination of the types of indexes which have been used in relation to road construction activity is given later in this report. However, at least a peripheral knowledge of major types is necessary at this stage. In general terms, the three major index types are:

- those which measure changes in the prices of inputs to road construction on the basis of general national price indexes;
- those which measure actual costs of representative units of inputs to road construction activity; and
- those which measure the costs of outputs of road construction activity.

All of these index types have been used in relation to road construction in Australia. Further, they are discussed in detail in Chapter 2. At this stage, it is sufficient to indicate that the index developed in this report falls into the first category.

NATURE OF ROAD CONSTRUCTION ACTIVITY

In an institutional sense, road construction activity in Australia is extremely complex. Such activity takes place at a variety of levels in both the public and private sectors. Obviously, some robust definition of road construction activity is necessary in the context of this report. Accordingly, road construction activity is defined to cover the activities of State, Territory and local government authorities involved in:

- construction of roads and related structures (such as bridges);
- maintenance and other operational activity related to the stock of roads and associated structures;
- development of contractual arrangements for works related to construction and maintenance; and
- absorption of overhead costs associated with road construction activity, including those involving the planning of roads and related structures.

Specific projects undertaken within the general confines of road construction activity vary widely between the authorities included in the definition given above. Further, the general nature of road construction activity tends to vary over time, and this variation is not necessarily similar for all authorities engaged in such activity. Both of these characteristics reflect variations in the responsibilities of road construction authorities, but they are also related to the presence of budget constraints, the extent and quality of the road stock and other factors. As a result of all this, the inputs required to undertake a given type of project (for example, resurfacing a given length of road) will vary considerably between projects in this class due to such factors as:

- site-specific physical characteristics (such as terrain and geology);
- traffic levels;
- prevailing design standards;
- the source and nature of materials used;
- the source and nature of equipment used; and
- the level of productive efficiency.

Outputs from road construction activity are the physical changes to the road system which result from projects undertaken. Outputs may therefore be measured in such general terms as the number of projects built or the length of roads constructed, repaired or realigned. However, the value of such changes to the output of the road system is difficult to measure in financial terms, as the end product is usually not market-priced[1]. As a result, the most common approach to measurement of road construction activity output has involved measurement of changes in the level of inputs. Wherever possible, this approach has been augmented by indicating likely changes in the productivity associated with use of these inputs.

An alternative approach is to consider output in terms of the services offered to road users[2] as a result of physical improvements to the road system. However, there is considerable room for debate as to the relationship between physical and operational conditions and the particular level of road user services available from a given section of the road system. This uncertainty as to the design and maintenance requirements necessary to achieve a given level of service means that there is a dimension of variation as to what inputs are required to produce a specific output in terms of such service levels. Measurement of changes in the output of road construction activity in terms of road user services provided was not considered to be a practical approach in the present study.

All of these characteristics of road construction activity indicate why the remainder of this report is primarily concerned with measuring the levels and prices of inputs to such activity. The productivity of these inputs (that is, the efficiency of converting inputs to various road construction outputs) is also discussed, but no empirical estimation of the parameters of this relationship are attempted.

MEASUREMENT AND IDENTIFICATION PROBLEMS

An inherent problem in producing price indexes for any major industry is that the quality and composition of the outputs are subject to change.[3] This is particularly so in relation to road construction, where activity is primarily directed towards maintaining or upgrading the *existing* road network. Accordingly, the activity on a given section of road can vary greatly with the stages in its life cycle and with its level of use. Hence, actual costs incurred in road construction activity over time relate to a production process producing outputs which are subject to continual changes in composition and quality. Observed changes in actual costs of outputs for road construction activity as a whole cannot be interpreted as changes in input prices only. They may also reflect changes in the composition and quality of the inputs and outputs, or in the input-output relationship itself.

Various attempts have been made to minimise the biases which may arise from such effects by seeking to measure costs for a relatively homogeneous unit of output. For example, costs could be measured in the following ways:

- by dividing larger projects into smaller units or by analysing intermediate outputs which have more homogeneous characteristics;
- by selecting 'representative' projects; and
- by grouping similar projects and measuring changes for the group as a whole.

1. Road construction activity is competitively priced where tenders are called. However, two problems are encountered in obtaining aggregate measures of price changes. First, a substantial share of road construction is not subject to tender, although this share may decline, particularly following the Commonwealth Government's announcement (in 1981) that all future construction under the National Roads Scheme must be let through tender. Also, tender prices may exclude some associated costs and may include others (for example, 'cost escalation' clauses, planning and administrative costs). For these reasons, tender prices may not be generally appropriate for the development of price indexes of the type considered.

2. Changes to the services offered to road users will affect travel time, vehicle operating costs, accident costs, comfort, stress and reliability of access.

3. Changes in the quality and composition of inputs and the input-output relationships also occur, and these aspects are considered in subsequent sections of this report dealing with the weighting of inputs and on productivity gains in the road construction industry.

These approaches to index development are preferred where the user of the index is interested in changes in the cost of some *fixed* output. The disadvantage is that a major work effort is needed to construct indexes for a large number of projects, to avoid the danger that those selected will not be representative of the activity as a whole. Examples of this approach are given in Chapter 2.

In an examination of actual costs for the industry as a whole, the preferred approach would be to construct an aggregate quality index. Such an index would allow expenditure on roads to be divided into its quantity, quality and price components. Construction of a quality index would require detailed observations of changes through time in the physical characteristics of roads. It could involve assessment of the levels of services offered to road users. This has not been attempted in this study. Completion of the National Association of Australian State Road Authorities (NAASRA) Data Bank[1], and subsequent updates to the data, may provide the information necessary for such an exercise.

After due consideration of these difficulties, the method chosen for this report was to develop 'fixed-weight input-price indexes' for Australian road construction activity. This is consistent with the primary aim of using price indexes to analyse actual road expenditure patterns, which embody changes in the quantity and quality of the road system. Important points relating to use and interpretation of such indexes are:

- that indexes of this type refer to a heterogeneous national road construction output which is changing in quality and composition over time; and
- that the conversion of actual road expenditure to expenditure at constant prices by the use of these indexes would thus refer to an output of changing quality and composition.

STRUCTURE OF THE REPORT

In Chapters 2 and 3 of this report, a number of existing road construction price indexes are examined. These indexes comprise:

- national road construction price indexes compiled by the BTE and the former CBR;
- State road construction price indexes compiled by the individual State road authorities (SRAs); and
- implicit price indexes derived from the Australian Bureau of Statistics (ABS) National Accounts, which relate to fixed capital expenditure on non-dwelling construction, but which have been used as a proxy for price changes in the road construction segment of the economy.

Chapter 2 includes an examination of each of these indexes in turn, with a brief description of the design of and annual movements in the indexes over the last 12 years (where available). Associated definitions of the basic types of price, quantity and productivity indexes discussed in Chapter 2 are given in Appendix I.

In Chapter 3, the various indexes presented in Chapter 2 are converted to a similar basis to allow comparison. Possible explanations of the observed differences in the growth rates indicated by these indexes are examined. Past estimates of productivity changes are also examined.

Chapter 4 presents the BTE's estimates of national input-price indexes for the road construction industry for the period 1969-70 to 1980-81. Separate indexes are presented for road construction activity by SRAs and LGAs. Separate treatment is also given to maintenance activity. Concluding remarks are presented in Chapter 5.

1. The NAASRA Data Bank aims to provide a complete and uniform inventory of the physical characteristics of the Australian road system.

CHAPTER 2 — REVIEW OF EXISTING ROAD CONSTRUCTION PRICE INDEXES

TYPES OF INDEXES

A substantial effort has been made over many years to develop appropriate price indexes for road construction activity. This has resulted in a wide range of different index types being produced, and has led to considerable debate as to their respective merits. Clearly, some users are seeking price indexes which relate only to a particular activity or a particular geographic region. However, there remains widespread debate as to the most appropriate approach, even with respect to indexes for aggregate activity in a State or the Commonwealth.

Among the existing road construction price indexes, several major index types can be identified. The 'price' changes measured by these types fall into three categories, which relate to the following characteristics.

- The prices of inputs (such as labour, materials and plant) to the road construction authority as indicated by national price indexes published, for example, by the Australian Bureau of Statistics (these are subsequently termed *input-price* indexes).
- The costs of representative units of inputs to the road construction industry, as indicated by actual costs incurred by road authorities (these are termed *input-cost* indexes).
- The costs of outputs of road construction activity. Such indexes are termed *output-cost* indexes. Two approaches have been taken to measuring the costs of outputs. The first involves measuring input-costs for a 'fixed' (constant quality) length of road; where a 'fixed' output can be identified over time, the movement in input-costs should equate that in output-costs in this special case. The second approach is to convert an input-price index to an output-cost index by use of a productivity index. Ignoring for the moment the measurement and quality change problems mentioned in Chapter 1, an output-cost index can be derived from an input-price index by multiplying the latter by the ratio of the volume of inputs to the volume of outputs[1].

All of these indexes involve some definition with regard to their basic characteristics. In the current context, the following characteristics of the indexes are of particular importance.

- The inputs to the industry may refer to the items actually purchased by road construction authorities, such as labour, materials and plant. Alternatively, they may refer to the inputs classified in accordance with the National Accounts Input-Output Tables, where direct and indirect labour costs, depreciation, taxes, profits and imports (for example) are identified.
- Input prices for different commodities may be weighted together to form a unified price index. This can be undertaken at a highly disaggregated level of road construction authority activity, or at a different aggregation level (such as that for total construction and/or maintenance activity).
- The weights used may be base period (fixed) weights in a Laspeyres type index (see Appendix I), which measures price changes for a fixed bundle of goods. Alternatively, they may be current-period variable weights in a Paasche type index, which can reflect changes in the composition of the goods as well as pure price

1. This ratio is the inverse of the *productivity index* (which is the ratio of the volume of outputs to the volume of inputs).

changes. These two index types are further explained in Appendix I.

Most of the available indexes, and their methods of construction, are well documented in a review by the Main Roads Department of Western Australia (1978). In the same year, the BTE published a revised approach to a method of index construction developed by the CBR (Burke 1978). This report has recently been critically reviewed by the Australian Road Research Board (ARRB) (Thoresen 1980). The interested reader may also wish to refer to the work by Dr Foldvary (ARRB 1967) which attempted to develop detailed disaggregate indexes for movements in costs, quantity and productivity for particular road construction outputs. In 1968, pilot studies by various SRAs to test the feasibility of the Foldvary approach led to the conclusion that existing costing and data recording systems were inadequate for the detailed indexes proposed. However, the recent report by the Main Roads Department of Western Australia (1978) outlines a longer-term proposal for developing indexes of the Foldvary type.

The remainder of this chapter provides details of the principal road construction price indexes that are available. Comments on the interpretation of the various indexes, and on their strengths and weaknesses, follow in Chapter 3.

INDEXES OF NATIONAL ROAD CONSTRUCTION ACTIVITY

Indexes of national road construction activity were developed by the CBR in response to the specific needs of its Roads Assessment Studies. The indexes relate to all construction and maintenance expenditure[1] for activity associated with the total Australian road system.

National Accounting concepts form the basis of these CBR indexes. Instead of considering expenditures by the industry in terms of the prices and quantities of inputs used, data from input-output analysis of the Australian economy were used to break down these expenditures into the primary national accounting components of such financial flows (see Figure 2.1). This required some modification to the basic input-output data and, in particular, required breakdown of the building and construction sector into 'road construction' and 'other building and construction'. The CBR selected specific price indexes to reflect price movements for each of the primary accounting components, and combined these to produce an overall input-price index. The original input-price index was later refined, and two measures of productivity change were applied to it to yield estimated output-cost indexes. Details of the indexes from this source which have been published are:

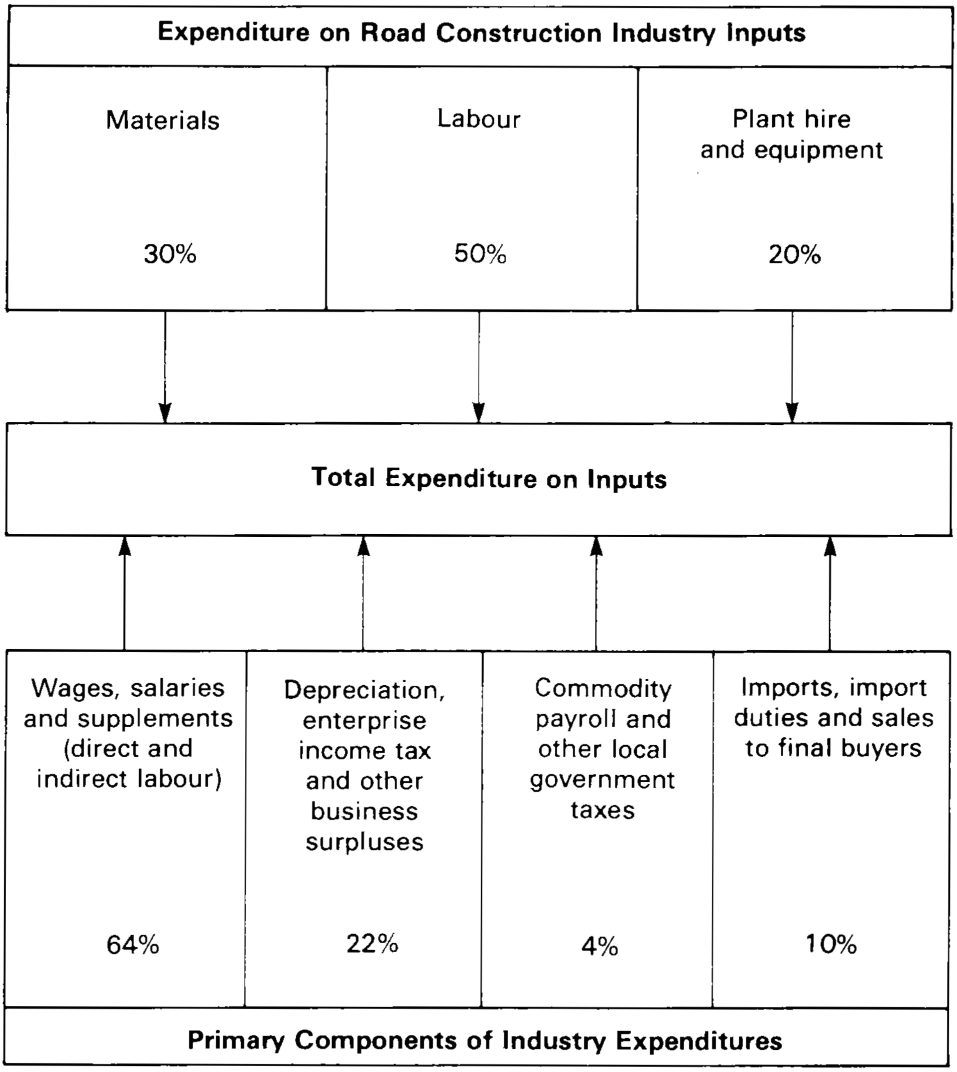
- CBR (1969), *Cost indexes applicable to road construction.* This analysis provided road price and quantum indexes for 1955-56 to 1965-66 (base year 1958-59).
- CBR (1975), *Report on roads in Australia.* This report included a road price index (unadjusted), and the same index adjusted for gains in labour productivity. The indexes covered the period 1962-63 to 1975-76 (base year 1962-63).
- Burke, R. (1978), *A road construction price index,* BTE Occasional Paper 27. This paper covered a road construction input-price index, a total productivity index and a derived output-cost index for the period 1963-64 to 1977-78 (base year 1968-69). This index, together with its component series, is presented in Table 2.1.

STATE ROAD AUTHORITIES INDEXES

The SRAs have each developed their own road construction price indexes. They are,

1. Maintenance covers expenditure on the following activities:
   - routine road surface operations;
   - all but major resealing or resheeting;
   - minor reconstruction work (ie, work under about 60 metres in length);
   - roadside and drainage maintenance and repairs; and
   - administration services directly associated with maintenance activity.

   Construction covers all other road construction activity.



[1] The expenditure breakdown shown is derived from the MRD (Qld) and CBRds (1975) indexes. They were selected for illustrative purposes only.

Figure 2.1
Sample comparison of road construction inputs with the primary components of road construction expenditure[1]

TABLE 2.1—BTE ROAD CONSTRUCTION PRICE INDEX (1978)

Year ended 30 June	*Wages salaries and supple-ments*	*Deprec-iation*	*Enter-prise tax*	*Other surplus*	*Commod-ity taxes*	*Payroll taxes*	*Local govern-ment rates*	*Sales by final buyers*	*Comple-mentary imports*	*Competing imports*	*Import duty*	*Sub-total*[a]	*Product-ivity index*	*Road*[b] *constr-uction price index*
Weight (per cent)	*62.29*	*5.68*	*6.02*	*12.27*	*2.83*	*0.90*	*2.06*	*0.15*	*2.89*	*4.63*	*0.28*	*100.0*	—	—
1964	73.3	92.3	100.0	116.5	79.7	76.3	71.6	87.3	110.1	93.6	93.6	83.5	87.4	95.6
1965	78.8	93.7	98.7	110.4	79.7	81.5	73.8	89.9	109.0	95.4	95.4	86.4	90.7	95.2
1966	82.4	95.0	95.6	99.2	79.7	85.2	80.8	92.5	108.6	97.8	97.8	87.4	94.1	92.9
1967	87.9	96.5	95.2	103.4	98.3	88.5	85.8	94.3	103.3	99.3	99.3	92.0	96.6	95.3
1968	93.0	98.1	100.1	93.0	100.0	91.7	93.1	97.5	100.6	98.4	98.4	94.4	98.5	95.9
1969	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1970	108.4	102.4	107.9	93.8	100.0	108.4	106.5	103.2	99.9	104.4	104.4	105.5	101.1	104.4
1971	120.5	105.6	103.4	87.2	121.5	113.1	115.3	108.1	99.9	108.2	108.2	113.2	103.3	109.6
1972	132.7	109.9	99.9	86.7	138.8	177.8	126.6	115.5	118.6	114.2	114.2	122.9	106.7	115.2
1973	144.6	114.4	110.6	91.8	140.8	200.7	137.0	122.5	125.2	112.2	112.2	132.4	107.8	122.8
1974	168.0	119.7	110.3	81.4	176.5	280.1	148.7	138.3	290.2	121.9	121.9	153.2	107.8	142.1
1975	210.7	128.4	102.9	61.3	181.5	410.0	170.8	161.3	589.5	154.9	154.9	189.5	111.5	169.9
1976	240.9	140.0	96.3	66.2	181.5	476.9	221.8	182.4	690.3	174.0	174.0	214.7	113.7	188.8
1977	270.9	154.3	86.5	76.2	181.5	534.5	263.5	207.5	760.6	202.6	202.6	239.7	115.2	208.1
1978[c]	298.3	171.2	86.5	68.1	189.5	588.5	290.4	227.3	825.0	228.0	228.0	261.1	116.7	223.8

a. The sub-total column represents a road construction index net of productivity changes, and is in the terminology of this paper an input-price index.

b. The Road Construction Price Index is derived as the sub-total index divided by the productivity index, and expressed as a percentage. It is therefore an output-cost index in the current terminology.

c. Provisional figures from original publication.

Source: Burke (1978).

for the most part, input-price or input-cost indexes relating to either specific categories of roadworks or to total SRA activities. However, the methods used in deriving them do vary significantly between SRAs, reflecting differences in the level of disaggregation applied to road construction activity and the choice of price or cost series for the various inputs.

New South Wales

Since 1939, the New South Wales Department of Main Roads (DMR) has produced its Cost Rise Index, which is based on cost movements in a relatively detailed list of departmental expenditure items. The expenditure of the department is classified into components of labour, stores (or materials), plant, haulage and other charges. Expenditure on administration, planning and design is identified separately. For each of these components, representative units are selected for the measurement of cost movements. Departmental expenditure records are used to weight these basic cost movement data into indexes for two geographical regions (the County of Cumberland — that is, the Sydney region — and the rest of the State) and three categories of works (maintenance, road construction and bridge construction). These individual indexes form the basis for the overall Cost Rise Index for New South Wales.

The DMR has more recently developed an index for the indexation of motor vehicle tax rates[1]. The prime requirements of such an index were, firstly, that it move in line with costs faced by the department and, secondly, that the price changes employed be compiled independently. As the Cost Rise Index did not meet this second criterion a new index was developed specifically for the purpose. This new approach identifies four basic input components; labour, bituminous materials, other materials and plant acquisitions, and employs published ABS indexes to measure changes in these components. The base data used in the Cost Rise Index have been restructured to provide appropriate weights for the new input categories, and these are shown in Table 2.2. The resulting DMR input-price index (based on ABS price indexes) is compared with the traditional DMR Cost Rise Index in Table 2.3. The latter index shows a slightly faster growth in prices since 1974, with the main divergence occurring in the estimates for 1980.

TABLE 2.2 — DMR (NSW) INPUT-PRICE INDEX COMPOSITION

Component	*Weight (per cent)*	*ABS index*
Labour	67	Average weekly earnings per employed male unit (NSW)
Materials:		
• Bitumen	6	Price indexes of articles produced by manufacturing industry: chemicals, coal and petroleum products (Australia)
• Other	14	Price index of materials used in building (other than house building): concrete mix, cement, sand, etc (Sydney)
Plant purchase	13	Price indexes of articles produced by manufacturing industry: transport equipment (Australia)

Source: NSW *Motor Vehicles (Taxation) Act* 1980, Schedule 3.

Victoria

The Victorian Country Roads Board (CRB) produces a series of cost and price indexes. In the terminology adopted in this report, the CRB cost index is an output-cost index and the price index corresponds to an input-cost index, but with a slight difference from the definition on page 5. The CRB price index at a specified time (eg 30 June) is not necessarily derived from 'actual costs incurred' but relates to actual prices prevailing at that time.

1. NSW, *Motor Vehicles (Taxation) Act* 1980, Schedule 3.

TABLE 2.3—DMR (NSW): INPUT-PRICE INDEX COMPARED WITH COST RISE INDEX (1968–69=100.0)

Year ended 30 June	*Component ABS indexes used in Input-price index*				*Input-price index*		*Cost rise*	
	Labour	*Bitumen*	*Other materials*	*Plant*	*Index*	*Percentage change*	*Index*	*Percentage change*
Weight (per cent)	67[a]	6[a]	14[a]	13[a]				
1970	108.6	99.2	103.5	102.4	106.5	6.5	105.1	5.2
1971	120.8	101.3	109.3	105.5	116.0	8.9	114.5	8.9
1972	132.8	104.1	113.5	111.3	125.6	8.3	123.1	7.5
1973	144.4	106.0	118.2	116.0	134.7	7.2	135.0	9.7
1974	167.5	111.6	132.6	124.9	153.7	14.1	153.7	13.8
1975	210.2	142.4	164.0	151.2	192.0	24.9	197.1	28.2
1976	238.1	168.2	191.1	175.8	219.2	14.2	228.1	15.8
1977	267.0	182.4	212.3	195.0	244.9	11.7	256.9	12.2
1978	294.2	200.7	230.7	211.6	269.0	9.8	278.1	8.7
1979	317.4	233.1	255.5	230.5	292.3	8.7	295.7	6.3
1980	349.0	307.4	291.0	252.2	325.8	11.5	339.8	14.9
1981	—	—	—	—	na	na	391.4p	15.2p

a. The weights are based on the average of 1977–78 and 1978–79 expenditure patterns. The equivalent 1968–69 weighting pattern would be: labour 62%, bitument 6%, other materials 16% and plant 16%. This would result in a slightly different overall index.

p. provisional estimates

na not available

Source: DMR (NSW, 1979) and personal communication.

For the input-cost index, the inputs used by the CRB are broken down into four categories: labour, materials, plant and sundries. Representative cost units for these inputs are selected from CRB records. These representative costs, which vary from activity to activity, are combined for the various CRB activities (Patrol and Other Maintenance, Bitumen Surfacing, Road and Bridge Construction).

Separate indexes are compiled for construction and maintenance (based on the above activities) and for land acquisition; urban works are distinguished from rural works. These indexes are combined, with the addition of a salaries component (for administrative overheads) to form the overall input-cost index for CRB activities. This overall index is the 'Direct Works and Salaries Composite Index' shown in Table 2.4.

The output-cost index developed by the CRB is designed to measure the cost of constructing an average kilometre of rural road (the dimensions of which have been derived from CRB records for the period 1972 to 1976). The CRB Annual Report for 1979-80 compared the input-cost and output-cost indexes for the period 1971-72 to 1979-80. The output-cost index rose faster than the input-cost index over much of the period. The reason for this greater rate of increase in the output-cost index is not possible to pinpoint as this index reflects the combined effect of various cost movements, such as changes in price, technology, job size, productivity, etc, within the complex operation of completed road construction.

TABLE 2.4 — CRB (VIC) DIRECT WORKS AND SALARIES COMPOSITE (INPUT-COST) INDEX

(30 June 1967 = 100.0)

As at 30 June	*Index*	*Percentage change*
1970	118.7	6.0
1971	131.0	10.4
1972	141.8	8.2
1973	159.4	12.4
1974	196.0	23.0
1975	229.9	17.3
1976	263.7	14.7
1977	286.6	8.7
1978	306.1	6.8
1979	324.6	6.0
1980	385.1	18.6
1981	436.2	13.3

Source: CRB (Vic, 1970-81 various issues).

Queensland

The Main Roads Department (MRD) of Queensland has developed a 'Roadworks Input-Cost Index'; in terms of the definitions in this report, this is an input-price index, and will subsequently be referred to as such. The index uses monthly ABS price indexes to measure price movements in three basic categories of inputs: labour, materials and plant (which is further subdivided into plant purchase and plant maintenance). The overall index is a weighted combination of the four individual indexes. The weights were derived from MRD records of the relative expenditures on the four inputs. Table 2.5 lists the component indexes and their weights, and Table 2.6 presents the resulting input-price index for road construction.

South Australia

Since 1970, the South Australian Highways Department (HD) has prepared an overall roadworks input-cost index. This index is a weighted average of input-cost indexes for several groups of road activity, such as road construction, maintenance and bridge

TABLE 2.5 — WEIGHTS AND ABS INDEXES USED IN COMPILING THE MRD (QLD) INPUT-PRICE INDEX

Component	Weight (per cent)	ABS index
Labour	50	Weighted average minimum weekly rates payable for adult males for all non-rural industry groups (Qld), as prescribed in Federal and State awards, determinations and agreements
Materials	30	Wholesale price index of materials used in building (other than house building), all groups (Brisbane)
Plant purchase	11	Price indexes of articles produced by manufacturing industry: transport equipment (Australia)
Plant maintenance	9	Weighted average minimum weekly wage for adult males for the engineering, metals and vehicles industry group (Qld).

Source: MRD (Qld, 1978).

TABLE 2.6 - MRD (QLD) INPUT-PRICE INDEX

Year ended 30 June	*Index*	*Percentage change*
1970	78.5	4.9
1971	84.7	7.9
1972	92.2	8.9
1973	100.0	8.5
1974	117.1	17.1
1975	151.2	29.1
1976	174.4	15.3
1977	195.1	11.9
1978	212.0	8.7
1979	225.3	6.3
1980	247.2	9.7
1981	277.7	12.3

Source: MRD (Qld, 1978) and personal communication.

construction. These indexes are derived in a variety of ways, including one which is a variation of the CBR 'project costing index' for road construction (CBR 1975)[1]. Thoresen (1980) noted that the HD index, while predominantly an input-cost index, does contain some contract prices; such prices would include productivity changes, although they are probably not a complete measure of total output costs. The index is given in Table 2.7 for the period June 1970 to June 1981.

Western Australia

The Main Roads Department (MRD) has recently undertaken a review of its index requirements (MRD 1978). The conclusion of the review was that, at least in the short-term, an overall input-price index based on the MRD (Qld) approach of using published ABS indexes should prove adequate for its needs. Such an index has now been developed, and is illustrated in Table 2.8. Its coverage is currently restricted to construction and specific maintenance activities. In the longer-term, more detailed and sophisticated price and other indexes are proposed, once departmental records become fully computerised.

1. This approach involved costing a representative sample of base-year jobs in subsequent years in order to keep the 'quality' of output relatively constant.

TABLE 2.7 — HD (SA) INPUT-COST INDEX

As at 30 June	*Index*	*Percentage change*
1970	100.0	—
1971	112.0	12.0
1972	120.3	7.4
1973	136.3	13.3
1974	166.5	22.2
1975	196.9	18.3
1976	231.5	17.6
1977	260.0	12.3
1978	278.2	7.0
1979	302.9	8.9
1980	337.7	11.5
1981	377.6	11.8

Source: HD (SA, 1979) and personal communication.

TABLE 2.8 - MRD (WA) INPUT-PRICE INDEX

Year ended 30 June	*Index*	*Percentage change*
1970	85.8	—
1971	91.8	7.0
1972	100.0	8.9
1973	106.9	6.9
1974	122.3	14.4
1975	153.4	25.4
1976	177.5	15.7
1977	203.2	14.5
1978	223.7	10.1
1979	239.2	6.9
1980	257.4	7.6
1981	284.1	10.4

Source: MRD (WA, 1978) and personal communication.

Tasmania

The Department of Main Roads (DMR) in Tasmania produces an input-cost index for the road system which is computed as a weighted average of three separate input-cost indexes for road construction, road maintenance and bridge expenditure. These indexes in turn reflect cost changes for basic inputs of labour, materials, plant, property acquisition and sundries. The resultant input-cost index, together with its component indexes, is given in Table 2.9.

IMPLICIT PRICE DEFLATORS

Another source of indexes which can be applied (at least indirectly) to road construction activity is found in implicit price deflators. Implicit price deflators can be obtained by dividing Australian National Accounts estimates of expenditure upon aggregate flows of goods and services measured in current prices by corresponding estimates at constant prices. The current base is 1974-75[1].

Two of the implicit price deflators produced by ABS have been used as guides to price movements in road construction. These are the deflators for:

- private fixed capital expenditure on non-dwelling construction; and
- public fixed capital expenditure on non-dwelling construction. Expenditure upon roads comprises approximately one-third of this expenditure category.

1. The derivation and interpretation of Implicit Price Deflators is discussed in ABS (1977, Appendix C).

TABLE 2.9—DMR (TAS) ROAD SYSTEM (INPUT-COST) INDEX

As at 30 June	*Road construction index*	*Road maintenance index*	*Bridge expenditure index*	*Road system index*	*Percentage change*
Weight (per cent)	62	22	16	100	
1970	100.0	100.0	100.0	100.0	—
1971	110.1	111.2	112.4	110.8	10.8
1972	121.0	122.1	124.5	122.0	10.1
1973	130.7	138.1	137.6	133.8	9.7
1974	155.7	171.9	173.8	162.4	21.4
1975	192.1	211.8	208.6	199.3	22.7
1976	225.3	247.6	244.3	233.6	17.2
1977	255.5	281.0	268.2	263.5	12.8
1978	274.9	301.5	287.8	283.3	7.5
1979	292.2	316.9	306.2	300.6	6.1
1980	329.3	355.6	339.3	337.6	12.3
1981	362.6	399.0	378.7	374.1	10.8

Source: DMR (Tas, 1979) and personal communication.

These indexes are presented in Table 2.10. Care should be exercised in interpreting these deflators. Because of difficulties in obtaining suitable data, constant price estimates for these categories of expenditure are derived through special-purpose indexes. With respect to the former, a fixed-weight index of wages and the price of material inputs in non-dwelling construction is used (for the 1974-75 based series the composition is approximately 37 per cent and 63 per cent, respectively). Hence this deflator is simply the special-purpose index. The index for public sector expenditure is also developed largely using input prices relevant to various functional categories.

In introducing the States Grants (Roads) Bill 1977 the Minister for Transport noted the Commonwealth Government's commitment to provide funds in 1978-79 and 1979-80 at least equivalent in real terms to the 1977-78 allocations. He stated that this would be achieved by adjusting the basic grant in line with movements in the National Accounts' implicit price deflator for private investment in 'other building and construction'[1,2]. The present (1980-81 to 1984-85) roads program does not contain any similar provision.

TABLE 2.10 - SELECTED ABS IMPLICIT PRICE DEFLATORS

Year ended 30 June	*Gross fixed capital expenditure on non-dwelling construction*			
	Public sector		*Private sector*	
	Index	*Percentage change*	*Index*	*Percentage change*
1970	56.7	5.0	56.5	4.6
1971	60.5	6.7	60.1	6.4
1972	64.4	6.4	64.6	7.5
1973	69.6	8.1	69.0	6.8
1974	79.5	14.2	79.0	14.5
1975	100.0	25.8	100.0	26.6
1976	116.4	16.4	116.0	16.0
1977	131.2	12.7	130.8	12.8
1978	142.8	8.8	142.0	8.6
1979	152.5	6.8	151.7	6.8
1980	171.6	12.5	169.6	11.8
1981	na	na	190.7p	12.4p

p provisional estimates
na not available

Sources: ABS (1980), ABS (1981).

1. Now termed 'non-dwelling construction'.
2. *Hansard,* House of Representatives, 15 September 1977.

CHAPTER 3 — COMPARISONS BETWEEN VARIOUS ROAD CONSTRUCTION INDEXES

The first part of this chapter compares the input-price and input-cost indexes outlined in Chapter 2, while the second part considers output-cost indexes and the implicit price deflators of national expenditure. The indexes have been converted to a common base year (1969-70) to facilitate comparisons. However, it should be noted that this is only a scale adjustment. The periods to which the weights refer still differ significantly, as in the original indexes, and the geographic and other differences between the indexes remain.

INPUT-PRICE AND INPUT-COST INDEXES

In Table 3.1, eight input-price or input-cost indexes are shown in three groups. The first group consists of indexes based on ABS and other generally available price indexes, while the second group covers those based on SRA actual cost items. The third group contains only the BTE 1978 input-price index (based on input-output expenditure components, and with no adjustment for productivity change).

The comparison indicates that the first two groups of indexes recorded broadly similar movements over the period 1969-70 to 1980-81 (noting that the input-cost indexes are generally based on costs at 30 June of the relevant year, whilst the input-price indexes employ average prices for the year to 30 June). The BTE 1978 index, however, exhibited a significantly slower rate of growth.

The many differences between the indexes with respect to component prices or costs, the weightings used, and the method of construction (that is, Laspeyres or Paasche types) make it very difficult to identify the sources of any divergences which occur between the final indexes. Further, it is quite conceivable that at least part of the variation is due to legitimate differences between the situations for which individual indexes were developed. Thus, geographic or similar factors could account for at least part of the observed differences. It is noted, however, that all indexes were dominated by their labour components and that there are significant differences in the weightings given to labour by the different indexes. As labour costs grew significantly faster than prices for materials and plant over the period under consideration (see for example the ABS indexes in Table 2.3), the indexes with a higher labour content would have recorded, other things being equal, a higher growth rate.

The various components of the BTE 1978 index have been examined in the search for possible reasons for divergences between this and other indexes. Most of the input components of the BTE index do not have market-determined prices, and the choice of proxy price series to represent them is a difficult task involving a considerable degree of subjective judgment. In particular, the method used to derive the price index for 'other surpluses' appears questionable.

Development of the BTE index involved an attempt to estimate the rate of return on capital by relating the value of surpluses and interest paid by enterprises to the employed capital stock valued at current prices. This valuation of the capital stock at current prices would tend to indicate the replacement value of capital, not its current market value. This apparent over-valuation of the capital stock would explain (at least in part) the sharp decline in the 'other surpluses' component over the study period, and may have introduced some downwards bias to the index.

TABLE 3.1—COMPARISON OF INPUT-PRICE AND INPUT-COST INDEXES 1969-70 TO 1980-81[a]

(1969-70=100.0)

Year (30 June)	BTE 1978 input-price index		SRA input-price indexes[b]						SRA input-cost indexes[b]							
			DMR (NSW) Input-price		MRD (QLD)		MRD (WA)		DMR (NSW) Cost rise		CRB (VIC)		HD (SA)		DMR (TAS)	
	Index	Percent change	Index	Percent change	Index	Percent change	Index	Percent change	Index	Percent change	Index	Percent change	Index	Percent change	Index	Percent change
1970	100.0	—	100.0	—	100.0	—	100.0	—	100.0	—	100.0	—	100.0	—	100.0	—
1971	107.3	7.3	108.9	8.9	107.9	7.9	107.0	7.0	108.9	8.9	110.4	10.4	112.0	12.0	110.8	10.8
1972	116.5	8.6	117.9	8.3	117.5	8.9	116.6	9.0	117.1	7.5	119.5	8.2	120.3	7.4	122.0	10.1
1973	125.5	7.7	126.5	7.3	127.4	8.4	124.6	6.9	128.4	9.6	134.3	12.4	136.3	13.3	133.8	9.7
1974	145.2	15.7	144.3	14.1	149.2	17.1	142.5	14.4	146.2	13.9	165.1	22.9	166.5	22.2	162.4	21.4
1975	179.6	23.7	180.3	24.9	192.6	29.1	178.8	25.5	187.4	28.2	193.7	17.3	196.9	18.3	199.3	22.7
1976	203.5	13.3	205.8	14.1	222.2	15.4	206.9	15.7	216.9	15.7	222.2	14.7	231.5	17.6	233.6	17.2
1977	227.2	11.6	230.0	11.8	248.5	11.8	236.8	14.5	243.4	12.2	241.4	8.6	260.0	12.3	263.5	12.8
1978	247.5	8.9	252.6	9.8	270.1	8.7	260.7	10.1	264.5	8.7	257.9	6.8	278.2	7.0	283.3	7.5
1979	—	—	274.5	8.7	287.0	6.3	278.8	6.9	281.3	6.4	273.4	6.0	302.9	8.9	300.6	6.1
1980	—	—	305.9	11.4	314.9	9.7	300.0	7.6	323.2	14.9	324.4	18.7	387.7	11.5	337.6	12.3
1981	—	—	na	na	353.8	12.4	331.1	10.4	372.3p	15.2p	367.5	13.3	377.6	11.8	374.1	10.8

a. As the percentage changes shown in this table are derived figures, they may differ slightly from those in Chapter 2, due to rounding.

b. Note that the input-price indexes and the DMR Cost Rise Index are based on 'average' prices for the year to 30 June, whilst the other input-cost indexes relate to costs at 30 June of the designated year. (The CRB index in also available on a financial year basis.)

p provisional estimates

na not available

Source: Refer to Chapter 2.

OUTPUT-COST AND EXPENDITURE DEFLATOR INDEXES

Table 3.2 compares the BTE 1978 output-cost index with the implicit price deflators for private and public fixed capital expenditure on non-dwelling construction. The corresponding BTE input-price index from Table 3.1 is also shown,to indicate the magnitude of the productivity adjustment. The figures in Table 3.2 indicate:

- almost identical year-to-year movements in the implicit prices for private and public expenditure;
- significantly faster growth for the expenditure deflators than for the BTE output-cost index; and
- closer resemblance between the trend in the expenditure deflators and that in the BTE input-price index than between the former and the BTE output-cost index.

There are many possible reasons for the wide divergence between the expenditure deflators and the BTE output-cost index. The two series are conceptually similar in that they both supposedly relate to final output or to expenditure (which should correspond in value when account is taken of stock changes). However, in most other respects the two series differ greatly, and they are both well removed from a best estimate of an output-cost index for road construction activity. The major limitations of these indexes are:

- The expenditure deflators were not designed for this purpose, and do not meet the normal *ceteris paribus* assumptions sought in price index construction (ABS 1977, Appendix C). In addition, it must be remembered that the expenditure deflators are, in fact, simply special-purpose indexes of wages and the prices of material inputs. These indexes were devised to produce the constant-price estimates of private and public fixed capital expenditure on non-dwelling construction. Finally, it is a major step to assume that implicit prices for road construction have moved in line with those for all non-dwelling construction.
- The productivity index used in the BTE index relates to movements in total productivity (that is, productivity from labour, capital and technology) in the non-farm sector. The method of estimation is described by Burke (1978) and is summarised in Appendix I. Thoresen (1980) outlines several technical reservations to this method of estimating productivity, and questions, in particular, the assumption of constant returns to scale. A further serious reservation concerns the applicability of a general non-farm sector productivity measure to road construction. Thoresen notes that there is some overseas evidence to suggest that in the 1970s overall productivity in road construction lagged behind productivity in general. If this has occurred in Australia, the BTE 1978 estimates would tend to overestimate productivity gains (and would underestimate output-cost increases) in road activity.
- The adjustment for productivity in the BTE index implicitly assumes that any changes in the composition and quality of inputs and outputs are negligible. Consideration of certain developments in road construction highlight the possible restrictiveness of this assumption. The first is that recent budget constraints have been associated with a shift in emphasis from major construction works to improved maintenance and planning operations. In addition, design standards have risen with increases in traffic flows and speeds, and roads of high engineering standards (particularly freeways and national highways) have become more prevalent. Finally, increased emphasis has been given to safety, environmental factors and the interests of non-users, as indicated by better provisions for pedestrians and cyclists, landscaping, noise screening and improved lighting and signposting. These changes in output composition and quality may have important implications for productivity measurement, as productivity gains are likely to differ between activities. For example, the scope for productivity gains from mechanisation and economies of scale may have declined, but increased gains may have been made in maintenance practices, organisation and administration, and improved materials.

TABLE 3.2—COMPARISON OF BTE 1978 INPUT-PRICE AND OUTPUT-COST INDEXES AND EXPENDITURE DEFLATOR INDEXES

Year 30 June	*BTE 1978 input-price index*		*BTE 1978 ouput-cost index*		*Implicit price deflators; gross fixed capital expenditure; non-dwelling construction*			
					Public sector		*Private sector*	
	Index	*Percentage change*	*Index*	*Percentage change*	*Index*	*Percentage change*	*Index*	*Percentage change*
1970	100.0	—	100.0	—	100.0	—	100.0	—
1971	107.3	7.3	105.0	5.0	106.7	6.7	106.4	6.4
1972	116.5	8.6	110.3	5.0	113.6	6.5	114.3	7.4
1973	125.5	7.7	117.6	6.6	122.8	8.1	122.1	6.8
1974	145.2	15.7	136.1	15.7	140.2	14.2	139.8	14.5
1975	179.6	23.7	162.7	19.5	176.4	25.8	177.0	26.6
1976	203.5	13.3	180.8	11.1	205.3	16.4	205.3	16.0
1977	227.2	11.6	199.3	10.2	231.4	12.7	231.5	12.8
1978	247.5	8.9	214.4	7.6	251.9	8.9	251.3	8.6
1979	—	—	—	—	269.0	6.8	268.5	6.8
1980	—	—	—	—	302.6	12.5	300.2	11.8
1981	—	—	—	—	na	na	337.5p	12.4p

p provisional estimates
na not available
Sources: Burke (1978); ABS (1980); ABS (1981).

CHAPTER 4 — THE DEVELOPMENT OF BTE INDEXES

FACTORS AFFECTING CHOICE OF INDEX

The BTE's aims and objectives in developing price indexes for road construction activity were stated in Chapter 1. To reiterate briefly, a principal aim is to produce a statistically robust price index which relates to road construction activity at the national level. It is further required that the index should be appropriate for analysis of trends in road expenditure at constant prices, and that it should provide a guide to trends in road construction costs in Australia. A further important consideration is that the index should be timely and readily capable of updating. The choice of index to meet these objectives involved three major questions.

The first question to consider was whether to construct an output-cost index or an input-price (or input-cost) index. The BTE has chosen to construct an input-price index. This type of index may be considered inferior to an output-cost index for some purposes, but the BTE's assessment is that the information needed to construct a robust output-cost index for road construction activity is not currently available in an appropriate form. Further (as mentioned in the previous chapter), severe reservations have been expressed about:

- using estimates of productivity in the non-farm sector to convert an input-price index for road construction activity to an output-cost index;
- ignoring the influence of changes in the quality and composition of inputs and outputs in deriving an output-cost index from an input-price index; and
- using National Accounts expenditure deflators for the whole non-dwelling construction industry as a proxy for output-costs in the road construction industry.

These considerations led the BTE to choose an input-price index as the most appropriate to its needs at the present time. In applying the input-price index to indicate the price and quantity components of road expenditure, it is noted that, other things being equal, this index will over-estimate the change in output costs to the extent that productivity gains have occurred in road construction.

The second question to be resolved was whether to measure industry inputs in terms of actual components of SRA and LGA activity (such as labour, materials, plant, etc) or in terms of the primary components of industry expenditure used in the National Accounts Input-Output Tables. The input-output approach has certain advantages in that it includes profits, taxes and local government rates. In addition, the cost of capital is measured by depreciation (as an estimate of the price of services provided) rather than in terms of its cost at the time of acquisition. Against this must be set some severe disadvantages of the input-output approach:

- the input-output tables are significantly dated (the most recent tables relate to 1974-75), and hence the index weights derived from the tables are dated;
- derivation of expenditure flows for road construction activity from the more aggregate flows in the tables is time-consuming and a potential source of error;
- the primary components of expenditure used generally do not correspond to expenditure items recorded by those responsible for road construction, and hence it is difficult to check or revise weighting patterns in the light of actual expenditure information; and
- proxy price indexes are needed for several of the primary components, and the choice of proxy indexes for items such as 'other surpluses' involves arbitrary

judgments and is a potential source of error.

These factors led the BTE to choose to develop an input-price index comprising actual expenditure items (as opposed to the primary components from the input-output tables used by the CBR).

The final question was whether to measure input prices in terms of ABS and other published price indexes, or in terms of the actual costs incurred in road construction activity. Data considerations restricted the BTE to use of readily-available price series (mainly from the ABS) for the various input components. The advantage of this approach is that the resulting index can be readily updated and is generally timely. The disadvantage is that movements in prices of inputs to the road construction industry may diverge from the average price movements of those inputs in the economy as a whole. However, there appears to be no *a priori* reason to expect persistent divergences in these input-price movements[1].

DISAGGREGATION OF ROAD CONSTRUCTION ACTIVITY FOR THE BTE INDEX

Although development of the BTE index was pitched at the national level, it was felt that disaggregation with respect to certain characteristics would be useful. Accordingly, road construction activity was divided into three sectors:

- construction by SRAs;
- construction by LGAs; and
- total maintenance.

This level of disaggregation is considered feasible in terms of data availability. At the same time, it identifies three main sectors of road construction activity which differ in terms of composition of inputs (and which hence might be expected to undergo differing total input-price movements).

Table 4.1 presents a guide to variations between SRAs and LGAs with respect to the relative significance of their construction and maintenance activities.

It also indicates differences in the shares of labour, material and plant costs in expenditure on construction and maintenance. The table relates to only two SRAs and about 250 LGAs (who responded to the BTE's Rural Local Government Survey (see Appendix II)), and reflects a somewhat arbitrary allocation of administrative overheads. Nevertheless, it is useful as a guide to the composition of expenditure. The apparent conclusions are that:

- LGAs allocate a significantly greater share of their road funds to maintenance work than do SRAs; and
- there does not appear to be a significant difference in the cost composition of maintenance work undertaken by SRAs or LGAs as a whole[2] (however, this does not preclude significant differences within particular SRAs or between LGAs, as the figures presented are category averages).

There are important differences between the composition of costs involved in constructing rural as opposed to urban roads. The construction of urban roads requires a higher component of materials for kerbing and guttering, footpaths, street lighting, provision of stormwater drainage, etc whereas rural roads require higher components of plant and labour. However, there was not sufficient data available to the BTE to accurately determine the extent of these differences, and certainly not sufficiently detailed data to calculate appropriate weights for an index based on a decomposition of urban and rural road construction.

1. Such price divergences would be expected to be greater in the short term, and in a particular location or particular road activity where localised supply and demand factors exert a greater influence on prices.

2. An apparent exception was 'plant purchase' which accounted for a higher percentage of total maintenance expenditure by LGAs than was the case for the two SRAs.

TABLE 4.1 — VARIATIONS IN COMPOSITION OF EXPENDITURE BETWEEN SRAs AND LGAs[a]

(Percentage of total expenditure)

Construction[b] authority	*Component*	*Activity*		*Total*
		Construction	*Maintenance*	
CRB (Vic)	Labour	40.0	12.8	52.8
	Materials	36.3	6.4	42.7
	Plant purchase	3.7	0.8	4.5
	Total	80.0	20.0	100.0
DMR (Tas)	Labour	36.4	17.6	54.0
	Materials	30.2	6.7	36.9
	Plant purchase	7.4	1.7	9.1
	Total	74.0	26.0	100.0
LGAs	Labour	30.4	24.9	55.3
	Materials	22.0	13.5	35.5
	Plant purchase	5.6	3.6	9.2
	Total	58.0	42.0	100.0

a. The figures in this Table are derived from SRA expenditure data and from the BTE's Rural Local Government Survey (see Appendix II). Note that the break-up between construction and maintenance activity for LGAs (58 per cent and 42 per cent respectively) is derived using data from BTE (1979, Table 6.3). The corresponding break-up between construction and maintenance for all SRAs as indicated by this study was 75 per cent and 25 per cent respectively.

b. Two SRAs were chosen for inclusion in this Table to give a general indication of the break-up of expenditure into construction and maintenance and between the three components listed. CRB (Vic) and DMR (Tas) were selected as they illustrate a large and a small State, and because cost information for these SRAs was in a form that could be readily broken down into the categories of interest.

INPUT COMPONENTS AND COMPONENT INDEXES

An examination of road construction industry cost movements led to the selection of seven major input categories. The price movements within each of these categories appeared to be relatively homogeneous. The categories are listed in Table 4.2 together with the component indexes considered appropriate to measure their price movements. No suitable component index was found for 'property acquisition', and this component was therefore deleted.

COMPONENT WEIGHTINGS

The weights for the three sub-indexes of maintenance, LGA construction and SRA construction were derived from Table 6.3 of the BTE's 1979 Roads Assessment Study (BTE 1979); this table gives estimated road expenditure by road category for the years 1974-75 to 1978-79 and the simplifying assumption was made that all local roads are constructed by LGAs and all other roads by SRAs. The weights (rounded to the nearest whole number) are:

	(per cent)
Maintenance	34
SRA construction	35
LGA construction	31
	100

Data on the relative sizes of the input components of LGA maintenance and construction were obtained from a Survey of Rural Local Government undertaken by the BTE in November 1980. To facilitate the application of readily available indexes, expenditure on certain components (plant hire and contract work) was redistributed among the other components (for details, see Appendix II). This gave weights for the designated input components, for each of LGA maintenance and construction. Note that because Sundry expenditure was so small (an overall weight of 0.4) this component was included with Other Materials.

TABLE 4.2 — BASIC INPUT COMPONENTS FOR THE BTE INDEX, AND PRICE INDEXES CHOSEN TO REPRESENT THESE COMPONENTS

Component	Price indexes	Source
Labour	Constructed from a weighted average of average weekly earnings per employed male unit, Australia (to represent salaried staff) and weighted average minimum weekly wage rates, male, all industry groups, Australia (to represent non-salaried staff)[a].	ABS, *Average weekly earnings, Australia,* (No. 6302.0) and ABS, *Wage Rates, Australia,* (No. 6312.0), various issues
Materials—Fuel	Price index of diesel automotive distillate.	ABS[b] unpublished
Materials—Bitumen	Price of bitumen index.	The Shell Company of Australia's Melbourne price of road making grade of bitumen.
Materials—Other materials and stores items	Price index of materials used in building (other than house building), Australia.	ABS, *Price index of materials used in building other than house building, six State capital cities,* (No. 6407.0), various issues.
Plant acquisition and replacement	Price index of construction and earth moving machinery and equipment[c].	ABS[d] unpublished
Property acquisition	No suitable index available.	
Sundry expenditure (not included elsewhere)	Implicit price deflator for government final consumption expenditure.	ABS (1981)

a. It would be desirable to use data series relating more directly to road construction occupations. However, the only such data found was that relating to the numerous and complex industrial awards which apply in this industry; these did not meet the BTE objective of using only readily available data.
b. The index for diesel automotive distillate is an unpublished component of the ABS, *Price Indexes of Articles Produced by Manufacturing Industry* (No. 6412.0) and is available on request from the ABS.
c. Due to the impact upon expenditure of the purchase of major items of plant, it is likely that accounting allocations made for the acquisition and replacement of capital would be more appropriate than actual purchases during a financial year.
d. The index for ASIC Class 3332 is an unpublished component of ABS, *Price Indexes of Articles Produced by Manufacturing Industry* (No. 6412.0) and is available on request from the ABS.

The SRA construction index weights were derived by first calculating an average break-down of total road expenditure into the input components, for all SRAs. The detail of the SRA data available varied from State to State, and overall Australian weights were determined directly by piecing together that data. Construction was estimated to be to 75 per cent of total expenditure, using data from Table 6.3 of the BTE's 1979 Roads Assessment Study. Assuming that the maintenance weights derived from LGAs are applicable to SRAs (except for plant acquisition[1]), the SRA construction weights were then derived by differencing.

The labour split — salaried and other — was determined using an average of HD (SA) and CRB (Vic) data for SRAs, an estimated one-third salaried labour and two-thirds other labour for LGAs, and taking into account the maintenance/construction splits indicated above.

The resulting component weights for the 1981 BTE indexes are set out in Table 4.3.

TABLE 4.3 — BTE INDEXES: COMPONENT WEIGHTS[a]
(estimated for base year 1979-80)

Component	Maintenance	SRA construction	LGA construction	Total activity
Labour				
Salaried	15.9	22.8	20.4	19.7
Other	44.1	32.1	32.1	36.1
Total	60.0	54.9	52.5	55.8
Materials				
Fuel	11.7	9.1	10.3	10.4
Bitumen	6.2	9.3	9.4	8.3
Other[b]	14.6	20.9	18.2	17.9
Plant acquisition and replacement	7.5	5.8	9.6	7.6
	100.0	100.0	100.0	100.0

a An explanation of the derivation of these weights is given in the text.
b. Includes sundry expenditure.

RESULTANT INDEXES

Combination of the component weights (Table 4.3) and component indexes (Table 4.2) yields the input-price indexes depicted in Table 4.4. The indexes were computed for the base year 1979-80, but have been (scale) adjusted so that 1969-70=100.0 to allow comparison with other indexes. The major conclusion which can be drawn from Table 4.4 is that the input-price movements in the three areas examined (LGA construction, SRA construction and maintenance) were very similar over the period 1969-70 to 1980-81. Price increases were higher in the more labour-intensive activities (namely maintenance and, to a lesser extent, SRA construction), but only marginally so. One reason for this is that the rapid increases in fuel and bitumen prices since 1974 have meant that total materials prices have not strongly lagged behind labour price movements as in earlier periods; indeed, in the past two years increases in fuel and bitumen prices have substantially outstripped rises in the labour components.

COMPARISON WITH OTHER INDEXES

In Table 4.5, the BTE 1981 input-price index for overall road construction activity is compared with the BTE 1978 input-price index, the DMR (NSW) cost rise index and the MRD (Qld) input-price index. These latter three indexes have been chosen to represent the three types of input-price (or input-cost) indexes discussed in Chapter 3. The following points can be made on the basis of these comparisons.

1. The evidence in Table 4.1 provides general support for this assumption. An apparent exception was plant acquisition for maintenance work, and the maintenance weight for this item was taken to be the weighted average of the LGA and SRA percentages.

TABLE 4.4 — BTE 1981 ROAD CONSTRUCTION INPUT-PRICE INDEXES

(Base year 1979-80, adjusted so that 1969-70 = 100.0)[a]

Year ended 30 June	Component indexes[b]						Road construction input-price indexes							
	Labour		Fuel	Bitumen	Other materials[c]	Plant acquisition and replacement	LGA construction		SRA construction		Maintenance		Overall activity	
	Salaried	Other					Index	Percentage change	Index	Percentage change	Index	Percentage change	Index	Percentage change
1970	100.0	100.0	100.0	100.0	100.0	100.0	100.0	—	100.0	—	100.0	—	100.0	—
1971	111.1	108.9	105.7	100.0	104.5	105.2	106.9	6.9	107.1	7.1	107.3	7.3	107.1	7.1
1972	122.4	120.4	110.5	109.8	111.3	111.2	116.1	8.6	116.4	8.7	116.8	8.9	116.4	8.7
1973	133.4	133.2	110.5	109.8	116.7	114.2	123.9	6.7	124.4	6.9	125.3	7.3	124.5	7.0
1974	155.0	157.6	110.2	109.8	131.9	120.1	139.8	12.8	141.1	13.4	142.6	13.8	141.2	13.4
1975	194.4	205.7	125.9	189.3	162.2	144.4	179.7	28.5	181.6	28.7	183.1	28.4	181.5	28.5
1976	222.3	236.0	169.3	212.6	186.6	169.4	207.9	15.7	209.7	15.5	212.1	15.8	209.9	15.6
1977	249.9	266.2	192.4	254.5	208.4	198.2	235.9	13.5	237.4	13.2	240.2	13.2	237.9	13.3
1978	274.6	290.6	232.9	272.8	226.0	215.8	258.7	9.7	260.3	9.6	263.7	9.8	260.9	9.7
1979	295.7	309.7	308.7	274.7	242.6	228.1	279.2	7.9	280.7	7.8	285.5	8.3	281.8	8.0
1980	324.9	336.9	497.4	380.8	274.2	252.1	324.6	16.3	325.1	15.8	330.3	15.7	326.7	15.9
1981	368.8	373.6	623.1	512.4	309.6p	281.5	375.1p	15.6p	375.4p	15.5p	379.2p	14.8p	376.7p	15.3p

a. The overall activity index and the sub-indexes were derived for the base year 1979-80, and then all indexes, including the components, were scale-adjusted to give 1969-70 =100.0, to facilitate comparison with other indexes discussed in the paper. Note that the adjusted scale (1969-70 = 100.0) version of the overall activity index cannot be derived simply from the three sub-indexes (LGA and SRA construction and maintenance) by using the weights given on page 37; similarly, in the adjusted scale, the three sub-indexes cannot be derived simply from the component indexes by using the 1979-80 weights in Table 4.3. Each of the required indexes must be constructed from the component indexes at their base year (ie 1979-80 = 100.0).

b. The indexes used to represent the component indexes are set out in Table 4.2.

c. Because it is so small, 'sundry expenditure' weighting has been incorporated in the 'other materials' weight.

p provisional estimates.

TABLE 4.5 — COMPARISONS WITH BTE 1981 INPUT-PRICE INDEX

(Base year 1969-70)

Year ended 30 June	*BTE 1981 input-price index (Overall activity)*		*BTE 1978 input-price index*		*DMR (NSW) cost rise index (Input-cost)*		*MRD (Qld) index (Input-price)*	
	Index	*Percentage change*	*Index*	*Percentage change*	*Index*	*Percentage change*	*Index*	*Percentage change*
1970	100.0	—	100.0	—	100.0	—	100.0	—
1971	107.1	7.1	107.3	7.3	108.9	8.9	107.9	7.9
1972	116.4	8.7	116.5	8.6	117.1	7.5	117.5	8.9
1973	124.5	7.0	125.5	7.7	128.4	9.6	127.4	8.4
1974	141.2	13.4	145.2	15.7	146.2	13.9	149.2	17.1
1975	181.5	28.5	179.6	23.7	187.4	28.2	192.6	29.1
1976	209.9	15.6	203.5	13.3	216.9	15.7	222.2	15.4
1977	237.9	13.3	227.2	11.6	243.4	12.2	248.5	11.8
1978	260.9	9.7	247.5	8.9	264.5	8.7	270.1	8.7
1979	281.8	8.0	—	—	281.3	6.4	287.0	6.3
1980	326.7	15.9	—	—	323.2	14.9	314.9	9.7
1981	376.7p	15.3p	—	—	372.3p	15.2p	353.8	12.4

p provisional estimates.

Source: Tables 3.1 and 4.4.

- Comparison of the BTE 1981 input-price index for all activity with the BTE 1978 input-price index shows a relatively slower growth in the 1981 index from 1969-70 to 1973-74. This is followed by an increasingly faster relative growth in the latter index up to 1977-78 (the last year for which the 1978 index is available). A possible reason for this is the explicit inclusion in the 1981 index of the rapid growth in fuel and bitumen prices since 1973-74. Also, there is a possible downwards bias in the 1978 index through the price index used for 'other surpluses'.
- The 1981 BTE input-price index rose at a slightly slower rate than the DMR (NSW) cost rise index over the period 1969-70 to 1975-76, but since then the BTE index has shown a slightly faster rate of growth. The most likely reason for this divergence is the greater weight assigned to the labour component, and the corresponding smaller weight allocated to other materials (including fuel and bitumen) by the DMR index than by the BTE index.
- The MRD (Qld) input-price index increased at a slightly greater rate than the 1981 BTE input-price index between 1969-70 and 1974-75, but since that time the BTE index has shown a faster rate of growth. Again this is probably due to the fact that the BTE index takes explicit account of fuel and bitumen prices, which have shown rapid growth over recent years.

CHAPTER 5 — CONCLUDING REMARKS

In this study, input-price indexes have been compiled for maintenance and for construction activity by SRAs and LGAs associated with the Australian road system. The BTE believes that these indexes are sufficiently robust and up-to-date to meet the basic requirements for a deflator of national expenditure on roads, and to act as a guide to participants in the industry regarding trends in road construction costs on a national basis.

The choice of index types and of component prices has necessarily involved some compromise between theoretical and practical considerations. Ideally, the BTE would have liked to disaggregate changes in expenditure on various road activities into three components — changes in input prices, changes in the input-output relationship (or productivity), and changes in the quality and composition of inputs and outputs. Practical considerations (and in particular limitations in the availability of uniform cost and output information) have resulted in no estimates being made here of productivity and quality changes related to Australian road construction activity. If the NAASRA Data Bank and related data are updated on a regular basis, this may provide the required information on cost and output changes which could form the basis for the above type of exercise. In the meantime, this report outlines some severe reservations to the use of productivity estimates for the non-farm sector to indicate productivity change in road activity. Similarly, conceptual reservations are expressed regarding the use of National Accounts implicit price deflators for expenditure on non-dwelling construction as a proxy for output-cost movements in the road construction industry. All of these characteristics reinforce the practical merit in using indexes based on input prices in the absence of an extremely comprehensive information base. The input-price indexes presented in the report have the following advantages.

- They comprise input components closely related to the road authorities' actual expenditure. This should make such indexes more sensitive to changes in actual costs; it also facilitates comparisons with the various SRA input-price and input-cost indexes.
- They use up-to-date weights.
- They provide ease of updating.
- They allow for relative ease of interpretation.

It is emphasised that the indexes need to be interpreted as input-price indexes. To the extent that productivity gains occur, other things being equal, these input-price indexes will tend to overstate increases in output costs and output prices for the road construction industry. In addition, other possible effects such as quality changes need to be borne in mind.

APPENDIX I — INDEXES

Indexes are statistical tools which are used to give a summary of the broad movement in the value of a bundle of goods over time. Each index number associated with the bundle of goods is expressed as a percentage of its value at some base period. Generally, the index is computed by attaching a weight to the unit value of each good on the basis of that good's contribution to the value of the bundle as a whole. These indexes are generally classified as either price, quantity or productivity indexes.

PRICE INDEXES

Price indexes measure changes in the price of a given bundle of goods through time by comparing the value of that bundle using sets of prices at two different points in time. This type of index may be derived by either the Laspeyres or the Paasche method. The Laspeyres approach selects a bundle of goods produced (or consumed) in a *base year* and compares changes in its value using base year and index year prices. This is equivalent to weighting the price movements of the individual goods by the proportion of expenditure upon each in the base year.

Laspeyres price index (for year t)

$$= \frac{\sum_i p_{it} q_{io}}{\sum_i p_{io} q_{io}} \tag{I.1}$$

$$= \sum_i \frac{p_{it}}{p_{io}} \cdot \frac{p_{io} q_{io}}{\sum_i p_{io} q_{io}} \tag{I.2}$$

where p_{io} is the unit price of good i in year o (the base year),
p_{it} is the unit price of good i in year t (the index year),
and q_{io} is the quantity of good i produced in year o.

Conversely, the Paasche approach compares changes in the value of a bundle of goods produced (or consumed) in the *current year* using base year and index year prices. This is equivalent to weighting the price movements of individual goods by the proportion of expenditure upon them if the current production bundle is valued at base year prices.

Paasche price index (for year t)

$$= \frac{\sum_i p_{it} q_{in}}{\sum_i p_{io} q_{in}} \tag{I.3}$$

$$= \sum_i \frac{p_{it}}{p_{io}} \cdot \frac{p_{io} q_{in}}{\sum_i p_{io} q_{in}} \tag{I.4}$$

where q_{in} is the quantity of good i produced in year n (the current year)
Note that the index year will often be the current year, that is: t=n.

Both types of indexes can be adapted to consider the quantities and prices of categories of goods rather than of individual items. Equations (I.2) and (I.4) are readily interpreted in this way. The only major difference between the two methods is that the weights assigned to each item are fixed in the Laspeyres index, while they may vary from year to year with the Paasche approach. This means that in the former a whole series of index numbers can be compared, while in the latter comparisons can only be made between a particular year and the base year.

Two specific problems arise in using the Laspeyres and Paasche indexes. Firstly, both implicitly assume that the relative prices of goods (or categories of goods) within the bundle do not change over time. When such changes do occur, it would be expected that the composition of the bundle of goods will alter as substitution takes place. Movements in relative prices will therefore lead to the Laspeyres index being an overestimate, and the Paasche index an underestimate of the *actual* average price movement associated with that bundle of goods.

The second problem involves the question of quality changes to the bundle of goods. In order to develop price indexes, the quality of goods should be fixed in the same way as quantities. The fact that such changes are likely to occur means that prices need to be adjusted to take account of quality effects. Hedonic price indexes are those which have been 'quality adjusted'.

QUANTITY INDEXES

Quantity indexes measure the change in the quantity of a bundle of goods produced (or consumed) through time. The rationale used is the same as for price indexes, except that in this case prices remain fixed (that is, constant real prices are used) while the quantities are allowed to vary. Again the approaches adopted are of the Laspeyres type or the Paasche type:

Laspeyres quality index (for year t)

$$= \frac{\sum_i p_{io} q_{it}}{\sum_i p_{io} q_{io}} \qquad (I.5)$$

$$= \sum_i \frac{q_{it}}{q_{io}} \cdot \frac{p_{io} q_{io}}{\sum_i p_{io} q_{io}} \qquad (I.6)$$

Paasche quality index (for year t)

$$= \frac{\sum_i p_{in} q_{it}}{\sum_i p_{in} q_{io}} \qquad (I.7)$$

$$= \sum_i \frac{q_{it}}{q_{io}} \cdot \frac{p_{in} q_{io}}{\sum_i p_{in} q_{io}} \qquad (I.8)$$

Quantity indexes will be influenced by quality changes and other factors in the same way as price indexes.

PRODUCTIVITY INDEXES

This type of index measures changes in the efficiency of an industry in converting inputs to outputs by comparing the volume of inputs (measured as the cost of these inputs in constant price terms) associated with producing a given output at different points in time.

A productivity index for the road construction industry was developed for the BTE 1978 index using a production function adopted by Deakin and Seward (1969) which is in turn based on the Cobb-Douglas function:

$$\Delta Y = (I - \propto)\Delta L + \propto \Delta K + \Delta ATOKE \qquad (I.9)$$

The logarithmic transform of the function is then differentiated with respect to time to give a measure of productivity:

$$\Delta ATOKE = \Delta(Y/L) - \alpha\Delta(K/L) \qquad (I.10)$$

where Y is the product of interest,
α is the share of capital in total rewards,
K is capital stock,
L is labour,
ATOKE is a measure of applied technical and organisational knowledge and external factors
Δ is a measure of exponential rate of growth.

Development of productivity indexes does, however, suffer from a number of problems when applied to road construction activity. Firstly, the association between inputs and outputs is influenced by non-productivity factors (such as factors shifting the production function). Secondly, there is difficulty in 'fixing' industry output, where this is defined in terms of physical projects.

APPENDIX II — RURAL LOCAL GOVERNMENT SURVEY

In November 1980, the BTE undertook a survey of rural local government authorities (LGAs). The prime objective of the survey was to provide data for a study of the social, economic and institutional importance of the road network, and of the road activities of local government in rural areas. Included in the survey were questions relating to road expenditure by LGAs. This information has been used to derive the weights applicable to the components of maintenance and LGA construction in the BTE 1981 Input-Price Index.

The base data provided by the survey were the contribution of the input components to construction and maintenance activity. The input shares were then adjusted for administrative overheads. The weights for the two road activities of construction and maintenance were calculated as 58 per cent and 42 per cent respectively, using data from Table 6.3 of the BTE's 1979 Roads Assessment Study (on the assumption that all local roads are constructed by LGAs and all other roads by SRAs). By applying these weights to the input component weights of the two activities, the weights for each component in total road expenditure were derived (refer Table II.1).

TABLE II.1 — RURAL LOCAL GOVERNMENT SURVEY: ORIGINAL DATA BREAKDOWN BY INPUT COMPONENTS AND ROAD ACTIVITY

Component	*Maintenance* (*per cent*)	*Construction* (*per cent*)	*Total road activity* (*per cent*)
Labour	49.1	39.8	43.8
Fuel	7.7	6.9	7.2
Bitumen	5.8	8.5	7.4
Other materials[a]	10.4	13.0	11.9
Plant purchase	3.9	4.2	4.1
Plant hire	18.6	18.6	18.6
Contract work	4.5	9.0	7.0
	100.0	100.0	100.0
	(42.0)	(58.0)	(100.0)

a. Includes sundry expenditure.

TABLE II.2 — RURAL LOCAL GOVERNMENT SURVEY: REDISTRIBUTED DATA BREAKDOWN BY INPUT COMPONENTS AND ROAD ACTIVITY

Component	*Maintenance* (*per cent*)	*Construction* (*per cent*)	*Total road activity* (*per cent*)
Labour	59.2	52.5	55.3
Fuel	11.6	10.3	10.8
Bitumen	6.1	9.4	8.1
Other materials	14.4	18.2	16.6
Plant acquisition	8.7	9.6	9.2
	100.0	100.0	100.0
	(42.0)	(58.0)	(100.0)

Not all the input categories identified in the survey can be measured using readily available indexes. The weights assigned to plant hire and contract work were therefore redistributed among the other components. Using CRB data, plant hire was redistributed on the basis of 40 per cent to labour, 24 per cent to plant acquisition and replacement, 18 per cent to fuel and 18 per cent to other materials. Expenditure on hired contractors was distributed to the other components on a pro-rata basis. These redistributions gave the final weights by input component and by activity.

The derivation of the component weights is presented in tabular form in the following Tables II.1 and II.2.

REFERENCES

Australian Bureau of Statistics (ABS) (1980), *Australian national accounts -national income and expenditure 1979-80,* (No. 5004.0), ABS Canberra.

__________(1977), *Australian national accounts - gross product by industry at current and constant prices 1976-77,* (No. 5211.0), ABS Canberra.

__________, *Average weekly earnings, Australia,* (No. 6302.0), ABS Canberra, various issues.

__________, *Price index of materials used in building other than house building, six State capital cities,* (No. 6407.0), ABS Canberra, various issues.

__________, *Price indexes of articles produced by manufacturing industry, Australia,* (No. 6412.0), ABS Canberra, various issues.

__________(1981), *Quarterly estimates of national income and expenditure, Australia,* June Quarter 1981, (No. 5206.0). ABS Canberra.

__________, *Wage rates, Australia,* (No. 6312.0), ABS Canberra, various issues.

Australian Road Research Board (1967), Road construction cost indices, Research News. *Australian Road Research* 3(2) June. pp82-93.

Bureau of Transport Economics (BTE) (1979), *An assessment of the Australian road system: 1979 Part I,* AGPS Canberra.

Burke, R. (1978), *A road construction price index,* BTE Occasional Paper 27, AGPS Canberra.

Commonwealth Bureau of Roads (CBR) (1969), *Cost indexes applicable to road construction.* Report on Australian Road Systems — 1968: Associated Bureau Paper No. 23, AGPS Canberra.

__________ (1975), *Report on roads in Australia,* AGPS Canberra.

Country Roads Board (Vic), *Quarterly price indices.* Kew, various issues.

Deakin, D.M. and Seward, T. (1969), *Productivity in transport: A study of employment, capital, output, productivity and technical change.* University of Cambridge, Department of Applied Economics, Occasional Paper 17, Cambridge University Press.

Department of Main Roads (NSW, 1979), *Road cost rise index.* Sydney.

Department of Main Roads (Tas, 1979), *Preparation of road construction price index.* Hobart.

Hansard, House of Representatives, 15 September 1977.

Highways Department (SA, 1979), *Documentation of the development of the South Australian State Road Authority roadwork price index.* Adelaide.

Main Roads Department (Qld, 1978), *Road cost index.* Brisbane.

Main Roads Department (WA, 1978), *Development of road construction price, cost and productivity indices in MRD, WA.* Report of ad hoc Departmental Committee, October 1978. Perth.

Thoresen, T. (1980), *A comparative analysis of Bureau of Transport Economics Occasional Paper 27,* Australian Road Research Board Internal Report, AIR 155-4.

BUREAU OF TRANSPORT ECONOMICS

RECENT PUBLICATIONS

REPORTS

The Long Distance Road Haulage Industry (1979)

An Assessment of the Australian Roads System (1979)

Sandy Hollow-Maryvale Railway: Economic Evaluation of Proposed Completion (1979)

Inwards Duty-Free Shopping at Australian International Air Terminals: an Economic Evaluation (1979)

Tasmanian Freight Equalisation Scheme Recommended Rates of Assistance for Southbound Cargoes, Livestock, and Timber at 31 January 1979 (1979)

Demand for Sea Passenger Transport between Tasmania and the Mainland (1980)

Trans-Tasman Shipping (1980)

A Study of Western Australian Ports (1981)

Tasmanian Freight Equalisation Scheme: a 'Landbridge' Approach to the Estimation of Subsidy Rates (1981)

National Travel Survey 1977-78: General Overview and Assessment (1981)

OCCASIONAL PAPERS

36 *The Road Transport Business: a Guide to some Financial Aspects* (1980)

37 *Consumption of Transport Energy in Australia 1975-76* (1981)

38 *Regression Analysis of Ship Characteristics* (1981)

39 *Utilisation of Urban Road Freight Vehicles* (1981)

40 *Some Characteristics of Truck Ownership in Australia* (1981)

41 *A Guide to the Control of Photochemical Pollution* (1981)

42 *National Travel Survey 1977-78; Statistical Adjustments and Final Results* (1981)

43 *Review of Road Freight Regulation in Britain* (1982)

44 *Economic Analysis of Non-price Rationing with particular reference to Petrol* (1981)

45 *Freight Transport Energy Consumption: a comparison between the Efficiency of the Modes in the Non-bulk Task* (1981)

46 *Demand for International Air Travel: a Conceptual and Operational Framework* (1981)

47 *Energy Policies and Company Cars: an Application of Experimental Design Methods in Economic Research* (1982)

INFORMATION PAPERS

1 *National Travel Survey 1977-78, Description of the NTS Data Base* (1979)

2 *Transportation Research Information Service (TRIS): Description of Outputs from BTE Processing* (1980)

CONFERENCE PUBLICATIONS

Proceedings of the Workshop on Economics of Road Design Standards (1980)
Paratransit: Changing Perceptions of Public Transport (1980)

Transport Outlook Conference 1978 (1980)

Workshop on Australian Transport Information Directory (1981)

Workshop on the Economics of Shipping Australian Agricultural Exports (1981)

Workshop on the Future of Urban Passenger Transport: Summary Report (1981)

Workshop on the Future of Domestic Freight Transport: Summary Report (1981)

Workshop on the Future of International Passenger Transport: Summary Report (1981)

Workshop on the Future of Non-urban Passenger Transport: Summary Report (1981)

Transport Outlook Conference 1981 - Papers presented

Outlook for Australian Transport 1981

Transport Finance and Cost Recovery

Transport Implications of Australian Resource Development

Market Segment Papers

Road Construction Price Indexes 1969-70 to 1980-81

R81/930 CAT. NO. 82 0018 5