CHAPTER 1

INTRODUCTION

1.1 THE PURPOSE OF THIS STUDY

This thesis is concerned with two separate but highly related problems. The first problem is the current lack of aggregate data on the economic activity of the individual states of the Commonwealth of Australia. The first part of this thesis is concerned with developing an original set of estimates of the gross state product of the State of Queensland. These gross state product estimates, at factor cost, are disaggregated both by industry and by the principal component contribution to gross product, and are produced on a quarterly basis for the period from September 1969 to June 1979. The second problem concerns the use of aggregate economic data in analysis, particularly in the construction and application of econometric models. The second part of this thesis, for which the first part is a necessary prerequisite, develops a macro-econometric type regional econometric model of the State of Queensland in the Commonwealth of Australia.

In the last twenty years there has been a strong growth in the modelling of national economic systems, helped by larger data bases, faster and more powerful computers, stronger theoretical bases, and better mathematical and statistical techniques. Most macro-econometric models rely on a set of national economic accounts to provide a theoretical framework and a data base. These models have been used mainly for three purposes:

(a) to examine the nature of short and medium run fluctuations in national economics;

(b) to forecast key economic variables, such as gross domestic product, numbers of unemployed and investment expenditure; and,

(c) to evaluate the quantitative effects of alternative government policy decisions.

These econometric models consist of sets of equations describing hypotheses about the relationships among a collection of economic variables. This allows an investigation of causes and effects to explore not just a particular relationship, but ramifications throughout an entire economic system. As Duesenberry and Klein put it, "Some interesting questions in economics may be answered from a knowledge of one or two economic relationships viewed in isolation. But most economists are convinced that many changes in policy or in other exogenous factors will have not only a direct effect in one sector of the economy, but will also have secondary or indirect effects on many other sectors".[1]

Regional economics has been affected by this proliferation of modelling. A considerable number of regional economic models has been constructed, especially in the USA. While a number of these regional economic models relies on the techniques of input-output and economic base theory, many regional models are now being constructed as modified copies of national macro-econometric models.

A number of potential applications of regional econometric models has been listed by Klein and Glickman (1977, pp. 21-2), who suggest that five " ... major American policy investigations as are now being considered could well be studied within the framework of regional ... models:

(i) revenue sharing between federal and state/local authorities,

(ii) effects of grant-in-aid paid by federal to state/local governments,

(iii) federal support for welfare payments,

(iv) selective programs to alleviate structural unemployment in special areas,

(v) the effect of the regional distribution of placement of federal contracts".

All of these applications are relevant to Australia. In particular, without limiting the range of other applications, it is believed that this study is timely and appropriate in the present stage of evolution of the Australian federation. It is not unlikely that,

---

[1]Duesenberry *et al.* (1965, p. 4).

if Stage II of the new federalism arrangements proposed by the present (1981) Liberal-National party Commonwealth government is implemented, the states will have to consider seriously, in the immediate future, the imposition of surcharges on federal rates of personal income tax, and access to other alternative revenue sources. Other writers[2] have pointed to an approaching crisis in Australian federalism, with projected demands for state government expenditures outstripping their projected revenue resources.

It is obvious then, that a clear rationale exists for the development of state econometric models in Australia.

1.2 THE SETTING OF THIS STUDY

This study is concerned with the economy of the State of Queensland. The Queensland Year Book[3] describes the evolution and nature of the system of government:

> Moreton Bay, the "Northern District of New South Wales", was first used in 1824 as a penal settlement, and by 1843 had become a distinct electoral division. As electors of New South Wales, residents in what is now Queensland had enjoyed responsible government since the *Constitution Act of* 1855, and when separation was effected by letters patent of 6 June 1859, an Order-in-Council of the same date gave Queensland a Constitution similar to that of New South Wales ... On 10 December 1859 the Governor [Sir George Bowen] landed at Brisbane and proclaimed the separation of Queensland from New South Wales.
> The 1859 Order-in-Council was validated by *The Australian Colonies Act of* 1861, and with the passing of *The Constitution Act of* 1867, responsible government in Queensland was consolidated.
>
> Since 1901, the former Colony of Queensland has been a State of the Commonwealth of Australia. The present system of government consists of the Governor, the Executive Council, and the Legislative Assembly, the Legislative Council having been abolished from 23 March

---

[2] See, for example, Groenewegen (1981).

[3] Queensland Year Book, ABS, Catalogue No. 1301.3, 1979, Vol 39, p. 60.

1922. The Executive Council is composed of the Governor and the Ministers in office. Local Government Authorities operate under legislation of the Queensland Parliament.

Figure 1.1 contains a map of Australia, showing the component states and territories.

Queensland is the third largest state in the Australian federation, in terms of population and economic activity.

Queensland has a land area of 1.7 million square kilometres and has a population of over two million persons. This is 22 per cent of the total area of Australia and 15 per cent of the population.

Further comparisons of Queensland with Australia are made in Table 1.1. It is clear from the evidence in this table that Queensland is a semi-tropical, relatively sparsely populated state with specialization of economic activity in primary production i.e., in agricultural and grazing production, and mining.

The population of Queensland has recently been increasing faster than that of Australia.

Manufacturing activity is also increasing faster in Queensland. From 1971-72 to 1978-79, value added in manufacturing increased in Queensland by 166%, and in Australia by only 129%.[4]

However not all Queensland economic indicators show superior performance compared to Australia. Unemployment is higher in Queensland, and Queensland labour earnings are generally lower than in other States. On the other hand, inflation is slightly lower in Queensland than Australia.[5]

---

[4]Source ABS, Catalogue Nos. 1301.3, 1301.0, 8202.0.

[5]Of course, this comment really refers to metropolitan areas, since the CPI does not cover provincial and rural areas. It should be noted that the comment is valid in terms of inflation, but not necessarily in terms of average levels of prices.

Figure 1.1: The states and territories of Australia

Table 1.1: Queensland in relation to Australia

Item (ABS Catalogue No. Source[a])	Units	Date or period of Measurements	Queensland	Australia	Queensland as a Percentage of Australia (%)	Last percentage expressed as a percentage of Queenslands population share (%)
Population	'000 persons	June 1979	2197.5	14423.6	15.2	100.0
Area	'000 sq km	-	1727	7682	22.5	148.0
Area in Tropics (1301.3)	'000 sq km	-	933	2957	31.6	-
Population increase	per cent	1977-78 to 1978-79	1.43	1.23	116.1	-
Civilian employees	'000 persons	March 1980	697.7	5029.4	13.9	91.4
Average weekly earnings per employed male unit	$	March qtr 1980	231.9	245.70	94.4	-
Consumer Price Index (6401.0)	Base: Year 1966-67 = 100.0	March qtr 1980	287.1	290.1	-	-
Unemployed receiving benefit	'000 persons	21 March 1980	51.3	316.8	16.2	106.6
Gross value of primary industry production	$m	1978-79	2307	10836	21.3	140.1
Value, at mine, of minerals produced	$m	1978-79	1405	5834	24.1	158.6
Value added in manufacturing	$m	1978-79	2318	22193	10.4	68.4
Gross domestic product at factor cost (5206.0 and this thesis)	$m	1978-79	13330	89068	15.0	98.7

[a] Unless otherwise noted in parentheses, the source is ABS, Catalogue No. 1305.3, *Queensland in Relation to Australia 1980*.

1.3 AN OUTLINE OF THIS STUDY

A more detailed rationale for the development of regional econometric models is provided in Chapter Two below. A comprehensive survey and evaluation of regional econometric models is also undertaken in Chapter Two, which reveals that most regional econometric models are for regions of the USA, and are annual, small, recursive and heavily dependent on national economic variables.

Chapter Three of this thesis is concerned with the first component of this thesis, the development of estimates of quarterly gross state product at factor cost by industry for Queensland for the forty quarters from September 1969 to June 1979. This product variable is a major aggregate measure of economic activity, and is also important for regional econometric models, since it forms the most important of the Keynesian national accounting identities. Much recent, unofficial, work on gross state product has not been as rigorous as possible. This is mainly due to inadequate access to or use of primary data sources. In this study, however, raw payroll tax tabulations by industry by month are used as the primary data source. This avoids many of the problems caused by crude or naive allocation methods, used in both Australia and the USA to estimate gross state product. The estimated data, gross state product by quarter, industry, and principal component, are a rich asset for studying the Queensland economy, although the main use of the data in this thesis is to provide necessary aggregate data required for modelling purposes.

Since gross state product has been estimated on a quarterly basis, and since there are serious deficiencies, both theoretical and practical, with annual models of economic systems, the Queensland econometric model developed in this thesis is also quarterly. Much of the data base required for this study however, was available only on an annual basis. To resolve this data deficiency, a method of distribution or interpolation of annual variables to quarterly was applied. This method is described in Chapter Four, where it is also shown that this method compares well with other methods. Use of this technique by model builders, particularly those in the USA, who have been restricted to annual data, should enable quarterly, rather than annual, models to be developed as standard practice.

Chapter Five describes the structure, and the detailed equations of the Queensland model. Thirteen blocks of associated endogenous variables and their equations are identified, and are discussed in turn. The Queensland model, in this preliminary version, consists of 110 endogenous variables and twenty-seven exogenous variables. (Twenty-eight of the endogenous variables are logarithmic or difference variables.) An unusual and important specification improvement in the Queensland model is the use of the familiar Keynesian national accounting identity first suggested in the seminal paper of Klein (1969).

Chapter Six describes four sets of dynamic simulation runs of the Queensland model. Historical validation runs over the estimation period, September quarter 1970 to June quarter 1978, show that the Queensland model compares satisfactorily with the simulation performance of other regional models. Since the model was estimated with both Ordinary Least Squares (OLS) and Two Stage Least Squares with four principal components (TSPC), dynamic simulations were run for both sets of estimated coefficients. There has recently been some dubiousness about the relative model simulation properties of OLS and TSPC. In the Queensland model OLS marginally outperforms TSPC over the historical validation runs. The second set of runs was for an ex post forecast from September quarter 1978 to June quarter 1979.

The third set of runs develops two illustrative dynamic multiplier series, while the fourth set performs policy experiments. These experiments were run over the benchmark period of March 1976 to June 1979. The first policy experiment studies the effect of an increase in the rate of personal income tax. The second experiment notes the sensitivity of the Queensland economy to national economic conditions. The third policy experiment examines the effect of a freeze of federal government grants. While these experiments cannot be regarded as sufficiently accurate to be useful for current policy purposes, they illustrate the kind of analysis to be expected from a later stage of the Queensland model.

This thesis produces preliminary results, and further work on the Queensland model is anticipated, with the constructive advice and participation of State government officials.

CHAPTER 2

REGIONAL ECONOMETRIC MODELS

2.1 ECONOMETRIC MODELS

In the period after the Second World War there has been a remarkable proliferation in the number and complexity of models of economic systems. A number of reasons for the emergence of models can be stated explicitly:

(i) Models provide a consistent and systematic framework for analysis. That is, they provide an apparatus for thinking, that is logically complete, consistent and constructed from a plan. Simply, models formalise thinking about a system.

(ii) Models provide an efficient medium for storing and transmitting information. They act as a data base, not just of numerical facts, but of the state of art of theoretical relationships.

(iii) Models force their builders clearly and formally to identify or reveal the assumptions which have to be made to simplify reality. This has obvious virtue.

(iv) Models improve communication and learning, partly by (ii) above, but, more importantly, by serving as a focus for debate. That is, they can often be built, simply to be torn down, and replaced by previously unimagined but more appealing and stronger structures.

(v) Models provide a discipline for the builder. The work is open to public scrutiny - or should be.

Additional reasons have been advanced by others,[1] but those above are sufficient to provide a justification for economic models.

An economic model is a theoretical statement of certain economic

[1]See, for example, Norton (1972) and Powell (1977).

functional relationships, often in algebraic terms. An econometric model is an elaboration and development of the economic model, so that the relationships are quantified. An econometric model is distinguished from an economic model by rigorous empirical content and analysis.

This can be regarded as an advance in economic model building, since quantitative answers to actual problems in economic systems can be obtained. This has been made possible by three intellectual developments in the last half century, paralleling developments in economic theory. They are:

(i) Since the 1930s, great advances have been made in measuring economic concepts. The best example of this is probably the development of national economic accounting which provides estimates of such important Keynesian aggregates as national income, gross product and consumption expenditure. This work, while pioneered by individuals,[2] has now been largely assumed by national statistical organizations (such as the Australian Bureau of Statistics).

(ii) The statistical and mathematical methodology necessary to formalize, estimate and operate relationships in economic models has advanced greatly since the formation of the Econometric Society in 1930. It is worth quoting part of the expressed aims of this Society: "The Econometric Society is an international society for the advancement of economic theory in its relation to statistics and mathematics ... Its main object shall be to promote studies that aim at the unification of the theoretical-quantitative and the empirical-quantitative approach to economic problems and that are penetrated by constructive and rigorous thinking similar to that which has come to dominate in the natural sciences."[3]

(iii) All of the effort necessary to produce the work listed above would be almost worthless were it not for the development of the electronic digital computer, which has not only eliminated the

---

[2]See, for example, Clark (1938).

[3]From Section I of the Constitution, quoted in every copy of *Econometrica*.

drudgery of tedious arithmetic, but has allowed model builders the capacity to plan and operate on a much higher level of complexity, simply because computers can construct, store, arrange and process numerical information in great quantity at great speed.

These advances have enabled econometricians to construct models of economic systems which provide numerical answers to questions posed by policy and decision makers, whether in government or in private business.[4]

This is an important service, given that actual economic systems are not amenable to replication and experimentation.

Most econometric model building effort has been directed to modelling aggregate or national economic systems. This is largely because of the development of Keynesian economics and the consequent attention given to solving problems of the stability and growth of national economies. This emphasis is an outcome of the greater involvement of national governments in economic management, and it has produced many benefits in understanding of econometric modelling. Much of the technical knowledge now held in this field has come from the Brookings quarterly econometric model of the United States (which has been completely superseded by newer, presumably better models). As Klein concluded in the mid-seventies review of the Brookings model in Fromm and Klein (1975, p. 14), " ... the Brookings model project served primarily as a research center for theoretical and methodological work on econometric model building".

Some of the major macro-econometric models which have been built in the United States are:[5]

---

[4]For a brief discussion on the worth of macro-economic modelling, see Jonson and Norton (1979).

[5]Of course, models have been built for many other countries: e.g. for the UK, see, Pearce (1976) and Ball (1974); for Canada, see, Helliwell *et al.* (1969); for Japan, see, Tatemoto *et al.* (1977). Waelbroeck (1976) contains details of models for Australia, Austria, Belgium, Canada, Finland, France, West Germany, Italy, Japan, Netherlands, Sweden, United Kingdom, United States of America and several groupings of developing countries.

(a) The Brookings quarterly econometric model.[6] This model was constructed in the early 1960s by a "committee" of economists each concerned with his own speciality. At the time, the Brookings model was the largest ever attempted and incorporated many new theories and techniques. It contained 176 endogenous and 89 exogenous quarterly variables, and was estimated from 1949 to 1960.

(b) The Wharton annual and industry forecasting model.[7] This model is a derived version of the original Wharton model, and provides disaggregated long-term forecasts of price and quantity data, through having built into it an input-output information system.

(c) The DRI (Data Resources, Inc.) Model.[8] This is currently the largest macro-econometric model, with 718 endogenous and 170 exogenous variables. It has been estimated from first quarter 1956 to second quarter 1976. The DRI model is also highly disaggregated by industry and is attached to an input-output system. It is interesting to note that this model was estimated and is maintained by a commercial venture which sells services, information and forecasts to subscribers in government and industry.

In Australia, there have been four major macro-econometric model building efforts. These are:[9]

(i) The Reserve Bank of Australia suite of models.[10] There are two groups of models - the first, RBI, was developed during the late 1960s and has by now decayed enough to be considered obsolete. The other group, RBII, contains 'minimal' models in continuous time. This group is currently being further developed and analysed.

---

[6]See Duesenberry *et al.* (1965).

[7]See Preston (1975).

[8]See Data Resources, Incorporated (1976).

[9]For a good introduction to the first three sets of Australian models, see Challen and Haggar (1979). This listing excludes two earlier models of the Australian economy, Kmenta (1966) and Nevile (1975). McKibbin (1980) is a comparative analysis of three Australian models.

[10]See Norton and Henderson (1972) and Conference in Applied Economic Research (1977).

(ii) The Australian Treasury and Australian Bureau of Statistics Model.[11] This model is similar in style to the earlier RBI model, but has been maintained sufficiently to be still in operation. It is usually referred to as the NIF model (National Income Forecasting). The model is quarterly. It is not limited to forecasting purposes and is the best placed to contribute economic policy advice to the Australian Government.

(iii) The IMPACT Model.[12] The IMPACT project is an inter-agency (Australian Government Departments) project designed to obtain " ... insights into a wide range of medium through long term issues relating to the *structure* of the Australian economy and its workforce".[13] The project consists of four modules, which comprise two models. This is shown in Figure 2.1.

(iv) The Institute of Applied Economic and Social Research Model.[14] This is the Institute Multi-Purpose Model (IMP model). This ambitious model was developed at the University of Melbourne largely as a contract service for providing econometric forecasts of the Australian economy for a number of private companies. The model structure has not been published, but has been reported to contain over 6000 equations in 8 modules covering 125 sectors of the economy. Brain (1977, p. 59) reported that a regional (state) module was planned.

2.2 THE CASE FOR REGIONAL ECONOMETRIC MODELS

Much effort has gone into certain areas of macro-econometric modelling - particularly into disaggregation by industry. This is an

---

[11] See Higgins and Fitzgerald (1973a).

[12] See Powell (1977).

[13] Powell (1977, p. 11).

[14] See Brain (1977).

Figure 2.1: The structure of the IMPACT project

Modules	Models
1. MACRO - a small macroeconomic model	
2. ORANI - an industry composition model	IMPACT medium term annual model
3. BACHUROO - an economic-demographic and labour force model	
4. SNAPSHOT - long term scenarios in demography, technology and trade	SNAPSHOT long term model

Source: Powell (1977)

important disaggregation and it is recognized that any serious attempt to model an economy must examine industry interrelationships.

However, this is not the only disaggregation which should be considered. Regions within nations also can behave differently from each other - just as can industries. Engerman (1965, p. 30) found that " ... It appears that regional cyclical differentials are of considerable importance, and that they are caused to a significant degree by specifically regional (as distinct from purely industrial composition) factors." The argument that regional differences are caused only by differences in industry structure is a gross simplification. It is tantamount to saying that the same industries behave in the same way, regardless of location. If this is true for regions, then it should be true also for nations. This would have fundamental new implications for inter-national trade theory, if it were true. To assume an industry homogeneous across regions implies constant supply and demand conditions facing the industry. That is, there are no structural differences between firms in the same industry, labour market conditions are the same everywhere, transport costs are not significant, and so on. This is clearly untenable. There exists, then, a case for the regional disaggregation of macro-econometric models, just as for disaggregation by industry.

The emergence of such supra-national economic systems as the European Economic Community (EEC) can support this point. Would it be seriously questioned that the establishment of common tariffs (to the rest of the world), common industry policies (e.g., in agriculture and iron and steel) and free factor mobility (within the EEC) has eliminated the justification for separate national macro-econometric models? Since the member nations of the EEC still have available formidable instruments in fiscal, monetary and external policy, and still have their own interests as primary objectives, the answer can only be that the justification still exists. In fact, it can be argued that common policies, and gradual economic integration, have resulted in a further need for economic modelling, viz a Community wide macro-econometric model, which should be disaggregated by industry, nation and (sub-national) region. (Efforts are now being made to integrate a number of national (broadly OECD) macro-econometric models together to investigate trade linkages.)[15]

There can be no doubt that, while the member nations of the EEC still concern themselves predominantly with their own macro-economic concerns, there exists a need for macro-economic coordination at the Community level. This is stated explicitly in the Treaty of Rome. As Swann (1970, p. 134) states it:

> The Community rules for dealing with cyclical and balance-of-payments problems are contained in Articles 103 to 109. Article 103 is the only one relating to cyclical policy. It states that member-states shall regard as a matter of common concern their short-term economic policies and shall consult with each other and the Commission on measures to be taken in response to current circumstances. Article 104 enjoins each member-state to walk the all too familiar tight-rope: they shall pursue the economic policies necessary to maintain equilibrium of the balance of payments and confidence in the currency whilst simultaneously ensuring high employment and stability of prices. In order to achieve all this, Article 105 requires the member-states to co-ordinate their economic policies. This Article specifically calls for co-ordination in monetary matters as well as collaboration between budgetary authorities and central banks. Article 106 ... is designed to deal with the problem of exchange control inhibiting the integration of commodity and capital markets. Article 107 requires each member-state to treat its policy with regard to exchange rates as a matter of common interest.

The situation in the EEC can be compared with that existing in a federation, e.g. the USA, Canada and Australia. The component states of a federation share common tariffs, common exchange rates, a common monetary system, free factor mobility and a central government with responsibility for the overall direction and coordination of stabilization policy. (It is possible that the EEC if political integration proceeds, may evolve to such an economic system.) The component states all have state governments which can implement certain economic policy instruments. In the USA, for example, state income taxes are not uncommon, and in Australia, Stage 2 of the New Federalism arrangements provide that,

---

[15]This is Project LINK, an attempt to study the international transmission mechanism by linking together a number of national econometric models through their trade equations. See Ball (1973) and Waelbroeck (1976).

(22) Under Stage 2 each State will be able to legislate to impose a surcharge on personal income tax in the State (but not company taxation or withholding tax on dividends and interest) additional to that imposed by the Commonwealth, or to give (at cost to the State) a rebate on personal income tax payable under Commonwealth law and to authorise the Commonwealth to collect the surcharge or grant the rebate as its agent.

.
.
.

(26) The level of any State surcharges or rebates will be a matter for consideration by each State; relevant decisions will be taken within an appropriate framework of consultation with the Commonwealth and, as considered appropriate by the surcharging or rebating State, with other States, but ultimately the level of surcharge or rebate will be a decision for each individual State. In exercising these powers the States will accept responsibility to work in parallel with and not in negation of the overall economic management policies of the Commonwealth.[16]

It is not meant to suggest here that stabilization policy, using fiscal instruments, is feasible for the states of the Australian Commonwealth. It is suggested, though, that the size of state governments in a federation such as Australia, and their influence on economic activity are often underestimated. In Australia, in 1978-79, government final consumption expenditure by State and Local Authorities was $10981m; while by Commonwealth Authorities it was only $5763m, about one-half that of the other governments.

Engerman (1965) has placed the primary responsibility for the determination of macro-economic stabilization policy with national or federal authorities. This is not unreasonable, given the need for overall national well-being, the need for coordination, and the difficulty, due to demand spillovers, of limiting or regionalizing state government policy effects. However, he goes on to say:

Nevertheless, the fact that the federal government is the most efficient unit for undertaking stabilization measures and for bearing their costs does not eliminate a concern with regional factors, nor does it follow that state (and

---

[16] Australian Treasury (1978, p. 14). This reference is the 1978-79 Budget Paper No. 7 of the Commonwealth of Australia.

> local) governments have no role to play in stabilization policy. Indeed, through proper inter-level cooperation, a more efficient regional orientation can be secured than would be possible by reliance on purely federal policies, such as the letting of contracts on the basis of regional criteria (as distinguished from cost alone), the use of regionally selected public works programs, or regionally oriented variation in excise tax rates. State and local governments can function as administrative and planning units in the implementation of federally financed policies. Perhaps the most efficient policy would establish federal grants to state (or local) governments yet leave these governments considerable discretion in the choice of specific programs.[17]

A different point of view, however, is provided by Breton and Scott (1978, p. 141), who claim that: (First) ...

> ... stabilization policy need not be conducted by 'national' governments. Both micro and macro stabilization policies can be carried out at various levels. Second, we have shown that organizational costs will vary with the level chosen. Third, we have shown that while it is feasible to assign powers pertaining to a different level than the currency and monetary policy powers are assigned, co-ordination problems might tend to place the assignment of powers to implement macroeconomic stabilization policies at one of the two levels only. But, to reiterate, that level need not be the 'national' level.

Without taking a position on the level of assignment of the stabilization functions in the Australian federation, it is suggested that more attention could be paid to state aspects of national stabilization.

In other words, it is suggested that the Australian states themselves demand answers to economic problems within their own borders, and share responsibility, with the Commonwealth, for their own economic performance. Table 2.1 demonstrates that there are differences in three of the main macro-economic indicators among the states and territories of Australia. Unemployment and inflation are shown since they are important indicators of stability. The state with the highest unemployment rate in May in 1979, South Australia, had a 44% higher rate than the lowest state, Victoria. Inflation (as measured by the rate of change of the consumer price index) had a range of 1.2% in

---

[17] Engerman (1965, p. 56).

Table 2.1: Selected economic indicators, by state

Region	Unemployment rate, total (%) (May 1979)	Consumer Price Index: All Groups. Percentage change from previous year[a] (%) (1979-80)	Average Weekly Earnings:[a] All employees ($) (May 1979)
New South Wales	6.3	10.6	210.40
Victoria	5.2	10.0	211.90
Queensland	6.4	9.7	199.10
South Australia	7.5	10.1	195.80
Western Australia	6.7	9.4	200.70
Tasmania	6.1	10.2	202.00
Northern Territory	5.7	-	-
Australian Capital Territory	7.7	10.7	242.50
Australia	6.2	10.1	207.90

[a] Metropolitan areas for states and territories. Weighted average of seven capital cities for Australia. Darwin not included.

Sources: ABS, Catalogue Nos. 6201.0, 6302.0 and 6401.0.

1978-79. Earnings were included in Table 2.1 to illustrate differences in wage-earner incomes among the states. Average weekly earnings in South Australia in May 1979 were $195.80. This was 7.6% below the figure for Victoria, the state with the highest average weekly earnings. Interestingly, the Australian Capital Territory had, for the periods listed in Table 2.1, the highest unemployment rate, the highest rate of inflation, and the highest average weekly earnings. While the high earnings reflects the concentration of well paid public servants, and thus a specialized industry/occupation structure, it is clear that the comparatively massive government expenditures in the ACT have not resulted in low unemployment in the ACT, but, due to the spillover effect of import leakages, have had employment generating effects which have been dissipated throughout Australia.

Table 2.2 shows annual growth in real gross product for both Queensland and Australia for the years 1970-71 to 1978-79. These GSP data are taken from Chapter 3 of this thesis. They reveal considerable differences in the level and timing of economic growth.

Differences in economic structure and activity among the states make the simple scaling down to the states of national aggregates from national macro-econometric models inappropriate. As well, since national econometric models do not include individual state policy instruments, they cannot be relevant to state policy makers. It is important to note that states have the political will to be interested in, and to affect in practice, their own economic growth, development and performance. It would be difficult otherwise to see the need for such state departments as Queensland's Department of Commercial and Industrial Development and Victoria's Department of Economic Development.

Klein (1969, p. 105) has given a clear rationale for the need for regional, as well as national econometric models:

> Users of econometric forecasts or policy simulations are generally not satisfied with estimates of *national* production, income, employment, and similar variables. They want to know these magnitudes for specific industries or regions. National governments and companies with nationwide markets are keenly interested in the national aggregates now generated by econometric models, but state governments and businesses with limited market areas have special interests in the generation of regional variables.

Table 2.2: Comparison of rates of real economic growth in Queensland and Australia, 1970-71 to 1978-79

Year	Rate of Growth of real GSP in Queensland (%)	Rate of Growth of real GDP in Australia (%)
1970-71	4.2	5.3
1971-72	7.1	4.3
1972-73	8.5	3.5
1973-74	5.1	4.9
1974-75	6.6	1.1
1975-76	0.7	1.5
1976-77	3.7	3.1
1977-78	1.9	0.7
1978-79	5.0	3.3

Source: This thesis and ABS, Catalogue No. 5204.0, 1978-79.

Callaghan (1977, p. 120)[18] made reference to " ... the need for more adequate tools of economic analysis to enable assessment of the State's economic structure--in particular the need to use input-output tables to determine inter-industry relationships on a quantitative basis, the preparation of regional (State) accounts on a national accounting basis and manpower planning to attempt to identify skilled labour shortages and future requirements of industry".

Regional or state econometric models would also help to provide more adequate tools.

Also, given general acceptance among economists of the validity of the position of Engerman (1965) (see above), regional econometric models should be of interest to federal macro-economic policy makers. In particular, it should be emphasized that there exists a need for attention to be paid, at the federal level, to the regional, or state, differential impacts of federal expenditure, and to the way in which these individual state results add up to the national macro-economic aggregates. There has been a lack of such attention, certainly in Australia. This can easily be demonstrated, by pointing out that no estimates are publicly or officially available for federal government expenditure in the separate states of Australia. This can be contrasted with the situation in the USA, where such estimates are generally available from official sources. Other national macro-economic policies and instruments may also have different effects in different states. The impact of levels of protection from overseas imports falls heaviest on those states not engaged in the production of overseas import substitutes. Variations in exchange rates can also be expected to have different state impacts, favouring those states which specialize in overseas export activity.

It is perhaps time that more attention was paid to these aspects of national stabilization policy, and it is suggested that the construction of an individual macro-econometric model of Queensland is an appropriate first step towards devising a state disaggregated national macro-econometric model of Australia.

---

[18]This reference is the *Inquiry into the Structure of Industry and the Employment Situation in Tasmania.*

2.3 REGIONAL ECONOMIC MODELS

Four main types of regional economic model have been developed empirically. These are:

(a) Economic base models,
(b) Input-output models,
(c) Systems dynamics models, and
(d) Regional econometric models.

These will be discussed in turn. However, since types (a) to (c) are not central to this study and since comprehensive references are available elsewhere[19] they will be discussed only briefly. A number of other types of regional model have been developed, but they are disparate in their objectives and methodologies, and generally are appropriate only for regions smaller than a state, both physically and functionally. Examples include:

(i) Impact or "implications" models such as the GRIM (General Regional Impact Model) developed in Stark *et al.* (1977), which determines the industrial employment and migration implications for a region of alternative projected population growth scenarios;

(ii) Programming models such as the DREAM (Dynamic Regional Economic Allocation Model) model developed in Karlqvist *et al.* (1978), which optimizes the objective functions of a model specified by a set of linear constraint equations, following the basic ideas of Tinbergen (1967).

(a) Economic or export base models

The specification of the economic base model is that regional outputs are determined by regional exports (the economic base of the region or its "basic" industries) i.e.,

$$y_r = f(x_r)$$

---

[19] See, for economic base, Isard (1960), for input-output, Richardson (1972), and for systems dynamics, see Forrester (1971).

where y_r is the rate of growth of output in region r, and x_r is the rate of growth of exports of region r. While this specification considers the importance of external trade to regional economic activity, unfortunately in its simplest form it concentrates on exports to the exclusion of other factors influencing regional growth, such as investment flows and immigration. It provides a theoretical justification for the specification of many early regional econometric models which allowed national output to "drive" regional output, since national output (demand) determined regional exports. This explains how economic base models may be considered in some cases to be a subset of regional econometric models.

Wong (1974), having found that the limited data requirements for estimating an economic base model for Tasmania made such estimation feasible, proceeded to determine two models, for the short and the long run.

Wong's results were, however, not particularly useful for general application. The long run model is inherently suspect and the short run model was a complete failure since, as Wong (1974, p. 244) admits " ... the estimated model contradicted the economic base hypothesis by producing the wrong (negative) signs for the regression coefficient". This means, of course, that an increase in basic activity would lead to a decrease in non-basic activity. This result may have arisen from incorrect use of data. Wong claims that the industry, building and construction, is basic. This is difficult to believe for an island state. This "contrary" classification is advanced by Wong because of the value of the location quotients for employment in building and construction.[20] These range from 1.05 (in 1970-71) to 1.73 (in 1952-53). Since the location quotients are all greater than one and in about half of the years of the period are greater than 1.3, the conclusion may seem justified. It is not justified, though, since a careful examination of the data reveals a set of high values (range from 1.32 to 1.73, mean of 1.5) for all the twelve years from 1948-49 to 1960-61, and a step down to a set of low values (range from 1.05 to 1.19, mean 1.1) for the eleven years from 1960-61 to 1970-71. There was a

[20]Wong (1974, p. 190).

reclassification in 1960-61 of industry groups in Tasmania, and it would seem that the data are biassed because of this.

Peppin (1974) is another example of an application of economic base theory in Australia. Peppin analysed the economy of Mount Isa, an isolated mining city in the north-west of Queensland. Three components of basic activity were identified with employment as the measuring statistic: employment by the main mining company in the area, Mount Isa Mines Limited; employment in "entities that service or provide inputs to Mount Isa Mines Limited",[21] and; "export employment in those industries unrelated in either input or output linkages to the operations of Mount Isa Mines Limited".[22]

Peppin found that, over the period from 1954 to 1971, the share of the company in total employment in the area fell, and, as well, the overall share of employment in export activity fell. The latter share declined from 81% in 1954 to 58% in 1971. However, during this time the population of urban Mount Isa rose from 7433 to 25240 and company employment rose from 2886 to 5434. Given these facts, it is not surprising that Peppin, amongst other things, concluded:

> Because regional employment multipliers had been utilized by other researchers to project future employment and population levels for the particular areas under study, multipliers were derived for Mount Isa at each of the census dates under study. However, in the case of Mount Isa these multipliers were found to have little value as predictive tools. In view of this, the growth in the number employed in Mount Isa was better analysed in terms of the changing economic structures that have come about. It was shown that between 1954 and 1971 the Basic/Non-Basic ratio decreased from 4.14 to 1.38, indicating a move towards greater internal self-sufficiency in Mount Isa's economy.[23]

Such conclusions underline the weakness of economic base theory as a modelling framework. The relationship between the economic base of a region and total economic activity in the region is unlikely to

---

[21] Peppin (1974, p. 105).

[22] Peppin (1974, p. 105).

[23] Peppin (1974, p. 106).

be stable in the longer term. Economic base models have generally been criticized[24] as being weak in that: firstly, the output of the non-export industries of the region may be affected by factors other than the growth of exports; secondly, the export sector may not be homogeneous; and, thirdly, they are necessarily only two-region, rather than multiregional, models. However, they are inexpensive to produce, and they do not require much data that are not generally available.

(b) Input-output models

An input-output model consists basically of a transactions matrix which summarizes, in tabular form, the equations, for a region and a period of time, for the n industries,

$$O_i = \sum_{j=1}^{n} x_{ij} + y_i \qquad i = 1, 2, \ldots, n$$

where O_i is the output of industry i,

x_{ij} is the purchases of industry j of part of the output of industry i, for use in the production of output of industry j, and,

y_i is the final demand for the output of industry i, by households, governments, exports and capital.

This can be rewritten in matrix terms,

$$O = X + Y$$

and the x_{ij}, the inter-industry transactions, can be expressed

as $x_{ij} = a_{ij} \cdot O_j$

where the a_{ij} are termed direct or technical coefficients, and measure the contribution of industry i as input to the production process which produces one unit of total output of industry j.

This also can be written in matrix terms,

$$O = A \cdot O + Y$$

and the equation solved for total industry outputs in terms of the matrix of direct coefficients and the vector of final industry

---

[24] See, for example, Richardson (1973, pp. 16-22).

demands,

$$O - A \cdot O = Y$$

$$O = (I - A)^{-1} Y .$$

The matrix $(I - A)^{-1}$ measures industry multipliers, and so changes in industry output requirements (and, by using $x_{ij} = a_{ij} \cdot O_j$, inter-industry transactions) can be determined from planned or proposed changes in industry final demand,

$$\Delta O = (I - A)^{-1} \Delta Y,$$

since A is assumed constant.

This assumption incorporates one of the main criticisms of input-output models, viz, the rigidity of production relationships. Furthermore, it is difficult to incorporate time into such models. They are comparative static frameworks by nature, and it is unusual to see any effort made to make them dynamic.

Advantages of input-output models include the wealth of detail on inter-industry relationships which is revealed and modelled, and the potential for the linking together of regional input-output models into a national interregional model which can determine, with precision, interregional structural and trading patterns. Unfortunately the data requirements are enormous for the construction of even a single regional transactions matrix. Given budget constraints this has forced most of the estimated regional transactions matrices to be scaled down versions of national matrices. This disadvantage, coupled with lack of data on interregional trade flows, has made progress in inter-regional input-output modelling sparse and slow.

As well, input-output models have not proved to be, by themselves, good forecasting models. They are an excellent tool in tracing the structural impacts of changes in final demand, but cannot by themselves provide forecasts of final demands and hence industry outputs and requirements. This has resulted in the recent development, in the USA, of the linkage of regional econometric model and input-output models. An example of this work is L'Esperance *et al.* (1977).

There have been many estimations of regional input-output models throughout the world. A small selection of US work would include demands,

$$O - A \cdot O = Y$$

$$O = (I - A)^{-1} Y .$$

The matrix $(I - A)^{-1}$ measures industry multipliers, and so changes in industry output requirements (and, by using $x_{ij} = a_{ij} \cdot O_j$, inter-industry transactions) can be determined from planned or proposed changes in industry final demand,

$$\Delta O = (I - A)^{-1} \Delta Y,$$

since A is assumed constant.

This assumption incorporates one of the main criticisms of input-output models, viz, the rigidity of production relationships. Furthermore, it is difficult to incorporate time into such models. They are comparative static frameworks by nature, and it is unusual to see any effort made to make them dynamic.

Advantages of input-output models include the wealth of detail on inter-industry relationships which is revealed and modelled, and the potential for the linking together of regional input-output models into a national interregional model which can determine, with precision, interregional structural and trading patterns. Unfortunately the data requirements are enormous for the construction of even a single regional transactions matrix. Given budget constraints this has forced most of the estimated regional transactions matrices to be scaled down versions of national matrices. This disadvantage, coupled with lack of data on interregional trade flows, has made progress in inter-regional input-output modelling sparse and slow.

As well, input-output models have not proved to be, by themselves, good forecasting models. They are an excellent tool in tracing the structural impacts of changes in final demand, but cannot by themselves provide forecasts of final demands and hence industry outputs and requirements. This has resulted in the recent development, in the USA, of the linkage of regional econometric model and input-output models. An example of this work is L'Esperance *et al.* (1977).

There have been many estimations of regional input-output models throughout the world. A small selection of US work would include

Isard and Langford (1971), Schaffer (1976) and Loviscek *et al.* (1979).

Australian studies have included an input-output table for Tasmania by Edwards (1977) and the GRIT suites of tables produced for Queensland and South Australia by Jensen *et al.* (1977) and West *et al.* (1979) respectively.

(c) Systems Dynamics models

Systems dynamics is a method for simulating the dynamic behaviour of complex systems by concentrating upon the feedback processes within the system, which consist of a set of simultaneous differential equations. This methodology was developed initially by Forrester (1961) and applied to business management (Industrial Dynamics). Later it has been adopted to study, in increasing order of aggregation, urban systems (Forrester (1969)), regional systems (Hamilton *et al.* (1969)), national systems (Forrester (1980)) and the world system (Meadows *et al.* (1972)). Forrester (1980) is part of a debate on the suitability of the systems methodology to modelling national economic systems. Hamilton *et al.* (1969) is an excellent account of the development of a multiregional systems model to " ... analyse the economy of the Susquehanna River Basin and to define the role the basin's water resources would or could play in the future development of this economy".[25] Stark *et al.* (1977) contains details of the development of urban, regional and interregional systems models in Queensland. Brookbanks *et al.* (1973) and Telford *et al.* (1974) set out the model developed for the Northern Economic Planning Region of the UK. The authors of Brookbanks *et al.* (1973) suggest that systems dynamics methodology has several inherently desirable characteristics including simplicity and flexibility in operation (specific computer simulation languages have been designed for this methodology, e.g., DYNAMO and CSMP) and the explicit modelling of feedback loops. They also suggest that the methodology possesses two technical advantages over " ... more traditional model building approaches. Firstly, it has the ability to handle non-linear relationships ... " and " ... systems dynamics seems

---

[25] Hamilton *et al.* (1969, p. 2)

to be superior in its explicit treatment of time".[26] The first advantage is apparent, although "more traditional" econometric models are becoming non-linear, since the solution of sets of non-linear simultaneous equations is no longer a serious constraint on econometric model building owing to the use of Gauss-Seidel algorithms. The second advantage is illusory, since the development of quarterly models (and some monthly models) has allowed lag (or delay) specifications as well as the "explicit treatment of time".

A main advantage of systems dynamics as a modelling methodology for economic systems, would seem to be its data requirements, which are not as voracious as traditional econometric models. This, as well as its flexible structure, makes systems dynamics particularly suitable for modelling sub-state economic systems.

(d) Regional econometric models

These are a specialized subset of econometric models. An econometric model can be defined as a set of relations, usually stochastic, and between empirically known variables, which represents some economic system.

Generally, for the linear case,

$$y_t \Gamma + x_t B = \varepsilon_t \qquad t = 1, 2, 3, \ldots, n \qquad \ldots. \; 2.1$$

where, for time period t, y_t is a vector of g endogenous variables,
x_t is a vector of k exogenous or lagged endogenous variables,
ε_t is a vector of g stochastic disturbance terms, and,
Γ and B are matrices representing the coefficients of the endogenous, and the exogenous and lagged endogenous variables, respectively.

Since Γ is square (for the system to be capable of solution, the number of equations should equal the number of endogenous variables), and can be assumed to be non-singular, the system can be rewritten,

[26] Brookbanks *et al.* (1973, p. 74).

$$y_t = -x_t B \Gamma^{-1} + \varepsilon_t \Gamma^{-1} \quad \text{.... 2.2}$$

or $$y_t = x_t \Pi + u_t$$

where $$\Pi = -B \Gamma^{-1}$$

and $$u_t = \varepsilon_t \Gamma^{-1} .$$

Equation 2.2 is the reduced form of the system, in which each of the exogenous variables is expressed as a linear function of all the exogenous and lagged endogenous variables in the system, and in which the impact multipliers are revealed.

A linear system can of course be solved deterministically, but a non-linear system must be solved using an iterative algorithm, e.g., the Gauss-Seidel procedure.

Econometric models can be more complex in their specification than export base models. The latter may be used as part of the overall specification of a regional econometric model. In general, econometric models are more flexible than either export base or input-output models. Econometric models lack the structural detail of the general-equilibrium input-output model, but are regarded as being less expensive to produce and, as well, may provide a better forecasting service.

2.4 A SURVEY OF SELECTED REGIONAL ECONOMETRIC MODELS

2.4.1 An overall survey

Table 2.3 gives a tabular listing of the important characteristics of twenty-three of the more interesting of the empirically estimated and published regional econometric models. Of these twenty-three models, there are twenty-one individual regions, eighteen in the USA. This reflects the historical development of regional econometric models in the USA, but is not independent of the type of region breakup. Fourteen of the regions are for states or provinces in federations,

Table 2.3 A Tabular Survey of Selected Regional Econometric Models

AUTHOR (DATE)	REGION (POPULATION : DATE) '000 persons (AREA)	NUMBER OF EQUATIONS (IDENTITIES) (BIVARIATE)	FREQUENCY	ESTIMATION METHOD(S) (PERIOD)	PER CENT OF VARIABLES MAPE < 5%	FORECAST SIMULATIONS	POLICY AND ANALYTICAL SIMULATIONS
RESEARCH SEMINAR ON QUANTITATIVE ECONOMICS (1965)	MICHIGAN (9,082 : 1972) (147,156 sq km)	78 (0) (np)	ANNUAL	OLS 1949-64	n.p.	n.p.	none
BELL (1967)	MASSACHUSETTS, STATE (5,787 : 1972) (20,269 sq km)	16 (3) (6)	ANNUAL	OLS and TSLS (1947-62)	n.p.	ex ante - 15 years	Effect of growth rates on unemployment rates
GREEN (1967)	ILLINOIS (11,251 : 1972) (144,387 sq km)	14 (2) (1)	ANNUAL	OLS 1929-63	n.p.	ex post - 46 years (1964-2010)	Effects on forecast values of changes in state taxes were measured
CZAMANSKI (1968)	NOVA SCOTIA, PROVINCE (756 : 1966) (54,550 sq km)	54 (23) (18)	ANNUAL	OLS with Cochrane-Orcutt (1950-65)	n.p.	n.p.	Sensitivity tests
DUTTA AND SU (1969)	PUERTO RICO,STATE (2,712 : 1970) (8,860 sq km)	35 (12) (6)	ANNUAL	OLS (1948-64)	n.p.	n.p.	n.p.

Table 2.3 (continued)

AUTHOR (DATE)	REGION (POPULATION : DATE) '000 persons (AREA)	NUMBER OF EQUATIONS (IDENTITIES) (BIVARIATE)	FREQUENCY	ESTIMATION METHOD(S) (PERIOD)	PER CENT OF VARIABLES MAPE < 5%	FORECAST SIMULATIONS	POLICY AND ANALYTICAL SIMULATIONS
L'ESPERANCE *et al.* (1969)	OHIO, STATE (10,783 : 1972) (106,125 sq km)	27 (11) (5)	ANNUAL	OLS TSLS (1947-64)	n.p.	n.p.	Implications on GSP of changes in military prime contracts
GLICKMAN (1971)	PHILADELPHIA, SMSA (4,878 : 1972) (9202 sq km)	26 (9) (9)	ANNUAL	OLS TSLS LISE 1949-66 (part only 1955-65)	52%	ex post - 1 year ex ante - 2 years	Regional impacts of different Federal anti-inflation policies. Regional effects of Federal taxsharing policies.
CROW (1973)	"NORTHEAST CORRIDOR" OF USA[a] (58,400 : 1972) (452,720 sq km)	50 (8) (5)	ANNUAL	TSLS with PC (Pooled data) OLS (1949-63)	45%	ex post - 2 years	Impact of alternative military spending policies
MATTILA (1973)	DETROIT SMSA (4,489 : 1972) (9552 sq km)	13 (0) (0)	ANNUAL	OLS TSLS (1956-70)	n.p.	n.p.	Estimation of impact multipliers

[a]The Northeast Corridor comprises: New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, and Virginia.

Table 2.3 (continued)

AUTHOR (DATE)	REGION (POPULATION : DATE) '000 persons (AREA)	NUMBER OF EQUATIONS (IDENTITIES) (BIVARIATE)	FREQUENCY	ESTIMATION METHOD(S) (PERIOD)	PER CENT OF VARIABLES MAPE < 5%	FORECAST SIMULATIONS	POLICY AND ANALYTICAL SIMULATIONS
HALL AND LICARI (1974)	LOS ANGELES, SMSA (7,000 : 1972) (10,540 sq km)	29 (10) (10)	ANNUAL	OLS TSLS (1959-70)	86% for selected variables	ex ante - 6 years	1. Impact sensitivity tests 2. Multiplier estimation
WONG (1974)	TASMANIA, STATE (390 : 1971) (67,800 sq km)	3 (0) (1)	ANNUAL	OLS (1948-49 to 1971-72)	n.p.	ex post - 5 years	n.p.
ADAMS *et al.* (1975)	MISSISSIPPI, STATE (2,263 : 1972) (122,496 sq km)	39 (10) (4)	ANNUAL	OLS IIV (1953-70)	n.p.	ex post 2 years ex ante 8 years	1. Multiplier estimation 2. Energy shortage effects
GHALI AND RENAUD (1975)	HAWAII, STATE (809 : 1972) (16,641 sq km)	100 (26) (22)	ANNUAL	modified TSLS (1958-68)	n.p.	n.p.	1. Multiplier estimation 2. Agricultural output changes 3. Taxation changes 4. Impact of high energy costs 5. Impact of tourism

Table 2.3 (continued)

AUTHOR (DATE)	REGION (POPULATION : DATE) '000 persons (AREA)	NUMBER OF EQUATIONS (IDENTITIES) (BIVARIATE)	FREQUENCY	ESTIMATION METHOD(S) (PERIOD)	PER CENT OF VARIABLES MAPE < 5%	FORECAST SIMULATIONS	POLICY AND ANALYTICAL SIMULATIONS
L'ESPERANCE (1977)	OHIO, STATE (10,783 : 1972) (106,125 sq km)	39 (17) (7)	ANNUAL	3SLS (1951-72)	n.p.	n.p.	Test of feasibility of optimal stabilization policy at the state level
CHANG, H. (1977)	TENNESSEE, STATE (4,031 : 1972) (107,039 sq km)	77 (24) (np)	ANNUAL	OLS with Cochrane-Orcutt (1952-72)	n.p.	n.p.	Effects of alternative tax policies on the state economy
FISHKIND (1977)	INDIANA, STATE (5,291 : 1972) (93,491 sq km)	34 (17) (np)	ANNUAL	TSLS (1960-73)	∼ 44%	n.p.	1. Regional impact of monetary policy 2. State income tax cuts
RUBIDA (1977)	COLORADO, STATE (2,357 : 1972) (268,753 sq km)	180 (33) (np)	ANNUAL	OLS (1960-74)	n.p. [mean RMSPE = 4.7%]	ex ante - 7 years	1. Multiplier estimation 2. Comparative national/state scenarios including - coal boom - drought - military activity

Table 2.3 (continued)

AUTHOR (DATE)	REGION (POPULATION : DATE) '000 persons (AREA)	NUMBER OF EQUATIONS (IDENTITIES) (BIVARIATE)	FREQUENCY	ESTIMATION METHOD(S) (PERIOD)	VARIABLES MAPE < 5%	FORECAST SIMULATIONS	POLICY AND ANALYTICAL SIMULATIONS
GLICKMAN (1977)	PHILADELPHIA, SMSA (4,878 : 1972) (9202 sq km)	228 (123) (8)	ANNUAL (QUARTERLY SUBMODEL)	OLS TSLS with PC IIV OLS with Cochrane-Orcutt (1947-71)	60%	ex post - 3 years ex ante - 2 years - 8 qtrs long term - 11 years	1. Multiplier estimation 2. Oil shortage impacts 3. Employment change impacts 4. Revenue sharing effects 5. No-growth implications 6. Budget balancing 7. Defence spending impacts
JEFFERSON (1978)	NORTHERN IRELAND (1,536 : 1971) (13,483 sq km)	43 (19) (6)	ANNUAL	OLS TSLS with PC (1958-73)	87% (of selected variables)	ex ante - 2 years	n.p.
CHANG, S. (1979)	MOBILE COUNTY, ALABAMA (377 : 1970) (7,299 sq km) (Population and area data refer to Mobile SMSA)	20 (6) (2)	ANNUAL	OLS and TSLS (1962-76)	71%	ex post - 10 years	Impact of closure of military base

Table 2.3 (continued)

AUTHOR (DATE)	REGION (POPULATION : DATE) '000 persons (AREA)	NUMBER OF EQUATIONS (IDENTITIES) (BIVARIATE)	FREQUENCY	ESTIMATION METHOD(S) (PERIOD)	PER CENT OF VARIABLES MAPE < 5%	FORECAST SIMULATIONS	POLICY AND ANALYTICAL SIMULATIONS
LATHAM *et al.* (1979)	DELAWARE, STATE (565 : 1972) (5133 sq km)	np (np) (np) [116 endogenous variables]	QUARTERLY	OLS TSLS OLS with Cochrane-Orcutt (1963-01 to 1974-04)	31%	ex ante - 6 qtrs	1. 10% increases in real national variables 2. increased local employment responsiveness
ROBERTS AND FISHKIND (1979)	FLORIDA, STATE (7,259 : 1972) (140,092 sq km)	52 (7) (2)	QUARTERLY	TSLS (OLS subset) (1970-01 to 1976-04)	n.p.	ex post - 2 qtrs	1. Alternative financial market specification effects explored 2. Turning point validation simulation
RUBIN AND ERICKSON (1980)	MILWAUKEE, SMSA (1,423 : 1972) (3771 sq km)	97 (41) (12)	ANNUAL	OLS (1954-75)	85% of selected variables (GRP: 3.5%)	ex ante - 10 years	Effect of decline in national demand

n.p. not published

and of the remaining seven, one is for Northern Ireland and another is for an aggregation of states in the USA, while the other five are for urban areas (e.g. SMSA's) in the USA. The choice of the state as the type of region for most of these models (and it is claimed that this selection of models is a fair representation of the complete population of regional econometric models) is not a coincidence, but reflects the suitability of the state as an ideal level for regional modelling. The size of the state as a region is large enough to be properly modelled as an aggregate, since leakages and openness are not as pronounced as they are in very small regions, and, as was discussed above, states are regional units with policy capacity.

However, this has not prevented small regions from being modelled. Mobile County, Alabama, (Chang, S. (1979)) is the smallest listed in this survey, although Tasmania (Wong (1974)) is not very much larger.

Table 2.4 shows a cross-classification by population and area of the twenty-one regions. While land area is not in itself an important economic factor, it does identify the urban models. The population of Queensland, the subject of this model, was only 1.9 million persons in 1971. The other regions closest to the population size of Queensland are Colorado (2.4m in 1972), Northern Ireland (1.5m in 1971) and Mississippi (2.3m in 1973).

2.4.2 An analysis of the selected models

It will be useful to group the twenty-three models listed in Table 2.3 above into types of regional econometric model.

Regional econometric models can firstly be grouped into unrelated equations models and simultaneous equations models. Unrelated equations models are those in which no regional endogenous variable is used to help to "explain" another, i.e., the equations are completely independent, with all explanatory variables being national and exogenous to the model. Glickman (1977, p. 39) calls these models, "simple econometric models". Wong (1974, p. 19) calls them, "empirical models". An example might be,

Table 2.4: Cross-classification of the selected model regions by population and area

Population (millions of persons)	Area ('000 sq km) (A)					
	$A \leq 10$	$10<A\leq 50$	$50<A\leq 90$	$90<A\leq 140$	$A>140$	Totals
< 1	2	1	2			5
1 - 2.9	2	1		1	1	5
3 - 5.9	2	1		2		5
6 - 8.9		1		1		2
9 - 11.9				1	2	3
≥ 12					1	1
Totals	6	4	2	5	4	21

$$GSP_t = \alpha_0 + \alpha_1\ GDP_t$$

$$REGEMP_t = \beta_0 + \beta_1\ NATEMP_t + \beta_2\ NATWAG_t$$

when

GSP_t = gross state product in period t

GDP_t = gross domestic product (of the nation) in period t

$REGEMP_t$ = regional employment in period t

$NATEMP_t$ = national employment in period t

$NATWAG_t$ = national wage rates in period t.

Simultaneous equations models are those in which endogenous variables may help to "explain" other endogenous variables. In these models the system is more complex and is interconnected. Various equations depend on one another. An example of such a model is the familiar two sector Keynesian model,

$$Y_t = C_t + I_t$$

$$C_t = a + b\ Y_t$$

$$I = I_o ,$$

where Y_t is partly composed of C_t, but C_t is determined by Y_t.

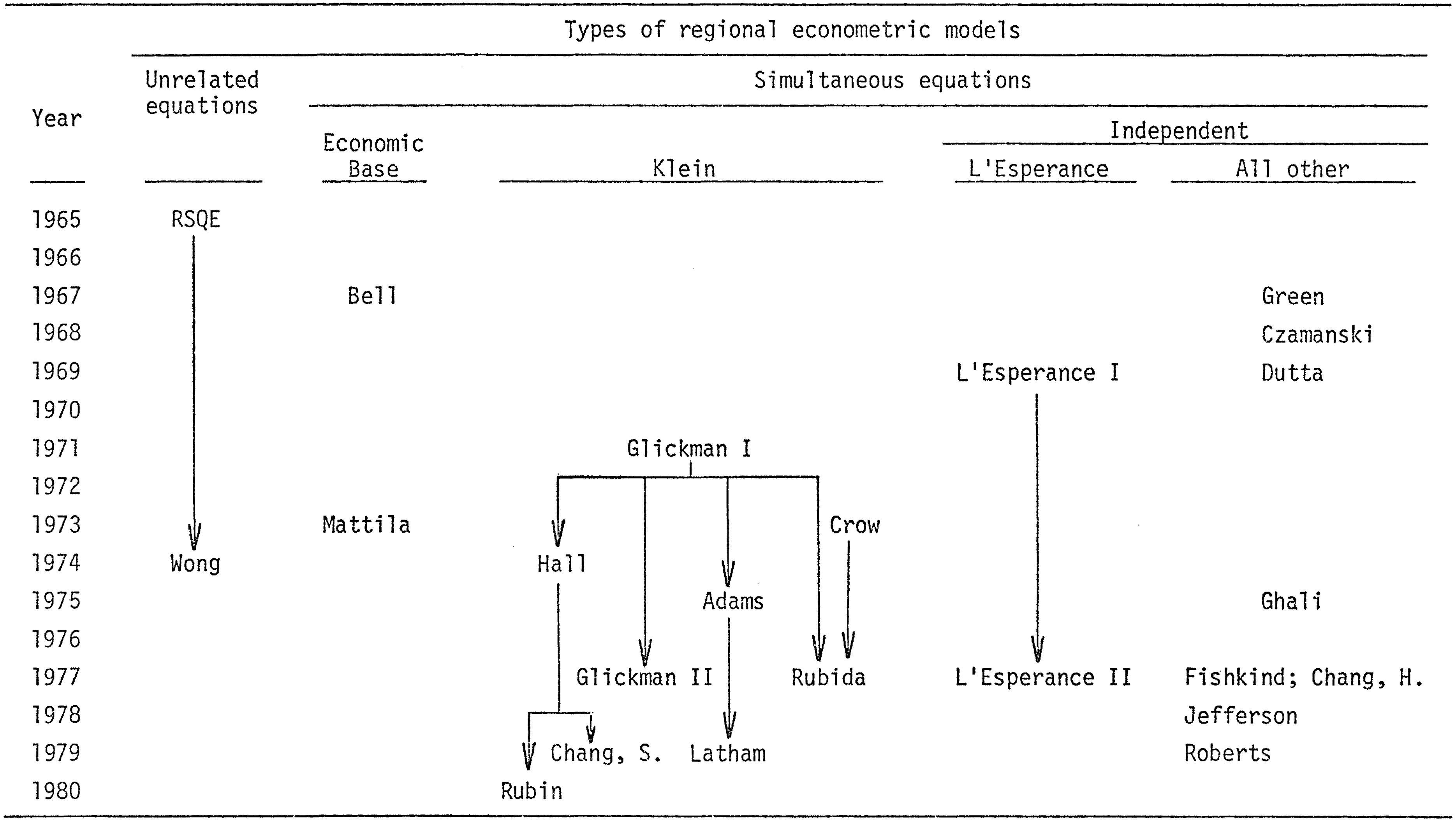
Simultaneous equations regional econometric models may be further classified into three types. These are:

(i) Economic base specification models,
(ii) Klein models, and,
(iii) Independent models, which can be further subdivided into;
  (a) L'Esperance models, and,
  (b) All other models.

Figure 2.2 shows how the twenty-three selected models have developed through time within their classification.

To a certain, but unmeasurable extent, there has been cross fertilization of ideas and techniques across the classification

Figure 2.2: Perspective of the selected models



Note: The arrows represent developmental influence. Only the first author name of a reference has been used.

barriers imposed here. However, this classification is a useful simplification of the differences among regional econometric models and provides a convenient framework for analysing the models in turn.

It should be emphasized that the models of the category *Independent* are classified together more on their dissimilarity to other models and their exclusion from certain research establishments, rather than on any internal similarities. They are a quite heterogeneous group, reflecting the inherent flexibility and catholic nature of econometric models.

The categories will be discussed in turn.

2.4.2.1 Unrelated equations models

The most important of these models is the Michigan model of the Research Seminar on Quantitative Economics of the University of Michigan at Ann Arbor. This is also the oldest model.

The technique of the unrelated equations model was to use a set of completely independent difference equations to predict state variables from related national variables. The state variables of the model included gross state product, personal income, employment, retail sales, labour force, state and local taxes and federal income taxes collected. The purpose of the model was to provide forecasts of these state variables for the Michigan Department of Economic Expansion. As Glickman (1977, p. 40) explains, "There is a Michigan law which prohibits a deficit in the state fiscal budget. Thus, knowledge of future tax revenues will give officials an estimate of the upper bound on expenditures for a given fiscal period". This seems reasonable, but does not provide any explanation of why non-tax variables were required. By the independent nature of the model equations, Michigan personal income, for example, could not affect the tax forecasts. Knowledge of non-tax forecasts may have been useful for decision makers other than those in the Department named above, but even if this is so, it is still not clear why, national variables should provide explanatory value superior to regional variables for some equations, e.g. retail sales, which are determined mainly by regional disposable income, rather than national components of gross product.

The technique has little to recommend it since the only theory behind it is *ad hoc*, and, in fact, the technique can be said to deny the existence of the workings of a regional economy. The technique provides nothing but the crudest kind of forecast.

Wong (1974) set out to determine the feasibility of constructing, for Tasmania, any one or all of a set of what were defined as different types of regional econometric model. These were: empirical models; economic base models; input-output models; production function models; and social accounting models. Of these, Wong decided only the first two were feasible. The most important criterion for feasibility was data availability. Wong then proceeded to estimate an unrelated equations model for Tasmania, after first constructing a set of estimates of gross state product of Tasmania.

The model is described by Wong (1974, p. 151) as:

> designed for forecasting three Tasmanian aggregates: gross state product, total personal income, and total employment. It comprises three regression equations, each of which relates a particular Tasmanian aggregate (the regressand) to a number of Australian (and some overseas-sector) economic indicators (the regressors). The regressors to be used in the final forecasting equations were chosen from a set of eighteen potentially relevant explanatory variables ... The method used to decide which of these variables will be used in the three equations of our REMM was stepwise regression.

Three different functional form specifications (absolute values, first differences, and logarithms) were tried, and lag structure (Koyck and Almon) experiments were performed. Three equations emerged as the final preferred set, and forecasts using these equations were compared with those from two "intrinsic" time series models. The results were mixed. Theil's U statistic was used as a measure of the closeness of the forecasts to the actual values. (The forecasts were ex post.) For actual values, Wong's model produced lower U statistics. However, for changes Wong's model produced the smallest U statistic only for personal income.[27]

Furthermore, Wong's results for gross state product suffer from

---

[27]Wong did not notice that his first "intrinsic" model produced a lower U statistic for gross state product than his unrelated equations model. See Wong (1974, p. 240).

a data construction bias. Gross state product was constructed using a very simple allocation technique from national gross domestic product, and so regressing gross state product on national manufacturing gross domestic product could be expected to produce biassed results (R^2, for instance, will be biassed upwards). This problem also occurred in the Michigan model. Glickman (1977, p. 41) calls this "built-in" correlation.

2.4.2.2 Economic base specification models

These models, while simultaneous, bear some relationship to the unrelated equations models. They are also related to the following category, Klein models.

These models make explicit and predominant use of economic base theory in the overall specification. Due to the popularity of economic base theory, this specification was used extensively in the early seventies. While Bell (1967) is amongst the earliest and best regional econometric models specified with pure economic base theory, a number of others have been estimated, particularly in the USA. Such models (e.g. Mattila (1973) and Anderson (1970)) concentrate on using the reduced form of an estimated recursive model to provide impact multiplier estimates.

Bell (1967) traces his specification to Thomassen (1957) who was the first to develop the linking of regional to national employment variables. As Bell (1967, pp. 110-1) puts it:

> One theory of regional growth places heavy emphasis on the role of the export base. The ability of the region to export products and derive income from "outside" the region greatly determines the rate of economic expansion. It is clear that export income may include (aside from product sales) capital income from previous "foreign" (i.e., in other regions) investment and various transfer payments from the federal government. Regional export income will be a direct function of U.S. GNP which represents "foreign" markets and the actions of the federal government,

$$X_t = a + bGNP_t .$$

This model is highly recursive. US GNP drives regional exports which, together with GNP, drives successive variables through the model.

The implication of this is that gross national product determines all the results and forecasts of the model. It is not clear how this represents an improvement over the unrelated equations models.

Mattila (1973) is typical of the work in economic base models. Mattila (1973, p. 1) provides an explanation of the specification:

> The export base theory of regional growth and development provides the basic framework for this model. According to the export base theory, the local industries which produce primarily for export are the prime movers of a region in the short run. The demand for the output of these industries is determined largely by exogenous forces outside the region. These exogeneously [*sic*] induced changes in the export industries are then transmitted to the local service industries resulting in a change in total regional income which is some multiple of the initial change in exports. It needs to be emphasized that the export base theory is a theory of short-run or cyclical change because it has received much justifiable criticism as a theory of long-run growth.

This model is hardly an improvement on the simple recursive workings of the model of Bell (1967), since it also is highly recursive, with Detroit motor vehicle and machinery production (determined exogenously) driving all other export sectors. As well, the statistical fit of many of the equations estimated by Mattila can be questioned, e.g. the t values for the coefficients of the four variables explaining annual changes in income originating in the government sector were 0.00, 0.03, 0.33 and 1.17.

2.4.2.3 Klein models

The models in this category either were developed as a result of the impetus provided by Klein (1969), and reflect the specifications of that paper, or have grown out of such models under the attention of econometricians from the Wharton School, or have developed from these models.

Klein (1969) outlined a case for the development of regional econometric models. These were to develop as analogues of national macro-econometric models, and were to be directly linked to such national models, if possible. The specification of these models was an amalgam of standard Keynesian theory and economic base theory.

> I would recommend the building of regional macromodels very much in a form like that of the typical national macromodel, containing endogenous regional variables, exogenous regional variables (peculiar to the region being modeled and drawn from related regions), and national variables. The national variables may be exogenous to both local and national models, or they should be generated as endogenous variables from a national model.
>
> The typical regional macromodel will be similar to the typical national macromodel but will have some characteristics of its own ...[28]

Figure 2.3 contains a listing, as it appeared in Klein (1969), of the suggested specification of a regional macro-econometric model. The structure will be familiar to anyone with experience of national macro-economic models built on Keynesian theory. Equation (6), the social accounting identity, is immediately recognizable, as is the specification of most of the other equations. The overall model specification is strongly influenced by the Klein-Goldberger and Wharton-EFU models developed at the University of Pennsylvania.

The relation to economic base is recorded in the following passage:

> It is in the regional export/import equations, though, that I suggest a crucial link to the rest of the economy. Exports are expressed in the form of a demand equation for the ith region's goods as a function of national activity and relative prices. Similarly, imports depend on the relative prices between goods produced in the ith region and (external) prices of imports. These equations view the relationship between the ith region and the nation in approximately the same form that I would view the relation between a nation and the rest of the world, apart from the special influences of exchange rates and foreign exchange reserves.[29]

Klein intended this structure to serve as a starting point for the actual estimation of models of regions. He preferred to see individual regional models emerge, rather than see an attempt " ... to build a complete set of interlocked regional models simultaneously and obtain national magnitudes as the sum or average of corresponding

---

[28] Klein (1969, p. 108).

[29] Klein (1969, p. 112).

Figure 2.3: Klein's specification of an ideal regional macro model

Equation No.	Equation	Description
(1)	$C_i = C_i\left(\frac{Y_i}{p_c}\right)$	regional consumption function,
(2)	$I_i = I_i(X_i, r, K_{i_{-1}})$	regional investment function,
(3)	$G_i^{SL} = G_i^{SL}(T_i^{SL}, N_i, r)$	regional government expenditure,
(4)	$E_i = E_i\left(X, \frac{p}{p_i^m}\right)$	regional export function,
(5)	$I_{m_i} = I_i^m\left(X_i, \frac{p_i}{p_i^m}\right)$	regional import function,
(6)	$p_c C_i + pI_i + G_i^{SL} + G_i^F + p_i^e E_i - p_i^m I_{m_i} = p_i X_i$	gross regional product,
(7)	$T_{p_i}^{SL} = T_{p_i}^{SL}(w_i L_i, \pi_i)$	direct regional taxation (state and local),
(8)	$T_{x_i}^{SL} = T_{x_i}^{SL}(p_i X_i)$	indirect regional taxation,
(9)	$T_i^F = T_i^F(w_i L_i, \pi_i)$	federal taxation,
(10)	$T_{R_i} = T_{R_i}(U_i, N_i)$	regional transfer payments,

Figure 2.3 (continued)

Equation No.	Equation	Description
(11)	$D_i = D_i(K_{i_{-1}})$	regional capital consumption,
(12)	$Y_i = p_iX_i - T^{SL}_{p_i} - T^{SL}_{X_i} - T^F_i + T_{R_i} - pD_i$	regional disposable income,
(13)	$X_i = X_i(L_i,K_i)$	regional production function,
(14)	$p_i = p_i(p,w_i,p^m_i)$	regional price level,
(15)	$p^e_i = p^e_i\ (p,w_i,p^m_i)$	regional export price level,
(16)	$w_i = w_i(U,U_i,p_c)$	regional wage rate,
(17)	$K_i = K_{i_{-1}} + I_i - D_i$	regional capital stock,
(18)	$T^{SL}_i = T^{SL}_{p_i} + T^{SL}_{x_i}$	total regional taxation,
(19)	$\pi_i = p_iX_i - pD_i - w_iL_i - T^{SL}_{X_i}$	regional nonwage income, and
(20)	$U_i = \rho_iN_i - L_i$	regional unemployment.

Figure 2.3 (continued)

Definition of variables

Regional dependent variables (i^{th} region):

C_i = consumer expenditures,

Y_i = disposable personal income,

I_i = capital formation (fixed nonresidential, residential, inventory change),

X_i = gross regional product,

G_i^{SL} = state and local expenditures on goods and services,

T_i^{SL} = state and local receipts,

E_i = exports of goods and services,

p_i^e = price index of exports,

I_i^m = imports of goods and services,

p_i = GRP deflator,

$T_{p_i}^{SL}$ = state and local direct taxes,

w_i = wage rate,

L_i = employment,

π_i = nonwage factor income,

$T_{x_i}^{SL}$ = state and local indirect taxes,

T_i^F = taxes paid to federal government,

Figure 2.3 (continued)

Definition of variables (continued)

T_{R_i} = transfer payments,

U_i = unemployment,

D_i = capital consumption, and

K_i = capital stock.

Regional independent variables:

N_i = population,

G_i^F = federal regional expenditures on goods and services, and

ρ_i = regional participation rate for labor force.

National variables:

p_c = index of consumer prices,

r = interest rate,

p = GNP deflator,

p_i^m = import price index (prices outside i^{th} region),

X = GNP, and

U = national unemployment.

Source: Klein (1969, pp. 108-9).

variables over all regions".[30] The reason for this was:

> The data requirements of the above method of regional model construction are formidable enough, but they are much lighter than those that would be involved in building up national totals from fully interlocked regional models. The national models have already proven themselves in repeated testing, and it is likely that much poorer results would be obtained by trying to build complete interregional systems from a much weaker data base.[31]

While data limitations have curtailed any attempt to develop a national model from a set of interlocking regional models over the subsequent decade, this must remain an ultimate goal of regional (and indeed national) model building.

With the econometric resources available at the University of Pennsylvania, it was not surprising that Klein's paper should be shortly followed by important empirical work. Glickman (1971) was the first work to emerge from the supervision of Klein. Glickman specified and estimated a twenty-six equation model of the economy of the Philadelphia Standard Metropolitan Statistical Area (SMSA). However, while this work represented a significant departure from previous econometric models of regions, the specification, due to data problems, could not be said to resemble closely that outlined in Klein (1969). However, Glickman (1971) represented the first serious attempt to introduce actual interrelationships among the regional endogenous variables and actual policy variables and functions.

While Glickman (1971) was clearly only a simple first attempt, it attracted imitations, such as Hall and Licari (1974) and Rubida (1977), it served as a foundation for a new generalized specification, Adams *et al.* (1975), and it was itself further enlarged and improved by Glickman (1977).

Hall and Licari (1974) was an attempt to evaluate the statement by Glickman that, "It must be stressed, then, that the worth of this model be judged on ... its worth as a prototype for other small area

---

[30]Klein (1969, p. 112).

[31]Klein (1969, p. 112).

econometric models".[32] Hall and Licari were particularly attracted to Glickman's structure by its simultaneity and hence its capacity to account for "important feedback and interactive effects contributing to the regional economy's overall behaviour".[33] The transplant of Glickman's specification was reported by Hall and Licari (1974, p. 352) to be a success:

> As for the model, itself, both intrasample and extrasample behaviour indicated a generally satisfactory performance capability, in fact, frequently better than in Glickman's original work with Philadelphia. However, there appears to be a need for the development of additional sectors such as banking and finance and aerospace to improve both resolution and short-run dynamics. Another logical step would be an expansion of the Los Angeles specification into an area-stratified model along Glickman's most recent lines.
>
> Nonetheless, the success of the application of Glickman's general structure to the Los Angeles SMSA offers strong evidence that it may indeed provide a meaningful prototype for the construction of small area econometric models throughout the country. One can easily envision a series of such regional models linked to the Wharton national model for the purpose of translating national economic forecasts into their regional counterparts. The greater availability of these regional projections would be a most welcome addition to the public policy decision matrix within small regions.

In fact, this form of specification is still being used in the USA for the estimation of models of small areas. Chang, S. (1979) is the latest published model incorporating the standard Glickman (1971) - Hall and Licari (1974) technique. This condensed application may become even more widespread following the release of the US Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System. This was used by Chang, S. (1979). This system makes available " ... annual time-series data of personal income and employment by industry source at the county level for years back as far as 1959".[34]

The structure of Glickman (1971) is contained in Figure 2.4.

---

[32] Hall and Licari (1974, p. 337).

[33] Glickman (1971, p. 16), quoted in Hall and Licari (1974, p. 337).

[34] Chang, S. (1979, p. 437).

Figure 2.4: The Structure of the Glickman (1971) regional econometric model

Equation	Dependent Variable	Regression Estimate
(1)	Output in Sector 1	Q1 = Q1(USGNP)
(2)	Output in Sector 2	Q2 = Q2(PY)
(3)	Output in Sector 3	Q3 = Q3(PY)
(4)	Gross Regional Product	GRP = Q1 + Q2 ÷ Q3
(5)	Investment in Sector 1	$I1 = I1(K1_{-1}, Q1, I1_{-1})$
(6)	Capital Stock in Sector 1	$K1 = K1_{-1} + (I1 - D)$
(7)	Employment in Sector 1	E1 = E1(Q1,TIME)
(8)	Employment in Sector 2	E2 = E2(Q2)
(9)	Employment in Sector 3	E3 = E3(GRP)
(10)	Total Employment	TEMP = E1 + E2 + E3
(11)	Average Annual Money Wage in Sector 1	MAW1 = MAW1(UNNO,MAW1*)
(12)	Average Annual Money Wage in Sector 2	MAW2 = MAW2(UNNO,MAW2*)
(13)	Average Annual Money Wage in Sector 3	MAW3 = MAW3(MAW3*)

Figure 2.4 (continued)

Equation	Dependent Variable	Regression Estimate
(14)	Consumer Price Index	P = P(TWB/GRP)
(15)	Average Annual Real Wage in Sector 1	RAW1 = MAW1/P
(16)	Average Annual Real Wage in Sector 2	RAW2 = MAW2/P
(17)	Average Annual Real Wage in Sector 3	RAW3 = MAW3/P
(18)	Non-wage Income	NWY = NWY(GRP)
(19)	Personal Income	PY = (RAW1)(E1) + (RAW2)(E2) + (RAW3)(E3) + NWY
(20)	Labor Force	LF = LF(TEMP,TIME)
(21)	Population	POP = POP(LF,TIME)
(22)	No. of unemployed	UNNO = LF - TEMP
(23)	Unemployment Rate	UNR = UNNO/LF
(24)	Consumption	C = C(PY)
(25)	Local Government Revenues	GREV = GREV(TAXR,PY)
(26)	Local Government Expenditures	GEXP = GEXP(GREV)

Figure 2.4 (continued)

Definition of Variables:

Q1	=	Output in Sector 1 (millions of 1958 dollars)
USGNP	=	United States Gross National Product (billions of 1958 dollars)
Q2	=	Output in Sector 2 (millions of 1958 dollars)
PY	=	Personal Income (millions of 1958 dollars)
Q3	=	Output in Sector 3 (millions of 1958 dollars)
GRP	=	Gross Regional Product (millions of 1958 dollars)
I1	=	Investment in Sector 1 (millions of 1958 dollars)
K1	=	Capital Stock in Sector 1 (millions of 1958 dollars)
$(K1)_{-1}$	=	Capital Stock in Sector 1 lagged one period (millions of 1958 dollars)
$(I1)_{-1}$	=	Investment in Sector 1 lagged one period (millions of 1958 dollars)
D	=	Depreciation (millions of 1958 dollars)
E1	=	Number of Employees in Sector 1 (thousands of employees)
TIME	=	Time (1949 = 0, 1950 = 1, . . . 1966 = 18)
E2	=	Number of Employees in Sector 2 (thousands of employees)
E3	=	Number of Employees in Sector 3 (thousands of employees)
TEMP	=	Total Employment (thousands of employees)
MAW1	=	Average Annual Money Wage in Sector 1 (current dollars)
MAW1*	=	Average Annual Money Wage in Sector 1 in U.S. (current dollars)
MAW2	=	Average Annual Money Wage in Sector 2 (current dollars)
MAW2*	=	Average Annual Money Wage in Sector 2 in U.S. (current dollars)
MAW3	=	Average Annual Money Wage in Sector 3 (current dollars)
MAW3*	=	Average Annual Money Wage in Sector 3 in U.S. (current dollars)
UNNO	=	Number of Unemployed in SMSA (thousands)
UNR	=	Unemployment Rate (percentage)
P	=	Consumer Price Index (1958 = 100)
TWB	=	Total Money Wage Bill (millions of current dollars)
RAW1	=	Real Average Annual Wage in Sector 1 (current dollars)
RAW2	=	Real Average Annual Wage in Sector 2 (current dollars)
RAW3	=	Real Average Annual Wage in Sector 2 (current dollars)
NWY	=	Non-wage Income (millions of 1958 dollars)
LF	=	Labor Force (thousands)
POP	=	Population (thousands)
C	=	Consumption (millions of 1958 dollars)
GREV	=	Total Local Government Revenue (millions of 1958 dollars)
TAXR	=	Local Tax Rate (percentage)
GEXP	=	Local Government Expenditures (millions of 1958 dollars)

Source: Glickman (1971, pp. 19-21).

Rubin and Erickson (1980), while using the foundation of Glickman (1971) and Hall and Licari (1974), extended the basic specification. They extended the number of equations from 29 (in Hall and Licari (1974)) to 97 (although 41 of these were identities). The main advances included disaggregation by industry (particularly in manufacturing), the inclusion of simple lag structures, logarithmic specifications of equations and an enlarged set of equations modelling the public sector.

Klein (1969) and Glickman (1971) were followed by a discussion article, Glickman (1974). In this review of the then state of the art of regional econometric modelling, Glickman (1974, p. 155) set out to:

> ... discuss Klein's paper and subsequent developments in the field of regional econometric models in the United States, examine the problems in constructing and predicting with econometric models as well as the important problems of evaluating them, and, finally, give some conclusions with recommendations for future work.

This paper was followed by two further review articles, Klein and Glickman (1977) and Glickman (1979). Both of these were the introductory and survey articles of special editions of the journal, *Regional Science and Urban Economics*.

Klein and Glickman (1977) summarized the progress made to that time in regional econometric model building, and in relevant techniques of econometric model building. The article is important in that it re-emphasizes the research strategy of Klein (1969):

> There are two time-honored approaches to regional model-building. One works from the 'top-down' and the other from the 'bottom-up'. In the 'top-down' approach, the regional model is designed as a satellite system, to be attached in a consistent way to a system for the national economy as a whole. In this approach, some regional variables are related to national macro variables, and these form a one-way interface, without feedback, between the national and regional models.
>
> The diametrically opposite way is to try to establish models for all the regions in a nation and combine the various relationships into complete national aggregates. This is building from the bottom up. This approach is clearly more satisfying to the regional researcher, since it enables 'distance' and other spatial variables and relations to enter the models in a meaningful way. It allows regional developments to have an explicit effect

> on national performance, and this is clearly desirable, for we do live in a feedback system with interdependence.
> It is more difficult to implement the bottom-up than the top-down system since the national models are already in existence, and it is relatively easy to spin off satellite systems. There are, however, compelling data reasons at least in the United States, for not wanting to use the bottom-up method except as an academic exercise to demonstrate feasibility.[35]

Glickman (1979) is a more modest contribution, which mainly reviews the articles in the two special issues of *Regional Science and Urban Economics*. These include not only descriptions of certain regional econometric models but also other applications of econometric techniques in regional economics.

Adams *et al.* (1975) provided, what was felt to be, after Glickman (1971), a typical structure for a regional econometric model in the USA. As they said, "At this time it is possible to consider a 'typical' structure for a regional model and to provide for it a somewhat clearer theoretical basis than has been customary".[36] In this article, the Keynesian social accounting identity for final demand, is formally replaced by the " ... so-called 'third' or output approach. Gross State Product (GSP) is the sum of gross output by sector".[37] The reason for this is explained:

> This significant modification in model structure reflects lack of certain critical data. On the expenditures side, it is rare to find reliable time series on consumption and nonmanufacturing investment for a region; data on imports and exports are nonexistent; and on the income side, profit cannot be meaningfully calculated. However, it is possible to establish a detailed and consistent set of data for gross product originating, employment, and wages and salaries by major sector for regions, states, and SMSA's. These are the basic statistics around which the regional model is structured.[38]

Figure 2.5 provides a copy of the flowchart of the typical

---

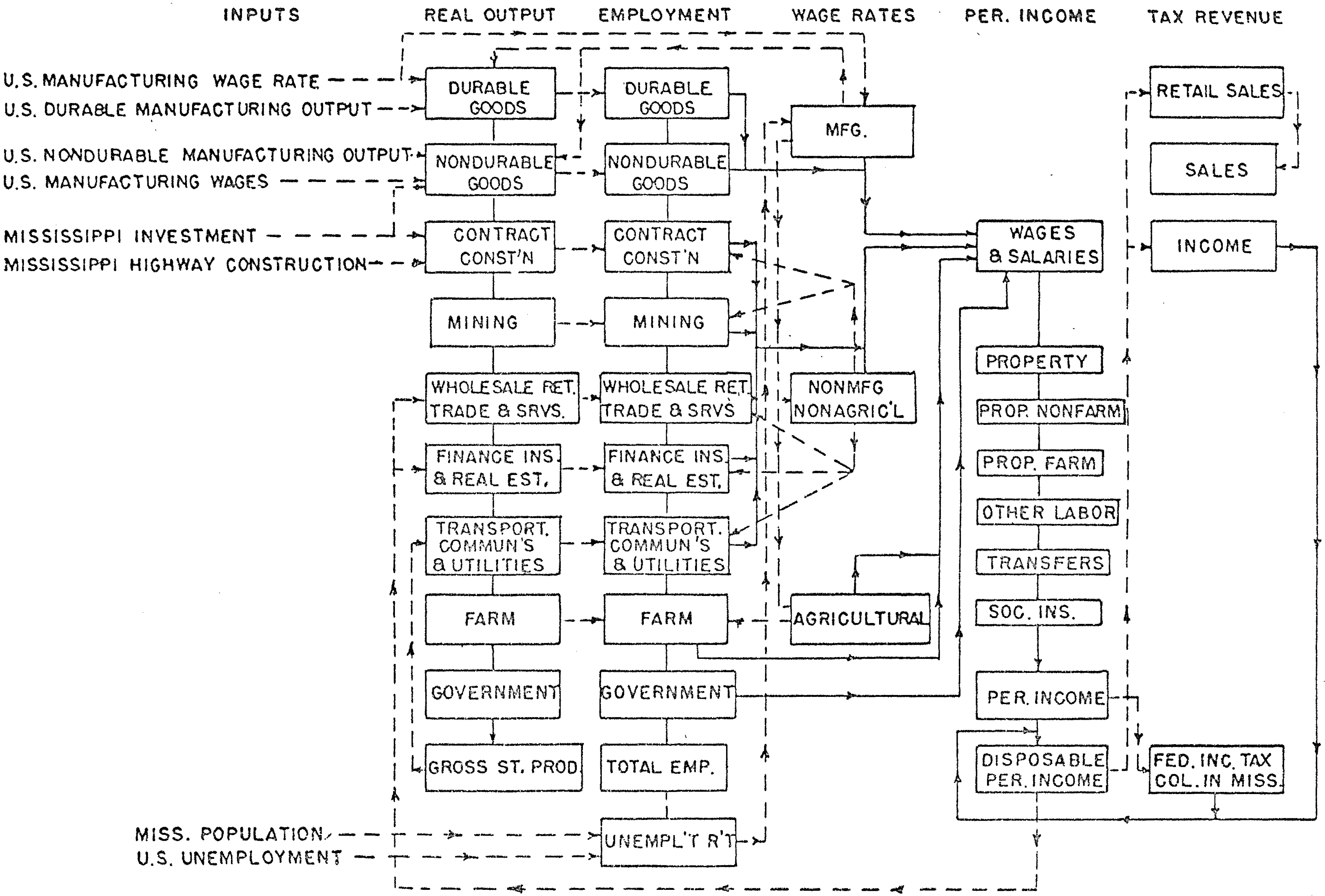
[35]Klein and Glickman,(1977, pp. 4-5).

[36]Adams *et al.* (1975, p. 286).

[37]Adams *et al.* (1975, p. 286).

[38]Adams *et al.* (1975, p. 286).

Figure 2.5: Causal flows in the Mississippi model



Source: Taken from Adams *et al.* (1975, p. 288).

specification suggested by Adams *et al.* (1975).

The attempt to specify the typical structure cannot be held to be a success in heavily influencing subsequent model production. Only two recognizable copies of the structure have been published, and both of these, Ballard and Glickman (1977) and Milne *et al.* (1980), are attempts at producing multi-regional models. Perhaps this is not surprising, since the design of Adams *et al.* (1975), being a type of "lowest common" model specification, is suitable for estimating numbers of regions together.

Latham *et al.* (1979) was an attempt to improve on the design of Adams *et al.* (1975). As they state the differences:

> (1) the region to be modelled is truly small [Delaware, with a population of just over half a million persons, c.f., Mississippi with over two million],
> (2) the model is estimated with quarterly rather than annual data,
> (3) the basic accounting identity around which the model is constructed is gross regional income rather than gross regional product, and,
> (4) the model introduces the use of a more elaborate microeconomic theory of the labour market into regional modelling.[39]

The first point above is uninteresting since it was chosen arbitrarily by the model-builders. The second and third points are related, since the requirement of quarterly forecasts precluded using product estimates, which were apparently available only with a two year lag. Income employment and government revenue estimates, however, were available quarterly with small availability lags of between two quarters and several weeks. The requirement of using quarterly data is particularly novel. Of the twenty-three models summarized above in Table 2.3, only two are quarterly. Both are recently published models. Latham *et al.* (1979) suggest that this trend is increasing. "Recent models recognizing the advantages of a quarterly rather than an annual specification include Friedlander *et al.* [(1975)], Seiver [(1976)] and Loxley and McCarthy [(1976)]".[40]

---

[39]Latham *et al.* (1979, p. 1).

[40]Latham *et al.* (1979, p. 3).

The fourth point is interesting, since Latham *et al.* (1979) specify an advanced (compared to previous regional models) micro-economic structure of the labour market, which uses CES production functions and stock-adjustment processes to obtain a set of equations specifying demand for labour services.

Crow (1973) owes some intellectual debt to Klein (1969), but not to Glickman (1971) for the concept of having his regional econometric model of three regions of the "Northeast Corridor" linked to the Wharton national macro-econometric model. Crow's work is particularly interesting and unusual in that he considers pooling time series and cross sectional data (for the three regions) for estimation. The model is based on a triple entry accounting system following the system of national accounts produced by the Office of Business Economics. However, while Crow (1973, p. 187) claims that his accounting system includes, " ... gross expenditure or final demand (consumption, investment, government and net exports) ... ", in fact net exports only appear in a net residual (or "catch all") variable, R1, which includes, in addition to net exports, the statistical discrepancy and net changes in stocks. This is ingenious, but it is unfortunate that a truly non-exogenous concept such as trade had to be included. It would have been preferable had, say, federal expenditures appeared in such a residual instead of net exports.

It is perhaps unfair to relate Rubida (1977) to Crow (1973) and Glickman (1971), since Rubida's model displays some originality. Evidence of this is the use of a computerized data base system, the inclusion of energy and finance sectors, and the use of " ... a priori economic base information that can be derived from the Colorado State University input-output model of the Colorado economy".[41] However, the overall model specification is recognizable as a successor of the Pennsylvania school, and the model is actually linked to the Wharton national macro-econometric model. This places it firmly in the Klein model category.

The triple-entry accounting system in Rubida (1977) is a copy of the technique developed in Crow (1973, p. 190), which attempted to

---

[41] Rubida (1977, p. iii).

" ... finesse one of the most glaring data gaps in regional economic accounting ... " since " ... insofar as gross product by industry is linked to the rest of the nation, [the GSP by industry equations] fill the role of the missing import and export equations in the demand side of the accounts".

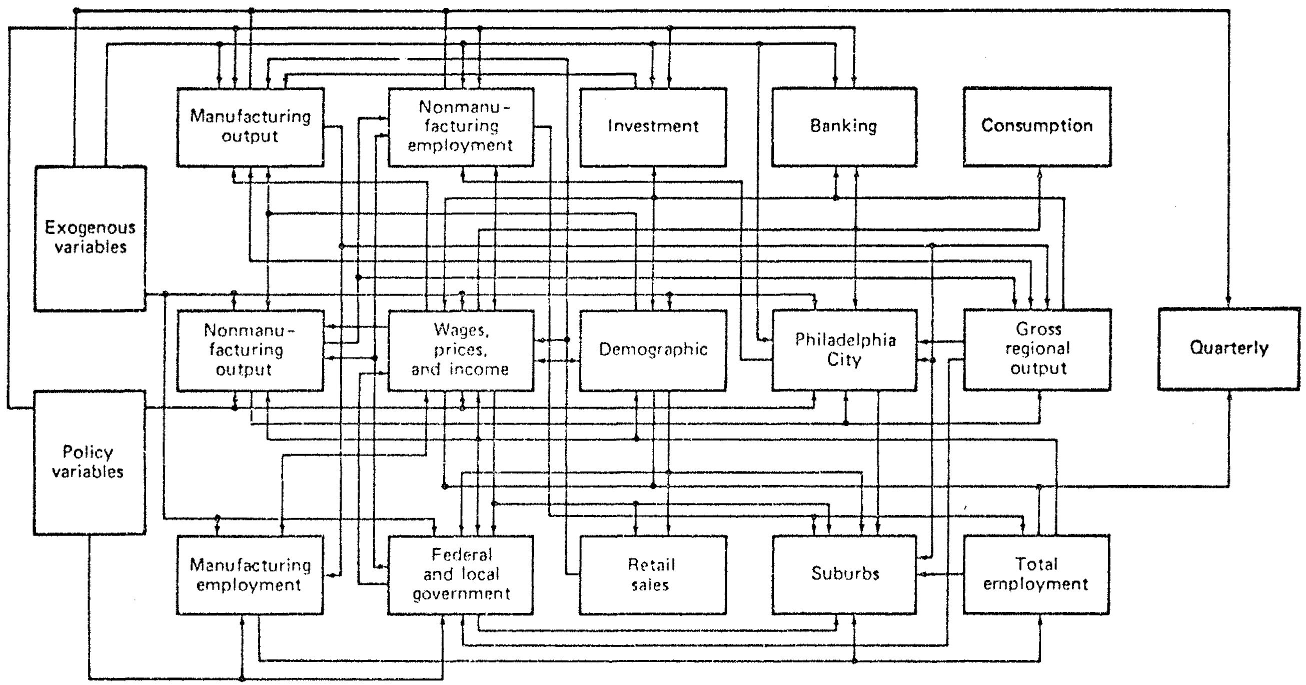
Rubida (1977) is a larger model than usual, with 180 equations, of which 147 are stochastic. It is one of the best regional models which have been produced, from the point of view of policy simulations. Three state "scenarios" were simulated, and their effects on the Colorado economy were forecast. These were a boom in the coal mining industry, a drought in the agricultural industry and a reduction in the number of military personnel in Colorado. These state "scenarios" were coupled with two alternative national "scenarios", full employment and continued high unemployment.

The largest, and certainly the most impressive, regional econometric model yet built, is that of Glickman (1977). This model represented a massive improvement and enlargement of the Philadelphia model in Glickman (1971). This model consists of 228 equations, of which only 105 are stochastic. It has fourteen Blocks, or groups of equations describing sectors of the model. These are,

Manufacturing Output
Non-Manufacturing Output
Manufacturing Employment
Non-Manufacturing Employment
Wages Prices and Income
Federal and Local Government
Manufacturing Investment
Demographic
Retail Sales
Banking
Philadelphia City
Suburban
Consumption
Quarterly Equations.

Figure 2.6 displays the flowchart of the causal flows within the

Figure 2.6: Causal flows within the Philadelphia model



Source: Taken from Glickman (1977, p. 79).

model, as shown in Glickman (1977, p. 79). It is apparent that the contribution of some blocks is limited and recursive - they contribute nothing to the interaction or feedback within the model. Suburban, consumption, banking and quarterly have no influence on other blocks. Still, the overall scope and technical excellence of the model are impressive.

Policy simulation experiments carried out on this model included:

(i) the impact of the oil shortage or "energy crisis" on the region;
(ii) the impact of a public service (Comprehensive Employment Training Act) employment program;
(iii) the impact of federal government revenue sharing;
(iv) the impact of a "no-growth" policy;
(v) the impact of balancing the budget of Philadelphia City Government; and,
(vi) the impact of reduced military spending.

As well, simulations modelled a newspaper firm's interactions with the regional economy and investigated the empirical implications of various theories of urban growth and suburbanization.

2.4.2.4 L'Esperance models

While only two of these models have been published, it is appropriate to separate them from Klein models, since they developed independently of Klein (1969), and from the other Independent models, since the model building effort in Ohio has been continuous for a decade. At least two models have been produced, and the models have been used seriously in advising Ohio policy makers for some time.

These models are L'Esperance *et al.* (1969) and L'Esperance (1977) and have been produced by the Centre for Business and Economic Research at the Ohio State University.

The specification of L'Esperance *et al.* (1969) was fairly simple. The model contained only twenty-seven equations and the basic theoretical framework was the standard Keynesian demand system. The model is divided into three blocks, two of which are recursive and one simultaneous. National variables have a strong influence on the model, but, with the simultaneous block, are not dominant. The model is unusual in that policy (or instrument) variables are explicitly listed:

> Percentage change in the amount of automobile installment credit outstanding in the U.S.
> Ohio's gross state product in federal government
> Ohio's gross state product in state and local government
> New housing units authorized in permit issuing places in Ohio
> Interest rate on corporate bonds
> Interest rate on 90 day Treasury bills
> Military prime contracts awarded in Ohio.[42]

However, the coverage of the regional economy by the variables of the model is not complete, since only product, investment, income, government tax revenue and retail sales are included. Employment, wages, prices and trade are obvious gaps.

This model was enlarged and improved in L'Esperance (1977) to include employment equations. This version of the Ohio Econometric Model contains thirty-nine equations (seventeen identities) and is one of the few regional econometric models to be estimated by Three Stage Least Squares.

The structure of the L'Esperance (1977) model is contained in Figure 2.7.

The main purpose of L'Esperance (1977) was to investigate the feasibility of stabilization policy at the state level. As L'Esperance says:

> State economic targets can be subjected to control through the use of instruments. Examples of instruments on the expenditure side of state government budget are the level and mix of expenditures; on the revenue side, examples are tax rates and tax structures.
> ... three kinds of experiments are performed. The first consists of a Tinbergen-type (1956) analysis; the second, a macrostatic policy analysis; and the third, a macrodynamic policy analysis.[43]

The conclusion was that the results of the experiments were " ... generally positive and suggestive of the feasibility of stabilization policy at the regional level".[44]

---

[42] L'Esperance *et al.* (1969, p. 798).

[43] L'Esperance (1977, pp. 27-8).

[44] L'Esperance (1977, p. 41).

Figure 2.7: The structure of the L'Esperance (1977) regional econometric model

---

An econometric model of Ohio (1951-72)

Coefficients are 3SLS estimates. In parentheses are shown the square roots of the sample variances.

(1) $GSP = GSP_{-1} + \Delta GSP$

(2) $PI = -2.849 + 0.891\ GSP - 0.334\ \Delta GSP$
$\quad (0.300) \quad (0.009) \qquad (0.024)$

(3) $UNE = CLF - E$

(4) $D = TR - G$

(5) $C = A + R$

(6) $DPI = PI - FIT$

(7) $\Delta DPI = DPI - DPI_{-1}$

(8) $F_T = -0.183 + 0.922\ AR$
$\quad (0.061) \quad (0.015)$

(9) $FIT = -1.213 + 0.179\ PI$
$\quad (0.183) \quad (0.007)$

(10) $FTR = \beta_i F_T, \quad i = 1, 2, 3$

(11) $A = -0.954 + 0.289\ DPI + 0.939\ \Delta AC|AC - 0.826\ AR_{-1}$
$\quad (0.123) \quad (0.014) \qquad (0.058) \qquad (0.068)$

(12) $\Delta GSP = \Delta GSP_{oth} + \Delta GSP_{known}$

(13) $GSP_{cc} = 0.484 + 0.729\ I_{sma} + 0.009\ HP + 0.018\ RTBS$
$\quad (0.065) \quad (0.118) \qquad (0.001) \qquad (0.008)$

(14) $GSP_{fi} = -0.247 + 0.156\ DPI - 0.011\ \Delta DPI$
$\quad (0.081) \quad (0.004) \qquad (0.008)$

(15) $GSP_{known} = GSP_{ma} + GSP_{cc} + GSP_{fi} + GSP_{td} + GSP_{so} + GSP_{fg} + GSP_{slg}$

(16) $GSP_{ma} = GSP_{ma_{-1}} + \Delta GSP_{ma}$

Figure 2.7 (continued)

Coefficients are 3SLS estimates. In parentheses are shown the square roots of the sample variances.

(17) $$\Delta GSP_{ma} = \underset{(0.097)}{-\,0.287} + \underset{(0.005)}{0.107}\,\Delta GNP_{ma} + \underset{(0.072)}{0.089}\,MPC$$

(18) $$GSP_{oth} = GSP_{oth_{-1}} + \Delta GSP_{oth}$$

(19) $$GSP_{so} = \underset{(0.061)}{0.150} + \underset{(0.003)}{0.113}\,DPI - \underset{(0.007)}{0.012}\,\Delta DPI$$

(20) $$GSP_{td} = \underset{(0.193)}{-\,3.187} + \underset{(0.036)}{0.542}\,A + \underset{(0.018)}{0.677}\,R$$

(21) $$IGF_{ma} = \underset{(0.199)}{1.074} + \underset{(0.014)}{0.144}\,GSP_{ma} + \underset{(0.021)}{0.240}\,\Delta GSP_{ma}$$

(22) $$I_{ma} = I_{sma} + I_{mma}$$

(23) $$I_{mma} = \underset{(0.039)}{-\,0.335} + \underset{(0.012)}{0.049}\,IGF_{ma} + \underset{(0.013)}{0.194}\,IGF_{ma-1} + \underset{(0.089)}{0.952}\,I_{sma} + \underset{(0.006)}{0.044}\,RTBS$$

(24) $$I_{sma} = \underset{(0.027)}{0.129} + \underset{(0.025)}{0.277}\,I_{mma} - \underset{(0.004)}{0.019}\,RCB$$

(25) $$AR = AR_{-1} + \Delta AR$$

(26) $$R = \underset{(0.225)}{4.594} + \underset{(0.010)}{0.262}\,DPI$$

(27) $$T_s = \underset{(0.021)}{-\,0.074} + \underset{(0.002)}{0.027}\,C + \underset{(0.0003)}{0.010}\,DUM$$

Figure 2.7 (continued)

Coefficients are 3SLS estimates. In parentheses are shown the square roots of the sample variances.

(28) $$TR = T_s + FTR + IGR + OR$$

(29) $$E = E_{ma} + E_{ds} + E_{gs} + E_{mm}$$

(30) $$E_{ma} = \underset{(57.21)}{231.6} + \underset{(0.046)}{0.722}\, E_{ma-1} + \underset{(47.54)}{432.3}\, I_{sma} + \underset{(0.445)}{5.672}\, \Delta GNP_{ma}$$

(31) $$E_{ds} = \underset{(28.57)}{10.59} + \underset{(3.26)}{8.08}\, GSP_{td} + \underset{(0.046)}{0.937}\, E_{ds-1} + \underset{(2.534)}{23.7}\, \Delta DPI$$

(32) $$E_{gs} = -\underset{(5.653)}{42.24} + \underset{(0.010)}{0.965}\, E_{gs-1} + \underset{(1.214)}{15.05}\, GSP_{gs}$$

(33) $$E_{mm} = \underset{(5.557)}{48.24} + \underset{(0.029)}{0.7276}\, E_{mm-1}$$

(34) $$\Delta AR = \underset{(0.041)}{0.1107} + \underset{(0.018)}{0.157}\, A\ \underset{(0.014)}{0.082}\, AR_{-1}$$

(35) $$GSP_{gs} = GSP_{so} + GSP_{fg} + GSP_{slg}$$

(36) $$OR = -\underset{(0.042)}{0.235} + \underset{(0.002)}{0.054}\, PI$$

(37) $$\Delta GSP_{oth} = \underset{(0.015)}{0.069} + \underset{(0.007)}{0.064}\, \Delta GSP_{known}$$

(38) $$\Delta GSP_{known} = GSP_{known} - GSP_{known_{-1}}$$

(39) $$GSP_{slg} = \underset{(0.049)}{0.511} + \underset{(0.028)}{0.427}\, G$$

Figure 2.7 (continued)

Symbols and variables

All data are in billions of 1958 dollars unless otherwise specified.

(1) *Endogenous variables*

A: Sales by all new car dealers in Ohio.

AR: Automobile registrations in Ohio, millions of registrations as of July 1.

ΔAR: Annual change in AR.

C: Sales by all establishments selling at the retail level in Ohio. C is constructed from the Center for Business and Economic Research retail sales index and the level of Ohio retail sales in 1958, as reported by the 1958 Census of Business.

D: State deficit (surplus).

DPI: Ohio Disposable personal income.

ΔDPI: Annual change in DPI.

E: Total non-agricultural employment in Ohio.

E_{ds}: Ohio Employment in distributive sector, i.e., trade.

E_{gs}: Ohio Employment in government and service sectors, including finance insurance and real estate.

E_{ma} Ohio Employment in manufacturing sectors.

E_{mm}: Ohio Employment in miscellaneous sectors, including mining and contract construction.

F_T: Gallons of taxable motor fuel sold in Ohio.

FIT: Federal income taxes of Ohio. (PI - DPI).

FTR: Fuel tax receipts in Ohio.

GSP: Ohio's Gross State Product.

ΔGSP: Annual change in Ohio's Gross State Product.

GSP_{cc}: Gross State Product in contract construction.

GSP_{fi}: Gross State Product in finance, insurance, and real estate.

$GSP_{(known)}$: $GSP_{ma} + GSP_{cc} + GSP_{td} + GSP_{so} + GSP_{fi} + GSP_{fg} + GSP_{slg}$.

GSP_{ma}: GSP originating in manufacturing in Ohio.

ΔGSP_{ma}: Annual change in GSP_{ma}.

Figure 2.7 (continued)

$GSP_{(other)}$: $GSP - GSP_{(known)}$. $GSP_{(other)}$ includes GSP in agriculture; mining; and transportation, communication and public utilities.

GSP_{so}: Gross State Product in services and other.

GSP_{td}: Gross State Product in trade.

GSP_{gs}: Gross State Product in government and services. See eq. (35).

IGF_{ma}: 'Internally Generated Funds' in manufacturing (profit-type income originating in manufacturing plus capital consumption allowances originating in manufacturing) in Ohio.

I_{ma}: Total investment expenditures for plant (structures) and machinery by all manufacturing establishments (existing, and those not yet in operation) in Ohio.

I_{mma}: Investment expenditures for machinery by all manufacturing establishments in Ohio.

I_{sma}: Investment expenditures for plant (structures) by all manufacturing establishments in Ohio.

OR: Other revenue.

PI: Personal income in Ohio.

R: Retail sales in Ohio excluding new-car dealer sales ($R = C - A$).

T_s: Retail sales tax receipts.

TR: Total revenue.

UNE: Total unemployment in Ohio.

(2) *Exogenous and lagged endogenous variables*

AR_{-1}: Last year's AR in Ohio.

$\Delta AC|AC = (AC - AC_{-1})|AC$: AC represents dollars of automobile installment credit outstanding in the US.

CLF: Total Ohio civilian labor force.

DPI_{-1}: Last year's DPI in Ohio.

DUM: Dummy variable; 0 for 1951-1967 (3% rate) and C for 1968-1971 (4% rate).

E_{ds-1}: Last year's E_{ds} in Ohio.

E_{gs-1}: Last year's E_{gs} in Ohio.

Figure 2.7 (continued)

E_{ma-1}:	Last year's E_{ma} in Ohio.
E_{mm-1}:	Last year's E_{mm} in Ohio.
ΔGNP_{ma}:	Change in gross national product in manufacturing.
G:	State government expenditures of Ohio.
GSP_{-1}:	Last year's Ohio GSP.
GSP_{fg}:	Gross State Product in federal government.
GSP_{ma-1}:	Last Year's GSP_{ma} in Ohio.
GSP_{slg}:	Gross State Product in state and local government.
HP:	New housing units authorized in permit issuing places in Ohio.
IGF_{ma-1}:	Last year's IGF_{ma} in Ohio.
IGR:	Intergovernment Revenue.
MPC:	Military prime contracts awarded in Ohio, billions of dollars.
RCB:	Interest rate on corporate bonds.
RTBS:	Interest rate on 90-day US Treasury bills.

Source: Taken from L'Esperance (1977, pp. 41-46).

While the efforts made at Ohio State University to model cyclical behaviour and simulate stabilization policy must be applauded and encouraged, it should be re-emphasized that without explicit inclusion of trade flows (particularly imports), no spillover effects can be measured, and the effect of government fiscal measures on local economic activity are probably overestimated.

2.4.2.5 Other Independent models

This set of models has been classified together by their own miscellany. They owe, to varying degrees, technical debts to one another and to other unrelated and simultaneous models.

The first of these models is Green (1967). The framework is uncompromisingly Keynesian, with the familiar social accounting demand identity dominant. An unusual feature of the model is the length of the estimation period. It is annual, but extends from 1929 to 1963 (dummy variables are included in most stochastic equations for the war years or the post war period). This is not inappropriate, since the model was originally designed to produce long run forecasts of the endogenous variables. The forecast horizon extended from 1964 to 2010. All variables (except for dummies, population and tax rates) are in per capita real values.

The structure of the model developed for Nova Scotia Province by Czamanski (1968) is summarized in Table 2.5 (which is a copy of Table 1 in Czamanski (1968)). Czamanski (1968) was an early model, but one which has seldom been rivalled in clarity and technical nicety. He isolates eight instrument variables and assigns these to eight targets out of the fifty-four endogenous variables. These instruments and target variables are listed in Table 2.6. These special variables were used in sensitivity tests run on the model.

The Nova Scotia model is recursive and was deliberately specified as such, to avoid using simultaneous equations estimators such as TSLS, because of degree of freedom problems. This also precluded many lagged variables from appearing in the model.

The model is composed of seven sub-models:

1. Iron and Steel Industry
2. Manufacturing and Employment

Table 2.5: Outline of the structure of the Czamanski (1968) regional econometric model

Target variables		8	Structural equations	31
Intermediate variables		46	Balance equations	5
			Definitional equations	18
Total endogenous variables		54	Total equations	54
Instrument variables		8		
Data variables				
Unlagged	29			
Lagged	7	36		
Lagged endogenous variables		6		
Total predetermined variables		50		
Predetermined parameters		8		

Source: Taken from Czamanski (1968, p. 148).

Table 2.6: Instrument and target variables in the Czamanski (1968) regional econometric model

Instrument variables

payments to military personnel (millions of dollars)

government subsidies and investments in housing and commercial services (millions of dollars)

direct general government investments in transportation, communication, power, and technical facilities, etc. (millions of dollars)

direct government investments in education and training (millions of dollars)

direct government investments in health, welfare, and administration (millions of dollars)

government subsidies and investments in agriculture, forestry, and fisheries (millions of dollars)

government subsidies and investments in manufacturing (millions of dollars)

aggregate surplus or deficit of all governments relating to Nova Scotia income and product transactions (millions of dollars)

Target variables

total employment (thousands)

gross regional product (millions of dollars)

balance of migrations during (t) (thousands)

index of educational standards

index of health standards

index of housing standards

per capita disposable income (dollars)

per capita disposable income in agriculture (dollars)

Source: Czamanski (1968, pp. 151-3).

3. Output and Investments
4. Households
5. Governments and Trade Deficit
6. Population and Migrations
7. Welfare.

Dutta and Su (1969) estimated a model for Puerto Rico, a political and economic island dependency of the USA. This model was the first regional econometric model to incorporate extensive data on trade flows. These were easily measured and available for such a geographical entity. Apart from the disaggregation and modelling of such import categories as food, non-durable goods, automobiles, durable goods, capital goods and raw materials, there is little of outstanding interest in the model. The trade data and modelling were not arranged to reflect the difference between the USA and the then rest of the world. This is disappointing since, "This relationship [with the USA] of "free association" has meant free trade, free flow of capital and unrestricted migration of population between the two. The situation is that of a two country model with free mobility of factors of production as well as of products, reinforced by a common monetary system".[45] The data seemed to be available (e.g. in 1964, Puerto Rico imported $1119m from the USA and $235m from the rest of the world), but the model ignored this.

Ghali and Renaud (1975) present an impressive demand-side model for Hawaii. Data problems in isolated geographical areas are generally fewer in number and less severe in degree than, say, mainland or urban areas. This model of Hawaii takes maximum advantage of this, using comprehensive trade data and national accounts developed for the State in Shang *et al.* (1970).

The treatment of federal government expenditure is interesting. There is extensive modelling of the state and local government sector, but federal government expenditures are treated as exogenous and are included in an aggregate term for Hawaiian exports, which is determined completely by US GNP.

Eight blocks of equations were specified:

---

[45] Dutta and Su (1969, p. 319).

1. Consumption expenditure (private)
2. Private investment
3. Imports and exports
4. State and local government current expenditures
5. State and local government investment
6. Total expenditures
7. Employment and labour force
8. Income

Policy simulations performed with the model included:

(i) the impact of taxation policy changes;
(ii) the impact of high energy costs; and,
(iii) the significance of the tourist industry.

Fishkind (1977, pp. 77 and 84-5) was an unusual model, since its stated purpose was:

> ... to investigate the differential regional impacts of monetary policy. While it seems clear that monetary policy will have differential impacts upon the levels of economic activity across states, no vigorous demonstration of this point exists. To this end we have constructed an econometric model for a state economy, Indiana. With the model, the effects upon Indiana's economy of periods of relatively tight or relatively easy monetary policy can be simulated and these effects can be compared with the behaviour of the national economy over these same time periods.
>
> In the United States monetary policy is conceived of and carried out primarily at the national level. An implicit assumption of this approach is that all regions of the nation are affected equally by the impacts of monetary policy. While there have not been any specific studies of the differential regional impacts of monetary policy, the existing literature is consistent with the hypothesis that no differential regional effects exist.

The model

> ... clearly records a differential regional impact of monetary policy. Moreover, this differential impact appears to be asymmetrical. During periods of substantial monetary growth the Indiana economy grows at much the same rate as the national economy. On the other hand, during periods of monetary restraint the Indiana economy grows much more slowly than the national economy.
>
> The existence of differential regional impacts of monetary policy has some potentially important policy

> implications because periods of monetary restraint force the citizens of some states to bear the brunt of any ensuing economic slow-down. Surely this is inequitable, especially when it appears that the differential impacts of monetary policy apply only to periods of monetary restraint. Is there some way that this adverse differential impact of a tight monetary policy could be offset? We can use our econometric model to help answer this question for the State of Indiana.

The model

> ... indicates that Indiana does possess policy instruments which can help to stabilize the region's economy. Furthermore, the model demonstrates that the Federal Government acting in conjunction with a state government can more evenly distribute the regional impacts of a restrictive monetary policy. We hasten to add that we are *not* advocating a state-run program of stabilization policy. Separate and uncoordinated stabilization policies pursued by each of the fifty states would obviously be chaotic, largely offsetting, and nonoptimal from the perspective of the national economy. However, our results indicate that there are important welfare and equity issues which have been neglected in the conduct of monetary policy insensitive to its differential regional effects.

Chang (1977), on the other hand, concentrates on fiscal policy, and uses his model of Tennessee to study " ... the economic effects of alternative state fiscal policies ...".[46] The main purpose of Chang (1977) is to specify a series of equations to explain state revenue, and to link these state revenue variables into equations determining state economic activity. The theoretical specification of revenues equals rate times base is used, with a logarithmic transformation. Simulations were then run using state tax rates as instruments and measures of aggregate activity as targets.

Jefferson (1978) is the only regional simultaneous equation model listed in this survey outside the North American economic area. This model for Northern Ireland is loosely based on the Philadelphia structure of Glickman but " ... several alterations in structure and specification have been initiated to reflect the peculiarities of the

---

[46] Chang (1977, p. 12).

Northern Ireland economy as a region of the United Kingdom and to take account of data availability".[47]

Seven blocks were specified, with the seventh being an important addition to the standard US models:

1. Output
2. Employment
3. Labour force and unemployment
4. Earnings
5. Personal income
6. Transfer payments
7. Regional trade

The model reflects economic base concepts. National variables are prominent. It is intended eventually to link the model to a national macro-econometric model of the UK, the sector classification is done using economic base, and the export sector is " ... assumed to be principally a function of United Kingdom demand for Northern Ireland's goods, though in recent years demand for Northern Ireland's manufactures from outside the United Kingdom is becoming more important".[48] The incorporation of the trade equations is not significant, however, since there is no feedback to other equations of the model.

Roberts and Fishkind (1979) is concerned primarily with monetary factors. An analytical model of regional financial markets is developed. Roberts and Fishkind (1979) argue that

> ... the effects of changes in monetary policies on sub-national economies have been generally ignored and an important link between the national and local economies has not been specified. This misspecification in regional models often results in poor forecasting accuracy and in a reduced scope for policy analysis, particularly in rapidly growing economies like Florida's.[49]

The analytical model suggests that " ... regional capital markets are imperfect because of information costs", and " ... if capital is

---

[47]Jefferson (1978, p. 256).

[48]Jefferson (1978, p. 256).

[49]Roberts and Fishkind (1979, p. 15).

not perfectly mobile then monetary policy will have different effects across regions ... ".[50] They rely on empirical findings by Ebner (1976) to support this. Ebner (1976) found that there were significant differences in the demand for deposits at savings and loan associations among six states, California, Florida, Ohio, Idaho, New Mexico and South Carolina. This was translated into the model by specifying a

> ... regional financial market based upon the theoretical analysis ... and a full complement of monetary and financial variables. In particular, savings flows into banks and savings and loan institutions determine, in part, the value of housing starts which, in turn, determines employment in construction and related industries. In addition, this model explicitly contains other major interactions of the various industrial sectors included in the model.[51]

This was then compared with a naive financial market for Florida, and simulation forecasts from both models were compared. The structural, rather than the naive model, generally produced smaller forecast errors, thus supporting the argument for explicit consideration of financial markets in regional econometric models.

2.5 AN ASSESSMENT OF EXISTING REGIONAL ECONOMETRIC MODELS

There are four major reviews of the state of regional econometric model building: Richter (1972), Engle (1974), Ratajczak (1974) and Glickman (1977).

Richter (1972) was intended to point out to regional economists some of the limitations of applying econometric techniques to building econometric models of regions. His criticisms were directed mainly to criticising econometric model building and techniques of econometric estimation. Apart from suggesting the use of cross-sectional data (for which he had a naive hope that autocorrelation and multicollinearity problems could be eliminated), little constructive advice was offered.

---

[50] Roberts and Fishkind (1979, pp. 22 and 24).

[51] Roberts and Fishkind (1979, p. 24).

The main problem seen by Richter (1972) in regional econometric model building was the lack of suitable data.

Engle (1974) was an attempt, not so much to criticise regional econometric models, but to determine a general *regional* specification for an econometric model. This specification was, not surprisingly, not estimated empirically, since data availability constraints were ignored. The design is well reasoned, with an emphasis on determining output jointly by supply and demand conditions. As regional data improve, the possibility of the model being built will improve.

Ratajczak (1974) was a more pragmatic investigation into then-current problems in building regional econometric models. He notes that a trade-off exists between data availability and theoretical specification and suggests concentration on labour market variables and relationships as one way of minimizing the problem.

Glickman (1977) provided the most comprehensive and detailed list of limitations and criticisms of regional econometric models of all these references. These were mainly contained in his list of characteristics of models as they then were. The problems can be summarized:

(a) Data availability

(i) The frequency of the time series data used in most regional econometric models was annual. This meant that, since most regional data had at that time only been collected since the 1950s, estimation sample sizes were typically very small (the annual models in the survey above, before 1976, ignoring Green (1967), had a mean estimation period of 17 years). This created not only estimation problems due to the small sample size, but potentially severe specification problems. Lack of degrees of freedom meant that many equations had to be over simplified, with bivariate equations appearing too frequently. Furthermore, lag structures were severely limited, with even single period lags being uncommon.

(ii) The range of variables was often very limited for regions. Little regional data at less than state level existed, and even these were not comprehensive. The lack of a number of important series either forced model builders to construct data (at some expense and difficulty), to introduce inappropriate specifications or to exclude sets of important relationships.

(iii) The construction of data introduced new problems when the construction was not done well. In many cases, regional output data had been constructed from crude allocation of national output. When these data were regressed on their national counterparts, as Glickman (1977, p. 64) says, "obvious biases in the $\bar{R}^2$ result".

(b) National linkages are too strong in most models. Many models are far too recursive, since they can be determined, after tracing back through the system, completely by a set of national variables. Some models are linked to so many national variables that regional interactions are untraceable. It then becomes doubtful whether or not the model does reflect the operations of a regional system.

(c) Spatial disaggregation is under-emphasized in most models. Little attention is paid to space in regional econometric models. This is not a particularly telling criticism, since regional econometric models may be linked together (see Crow (1973)) and may form interregional systems. Intra-regional modelling may be done either by similar systems of models for small areas or by incorporating or linking micro models to the regional models (e.g. land use allocation models).

A comment made by Klein and Glickman (1977, p. 10) neatly summarizes the state of the art of regional econometric model building at that time.

> Overall, regional econometric models are often (a) simple, (b) constructed from annual data, (c) static, (d) highly recursive, and (e) linked structurally to national economic development.

These limitations have been reiterated by Richardson (1978), who also challenged the usefulness of the macro-economics approach to the study of regions. This challenge, however, is clearly directed at applying demand models to small areas, where local policy makers and instruments are both missing, and spillover effects are very high. It follows that the application of macro models to small area regions is inappropriate. Richardson (1978, p. 94) states that "Probably the most useful function of an interregional income model is in the evaluation of interregional stabilization policy". However, he feels that data problems reduce the possibility of the development of interregional income models. This is curious given his assertion that interregional input-output models would be less difficult to develop than interregional econometric models using standard social accounts. Which is the more difficult to develop depends on consideration of such matters as what region or interregional system is being considered, the suitability of the data collection of such an area and the budget for the project. (In any case, the techniques (of econometric models and input-output models) are not now regarded as being substitutes, but as being complements.) The point probably reflects Richardson's pre-occupation with regions smaller in size and political importance than states of a federation.

The constructive criticisms made in the above references have had an influence on recent work on regional econometric models. Of the five models since 1977 listed in Table 2.3 above, two are quarterly, and these are the only quarterly regional econometric models listed in Table 2.3. Of the other three annual models, two are for small or sub-state regions. (This development was suggested by both Glickman (1977) and Richardson (1978). Glickman does not consider the inappropriateness of a macro-economic specification for small area models, while Richardson is inconsistent in advocating the development of small area models and then criticizing the appropriateness of the macro-economic specifications used.) The third annual model is for Northern Ireland. This model is noteworthy for attempting to include import and export variables.

Both of the quarterly models were for states of the USA, although Delaware is small both in population and land area. This is hardly coincidental, since the possibilities of gathering quarterly time series data are greater for states than sub-state regions. As well, the range of variables in the data base is generally wider, and the quality of the data is generally better. These improvements are usually obtained because of the existence of an official state statistical organization, and the increased scope for collection of data as administrative by-products in political or administrative territories. That these benefits are only generally, and not always, available for states is noted in Latham *et al.* (1979), since states as small as Delaware do not have statistical collections available to match those of the larger SMSA's of the USA. Their response to this problem was to adopt a number of specification modifications, including some similar to the concentration on labour market variables suggested by Ratajczak (1974). Roberts and Fishkind (1979), the other quarterly model, concentrated upon developing an integration of monetary factors into their model of Florida.

All recent work has emphasized the integration of the state and local government sector into model specification.

Other important developments in regional econometric model building are listed below.

(a) Regional input-output models and regional econometric models have been linked. This development has been suggested by the implementation of such linkages at the national level.[52] The impetus for this came from the limitations of input-output as a dynamic analysis, so that forecasts of final demand by component and industry generated by regional econometric models are translated into production requirements and factor shares by input-output mechanisms. As L'Esperance *et al.* (1977, p. 54) point out,

> ... efforts and funds allocated to [input-output] models considerably exceed those committed to building regional econometric models of which only a handful exists. Efforts are being made to redress this balance because Keynesian type regional econometric models offer the potential of coherently depicting and forecasting the economy's final demand segment, an important component of an I/O model. At the present time, the final demand sector of I/O models is "driven" by a number of *ad hoc* procedures. It is our contention that the description of a regional aggregate demand sector incorporated within a well-specified state econometric model should be able to predict the I/O final demand vector better than these *ad hoc* procedures. Taking a broader view, conjoining an I/O model with an

[52] See Preston (1975).

econometric model should result in a more fully integrated approach to the economic analysis of a region than has hitherto been the case. It combines a theory of production with a theory of aggregate demand.

(b) The development of multiregional econometric models is proceeding. This work began slowly with Hamilton *et al.* (1969), Glejser (1973) and Crow (1973), and has only recently been continued with regional econometric specifications. Ballard and Glickman (1977) provided an initial multiregional specification, using the standardization of Glickman's approach given in Adams *et al.* (1975). A number of separate regional models are constructed and are then linked together using an " ... interaction variable ... " which " ... measures the level of economic activity outside the region which affects a particular county. Its construction is based upon a hypothesis similar to the gravity system approach: the level of outside influence will increase proportionately with the size of activity in these areas, while adjusting inversely with the impedance (transportation costs) between areas".[53] This work was followed by Milne *et al.* (1980) and Treyz (1980). Milne *et al.* (1980) developed the concepts in Ballard and Glickman (1977) to specify a multiregional model of the USA, while Treyz (1980) outlined a new specification for a smaller multiregional model area. The estimation of a national economic system by a multiregional model was not new. Courbis (1979) describes the REGINA national-regional model of the French economy; Brown (1972) describes the specification of a national-regional model of the Italian economy; and Saltzman and Chi (1977) describe a three level integrated model of the New York, Rest of the USA and the whole USA economies.

[53] Ballard and Glickman (1977, p. 162).

2.6 IMPLICATIONS FOR THE SPECIFICATION OF AN ECONOMETRIC MODEL OF QUEENSLAND

Given the above discussion it is proposed that an econometric model of the State of Queensland to be developed in this study should have the following characteristics.

(a) It should use quarterly data, with as long an estimation period as possible. This will:
  - (i) introduce more degrees of freedom into the estimation process than would be possible in an annual model; this will avoid problems of small sample estimation, and allow greater freedom in model specification;
  - (ii) allow better lag specifications to be introduced; and
  - (iii) allow the explicit modelling of seasonal patterns.

(b) It should be broadly based on the Klein (1969) specification. It should be clear from much of the discussion above that the original specification of Klein has not been adequately tested. Modifications have arisen because of data constraints. These constraints usually have been the absence of export and import variables, price and consumption variables, and investment and capital stock variables. Gross product variables have been able to be constructed, albeit with varying degrees of crudeness. The data constraints have resulted in model specifications greatly different from the original Klein specification.

Queensland, however, has annual data for private final consumption expenditure, and quarterly data for external trade and consumer prices, published by the ABS. Unfortunately investment and capital stock variables are not available, and their estimation is well beyond the capacities of a study such as this. However, the availability of the consumption, external trade and price data (although each of these is not without estimation problems and inadequacies) does suggest that an initial attempt on the Klein specification can be made.

Modifications which will be made include the dropping of investment and capital stock variables and equations. This prevents this model from being a good approximation to the Klein specification, but it can be said that this Queensland model, because of the inclusion of gross product, consumption, import and export and price variables and equations, is the closest approximation yet to the Klein specification.

Another modification is that the Queensland model will not be linked to a national macro-econometric model of the Australian economy, unlike Klein's suggestion that a US Klein type regional econometric model should be linked to the Wharton-EFU model. Since the Queensland model is only in its preliminary stage of development, this is not a serious problem. Indeed, the recent emphasis overseas on regional-national models may make such linkage redundant.

(c) It should be as simultaneous and regionally oriented as possible. This is in line with Klein's original specification, where the main influence of national economic activity was in determining the level of regional exports, and relative prices and wage rates.

(d) It should be allowed to include industry disaggregation. Since industrial structure has a strong influence on regional economic activity, it is important to introduce disaggregation by industry of such variables as wage rates, employment and gross product.

(e) It should be strongly related to state and local government. The primary users of regional econometric models in the USA have been state and local governments. In particular, recognition should be made of the constraints on fiscal activity of state and local governments due to budget limitations, and the importance of federal government grants to state and local government.

The five characteristics listed above give a broad outline of a preliminary specification of an econometric model of the State of Queensland. However, before proceeding with detailed specification, estimation and simulation of a Queensland model, attention must be given to two crucial aspects of the data available to this proposed model.

Firstly, since gross product (by quarter and industry) is an indispensable part of the formal Keynesian accounting specification of Klein, it will be necessary to develop original estimates of the gross product of Queensland. Most estimates of gross product in regional econometric models in the USA have been annual, highly aggregated, and obtained by crude allocations. These deficiencies should be avoided, or minimized to the greatest extent possible.

Secondly, a number of other key variables are not available, or are only available on an annual, not a quarterly, basis. Unfortunately, the size of the task of obtaining reasonable estimates of gross product prevents the making of any extra effort to estimate other variables, such as investment and capital stock, and to re-estimate other variables, such as export and import variables, which are available officially from the ABS, but are not considered to be wholly reliable.[54] Also, some important variables, such as private final consumption expenditure, are only available annually. Given that there are to be no annual equations, three alternatives are possible in treating this problem:

(i) eliminate the variable from the model - this is drastic and wasteful and must be considered to be a last resort;

(ii) mix annual and quarterly data together - this is unusual, and the techniques and implications of such a method for single equation systems are only just being developed[55] and can only be regarded as experimental; and,

(iii) estimate (interpolate or distribute) quarterly values from the annual totals.

Approach (iii) is the one adopted in this study. The method used is that of Chow and Lin (1971), which produces BLU estimates of quarterly values, using information provided by related series. This has the desirable property of adding degrees of freedom to the data, which is not done by purely arbitrary mathematical techniques. The estimation of these quarterly data is an original step in regional econometric model building and should allow, if carefully done, the common development of quarterly, rather than annual, models.

[54] In particular, in the case of interstate imports, the ABS believes the volume of road freight imports may be underestimated.

[55] See Gilbert (1977).

CHAPTER 3

THE GROSS STATE PRODUCT OF QUEENSLAND

3.1 THE IMPORTANCE OF GSP

The discussion of regional econometric model specification above has introduced the notion that gross state (or regional) product estimates are important in model specification. This view is supported by Ratajczak: "Some data, such as gross regional product, may be necessary in nearly all specifications of regional economic systems, while other information ... may not be missed by some model builders".[1] This view has been accepted mainly since the publication of Klein's seminal paper[2] advancing the case for the development of national-analogue models of regions based on Keynesian theoretical foundations.

This argument, that GSP is important and necessary in the specification of regional econometric models, is a sufficient reason for this development of estimates of GSP for Queensland. However this argument can be strengthened by noting that GSP has other uses and properties which are also important for economic analysis.

Since GSP is a regional statistic equivalent to the gross domestic product of a nation, it is the single most important indicator of the size and economic performance of the regional economic unit of a nation (i.e., a state in this study). Moreover there is no other economic time series which performs this task to the same extent. It has been suggested to the author by various State Government officials concerned with the economic development of Queensland, that estimates of GSP would be welcomed by and would be useful to them, both in analysing and publicizing the economic performance of Queensland. Certainly such

[1]Ratajczak (1974, p. 51).

[2]Klein (1969).

estimates have been welcomed and used in overseas regions, e.g., the State of Ohio in the USA federation.[3] This recognition is not limited to state governments. The Security Pacific Bank, in an advertisement in *The Economist* on 28 March 1981, announced, "California: The eighth largest nation in the world? No, but if it were a country, its gross national product would have ranked eighth in the world in 1980!".

A controversy has arisen in the USA over the rival merits of regional income versus regional gross product as the most satisfactory measure of regional economic activity.[4] This controversy is ill-founded since the two variables measure different concepts, and should not be regarded as being close substitutes. Each variable has its own "merits". That they do not measure the same concepts is easily demonstrated by the fact that there are regional differences in the cyclical behaviour of the personal income to gross product ratio.[5] Certainly this argument is supported by the ratio of Queensland personal income to gross product over the last decade. Table 3.1 and Figure 3.1 show the behaviour of the ratio for both Queensland and Australia from 1969-70 to 1978-79. It is noticeable that the Queensland ratio is usually one or two percentage points below the Australian ratio. Of course many of the components of personal (or household) income are also included in gross product, but some, such as transfers of income from general government are not included in product. It is easy to see that in times of recession, these series may move in opposite ways, i.e., the total of unemployment benefits paid to recipients in a State may be increasing, while total profits (or operating surplus) may be decreasing.

It seems that the core of the controversy is the difficulty of estimating corporate profits on a regional basis. These difficulties, while serious, have been over-emphasized in some of the debates, due to some confusion between the income-received nature of personal income and the income-produced nature of gross product, where gross product is

---

[3]See L'Esperance (1976) and also note Weber (1979b, p. 217).

[4]Graham (1972).

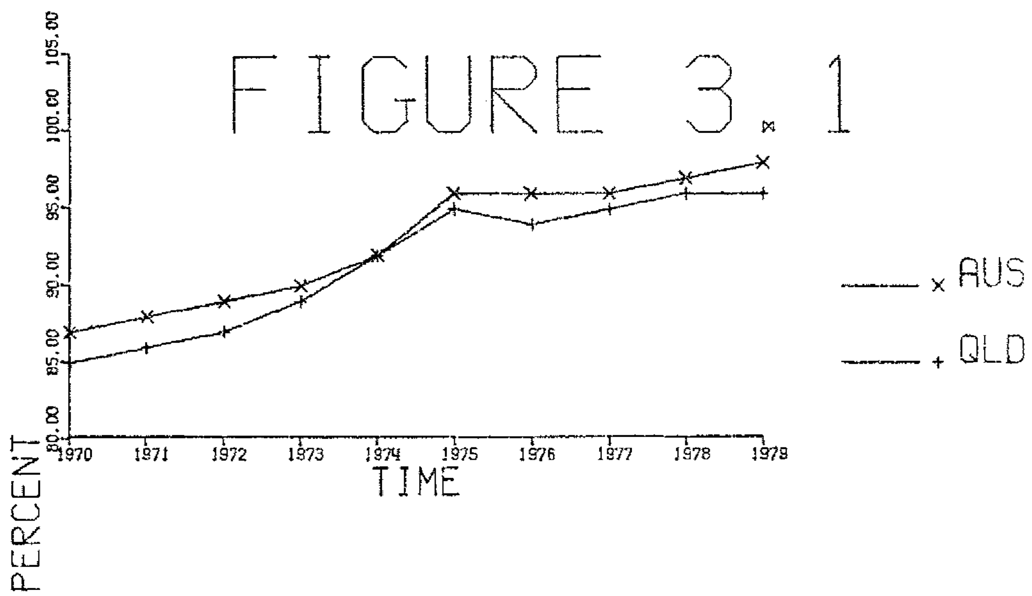
[5]See L'Esperance (1976, p. 5), Ratajczak and Williams (1972), and Renshaw (1975).

Table 3.1: Queensland and Australian Household Income to Gross Product ratios

Year	Gross Product ($m)		Household Income ($m)		Ratio (%)	
	Queensland	Australia	Queensland	Australia	Queensland	Australia
1969-70	3563	27369	3033	23684	85	87
1970-71	3949	30313	3409	26539	86	88
1971-72	4573	33835	3988	30046	87	89
1972-73	5340	38486	4743	34501	89	90
1973-74	6326	45967	5812	42452	92	92
1974-75	7807	55088	7397	52827	95	96
1975-76	9170	64127	8654	61646	94	96
1976-77	10534	73350	9953	70489	95	96
1977-78	11513	80150	11033	77856	96	97
1978-79	13176	89068	12665	87033	96	98

Source: this thesis and ABS: *National Income and Expenditure*, 1978-79.

Figure 3.1: Household Income to Gross Product ratios



Source: Table 3.1.

defined as a *domestic* rather than a *national* concept.[6]

3.2 METHODS OF ESTIMATION OF GSP

There are three different approaches to the estimation of gross product. These are summarized in Table 3.2.

Klein (1969) suggests an uncompromising reliance on the expenditure approach in his outline of the specification of a regional model. However this has practical problems in the Australian context. Since there is a lack of state time series data for all industries on gross fixed capital expenditure and increase in stocks, there appears to be little hope of constructing expenditure-based time series estimates of GSP, even though the ABS publishes annual estimates of private final consumption expenditure by state, and some states have data on exports and imports. The trade data are not consistently available among the states, and is published only for Western Australia, Tasmania and Queensland. Also, no data have been published on the distribution of final consumption expenditure and gross fixed capital expenditure by federal government authorities in the geographical areas of the states. However, these estimates for state and local government authorities are readily available.[7] The lack of data on federal government expenditures and private gross fixed capital expenditure for tertiary (or service) industries is crippling, ruling out estimation on the expenditure side.

Most of the social accounting data constructed for regional models in the USA have followed the approach of Kendrick and Jaycox (1965). Their approach indicates that, "In *private non-farm industry* gross product originating can be estimated from the [Department of] Commerce estimates of that portion of personal income originating in current production (wages and salaries, other labour income and the net income of proprietors) by industry group, blown up by the national ratios of

---

[6]See Renshaw (1975, pp. 43-4) on this point.

[7]For basic statistical sources of all these data, see ABS, Catalogue Numbers 5204.0, 5402.3 and 5504.0

Table 3.2: Alternative Approaches to the Estimation of Gross State Product

Expenditure on GSP	*Income* by principal component	*Value added* by industry
Private final consumption expenditure	Wages, salaries and supplements	Primary - Farm
Gross fixed capital expenditure - Private - Public	Gross Operating Surplus - companies - unincorporated - ownership of dwellings - public - financial	Primary - Non farm
Government expenditure - consumption - capital	(Less Imputed Bank Service charge)	Mining
Net exports of goods and services		Manufacturing
Increase in stocks		Electricity
Less Net indirect taxes		Construction
		Trade
		Transport
		Finance
		Public Administration and Defence
		Community
		Ownership of dwellings
Gross State Product at Factor Cost	Gross State Product at Factor Cost	Gross State Product at Factor Cost

Source: Adapted from Kendrick and Jaycox (1965, p. 155).

gross product to the covered portion in each group by component".[8] In other words, an amalgamation of the income and value added approach is proposed. This produces a set of data similar in nature to Table 17 (Gross Domestic Product at Factor Cost by Industry and Principal Components) in *Australian National Accounts, National Income and Expenditure*.

The Kendrick and Jaycox approach is practical and is the basis of the method used below in estimating GSP for Queensland.

Conceptual and practical issues associated with problems and methods of estimation of regional economic accounts are discussed in N.B.E.R. (1957), Hochwald (1961), Hirsch (1964) and Kendrick (1972).

Renshaw (1975) gives a good account of some of the issues involved in "blowing-up" state labour income by national ratios of labour income to gross product, while Weber (1979) gives a recent synopsis of current variations of this method which are being used in the USA.

3.3 A SURVEY OF GSP ESTIMATION

This brief survey of GSP estimation is divided into four sections, based on the country of origin viz. USA, Canada, UK and Australia.

It should first be noted though, that there has been much work done on income and product estimation for sub-state regions both in Australia and overseas. Since this thesis is concerned particularly with the analysis of component states of a federation, these sub-state estimations will not be discussed in detail.[9] In any case, the justification and practical possibilities of estimating regional gross product disappear quickly as the openness of the region increases. For

---

[8]Kendrick and Jaycox (1965, p. 157).

[9]Included in such work in Australia are Clark (1945), Clark (1949), Kerr (1963), Harris (1968) and Gordon (1978). The major difference between a state and a sub-state region is the existence and non-existence of a single political unit (government) with constitutional authority over the jurisdicture area included in the region.

small regions (certainly for sub-state regions in Australia), it would seem that personal income series are the only estimates of economic activity likely to be made, and even in this case estimates would tend to be confined to population census years and would also depend heavily on the availability of economic census establishment data.

However this restriction will not be applied to the UK, which is not strictly an economic federation like Australia, Canada and the USA, whose structures follow from the federation of separate colonial governments. While Wales, Scotland and Northern Ireland may be regarded in some ways as provinces, the regions of England have no political-administrative identity corresponding to the state of a federal system. The UK is included in this survey, firstly, to demonstrate that estimation of GSP need not be confined to federal systems (even though it may be more appropriate in a federal system); and secondly, to reveal the quality of the gross regional product estimation work carried out in the UK by the official statistical organization, the Central Statistical Office.

While this survey is confined to work in four countries, it is to be noted that GSP estimation has proceeded in other countries. EEC regional policy has resulted in the development of sets of regional accounts in all member states. For example, references to GDP estimates of the West German Länder have been made in Spahn (1977b, p. 241) and *The Economist* (1980, p. 13).

3.3.1 GSP Estimation in the USA

The main strands of GSP work published for the states of the USA federation are shown in Table 3.3. This survey, it must be emphasized, does not address itself to estimates of gross regional product i.e., estimates for sub-state regions, whether FEA's, SMSA's, counties etc.

Table 3.3 does not include mention of authors whose contribution can be considered wholly theoretical or methodological. Important contributions have been made by a number of individual authors in the edited works by Hochwald (1961) and Hirsch (1964). However the most recent methodological and survey contribution, that of Weber (1979b), will be discussed at the end of this section.

Table 3.3: Selected GSP Work in the USA

Author (Year)	State	Years
Kendrick and Jaycox (1965)	Maryland	1953-64
Green (1967)	Illinois	1929-63
Moody, Puffer and Williams (1967)	All states[a]	1953-63
L'Esperance, Nestal and Fromm (1969)	Ohio	1955-65
Charlesworth and Herzel (1970)	Kentucky	1968
Shang, Albrecht, Ifuku and Oshima[b] (1970)	Hawaii	1958-68
Lynch (1971)	Idaho, Oregon and Washington	1965-69
Kattke (1972)	South Dakota	1960-70
Polenske (1972)	All states	1947, 1958, 1963
Niemi (1975)	Twelve south-eastern states[c]	1950-70
Weber (1979b)	New Jersey	1950-76

[a] Only published as eight regions, aggregations of states, summing to the nation.

[b] This work was developed and supervised by H.T. Oshima.

[c] Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana.

It is fair to say that the article by Kendrick and Jaycox (1965) has been the most important work since Hirsch (1964). The method named after Kendrick and Jaycox has generally been applied by almost every researcher in the USA working on GSP estimation since 1965. Green (1967), Shang *et al.* (1970), Polenske (1972) and Moody, Puffer and Williams (1967) are the few exceptions.

Of these, Shang *et al.* (1970), under the direction of H.T. Oshima, was concerned with Hawaii, an island state, where the wealth of data on trade enabled the development of a consistent set of product accounts on both the income and expenditure sides. These accounts represent one of the best sets of subnational economic accounts developed anywhere in the world.

Polenske (1972) developed what were termed State Estimates of the Gross National Product for the years 1947, 1958 and 1963. These estimates were destined for use in the Harvard Economic Research Project on the construction of the ambitious Multiregional Input-Output Accounting System. The estimates were those of final demand i.e., personal consumption expenditures, gross private capital formation, net inventory change, foreign exports and imports, and government purchases.

The volume of work performed was massive, since the data were produced for 51 states and 87 industries. Furthermore the lack of official estimates of components of final demand by state meant that estimation had to proceed largely from original data sources. The results can only be commended, but the cost of the effort means that systematic production of a time series of the estimates would have to await the involvement of government agencies. Certainly it is not apparent that such time series estimation is possible, using Polenske methods, due to the disaggregation needed for input output models and the irregular timing of suitable data gathered by official surveys.

Green (1967) developed estimates for Illinois of both gross state income and GSP. These were defined as being equivalent, with gross state income being the sum of income components such as compensation of employees, net interest, rental payments, proprietor income, corporate profits, indirect business taxes, personal contributions to social insurance, capital consumption allowances and less subsidies (less current surplus of government enterprises). Gross state product was defined as the sum of expenditures - consumption, investment, state and local government, and net exports. Estimation proceeded by using as much published data for components as possible, and then using what amounts to a relative of the Kendrick and Jaycox approach - "The remaining components were allocated to Illinois from national totals. The allocators were based on series that reflected the share of a closely related variable applicable to Illinois".[10]

Moody, Puffer and Williams (1967) also estimated final demand components of GSP for input to an econometric model. The estimation procedures were generally crude allocations of national variables into states on the basis of the state distribution of related variables. For example, national personal consumption expenditure was allocated to the states on the basis of shares of personal income. Since this method does not produce industry estimates, and since some of the methods are heroic in their assumptions, the methodology of Moody *et al.* has been discarded, for the mainland states of the USA, in favour of the method of Kendrick and Jaycox.

The method of Charlesworth and Herzel (1970) is, in spite of claims of the authors, related to the Kendrick and Jaycox method. Their method relies on information available from the Kentucky Department of Revenue from state corporate income tax returns. This enables the problem of estimation of corporate profits to be reduced, since all-Kentucky corporations are readily identified and their profits measured. The problem of allocation (to Kentucky) of the profits of multi-state corporations was solved by using payrolls, weighted by value-added indexes, as the allocator. This approach may be regarded as being a precursor of the modern adjusted Kendrick and Jaycox method.

The method of Kendrick and Jaycox has been briefly described above. The most widely known of the many applications of this method are those by L'Esperance *et al.* (1969) for Ohio and Niemi (1975) for the twelve south-eastern states. The estimates for Ohio are a straightforward use of the method of Kendrick and Jaycox with a minor adaptation in the estimation of state and local government wages, salaries and supplements. Two less well-known, but straightforward, applications of the Kendrick

---

[10] Green (1967, p. 29).

and Jaycox method are for Idaho, Oregon and Washington (Lynch (1971)) and South Dakota (Kattke (1972)).

The estimation procedure applied by Niemi follows the basic Kendrick and Jaycox method with a modification to the procedure of estimating gross product in manufacturing. The explanation of the method detailed in Niemi (1975) is worth listing:

> ... the estimation is conducted on the following component breakdown:
>
> Government
> Farm
> Private Nonfarm
> Mining
> Construction
> Manufacturing
> Trade
> Finance, Insurance and Real Estate
> Transportation, Communication, and Public Utilities
> Services and Other
>
> Gross product originating is estimated separately for each of the major industry categories.
>
> In the government sector, the procedure follows the Department of Commerce concept of gross government product, defined as the compensation of general government employees. This involves summing wages and salaries plus supplements ...
>
> The estimates of gross farm product are computed entirely from data published by the U.S. Department of Agriculture ...
>
> An identical procedure is followed for all industries in the private nonfarm sector. The technique involves the application of a series of national coefficients to available state data and estimated state totals. The procedure followed for the private nonfarm industries was made possible by the Commerce Department's development of estimates of G.N.P. by major industry. The foundation for the gross state product estimate for the private nonfarm industries is income received by persons for participation in current production. Income received is defined to include wage and salary disbursements, other labor income, and proprietors' income. In contrast to personal income, it does not include transfer payments, rental income, interest, and dividends.
>
> The national ratio of income originating to income received is used in order to obtain state income originating estimates by industry for given years. A similar utilization of national coefficients is made in estimating capital consumption allowances and indirect business taxes for each industry for each year ...
>
> The estimate of gross product originating in manufacturing yielded by the above procedure is adjusted to better reflect the peculiarities of the individual states. John Kendrick

> developed the adjustment procedure and suggested it to this author ... The purpose of adjusting the estimate of gross product originating in manufacturing is to eliminate any bias introduced by this assumption of similar factor proportions. State manufacturing value added and labor payroll data, published by the Commerce Department in the *Annual Survey of Manufactures*, [*sic*] serve as the foundation for the adjustment ...[11]

This method has served so well that it has now been formally codified, with a number of the adjustments that have developed, by Weber (1979b). According to Weber,

> Several recent advances in the theory and the advent of a complete revision of national and regional statistics by the U.S. Department of Commerce provide an appropriate impetus to a review and synthesis of the proposed methods.[12]

Weber has specified three basic methods:

(i) the direct calculation method,

(ii) the value added method, and,

(iii) the income received method.

The direct calculation method is self explanatory, and is used in the USA only for the agricultural sector. The government sector is handled by the modified direct calculation treatment detailed by L'Esperance *et al.* (1969).

The weighted value added method applies in the USA to the mining and manufacturing sectors. This method uses information on value added gained from official surveys and censuses,[13] and allocates GSP from state value added by the national ratio i.e.,

$$GSP_i = \left(\frac{GNP_i}{VAN_i}\right) VAS_i$$

where,

i	=	industry or sector
GSP	=	gross state product
GNP	=	gross national product
VAN	=	value added, for the nation
VAS	=	value added, for the state.

---

[11] Niemi (1975, pp. 9-11).

[12] Weber (1979b, p. 217).

[13] Annual Survey of Manufacturers, Census of Manufacturers, Census of Mineral Industries; U.S. Department of Commerce.

This approach was necessary since the definitions by which the survey data on value added are compiled do not correspond with the economic accounting definition of value added. This is similar to the case in Australia, where in the IEC, "value added" less "wages and salaries" does not correspond to the social accounting concept of gross operating surplus.

The income received method in its unweighted form is similar. GSP is found by allocating GNP to the state on the basis of the state's share in national Income Received by Persons for Participation in Current Production (usually termed "income received"). In the USA this can be done on a business sector or industry basis, i.e.,

$$GSP_i = \left(\frac{GNP_i}{IRN_i}\right) IRS_i$$

where,

IRN = income received, for the nation

IRS = income received, for the state.

This can be modified to take account of the extra information provided by official surveys and censuses for manufacturing. According to Weber, " ... the ratio of Value Added per dollar of labor costs in the state to the Value Added per dollar of labor costs for the nation is used as a proxy for the relative productivity of the two areas".[14]

So, for manufacturing industry, m,

$$GSP_m = \left[\frac{\left(\frac{VAS_m}{LPS_m}\right)}{\left(\frac{VA_m}{LP_m}\right)}\right]\left(\frac{GNP_m}{IRN_m}\right) IRS_m$$

where,

VA = value added, for the nation

LP = labor payroll, for the nation

VAS = value added, for the state

LPS = labor payroll, for the state

More work than that discussed above has been done on GSP estimation in the USA. In particular, passing reference could be made

[14]Weber (1979b, p. 222).

to many individual efforts, mostly based on the method of Kendrick and Jaycox, and many originally estimated in order to provide important data for regional econometric models. These include Adams, Brooking and Glickman (1975), Rubida (1977), Fromelt (1973) and Rice and Gober (1973). Certainly Weber has claimed "Estimates of Gross State Product and its various sectors for *all* states and many regions of the United States have been presented ... over the past few years".[15]

3.3.2 GSP Estimation in Canada

There are two main strands of work on GSP estimation in Canada. The first is the report by Czamanski (1968) on income and product accounts for Nova Scotia. This was followed by Chari and Frank (1970) for Ontario. This was a forerunner to the official estimates for all Provinces prepared by Statistics Canada (1977).

Czamanski (1968) prepared the estimates for Nova Scotia for input to his regional analysis of that region.[16] His report provides one of the most comprehensive sets of economic accounts for a region yet published. However his work relied heavily upon unpublished estimates provided by the Dominion Bureau of Statistics (later renamed Statistics Canada). Furthermore his descriptions of the derivations of income of farm and other unincorporated enterprises and company profits are extremely vague.

Chari and Frank (1970) provide an example of the intermediate stage of state or province government interest in regional income and product accounts, i.e., between private researchers such as Czamanski and official federal agencies such as Statistics Canada. This paper details an attempt by officials of the Department of Treasury and Economics to provide a " ... methodology for the development of a comprehensive set of provincial economic accounts on the basis of the "national" concept".[17]

In 1977, Statistics Canada released a report by their Gross

---

[15]Weber (1979b, p. 217). Emphasis added.

[16]See also Czamanski (1972).

[17]Chari and Frank (1970, p. 5).

National Product Division, containing preliminary (or "experimental") estimates of GDP for the Canadian Provinces. The report stated that, "By 1973 there was a general feeling that Statistics Canada ought to be involved in regional product measures in a deliberate and formal way". This led to the establishment of a Federal-Provincial Committee to oversee the development of provincial accounts and ensure cooperative effort and comparability of estimates. The motivation behind this official interest, in Canada, was most likely the fear that unofficial estimates of poor quality could encourage political movements for the disintegration of the Canadian federation. This was obvious, although unstated, in the contents of the Press Release by the federal Finance Minister, Mr D.S. Macdonald, on the release date of the provincial accounts report. "The accounts show the way Confederation has operated to the advantage of all parts of the country, he said ... But the Finance Minister cautioned that no system of economic accounts can adequately measure the economic benefits of being part of Confederation ... In particular, the new figures today cannot be used to calculate a "balance sheet" on Confederation as attempted recently by the Government of Quebec...."[18]

The estimates, while official, are still regarded as experimental, and apparently further development is proceeding to revise and extend the available narrow range of estimates.[19]

Tables showing gross provincial product accounts, and the Government Revenue and Expenditure Accounts, are presented in the report. It is instructive to note the official description of the problem of allocation of corporate profits to provinces.

> Three procedures were used to distribute profits. The most conceptually appropriate of these is based on the concept of "operating surplus", defined as the excess of value added over labour income, depreciation, and indirect taxes less subsidies. Operating surplus series, however, have been estimated only for manufacturing, mining, and construction. Profits in other industries were allocated according to the "taxation formula" [The taxation formula generally uses a weighted average of wages and salaries to subdivide taxable income and hence profits.],

---

[18]Macdonald (1977, p. 1).

[19]Chrétien (1978, p. 1).

and, where this was not possible, according to the provincial distribution of labour income.

Each of these procedures suffers from some important drawbacks, and there is a degree to which they are mutually incompatible. Company data, which may include information on more than one establishment, are used to calculate the taxation formula and Canadian profits by industry, while establishment data are employed to calculate labour income and value added, and hence operating surplus values. The provincial distribution of profits by industry may have been affected by this use of a combination of establishment and company data.[20]

3.3.3 GSP Estimation in the UK

In spite of the fact that the United Kingdom is not a federation as are Australia and the USA, GSP estimation, or rather, estimation of GDP on a regional basis, in the UK has advanced beyond the stages reached in either of those countries. Estimates of regional GDP are now prepared by the official Central Statistical Office. This has been the case since 1973 when the CSO announced that, "The negotiations that have been taking place in Brussels on the formulation of a Community Regional Policy have identified the need for estimates of GDP for each of the regions in the member countries".[21]

Table 3.4 lists the UK work on GSP estimation.

Regional product estimation began in the UK with the "tentative calculations by Deane and Stone for 1948".[22] However the first estimates of regional gross product to be completed were those for Wales by Nevin (1956). (This work was extended over the next decade to culminate in the detailed set of income and product accounts for Wales published in Nevin *et al.* (1966).) This work in Wales was closely followed by publication of estimates of the GDP of Northern Ireland by Carter (1958).

In 1964, in a report prepared for the Government of Northern Ireland on economic development of that region (Wilson (1964)), the first official estimates of regional GDP at factor cost appeared. These were tabulated in an appendix, with the note that, "The Economic Section

---

[20] Statistics Canada (1977, pp. xii and xiii).

[21] CSO (1973, p. lxxi).

[22] Woodward (1970, p. 63).

Table 3.4: GSP WORK IN THE UK

Author (year)	Region	Years of estimation
Deane (1953)	All regions	1948
Nevin (1956)	Wales	1950
Carter (1958)	Northern Ireland	1950-56
Wilson (1964)	Northern Ireland	1950, 1954, 1958, 1960-62
McCrone (1965)	Scotland	1951-60
Nevin, Roe and Round (1966)	Wales	1948-64
Woodward (1970)	All regions	1961, 1964
CSO (1973)	All regions	1966-71
Kent-Smith and Pritchard (1975)	All regions	1966-72
CSO (1978)	All regions	1968-75
CEPG (1980)	All regions	1966-78

of the Government has now produced estimates of the Gross Domestic Product in Northern Ireland, i.e., a measure of the value of the goods and services produced, before providing for depreciation or stock appreciation for the period 1950-1962".[23] No further details were given on the derivation of the figures, although the results were used in the text.

McCrone (1965) derived estimates of regional GDP for Scotland in order to provide a consistent, comprehensive set of statistics on Scotland which would be directly comparable with those of the nation. He gives a persuasive rationale both for product estimates, and for domestic product rather than national.[24] An appendix provides a clear and detailed description of the method used by McCrone. These estimates were prepared on an industry basis. McCrone points out that this approach is not that usually used for estimating national accounts, but gives the reasons for the necessity to develop regional accounts in this way. These reasons include not simply the advantages to be had for analytical purposes in having industry breakdowns, but also the more pressing data problems of inadequate income tax tabulations by region, through lack of availability and through the familiar head-office reporting problem.[25]

Woodward (1970) was the first to complete the construction of estimates of regional GDP for not just the "kingdom" or "principality" regions, but for the regions of England as well. This deficiency in coverage was noted by McCrone, who correctly attributed it to lack of regional data sources.[26] Woodward, however, felt that the availability of data had improved sufficiently around the late 1950s and early 1960s to enable estimates to be made on a preliminary basis for 1961 and 1964. This was a major piece of work. He used the earlier work skilfully and was able to contrast his estimates with those of Nevin *et al.* (1966)

---

[23]Wilson (1964, p. 144)

[24]McCrone (1965, pp. 15-19).

[25]This is of course the "enterprise"-"establishment" problem. In income tax returns, enterprise returns are the norm, creating obvious problems in the allocation of corporate profits.

[26]McCrone (1965, pp. 14-15).

for Wales, McCrone (1965) for Scotland and the official estimates for Northern Ireland. Estimates of regional GDP by industry were calculated for 1961, by estimating industry breakdowns separately for income from employment, income from self-employment and gross trading profits of all companies.

In 1973, membership of the UK in the European Economic Community produced the side effect of having the official statistical organization in the UK produce official estimates of regional GDP, thus relieving individuals of this task. Three articles, CSO (1973), Kent-Smith and Pritchard (1975), and CSO (1978) have summarized this work. CSO (1973) presented only very preliminary results - picking up the work of Woodward and determining the first time series of estimates for all regions of the UK. No details by industry were available.

Kent-Smith and Pritchard (1975) revealed that the estimation approach using factor incomes (rather than expenditures) was now officially preferred since " ... not only is it easier to interpret the information but also the quality of the basic data from which the regional estimates are made is higher".[27] Work had not ceased on expenditure estimates, but clearly the poor quality of the estimates precluded publication.

The method of estimation of the "regional dispersion of profits"[28] outlined in Kent-Smith and Pritchard (1975) is interesting. They considered that there were three "proxy measures"[29] suitable for use as allocators of national profits to regions. The first considered was capital stock. This was immediately rejected since no regional data on capital stock exist and "there is no possibility of such figures being made available".[30] The second allocation variable considered was net output data by industry. This too was rejected since the data were of poor quality, gathered on an "establishment" basis.[31] The third was

[27] Kent-Smith and Pritchard (1975, p. 87).

[28] Kent-Smith and Pritchard (1975, p. 89).

[29] Kent-Smith and Pritchard (1975, p. 89).

[30] Kent-Smith and Pritchard (1975, p. 89).

[31] The UK statistical concept of an "establishment" apparently corresponds with the Australian "enterprise".

employment. This was selected for us largely because of data availability, with the important reservation that " ... it is impossible to distinguish between those employees who work for companies, and who would therefore be relevant to our method for the distribution of profits, and those employees who work for self employed people, who should, ideally, be excluded from this calculation".[32] This allocation was not performed on an industry basis.

CSO (1978) is the most comprehensive official description available of sources and methods of constructing regional estimates of GDP. The official statement on the history and rationale of these estimates in the UK is interesting:

> The decision of the Central Statistical Office (CSO) to work towards the production of estimates of regional accounts nearly 5 years ago can be seen as an exercise to draw together and extend the limited series of regional accounts both official and unofficial which already existed. The pronounced national identities of Scotland, Wales and Northern Ireland, together with long standing economic problems in these countries calling for specific economic analysis has meant that they, in the past, took the lead in producing accounts for their countries with the object of enabling comparisons to be made between their economies and the United Kingdom as a whole. Unofficial estimates of gross domestic product and some other elements of regional accounts in Scotland had been produced by McCrone, and Begg, Lythe and Sorley, by Nevin, Roe and Round in Wales and by Carter and Robson in Northern Ireland. The Scottish and Welsh Offices and the Department of Finance, Northern Ireland responded to the need for government series and official gross domestic product estimates are now available.
>
> Prior to the publication of regional accounts by the CSO, there had been no official estimates for the English regions, although unofficial estimates, the most recent of which were by Woodward, have been published. The CSO, entering rather late into this field, has attempted to co-ordinate all of the separate official estimates with the object of providing a consistent set for all regions including the regions of England. In developing along these lines of approach, the CSO has maintained a close consultation with officials in Scotland, Wales and Northern Ireland, from whom it has received invaluable advice (and criticism) and, for many of the estimated components, data.[33]

---

[32] Kent-Smith and Pritchard (1975, p. 89)

[33] CSO (1978, p. 1)

It is also interesting to note their official statements on their methods of estimating regional profits by industry. For manufacturing, regional profits were estimated by converting regional census of production (ACOP) net output data to estimates of profits. For industries outside manufacturing, " ... profits are generally allocated at SIC Order level by region in proportion to employment".[34]

The most recent work in the UK has been the extension of the CSO estimates by the Cambridge Economic Policy Group. This work, CEPG (1980) extends regional accounts to include not only regional expenditure and income, but also employment and population.

3.3.4 GSP Estimation in Australia

Previous Australian GSP work is summarized in Table 3.5.

The efforts made by T.A. Coghlan, the New South Wales Government Statistician between 1886 and 1905, were remarkable for the time, and place Australia in the earliest ranks of countries for which modern national incomes estimates were prepared. Indeed, Arndt (1949) has claimed that "It would seem that his estimates were the first official estimates of national income anywhere; and he also seems to have been the first (if Gregory King be left in a class by himself) to have attempted parallel estimates of national income, output and expenditure on lines at least approaching modern techniques".[35] Table 3.6 presents Coghlan's results for New South Wales for 1894. It should be noted that Coghlan's concept of production activity (which excludes tertiary industries) does not permit an equivalence of the totals of national income, national expenditure and the value of production of New South Wales.

H.W. Arndt and N.G. Butlin produced alternative estimates to those of Coghlan's for "National Output, Income and Expenditure of N.S.W., 1891".[36] These estimates cannot be regarded as mere revisions, even though they drew heavily on Coghlan's work; instead they were the

---

[34]CSO (1978, p. 13).

[35]Arndt (1949, p. 616).

[36]Arndt and Butlin (1950, p. 30).

Table 3.5: Previous Australian GSP work

Author (Year)	State	Years of estimation
Coghlan (various[a])	New South Wales	various 1886-1900
Clark[b] (1940)	Queensland	1928-29 to 1938-39
Arndt and Butlin (1950)	New South Wales	1891
Salter (1953)	Western Australia	1947-48 to 1950-51
Kerr (1963)	Western Australia	1953-54 to 1955-56
Snooks (1972)	Western Australia	1923-24 to 1938-39
Wong (1974)	Tasmania	1953-54 to 1969-70
Hudson (1976)	Tasmania	1962-63 to 1972-73
Donovan (1978)	All states	1953-54 to 1965-66

[a] See Coghlan (1894) for a sample of his work, and Arndt (1949) for a summary of Coghlan's work. Coghlan was in fact the New South Wales Government Statistician, but published the work under his own name.

[b] Colin Clark was the author of these data published anonymously in the 1940 Queensland Year Book. He was then the Queensland Government Statistician.

Table 3.6: Coghlan's economic accounts of New South Wales, 1894

National income

Sources of income	(£'000)
Pastoral industry	9,292
Dairy farming Agriculture	5,118
Forestry and fisheries	410
Mineral production	4,264
Manufacturing	7,940
House rents	5,661
Professional	3,129
Civil servants and government employees	2,978
Other tradesmen and labourers	-
Other mechanical and labouring	-
Personal and household service Food distribution	3,574
Trade and commerce, n.e.i.	-
Commerce, trade, etc.	7,468
Trade and shipping	-
Other trade and earnings of capital	-
Shipping Transport (by land)	3,184
Construction	5,834
Female wage earnings	-
Miscellaneous pursuits	228
Total	59,080

National expenditure

Expenditures	(£'000)
Consumption:	
Food and beverages	16,239
Fermented liquors	3,931
Tobacco	1,208
Clothing and drapery	6,567
Furniture	477
Rent (dwellings)	5,661
Locomotion	1,600
Fuel and light	1,853
Domestic service Lodgings	1,450
Medical and nursing	1,432
Religion, charities and private education	754
Art and amusement	998
Books and newspapers	758
Direct taxes not falling on trade	-
State services, postage, succession dues	579
Other household expenses	1,950
Miscellaneous expenses	1,199
Total	46,656
Savings, etc.:	
Local rates	506
Losses by fire	-
Calls by banks	750

Value of production

Productive activity	(£'000)
Agriculture	3,396
Pastoral industry	11,168
Dairy farming	2,548
Forestry and fisheries	689
Mining	4,858
Manufacturing	7,627
	30,286
Less: Raw materials twice included	185
Total primary production	-
"Value of production"	30,101

Table 3.6 (continued)

National income		National expenditure		Value of production	
Types of income	(£'000)	Expenditures	(£'000)	Productive activity	(£'000)
Wage-earners	23,636	*Savings, etc.:* (continued)			
Persons working on own account	6,959	Conditional purchase (of land from the Crown)	1,052		
Professional } Civil servants }	5,633	Life insurance premia	910		
Employers with earnings of capital owned in New South Wales	14,181	"Savings" (at least)	3,300		
House rents	5,661	Absentee incomes	3,010		
Absentee incomes	3,010	Wear and tear	-		
		(Balance)	(2,896)		
Total	59,080	National (private gross) income	59,080		

Source: Arndt (1949, pp. 619, 620, 623, 624).

result of a reworking of the 1891 Census data and other sources (largely Coghlan's) based on more modern concepts. These concepts included the triple entry system, which Coghlan had pioneered but had not formally recognized. Their results are shown in Table 3.7.

Colin Clark is best known for his pioneering efforts in the estimation of national income and outlay accounts for the UK during the 1930s.[37] That work equipped him for what must have then seemed the simple task of preparing estimates of gross and net production for Queensland and its regions (and for Australia) when he became Queensland Government Statistician in 1937. The 1940 Queensland Year Book contains estimates from 1928-29 to 1938-39 of Clark's "gross national income" for Queensland, by which he meant "the value, at current prices, of all goods and services produced in the state".[38] In concept, this gross national income of Queensland was a precursor of GSP at factor cost, since indirect taxes were estimated as an aggregate amount and were not allocated out by industry. The estimation methods were briefly outlined in the 1940 Queensland Year Book. Clark's estimates for Queensland in 1938-39 are given in Table 3.8. His "Final Value of Goods and Services Produced in Queensland" is the modern "domestic" concept of gross product, and his "Value of Goods and Services available for Consumption or Investment by Queensland Residents" is related to the "national" concept.

The works of W.E.G. Salter and A. Kerr on economic accounting estimates of Western Australia should be considered together, since Salter's mimeographed research report is the precursor of Chapter II of Kerr's monograph, which presents the estimates (of state income) made by J. Nevile and N.P. Campbell.

Salter's task was to estimate state income "broken down into a series of productive sector incomes".[39] This was deemed to be an essential preliminary work to obtaining estimates of income for the geographical regions of Western Australia. The method developed in

---

[37] An account of the interactions between Keynes and the early econometricians, including Clark, is contained in Patinkin (1976).

[38] Queensland Year Book, No. 4, 1940, p. 172.

[39] Salter (1953, p. i).

Table 3.7: Arndt and Butlin's economic accounts of New South Wales, 1891

National income (£'000)	
Wages and Salaries	29,827
Company Income	4,301
Surplus of Public Authority Undertakings	1,950
Income of Unincorporated Businesses, Farmers, Professions etc.	25,519
Net rent and interest	5,515
Net house rents	3,693
Other net rent and interest	1,822
Net National Income at Factor Cost	67,112

National expenditure (£'000)	
Consumer Outlay	
- Goods	32,675
- Services	14,697
Investment Outlay	
- Public	6,831
- Private	7,453
- Other	11,825
Less Depreciation	10,519
Total Current Government Outlay	7,362
Total Outlay	70,324
Less Indirect taxes	3,522
Net Interest paid abroad	4,983
Less Net capital imports	4,129
Net reduction in goldstocks	- 746
Residual item	202
Net National Expenditure at Factor Cost	67,112

National output (£'000)	
Primary Industries	19,668
Secondary Industries	18,311
Tertiary Industries	25,210
House rents	3,923
Net National Output at Factor Cost	67,112
Depreciation	10,519
Indirect Taxes	3,522
Gross National Product	81,153

Source: Arndt and Butlin (1950, pp. 31, 33-5).

Table 3.8: Clark's estimates of national income for Queensland, 1937-38

Queensland national income (£m)		
Source	Gross	Net
Agricultural Production	11.3	*10.4*
Pastoral Production	13.1	*12.7*
Other Primary Production	13.5	*12.8*
Manufacturing Production	19.1	*16.4*
Unrecorded Production	0.9	*0.8*
Transport and Distribution	27.8	*23.8*
Public Works - Construction and Maintenance ..	5.5	*2.7*
Private Building - Construction	2.8	*2.6*
Public Administration (excluding Railways, Tramways, and Post Office)	5.1	*5.1*
Railways	5.8	*2.3*
Tramways	0.8	*0.6*
Post Office	2.4	*1.9*
Domestic, Professional, and Personal Service ..	10.1	*10.1*
Rents - Occupied Houses	11.2	*9.1*
Unemployment Relief Tax Fund	0.6	*0.3*
Interest and Exchange on Public Debt	2.5	*2.5*
Passenger Transport (excluding Railway and Tramway)	0.9	*0.7*
Insurance	1.6	*1.6*
Indirect Taxes	8.6	*8.6*
Final Value of Goods and Services Produced in Queensland	143.5	*125.0*
Deduct -		
Income due outside Queensland -		
Interest on Public Debt	6.8	*6.8*
Foreign Companies and Absentees	2.6	*2.6*
Taxes, etc. to Canberra	7.0	*7.0*
Add -		
Income received from outside Queensland -		
Commonwealth Bond Holdings and Dividends received	2.6	*2.6*
Taxation of Absentees and Foreign War Pensions	0.1	*0.1*
Commonwealth Government Loan and Revenue Expenditure	6.1	*6.1*
Value of Goods and Services available for Consumption or Investment by Queensland Residents	135.9	*117.4*
Deduct Local Rates and State Direct and Indirect Taxes	12.2	*12.2*
Value of Private Incomes of Queensland Residents	123.7	*105.2*

Note: "The distinction between gross and net national income represents the amount which must be deducted ... to provide for depreciation and maintenance of capital." Queensland Year Book, No. 4, 1940, p. 172.

Source: Queensland Year Book, No. 4, 1940, pp. 174-5.

detail in this pioneering report was to estimate, by productive sector (a primitive classification of industries), each of the following forms of factor income,

> "Wages and Salaries
> Supplements
> Unincorporated Income
> Company Income
> Net Rent and Interest etc.
> Surpluses of Public Authority Business Undertakings".[40]

This institutional structure replaced the more theoretical division of factor incomes into "wages and salaries, etc. and surplus" which was "not measurable in terms of Australian data".[41] The main data sources used were payroll tax tabulations, employment data, and income tax tabulations.

Chapter II of Kerr's monograph presents revised estimates of state income at factor cost by productive sector. Table 3.9 gives these estimates for 1955-56 for Western Australia.

The estimates for Western Australia prepared in Snooks (1972) were based on the methods of N.G. Butlin. They cover the period of the Great Depression during the 1930s, and were designed to provide an empirical framework to discuss (as an exercise in economic history) the relative economic performance of Western Australia to Australia during that depression.

The separate works of W.L. Wong and D.C. Hudson in the preparation of estimates of gross product for Tasmania are for comparatively recent time periods. Wong (1974) estimated annual GSP at factor cost as an aggregate for Tasmania for 1953-54 to 1969-70 using a rather simple estimation process. He used the ABS estimates of the three labour income components of the personal income series published in NIE; wages, salaries and supplements, income of unincorporated enterprises, and dwelling rent. National proportions of GNP [*sic*] to labour income

---

[40]Salter (1953, p. 8).

[41]Salter (1953, p. 8).

Table 3.9: Kerr's estimates of state income at factor cost by productive sector for Western Australia, 1955-56

	Wages and Salaries (£m)	Supplements to wages and salaries, Unincorporated Income, Company Income, Net Rent and Interest and Surplus of Public Authority Business Enterprises (£m)	State Income at Factor Cost by Productive Sectors (£m)
Hunting, Fishing, and Trapping	1.110	1.194	2.304
Agricultural, Pastoral and Dairying	11.377	38.858	50.235
Forestry	.860	.791	1.651
Mining and Quarrying	8.787	2.874	11.661
Manufacturing	39.999	18.400	58.399
Building and Construction	12.816	6.066	18.882
Transport and Communication	23.602	.967	24.569
Finance and Property	5.495	4.223	9.718
Commerce	27.697	21.370	49.067
Public Administration and Professional	24.094	5.043	29.137
Sport, Entertainment, Personal and Domestic Service	8.122	4.735	12.857
Dwelling Rent	0.0	8.220	8.220
	163.959	112.741	276.700

Source: Kerr (1963, pp. 36-37).

were then applied to allocate out, to Tasmania, a share of national entrepreneurial income (company income and inventory valuation adjustment). The sum of labour income and entrepreneurial income was GSP at factor cost. Table 3.10 shows his method and his estimate for 1969-70. It has to be noted that even this simple approach was not performed faultlessly. Wong confused gross operating surplus with income. This can easily be seen from Table 3.10, which is copied exactly as a worksheet of Wong's. He equates, conceptually, gross operating surplus of unincorporated enterprises and income of unincorporated enterprises. In fact, the difference between them is the sum of depreciation allowances, net rent and interest paid, and third party insurance transfers. These items are not available on a state basis for the non-farm sector. However, in the spirit of Wong's allocation methods, income of unincorporated enterprises for Tasmania can be adjusted to gross operating surplus by applying the national ratio. Using more recent NIE estimates for 1969-70, GSP for Tasmania using Wong's method would be $682m; but adjusting for this error gives a new GSP of $721m, a difference of 6%.

The estimates of Hudson (1976) on the other hand were for annual GSP at market prices, disaggregated by industry. Hudson's estimates for 1969-70 are given in Table 3.11. The approach used by Hudson was a combination of single factor ratio allocation and OLS allocation to scale down national totals of gross product at market prices by industry. By OLS estimation is meant the process whereby Hudson regressed, using ordinary least squares regression, certain Australian explanatory variables (known for both Australia and Tasmania) on Australian GDP. By inserting Tasmanian values of the explanatory variables into the estimated equation, he determined estimates of GSP for Tasmania. Three types of equation were estimated:

(i) "original"[42] equations, in which the national GDP values were regressed against the national explanatory variables,

(ii) "adjusted" equations, in which all the values in (i) above were, arbitrarily it would seem, scaled downwards by a factor of 10 to approximate the levels of Tasmanian data,

---

[42]The terminology in quotes is that of Hudson (1976, p. 38).

Table 3.10: Wong's estimate of GSP at factor cost for Tasmania, 1969-70

Worksheet for Computing Gross State Product by the Income-Approach, 1969-70

	Australian Figures:	($m)
1.	Wages, Salaries and Supplements	15763
2.	Gross Operating Surplus of Unincorporated Enterprises	4226
3.	= (1) + (2)	19989
4.	Gross National Product at Factor Cost	27047
5.	Entrepreneurial Income = (4) - (3)	7058
	Tasmanian Figures:	
6.	Wages, Salaries and Supplements	434
7.	Income of Unincorporated Enterprises	82
8.	= (6) + (7)	516
9.	Entrepreneurial Income = $\frac{(8)}{(3)}$ x (5)	182
10.	Gross State Product at Factor Cost = (8) + (9)	698
11.	Proportion of Labour Income from current production to Gross State Product in percentage = $\frac{(8)}{(10)}$ x 100	74%

Source: Wong (1974, p. 248)

Table 3.11: Hudson's estimates of GSP at market prices by industry for Tasmania, 1969-70

Industry Division	GSP ($m) (current prices)
Agriculture etc.	79.712
Mining	69.081
Manufacturing	226.083
Electricity etc.	38.722
Construction	77.297
Wholesale, retail	178.328
Transport	57.084
Finance etc.	29.530
Public Administration etc.	30.312
Community services etc.	85.071
Ownership of dwellings	56.014
Customs duties	11.932
Imputed Bank Charges	-20.357
TOTAL	918.809

Source: Hudson (1976, p. 48).

and,

(iii) "difference" equations, in which percentage annual changes in national GDP were regressed against percentage annual changes in the national explanatory variables.

There are many problems related to this approach. It is obvious that the equations of type (i) above are inappropriate, since the intercept term estimated from Australian data will be irrelevant and error producing for Tasmanian data. In fact, in no industry is the preferred equation that of specification (i). This problem cannot be overcome by arbitrary adjustments such as that used to derive equations of type (ii). Certainly no justification was provided by Hudson. Specification (iii) appears sensible, but does not provide estimates of the level of GSP. Indeed, at least one annual value of GSP for each industry has to be found external to the estimation performed by equations of type (iii). In cases when method (iii) provided the preferred equation, Hudson used either modified versions of Wong's estimates or ABS estimates of value added from economic censuses to provide a starting point level of GSP.

Out of thirteen industries, two were estimated with the "adjusted" equations, four with "difference" equations, customs duties (treated as a separate industry since it would be impractical to distribute it out to actual industries) were known, and the remaining six industries were estimated using single factor allocations.

Certainly the statistical fit of a number of the equations estimated by Hudson is suspect. For example, in the type (iii) "difference" equation for the industry, Electricity, Gas and Water: the coefficient for the explanatory variable, electricity generated, was negative and its t value showed it to be not significant; the t value for the other explanatory variable, employment, was even lower in absolute terms; the coefficient of determination was only 0.21; and the F value for (2,7) degrees of freedom was only 1.36. Given these facts, it is difficult to describe Hudson's methods as useful.

Also, it is not known why only parts of the information for states provided in NIE by the ABS were considered useful by Wong and Hudson. For example, both Wong and Hudson ignored the wealth of information available for farm product. Furthermore, Hudson, who concentrated (for no clearly explained reason) on estimates at market prices rather than factor cost, ignored the wages, salaries and supplements estimates for Tasmania available in NIE.

The most recent work on GSP estimation in Australia is that of Donovan (1978), who estimated GSP at factor cost by industry for all states of Australia annually for the period 1953-54 to 1965-66. It is not known why the lag between publication and estimation was so long. The estimation was done to provide a measure of economic activity so that the study could investigate

> ... the growth of the Australian system of State economies, 1953/54 to 1965/66. It explores a gap in the range of applied economic research into Australia's economic growth, with three objectives:-
>
> - to observe and compare the growth paths of the State economies;
> - to attempt a classification of the sources of differences amongst their growth rates; and, in doing so
> - to explore whether geographical disaggregation in growth analysis is a forward step for both national and State forecasting and planning.
>
> Thus the study was an exploratory one; not concerned with any perceived regional development problem at the State level.
>
> A regional social accounts type of analytical framework was chosen as a desirable elaboration of the basic measure of economic growth i.e., gross product originating in each State. The social accounts of the States were constructed on the basis of assumptions and estimating procedures that were necessary due to lack of available data.[43]

Table 3.12 shows a comparison of Donovan's estimates of GSP for Tasmania and those of Wong and Hudson for the period 1962-63 to 1965-66, during which the three sets of estimates overlapped. It shows that Donovan's estimates differ from each of the Tasmanian sets of estimates in both the level and the rate of growth. Table 3.13 shows Donovan's estimates for Queensland for the period 1953-54 to 1965-66. Certainly data scarceness and limitations shaped the development of Donovan's estimates. The industry disaggregation which was used is broad, consisting of Farm, Mine, Make, and Other. The estimates for the states were obtained by allocation procedures from the national totals of principal components of gross product using related series for which

[43]Donovan (1978, p. ii).

Table 3.12: Comparison of Tasmanian GSP estimates, 1962-63 to 1965-66

Year	GSP at market prices of Tasmania				GSP at factor cost of Tasmania ($m)			
	Hudson		Donovan		Wong		Donovan	
	actual values ($m)	percent increase (%)	actual values ($m)	percent increase (%)	actual values ($m)	percent increase (%)	actual values ($m)	percent increase (%)
1962-63	485	-	477	-	390	-	437	-
1963-64	538	10.9	515	8.0	429	10.0	473	8.2
1964-65	588	9.3	570	10.7	469	9.3	524	10.8
1965-66	636	8.2	598	4.9	493	5.1	545	4.0

Sources: Donovan (1978, pp. 93 and 103), Wong (1974, p. 248) and Hudson (1976, p. 48).

Table 3.13: Donovan's estimates of GSP for Queensland, 1953-54 to 1965-66

ESTIMATED GROSS STATE PRODUCT AT FACTOR COST
BY INDUSTRY, QUEENSLAND
1953/54 to 1965/66
($m.)

Yr. End June	FARM			MINE			MAKE			OTHER			TOTAL		
	WSS	GOS	GP	WSS	GOS	GP	WSS	GOS	GP	WSS	GOS	GP	WSS	GOS	GP
1954	67	217	284	17	6	23	142	74	216	348	211	559	574	508	1082
1955	70	224	294	20	10	30	154	79	233	384	241	625	628	554	1182
1956	69	233	302	24	13	37	163	82	245	419	248	667	675	576	1251
1957	71	288	359	26	12	38	176	90	266	446	274	720	719	664	1383
1958	76	218	294	24	7	31	178	101	279	458	285	743	736	611	1345
1959	75	265	340	25	12	37	195	111	306	486	326	812	781	714	1495
1960	75	276	351	27	17	44	207	115	322	558	356	914	867	764	1631
1961	76	270	346	27	18	45	216	121	337	604	359	963	923	768	1691
1962	78	253	331	26	14	40	222	125	347	619	370	989	945	762	1707
1963	84	310	394	27	20	47	232	147	379	655	419	1074	998	896	1894
1964	90	376	466	29	25	54	259	171	430	719	464	1183	1097	1036	2133
1965	96	323	419	31	26	57	298	176	474	802	497	1299	1227	1022	2249
1966	93	309	402	38	29	67	316	201	517	870	531	1401	1317	1070	2387

Source: Donovan (1978, p. 90), part of Table 6.

data were held by state. Donovan used the ABS figures for wages, salaries and supplements, and allocated out national gross operating surplus by state and industry on the basis of other variables, known for the states by industry.

In summary, it appears that while Australian GSP estimation has exhibited, in the past, rigour and reliance on primary sources of data, this rigour has disappeared in recent times. There has been a tendency, particularly in the Tasmanian work, to rely on simple (but quick and inexpensive) allocation methods, rather than the more basic and detailed methods of data construction, which have been exhibited in the earlier works of Clark (1940), Arndt and Butlin (1950), Salter (1953), Kerr (1963) and Snooks (1972), and which placed heavy reliance on the use of primary sources of data within the state. The method of Donovan (1978) is a compromise between the two extremes, although its highly aggregated industry structure illustrates that it owes more to simple allocation methods than primary data sources. There is no significant use of detailed primary state data sources, such as payroll and income tax tabulations, in any of the modern works.

In view of the differences which are revealed in Table 3.12, it seems that a return to the older methods may be both useful and necessary, regardless of the cost.

These comments do not apply, of course, to the modern estimates made by the ABS and published annually in the state tables on household income, farm income and private final consumption expenditure in *Australian National Accounts: National Income and Expenditure*.

3.4 ESTIMATION OF QUEENSLAND GSP

3.4.1 Broad Outline of the Method

The method to be employed for the construction of these estimates of Queensland GSP is an adaptation of the Kendrick and Jaycox allocation method. That is, this method will estimate gross state product, by industry, by applying national ratios of labour income received from current production to total income originating, to state figures of labour income received from current production.[44]

This method will produce quarterly estimates of Queensland GSP at factor cost, by industry and by principal component. The result will be similar in nature to *Table 17* of *Australian National Accounts: National Income and Expenditure* (gross domestic product at factor cost by industry and principal component).[45] Table 3.14 shows the basic data in *Table 17* for 1977-78 for Australia adjusted to conform to the nature of these estimates. The main differences between *Table 17* and these estimates are that *Table 17* contains annual data only, gross operating surplus will not be disaggregated in these estimates, and there is a slight aggregation of industries in these estimates.

Adapted, this method consists of:

(a) The direct use of official ABS estimates for gross farm product at factor cost and wages, salaries and supplements for Queensland.

(b) The direct estimation of gross product at factor cost for the industries, public administration and defence, ownership of dwellings and nominal industry.

(c) The construction of quarterly estimates of wages and salaries by industry for Queensland using monthly payroll tax tabulations as the major data source. Allocation of supplements is then made using national industry wages and salaries to supplements proportions. Allocation to industries to take account of coverage errors and exemption (from payroll tax) discrepancies is then made to ensure that the total of wages, salaries and supplements for all industries for each year for Queensland agrees with the ABS figure.

(d) The estimation of gross operating surplus by industry by applying the national ratios of gross operating surplus to wages, salaries and supplements for each industry to the previously estimated state figure for wages, salaries and supplements for that industry. Adjustments are made to these national ratios for the industries mining, manufacturing and electricity, gas and water, since state

---

[44] See Kendrick and Jaycox (1965, pp. 157-8).

[45] ABS, Catalogue No. 5204.0, termed NIE in this chapter.

Table 3.14: Gross domestic product at factor cost by industry and principal components, Australia, 1977-78

($m)

Industry	Principal components: Wages, salaries and supplements	Principal components: Gross operating surplus	Gross domestic product at factor cost
Agriculture, forestry, fishing and hunting	894	3131	4025
of which			
Farm	717	3004	3721
Non-farm	177	127	304
Mining	1181	2249	3430
Manufacturing	12307	4308	16615
Electricity, gas and water	1294	1326	2620
Construction	4472	1876	6348
Wholesale and retail trade	7792	3948	11740
Transport, storage and communication	4475	1684	6159
Finance etc. and business services	4356	3997	8353
Public administration and defence	4140	-	4140
Community services, entertainment etc., and personal services	10623	1959	12582
Ownership of dwellings	-	6292	6292
Nominal industry	-	-2154	-2154
Total	51534	28616	80150

Source: ABS, Catalogue No. 5204.0, *Australian National Accounts: National Income and Expenditure, 1978-79, Tables 17 and 28.*

estimates are available from time to time of wages and salaries and value added, from the Integrated Economic Censuses of the ABS.

(e) The sum of wages, salaries and supplements and gross operating surplus, by industry, gives gross state product by industry. The sum of GSP by industry is of course total GSP for Queensland.

(f) Where possible, Queensland-specific quarterly allocation or estimation is performed. Otherwise, appropriate national allocators are used.

This method does not exactly correspond with that of Kendrick and Jaycox. This is to be expected since there is no reason to suppose that Australian sources of data would be so similar to those in the USA that a straight adoption would suffice. In particular, the choice of wages, salaries and supplements instead of the sum of wages, salaries and supplements, and income of farm and other unincorporated enterprises, as the allocation base is different. In Australia, there are no estimates available, and no possibility of obtaining estimates, for income of other unincorporated enterprises *by industry*. This, for sound practical reasons, immediately dictates the choice. Further, there is no *a priori* reason to believe that gross operating surplus of trading and financial enterprises allocated from wages, salaries and supplements and income of unincorporated enterprises, would be a superior estimate to total gross operating surplus estimated from wages, salaries and supplements only.

It should be noted that the estimation of wages, salaries and supplements by industry forms a large and important part of the method used in this study, and such estimation was only possible through the provision of detailed payroll tax tabulations by the Queensland Government through the ABS Queensland Office.

The primary data sources used are detailed in Appendix A.

Of course this method may be regarded as crude in comparison with others where income tax tabulations are used to gain better estimation or allocation of company profits.[46] However, the use of income tax tabulations still does not completely solve the severe conceptual and practical problems involved in allocating Australia-wide or multi-

---

[46] See Salter (1953).

national enterprise profits to the geographical origin of the states, particularly with firms with centralized computing and accounting operations. Also, this method is clearly superior to any other modern Australian GSP estimation method, and is comparable, as far as is possible, with most overseas estimation methods. This is not to say that this method cannot be further improved and developed, and is completely error-free. Indeed, it is anticipated that further refinements of the technique will allow gradual improvements in the estimates to be made in subsequent work.

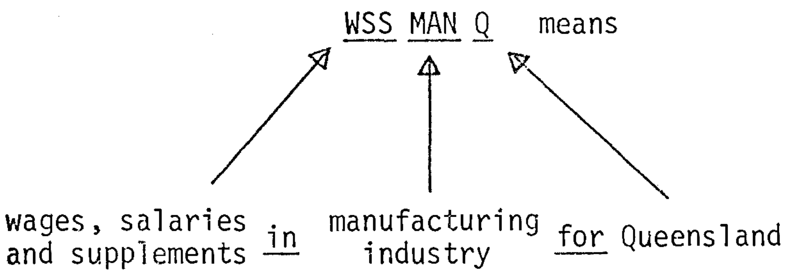
3.4.2 Abbreviations and Notation

It is convenient to use a number of abbreviations and notations in the text.

Abbreviations are listed in Table 3.15.

Generally, within this chapter, except when the meaning is clear otherwise, a "Q" at the end of a variable name, e.g. WSSQ, means that the variable pertains to the state i.e., Queensland. Lack of a "Q" indicates the total for Australia (inclusive of Queensland).

A variable may be classified by industry, e.g.



(WSSQ would be the total wages, salaries and supplements in Queensland for all industries.)

3.4.3 The Computerized Estimation System

In developing this method of estimation, two working papers were produced and circulated. In those working papers, estimation proceeded with a series of worksheets or pro formas. In the second working paper, there were twenty-two different worksheets, and twenty-eight in all which had to be completed. These worksheets were completed by hand.

Table 3.15: Abbreviations used in GSP estimation section

Variable name	Variable description
AGR	Agriculture
F	Primary - farm
NFA	Primary - non-farm
MIN	Mining
MAN	Manufacturing
ELE	Electricity
CON	Construction
TRD	Trade
TRN	Transport
FIN	Finance
PAD	Public administration and defence
COM	Community
ODW	Ownership of dwellings
NOM	Nominal industry
fc	factor cost
GDP	Gross domestic product
GFP	Gross farm product
GNFP	Gross non-farm product
GOS	Gross operating surplus
GSP	Gross state product
mp	market prices
IBSC	Imputed bank service charge
NIE	ABS, Catalogue No. 5204.0, *Australian National Accounts: National Income and Expenditure*
NRF	Net rent and interest paid and third party insurance transfers in the farm industry
PFCER	Private final consumption expenditure on rent
PMG	Postmaster General's Department (later Australia Post and Telecom)
SUP	Supplements
TGR	Total gross rent
WNRF	Wages, net rent and interest paid and third party insurance transfers in the farm industry
WS	Wages and salaries
WSCWI	Wages and salaries paid to commonwealth public servants not in PMG or PAD
WSD	Wages and salaries paid to defence forces personnel
WSI	Wages and salaries paid in an industry measured by an Integrated Economic Census
WSPA	Wages and salaries paid to employees in public administration
WSPMG	Wages and salaries paid to Postmaster General's employees
WSPT	Wages and salaries measured by payroll tax
WSS	Wages, salaries and supplements
WSSB	Wages and salaries paid in small businesses not covered by payroll tax
VAI	Value added for an industry measured by an Integrated Economic Census

Note: a Q at the end of the variable name indicates Queensland.

This system worked well for the development of the method and for the production of preliminary estimates, but with the settling of the estimation method, and the need to produce more than one or two years of quarterly estimates, it became apparent that the estimation method should be computerized, that is, coded in a higher level computer language and filed in the memory of a computer system.

Niemi (1975) had discussed this practical issue. His estimation method was so simple that he continued to use a calculator and work-sheets rather than program a computer.[47] But this decision was simple for Niemi since he apparently had only one worksheet, did not have to estimate state personal income received from current production, and did not produce quarterly disaggregations. The difference between the amount of detail in Niemi's method and this method is enormous.

It was decided that the programming of the method should:

(a) proceed in FORTRAN, since this was the most familiar and best-supported language available at James Cook University, and the estimation method lent itself to a mathematical language rather than a formatting language such as COBOL;

(b) proceed in a structural design so that individual segments of the estimation method could be programmed and run separately; and,

(c) proceed so that modifications to the method through programming changes, and updates and extensions of the input data, could be made easily and clearly.

The estimation method was then coded into a FORTRAN program. This was then typed into the James Cook University DEC-System 1091.[48] It was then thoroughly debugged, and run with the data and methods of the early working papers as a form of validation. A compilation listing of this program is available on request from the author.

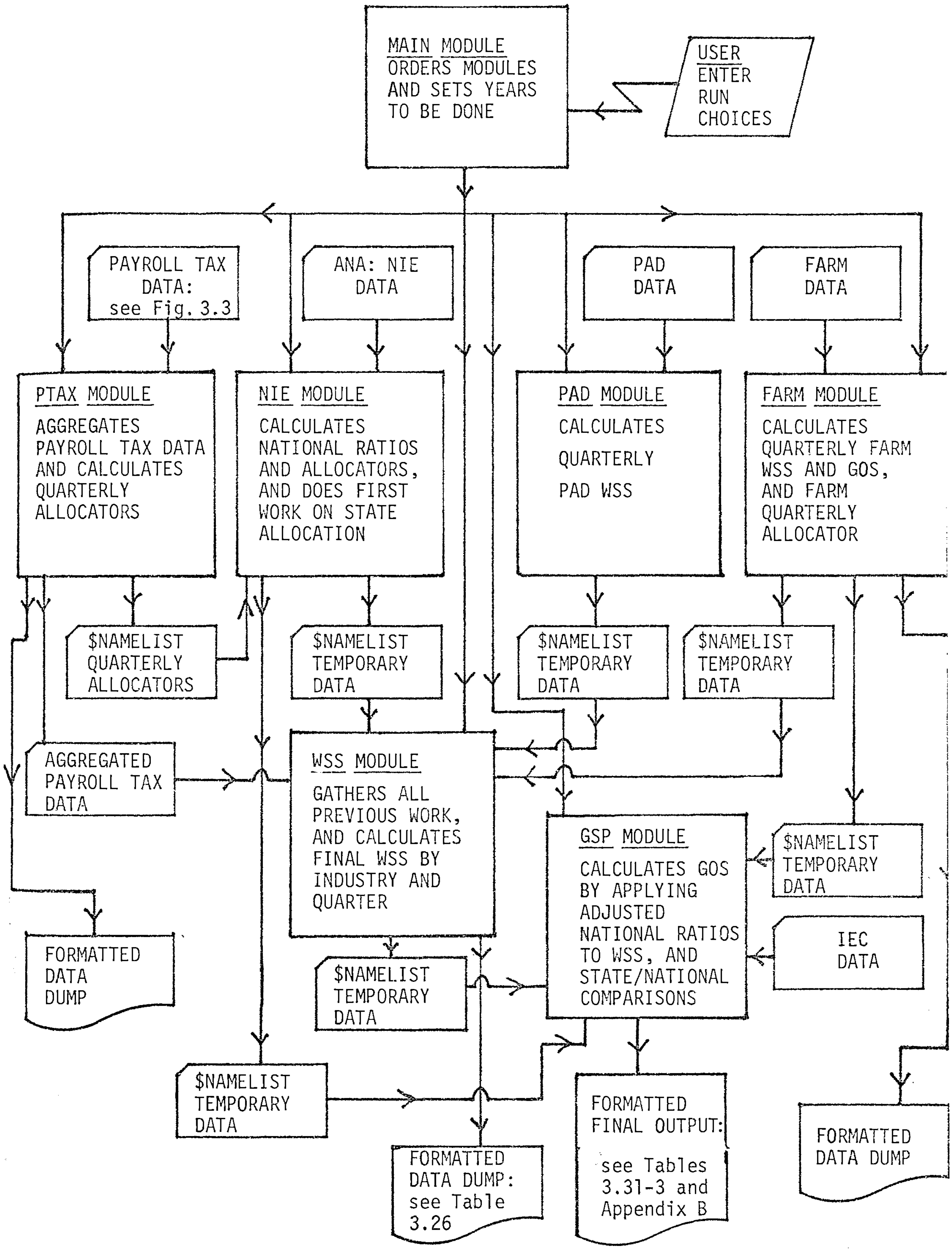
Figure 3.2 presents a flow chart of the structured program which operates this estimation method. The program consists of seven distinct modules. The first module, MAIN, is the main routine of the program.

---

[47]Niemi (1975, p. 102) and see "Exhibit A", his worksheet, on p. 12.

[48]The James Cook University DEC-System 1091 timesharing computer has a KL10 c.p.u., 512K words of 36 bit memory, 1000M characters of disk storage, tape drives, printer, plotter etc., and 90 online terminals.

Figure 3.2: Flowchart of the programmed GSP estimation system



The other six modules are all subroutines called by MAIN. MAIN offers, when executing, a choice of:

(a) What set of years is to be estimated. This is useful since occasionally minor input data changes or method changes might affect only one or several years - in which case it may be wasteful to regenerate all results. This is quite possible since, in most cases, one year's data and method have no bearing on the results of any other year. (The sugar allocator (see below) is a notable exception.)

(b) What modules are to be run. This is useful since some of the modules are also independent. For example, if changes are made in the coding of only the NIE module, then only the NIE, WSS and GSP modules need to be run to generate a final set of new results.

The above choices are made possible by the incorporation of the writing onto disk memory of default NAMELIST output data files after each module is executed. This ensures that if a module needs information from other modules which are not being modified, then old, correct information (intermediate output) is currently stored in computer memory and is thus available. This prevents unnecessary re-executing of correct code and input data.

A full run of ten years of estimation and all modules takes about 16 seconds of c.p.u. time on the DEC-System 1091; not a long time by computer standards, but possibly several man-years work with a calculator and worksheets. This time does not include a considerable amount of computer time necessary to treat the raw payroll tax tabulations. This work is done separately, and the payroll tax module (PTAX) merely aggregates the data. The preliminary calculations, which are heavy, are described in section 3.4.7 below. It would be impractical to include this work in the main estimation system, since the sorting, checking and reclassifying of the payroll tax data are essentially separate, preliminary tasks.

3.4.4 Quarterly and Industrial Breakdowns

The decision to estimate GSP on a quarterly basis was made primarily for modelling reasons, including the desire to increase degrees of freedom in estimation, and the desire to model and investigate changes of less than a year. This is an important contribution to model specification. Additionally the availability of payroll tax tabulations by month provided a very rich data resource - one not to be wasted if possible. These were compelling reasons to produce the estimates on a quarterly basis.

No other work on quarterly estimation of GSP has proceeded in Australia. The ABS do not produce quarterly estimates even for the nation by industry. Also, reference to GSP quarterly estimation overseas is sparse. Weber (1979a) discusses briefly the preparation of quarterly estimates of GSP for New Jersey. Kendrick and Jaycox (1965) also suggest that they had concerned themselves with quarterly estimation.[49] No work on quarterly GSP estimation in the UK or Canada could be found.

The industry breakdown is the standard set of industries used in the Australian National Accounts i.e., the Australian Standard Industrial Classification (ASIC) industry divisions, ownership of dwellings, and the imputed bank service charge nominal industry. The only modification is that *Community Services* (division K) and *Entertainment, recreation, restaurants, hotels and personal services* (division L) are merged. This was done for modelling reasons.

An outline of the industries is given in Table 3.16.

Throughout the rest of this section, when empirical facts are presented, they will by way of illustration generally refer to the year, or to one of the quarters of, 1977-78. The results for Queensland for 1977-78 and comparable figures for Australia for 1977-78 are presented in Table 3.17.

3.4.5 Direct Insertion from Official Sources

Wages, salaries and supplements for Queensland (WSSQ) are published annually by the ABS in the household income by state tables of NIE, and these must be accepted by any individual researcher as the best estimates available. In this work, these estimates are inserted

[49]Kendrick and Jaycox (1965, pp. 163-168).

Table 3.16: Industries used in this study

This study's industries	ASIC	National income and expenditure industries (*Table 17*)
AGRICULTURE	A	AGRICULTURE, FORESTRY, FISHING AND HUNTING
(Sometimes split into		
FARM	01,02	
NON-FARM)	03,04	
MINING	B	MINING
MANUFACTURING	C	MANUFACTURING
ELECTRICITY	D	ELECTRICITY, GAS AND WATER
CONSTRUCTION	E	CONSTRUCTION
TRADE	F	WHOLESALE AND RETAIL TRADE
TRANSPORT	G,H	TRANSPORT, STORAGE AND COMMUNICATION
FINANCE	I	FINANCE ETC., AND BUSINESS SERVICES
PAD	J	PUBLIC ADMINISTRATION AND DEFENCE
COMMUNITY	K,L	COMMUNITY SERVICES AND ENTERTAINMENT AND PERSONAL SERVICES
OWNERSHIP OF DWELLINGS	-	OWNERSHIP OF DWELLINGS
NOMINAL INDUSTRY	-	NOMINAL INDUSTRY

Table 3.17: Estimates of gross product, by industry and principal component for Queensland and Australia, 1977-78

Industry	Wages, salaries and supplements ($m)	Gross operating surplus ($m)	Gross state product at factor cost ($m)
	Queensland		
AGRICULTURE - FARM	161	729	890
- NON-FARM	61	44	105
MINING	258	435	693
MANUFACTURING	1194	367	1560
ELECTRICITY	151	163	313
CONSTRUCTION	651	273	925
TRADE	1456	738	2194
TRANSPORT	830	312	1142
FINANCE	670	615	1286
PAD	652	0	652
COMMUNITY	1064	196	1261
OWNERSHIP OF DWELLINGS	0	818	818
NOMINAL INDUSTRY	0	325	325
TOTAL	7148	4365	11513
	Australia		
AGRICULTURE - FARM	717	3004	3721
- NON-FARM	177	127	304
MINING	1181	2249	3430
MANUFACTURING	12307	4308	16615
ELECTRICITY	1294	1326	2620
CONSTRUCTION	4472	1876	6348
TRADE	7792	3948	11740
TRANSPORT	4475	1684	6159
FINANCE	4356	3997	8353
PAD	4140	0	4140
COMMUNITY	10623	1959	12582
OWNERSHIP OF DWELLINGS	0	6292	6292
NOMINAL INDUSTRY	0	2154	2154
TOTAL	51534	28616	80150

Source: This study and NIE, 1978-79.

directly so that the total of WSSQ in 1977-78 in Table 3.17 ($7148m) is found in *Table No. 64 Household Income, Queensland* on page 48 of *Australian National Accounts: National Income and Expenditure 1978-79*. This reduced the estimation problem to determining WSSQ breakdowns by industry and quarter.

Also in NIE, the ABS publish estimates of farm income by state. This provides estimates for Queensland of gross farm product (GFPQ) e.g., for 1977-78 of $890m (see Table 3.17).

This figure also was inserted directly into these estimates. This is the only industry for which official ABS state estimates are available.

This total, GFPQ, needed to be determined by principal component, i.e., needed to be split into wages, salaries and supplements, and gross operating surplus. This was not published in the relevant table of NIE,[50] but a figure was published for the years 1969-70 to 1977-78 for wages, net rent and interest paid and third party insurance transfers. Wages, salaries and supplements for each year was found by assuming that Australian proportions of wages, salaries and supplements to the rest of this aggregate (i.e., net rent etc.) applied in Queensland, so,

$$\text{WSSFQ} = \left(\frac{\text{WSSF}}{(\text{WSSF} + \text{NRF})} \right) \text{WNRFQ}.$$

For 1977-78,

$$\text{WSSFQ} = \left(\frac{717}{(717 + 402)} \right) \cdot 251$$

$$= \$160.8\text{m}$$

This procedure could not be followed exactly in 1978-79 since, for Queensland, the published wages, net rent, etc. figure was further aggregated to include depreciation, and the Australian figure was presented in a similar aggregate. For 1978-79 then, this aggregate was split up using 1977-78 information.

Gross operating surplus was calculated as the balance between GFPQ and WSSFQ.

---

[50] NIE 1978-79, *Table 70*, p. 52.

These figures for farm product, wages and operating surplus are annual, and must be allocated to quarters. This considerably more complex problem was handled by constructing a detailed quarterly allocator of farm activity in Queensland for each year.

The basic method was to find quarterly seasonal allocators for individual farm production commodity groups, and find a weighted average of these which would then apply to the total farm annual estimates.

The commodity groups chosen, and the weights for 1977-78 are shown in Table 3.18. The weights are proportions of the gross value of production for each of the farm commodity groups.[51]

The individual commodity group allocators will be discussed in turn.

The sugar allocator (or the percentage of activity in the sugar industry in each quarter of the year) was constructed by:

(a) determining individual seasons for each sugar mill in Queensland;
(b) determining a time range for each sugar area or region. These regional seasons, and individual mill seasons, are shown in Table 3.19 for the 1977 sugar industry "year" or season (i.e., the season mainly in the 1977-78 financial year);
(c) calculating the proportions of the number of days in the harvesting and crushing season (a proxy for activity) over total days in each quarter of the year for each sugar region (and also the proportions of days off-season);
(d) weighting these proportions by the quantity of cane cut in each region in the sugar year. (Since cane cut is used as the strength-of-activity indicator, a certain amount of cane cut was allocated artificially, since no cane is cut off-season, to the off-season to take account of the limited activity that exists off-season. Since most of this product would be mainly wages, this allocation to off-season was calculated by two-fifths of the proportion of WSSFQ to GFPQ. In 1977-78 this was 7.2%. So tonnes of cane cut were then allocated out into quarters by region for both season and off-season. These amounts were then summed over the regions

---

[51]See ABS, Catalogue No. 1301.3, 1980, pp. 422-3.

Table 3.18: Gross value of farm production,
Queensland, 1977-78

Commodity group	Gross value of production ($m)	Weight (%)
SUGAR	411	29.2
WOOL	107	7.6
BEEF	293	20.8
MUTTON	7	0.5
PIGMEATS	44	3.1
OTHER	545	38.7
TOTAL	1407	100.0

Source: ABS, Catalogue No. 1301.3, 1980, pp. 422-3.

Table 3.19: Sugar mill seasons in the 1977 sugar "year"

Statistical Division	Mill	Season Start	Season End
Moreton	Rocky Pt	26 JUL	18 NOV
	Moreton	28 JUN	6 DEC
		28 JUN	6 DEC
Wide Bay-Burnett	Maryborough	21 JUN	5 DEC
	Isis	20 JUN	2 DEC
	Qunaba	27 JUN	4 NOV
	Millaquin	20 JUN	17 NOV
	Bingera	20 JUN	21 NOV
	Fairymead	20 JUN	18 NOV
		20 JUN	5 DEC
Mackay	Cattle Creek	27 JUN	18 NOV
	Plane Creek	14 JUN	14 NOV
	N. Eton	27 JUN	14 NOV
	Pleystowe	6 JUN	11 NOV
	Racecourse	20 JUN	8 NOV
	Marian	21 JUN	14 NOV
	Farleigh	14 JUN	8 NOV
	Proserpine	8 JUN	9 NOV
		6 JUN	18 NOV
Northern	Inkerman	21 JUN	11 NOV
	Pioneer	17 JUN	14 NOV
	Kalamia	9 JUN	28 NOV
	Invicta	6 JUN	8 NOV
	Macknade	28 JUN	16 NOV
	Victoria	16 JUN	1 NOV
		6 JUN	28 NOV
Far North	Tully	16 JUN	16 NOV
	Mourilyan	29 JUN	11 NOV
	S. Johnston	23 JUN	30 NOV
	Goondi	28 JUN	22 NOV
	Mulgrave	5 JUL	10 NOV
	Babinda	29 JUN	29 NOV
	Hambledon	28 JUN	22 NOV
	Mossman	17 JUN	22 NOV
		16 JUN	30 NOV

Source: 1979 Australian Sugar Yearbook

and seasons to give a Queensland figure of activity (in tonnes of cane cut, even though no cane was cut in the off-season) in the sugar industry for the four quarters of the sugar year (June, September, December and March).);

(e) adjusting, over an extended range of years, quarters of the sugar years to their correct financial year;

(f) summing the amounts over the financial year, and calculating the proportional allocators for each quarter.

These proportional allocators were then used as the sugar commodity group quarterly allocators. Table 3.20 shows the allocator for 1977-78.

Table 3.20: The sugar commodity quarterly allocators for 1977-78

Year	Quarter	Allocator (%)
1977	III	53.29
1977	IV	34.97
1978	I	3.48
1978	II	8.26
1977-78		100.00

The allocator for the wool commodity group was constructed by finding the quarterly percentages of the annual total of wool received into store (Queensland wool, excluding wool for resale).[52]

[52] The source of these data is ABS, Catalogue No. 1304.3.

The allocators for the commodity groups, beef, mutton and pigmeats, were constructed by finding the quarterly percentages of the annual totals of livestock slaughtered for each type.[53]

The allocator for "other", i.e., everything else, was based on the quarterly seasonal patterns of Australian gross value of farm production,[54] after the commodity groups wool, livestock slaughterings and sugar cane were removed. This "other" group included wheat, other grain crops, other crops and other livestock products. This method wa used because no satisfactory empirical Queensland seasonal pattern of the production of these commodity groups could be found.

These data, accumulated so far, can be organized into a four (quarters) by six (farm commodity groups) matrix of percentages of activity (X),

	(Sugar)	(Wool)	(Beef)	(Mutton)	(Pigmeats)	(Other)	(Quarter)
X =	53.29	37.29	27.52	24.67	25.14	9.44	III
	34.97	22.91	22.00	22.61	25.41	43.89	IV
	3.48	18.43	20.75	25.00	23.78	27.74	I
	8.26	21.37	29.73	27.73	25.68	18.93	II

and into a vector of six commodity group weights (Y),

Y =	0.2921	(Sugar)
	0.0760	(Wool)
	0.2082	(Beef)
	0.0050	(Mutton)
	0.0313	(Pigmeats)
	0.3873	(Other)

Multiplication of activity (X) by weights (Y) gives a quarterly allocator of Queensland seasonal farm activity, viz, in 1977-78,

	(%)
III	28.70
IV	34.45
I	18.35
II	18.50.

---

[53]The source of these data is also ABS, Catalogue No. 1304.3.

[54]These data are given in ABS, Catalogue No. 5206.0.

Both WSSFQ and GFPQ were allocated into quarters using this Queensland farm allocator. All of this work on the farm industry was done in the FARM module.

3.4.6 Public Sector WS Estimation

Since the coverage, by the payroll tax tabulations source, of public sector wages and salaries was sparse and misleading, it was decided to estimate wages and salaries for the public sector by separate methods. While a number of Commonwealth Government authority and enterprise employees are covered by the payroll tax tabulations, most, including public servants covered by the Act, PMG (or Telecom and Australia Post) employees, and the defence forces are not. Furthermore, without expensive detailed review of ABS and State Government Treasury worksheets, it would be impossible to determine for the ten years which state government employees had been included in the payroll tax tabulation for "Commonwealth, State, Semi-Government" and to which ASIC industry class they belonged. It must be noted that the ABS do not themselves rely on the payroll tax source for their estimates of wages and salaries in the industry public administration. Instead, the figures are extensively reworked.

Furthermore, the payroll tax tabulation figures for local government in "Local Government" are held by the ABS to be completely unreliable from the viewpoint of industry specification. Again, the ABS do a complete reworking of these figures, using results from the Local Government Form H8, for use in average earnings and NIE estimates.

Coverage is difficult to understand, since the accounts presented by the State Treasurer to Parliament do not list for each department concerned with public administration activities the amount of payroll tax paid. This is only published for such departments as Police, Education and Railways. Also, some parts of local government are exempt - broadly, *public administration*. The Act states that

> The wages liable to pay-roll tax under this Act do not include wages paid or payable--...
>
> (e) by a local authority, except to the extent that those wages are paid or payable--
> (i) for or in connexion with; or
> (ii) for or in connexion with the construction of any

> buildings or the construction of any works or the installation of plant, machinery or equipment for use in or in connexion with,
>
> electricity generation, distribution or supply, water supply, sewerage, the conduct of transport services (including ferries), of abattoirs, of public markets, of parking stations, of quarries, of cemeteries, of picture theatres, of milk supply, of hostels, of hotels or of bakeries or of any other activity that is a prescribed activity;[55]

These problems meant that a completely different approach had to be adopted to estimate the wages and salaries of commonwealth government public servants (under the Act) resident in Queensland, but not in public administration; the wages and salaries of public administration public servants whether commonwealth, state or local; the wages and salaries of PMG (later Telecom and Australia Post) employees; and the wages and salaries of defence force employees. The problem of state and local government employees not in public administration was handled as described below in the payroll tax section.

The estimation of WSCWIQ was done by:

(a) assuming (from a general inspection of staffing levels in Queensland by department) the industry category of 40% of Commonwealth Government employees in Queensland (excluding PMG and defence force personnel) is non-*public administration and defence;*

(b) finding an average yearly wage and salary for commonwealth employees in non-public administration and defence industries. This was done by forming a weighted average of various[56] departmental average yearly wages and salaries per employee. The weights were proportions of employees, resident in Queensland, of those various departments. The average yearly wage and salary of these commonwealth "industrial" workers was estimated in 1977-78 to be $11,100;

(c) multiplying the number of these employees by the average yearly

---

[55] *Payroll Tax Act* 1971, section 10.

[56] The commonwealth departments used were Civil Aviation, Health, Housing, Meteorology, Primary Industries, Repatriation, Shipping, Social Services, Supply and Works or their renamed and reorganized equivalents.

wage, which gives an estimate of the wages and salaries paid in Queensland to commonwealth government employees, under the Act, but not in PAD or PMG. In 1977-78 this amounted to $61.52m;

(d) allocating this amount into quarters on the basis of the quarterly allocation of WSS;

(e) allocating these quarterly totals into industries by allocators calculated from the industry employment of commonwealth employees in Queensland from the 1971 and 1976 Censuses of Population and Housing. The two allocators used, one from 1969 III to 1974 II, the other from 1974 III to 1979 II, are given in Table 3.21.

The estimation of WSPAQ was done by:

(a) calculating weekly wage rates by sex for each quarter for the industry public administration. This was done by applying the higher public administration industry differential (revealed by the ABS October Surveys) over average weekly earnings for all industries, to average weekly earnings for each quarter. This adjustment was performed separately by sex. When no public administration figures were available in years before 1973, figures for the industry transport were used instead. (Female earnings were of course adjusted by male equivalent ratios.);

(b) calculating quarterly employment levels for males and females for each quarter by averaging the published monthly estimates of employment by sex in public administration.[57]

(c) multiplying out earnings and employment which gives wages and salaries paid to each sex for that quarter;

(d) adjusting this result to agree with the different sources and methods used by NIE. (This adjustment also allows for the confidentiality of data provided on wages and salaries paid to defence force personnel.)

The estimation of WSPMGQ was done by:

(a) calculating quarterly employment levels by sex for ASIC industry class 5600 for Queensland;

(b) applying ratios derived from the 1971 and 1976 Census of Population and Housing to these levels to estimate the number of commonwealth

---

[57] See ABS, Catalogue No. 6214.0.

Table 3.21: Industry allocators for WS for non-PAD commonwealth employees

Industry	Period 1969 III to 1974 II (%)	1974 III to 1979 II (%)
PRIMARY - FARM	0.1	0.1
- NON-FARM	0.1	0.1
MINING	0.3	0.0
MANUFACTURING	4.6	6.1
ELECTRICITY	0.9	0.1
CONSTRUCTION	43.0	20.8
TRADE	1.2	0.9
TRANSPORT	18.4	18.5
FINANCE	1.5	27.6
PAD	0.0	0.0
COMMUNITY	29.8	25.8
TOTAL	100.0	100.0

Source: (a) ABS: 1971 Census of Population and Housing: Table 70, Industry by industry sector by sex (employees only).

(b) ABS: 1976 Census of Population and Housing: Table 161, Industry by occupational status by government/non-government employment by sex (employed population for state of usual residence).

employees in PMG (or the later Telecom and Australia Post);[58]

(c) calculating quarterly wages and salaries by multiplying employment by annual average weekly earnings for that industry.

Initially, since nothing is published which could lead to the estimation of wages and salaries of defence forces in Queensland, census ratios of Queensland's share of defence force employment were applied to national estimates in NIE of wages and salaries paid to the defence forces. However, this clearly unsatisfactory method has now been replaced by official, confidential quarterly estimates of WSDQ provided by the Department of Defence through the Central Office of the ABS. Unfortunately, the confidentiality agreement precludes the publication, separately, of WSDQ and WSPAQ, although the combined figure may be published.

The estimation of WSPAQ was handled in module PAD while WSCWIQ, WSPMGQ and WSDQ were done in the NIE module.

3.4.7 Supplements Estimation

The amount of supplements to wages and salaries in Queensland (SUPQ) annually is assumed to be the same proportion of WSSQ, that Australian supplements is of WSS i.e.,

$$\text{SUPQ} = \left(\frac{\text{SUP}}{\text{WSS}} \right) \text{WSSQ.}$$

In 1977-78 then,

$$\text{SUPQ} = \left(\frac{2682}{51534} \right) \cdot 7148$$

$$= \$372\text{m.}$$

This was allocated into quarters by the quarterly split of wages and salaries in Queensland as measured by payroll tax, and into industries, quarter by quarter, on the basis of the industry proportions

---

[58] For 1969 III to 1974 II, the ratio was 95.57% for males and 94.39% for females. For 1974 III to 1979 II, the ratio was 99.36% for males and 98.14% for females.

of SUP for that year. The split into primary farm and primary non-farm is done by the ratio,

$$\frac{GDPAGR - GFP}{GDPAGR} \left(= \frac{GNFAP}{GFP + GNFAP} = \frac{GNFAP}{GDPAGR} \right) .$$

In 1977-78 this ratio was 7.6%, i.e., primary non-farm was 7.6% of agriculture, forestry, fishing and hunting.

3.4.8 Payroll Tax Tabulation WS Estimates

These tabulations form the second main foundation, after the annual official WSSQ estimates, for this work. It would be impossible to have made the estimates of this study without them. They were made available by the Queensland Office of the ABS. Tabulations provided by the ABS showed monthly employment levels by sex, monthly wages and salaries paid, and number of establishments from which the data had been collected. Final and preliminary figures were both available. Two sets of tabulations were provided, at different levels of aggregation. One table, *Table 9*, provided details at the industry class level (4 digit) in ASIC, while the other, *Table 7*, provided the same information aggregated to sixty-four "payroll tax" industries.

This was a wealth of data, because it covered a large proportion of total WSSQ, was available monthly, which meant quarterly estimates could be produced, and was available for a detailed industry breakdown. However, even this source, rich as it is, cannot be considered problem-free. The major problem was the break, in November 1975, in the industry classification system from the old Classification of Industries (CLI) to the new Australian Standard Industrial Classification (ASIC). Other problems were not as severe, but were mainly time consuming and elusive errors and inconsistencies in the tabulations.

Very little of the large amount of work carried out on these tabulations was done by hand. At an early stage it was appreciated that the task could only be done with the aid of a computer. All the data were punched onto cards by the staff of the University Administration Data Processing Section. The cards were then read onto disk files.

Although care was taken in the punching and verification of the cards, a number of punching errors existed on these disk files. Substantial error checking was then carried out by specially written FORTRAN programs designed to make month-to-month-to-month comparisons, and to check totals. When inconsistencies, errors or sudden breaks were reported, corrections were determined by reference to the original tabulations and were inserted into the disk files. This process not only eliminated the punching errors, but also revealed the nature of the data itself. This was valuable, since in a number of cases enterprises (e.g. Queensland Railways) temporarily moved industry for a number of months, or inexplicably disappeared for a month. These inconsistencies were also sometimes eliminated by recourse to expert advice from ABS officers.

The whole process is shown in Figure 3.3, which gives a flowchart of the series of programs and data files which reduce the raw data file to the final usable data file (THLOT), suitable for input to the GSP estimation module PTAX.

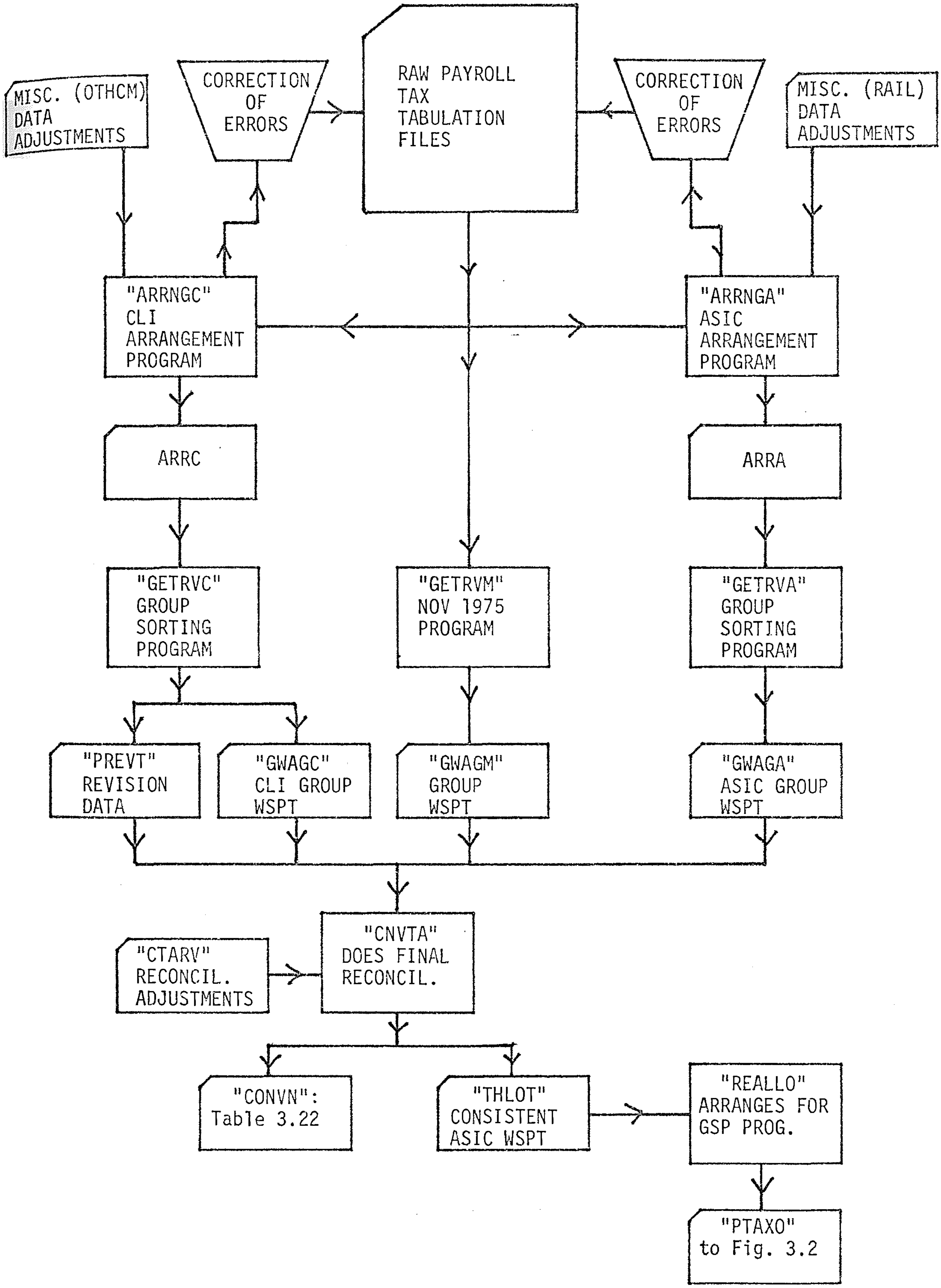
First of all retabulation was done to present the correct, revised data, recheck for errors, and make two of the minor adjustments.

It is obvious by considering Figure 3.3 that this proceeded in two parallel streams, one for CLI data, i.e., up to October 1975, and one for ASIC, after November 1975. The programs were, respectively, ARRNGC and ARRNGA. The data file OTHCM made a minor adjustment to the CLI data, putting the CLI industries 743, 744 and 749 in their correct place. The data file RAIL made a minor adjustment to the ASIC data, putting the railways back into transport from manufacturing for the first fifteen months. The resulting retabulation files were named, respectively, ARRC and ARRA.

At this point the major problem had to be faced, viz, the reclassification of industries. The fact that this was such a severe problem was not fully appreciated until after the second working paper on GSP had been completed.[59] It was then noted that typically the amount of wages and salaries measured from the payroll tax source in the three industries, mining,manufacturing, and electricity, gas and

[59] Crossman (1980) and supplement.

Figure 3.3: Flowchart of the processing of the payroll tax tabulations



water, actually *exceeded* the amounts measured by the Integrated Economic Censuses. For example, for 1973-74, for manufacturing, wages and salaries as measured by payroll tax tabulations was \$124.5m; while from the IEC source, it was only \$114.6m. On closer examination, this was seen to be the fault of a superficial industry reconciliation method of CLI to ASIC.

It was noted that, in the case of the introduction of the IEC, the ABS had itself noted that, "As a result of the changes in scope arising from the adoption of the A.S.I.C., the number of establishments classified to the manufacturing sector ... in Australia fell .... In Queensland, the 1967-68 figure of 6,100 manufacturing establishments was reduced in 1968-69 to some 4,100 establishments".[60] In other words one of the effects of using ASIC was to allocate establishments out of the old CLI manufacturing categories. These were mainly repair establishments which were transferred to the retail trade census or wholesale trade census.[61] This made it apparent that the problem was the old reconciliation method which had equated manufacturing in CLI and ASIC.

A detailed reconciliation of industries between CLI and ASIC was therefore done for November 1975 using the payroll tax tabulation results. This was possible since the tabulations for November 1975 had preliminary November figures in CLI, and the December 1975 tabulations had final November figures in ASIC. A satisfactory reconciliation, done by hand, was found at the 4-digit level. This was then validated using the computer.[62] It was found that a good reconciliatio could be had by aggregating the industry classes into 52 "groups",[63]

---

[60]ABS (1972, p. 2).

[61]These repair establishments included motor vehicle repairs, dry cleaning and laundry services, watch and jewellery repairs, boot and shoe repairs, custom dressmaking and tailoring and domestic appliance repair.

[62]This also found that in November 1975, in manufacturing, there was a fall in wages and salaries of \$5.2m due to the change in classification.

[63]"Groups" is placed in parenthesis to distinguish these "groups" from ASIC industry groups (3-digit). These "groups" were coded from 1 to 52 and have not been assigned descriptive labels.

with some minor adjustments. The differences between the CLI "group" totals for November 1975 and the ASIC "group" totals for November 1975 contained both revision (i.e., preliminary to final) and reclassification components. The solution to the problem caused by the change to ASIC, i.e., the method of converting CLI to ASIC, was then clear. Each CLI "group" figure for each of the 76 months, June 1969 to October 1975, needed to be adjusted by its "group" reclassification component. For the lack of better information, this had to be the proportion of reclassification at November 1975.

First, however, an estimate of the revision component for each "group" at November 1975 was made by applying average percentage "group" revisions over the entire period June 1969 to October 1975 to the November CLI "group" totals. The residual was then held to be the reclassification component alone. This derivation is shown in Table 3.22.

Reconciliation to ASIC was then made by applying "group" reclassification proportions to CLI "group" totals for the entire 76 months of CLI.

The reconciliation was done by computer. Four FORTRAN programs were used. This can be seen from Figure 3.3. The programs GETRVC and GETRVA produced "group" rearrangements of the CLI and ASIC respective time periods of data. (GETRVM did the same for November 1975.) These programs also produced further listings and analyses of the data e.g. GETRVC produced the average monthly revisions of wages and salaries, referred to above.

The program CNVTA was then run to produce a time series, for 120 months, of the 52 reconciled industry "groups". This was contained in the output data file THLOT. The method summary contained in the file CONVN is shown as Table 3.22.

The module PTAX reads in THLOT, aggregates the "groups" to ASIC industry divisions, and reallocates the wages and salaries of the local government "group" out completely and allocates out the wages and salaries of the state government "group" to other industries. This was done because of the complete unreliability of the local government figures and the inclusion of non-public administration industry employees in the state government figures. The allocation out of the

INDUSTRY GROUP	NOVEMBER CLI WAGES	TOTAL NOVEMBER REVISION RECLASS.	MEAN 1969-1975 REVISION SIZE	ESTIMATED AMOUNT NOVEMBER REVISION ALONE	ADJUSTED TO CORRECT SUM	RESIDUAL WAGES DUE ONLY TO RECLASS.	PERCENTAGE RECLASS
1	54056	1486	-1.1800	-637.9	-610.8	2096.8	3.8790
2	2868776	-173613	-0.5200	-14917.6	-14285.8	-159327.2	-5.5538
3	107017	-3417	-0.6100	-652.8	-625.2	-2791.8	-2.6088
4	1772312	6633184	0.0600	1063.4	1018.3	6632165.6	374.2098
5	7512779	-6492977	-0.5000	-37563.9	-35972.9	-6457004.1	-85.9469
6	6562583	6717	-0.0200	-1312.5	-1256.9	7973.9	0.1215
7	4709516	-78919	-0.9800	-46153.3	-44198.4	-34720.6	-0.7372
8	610739	-140735	-0.3500	-2137.6	-2047.0	-138688.0	-22.7082
9	1128857	455967	-1.8000	-20319.4	-19458.8	475425.8	42.1157
10	2575940	-135381	0.0200	515.2	493.4	-135874.4	-5.2747
11	4976327	846339	-0.7700	-38317.7	-36694.8	883033.8	17.7447
12	7029566	-3202886	-0.6700	-47098.1	-45103.3	-3157782.8	-44.9214
13	1879244	846816	-1.2200	-22926.8	-21955.7	868771.7	46.2299
14	5149720	-1115511	-0.6200	-31928.3	-30575.9	-1084935.1	-21.0678
15	747598	3525	-0.5000	-3738.0	-3579.7	7104.7	0.9503
16	1647462	-99752	-0.8200	-13509.2	-12937.0	-86815.0	-5.2696
17	421425	9063	-2.2900	-9650.6	-9241.9	18304.9	4.3436
18	25131041	-1574234	-0.3100	-77906.2	-74606.5	-1499627.5	-5.9672
19	3557895	174115	-0.7700	-27395.8	-26235.4	200350.4	5.6312
20	2236998	-455894	-0.6700	-14987.9	-14353.1	-441540.9	-19.7381
21	5287022	-252732	-0.2900	-15332.4	-14683.0	-238049.0	-4.5025
22	2368074	3826	-1.8800	-44519.8	-42634.2	46460.2	1.9619
23	531884	-53969	-0.3600	-1914.8	-1833.7	-52135.3	-9.8020
24	357097	51180	-1.8100	-6463.5	-6189.7	57369.7	16.0656
25	1142825	-502444	-0.4000	-4571.3	-4377.7	-498066.3	-43.5820
26	568607	-10400	-1.1500	-6539.0	-6262.0	-4138.0	-0.7277
27	6585047	3571312	-0.0900	-5926.5	-5675.5	3576987.5	54.3198
28	15969	786	0.0000	0.0	0.0	786.0	4.9220
29	10437343	-3963235	-0.6600	-68886.5	-65968.8	-3897266.2	-37.3396
30	9385733	1112044	-0.8100	-76024.4	-72804.4	1184848.4	12.6239
31	26613039	1741702	-0.6700	-178307.4	-170755.2	1912457.2	7.1862
32	16822235	20127	-0.4200	-70653.4	-67660.9	87787.9	0.5219
33	7606078	2289036	-0.8100	-61609.2	-58999.8	2348035.8	30.8705
34	5985812	-1424568	-0.9800	-58661.0	-56176.4	-1368391.6	-22.8606
35	1849500	840558	-0.7100	-13131.4	-12575.3	853133.3	46.1278
36	1722591	-604408	-0.3200	-5512.3	-5278.8	-599129.2	-34.7807
37	22584035	323627	0.1700	38392.9	36766.7	286860.3	1.2702
38	2563812	70169	-0.1100	-2820.2	-2700.7	72869.7	2.8422
39	139504	995189	-1.6300	-2273.9	-2177.6	997366.6	714.9376
40	45979	15237	-0.1600	-73.6	-70.5	15327.5	33.2923
41	8607287	27029	-0.2400	-20657.5	-19782.5	46811.5	0.5439
42	5248079	-15275	-0.2000	-10496.2	-10051.6	-5223.4	-0.0995
43	10038427	1922205	-0.8400	-84322.8	-80751.3	2002957.3	19.9529
44	37283244	2691526	0.0000	0.0	0.0	2691526.0	7.2191
45	4889664	-3978836	-0.0200	-977.9	-936.5	-3977899.5	-81.3532
46	3793268	-355982	-0.4400	-16690.4	-15983.5	-339998.5	-8.9632
47	97274	-38730	-0.1400	-136.2	-130.4	-38599.6	-39.6813
48	2185218	38198	-1.0800	-23600.4	-22600.8	60798.8	2.7823
49	6452124	-195747	-0.4800	-30970.2	-29658.5	-166088.5	-2.5742
50	3158793	-513985	-0.3400	-10739.9	-10285.0	-503700.0	-15.9460
51	10370	-10370	-0.0600	-6.2	-6.0	-10364.0	-99.9425
52	9352745	-488696	-0.5500	-51440.1	-49261.4	-439434.6	-4.6985
53	294408530	-1191732	-0.4400	-1244440.3	-1191732.0	0.0	0.0000

Table 3.22: Estimation of CLI to ASIC reconciliation proportions

state government figures was done with the industry distribution of state government employees shown at the 1976 Census of Population and Housing. The residual figure in PAD was then zeroed out since WSPAQ was estimated elsewhere.

The final operation on the payroll tax tabulation data is then the aggregation, by PTAX, of WSQ into quarters (and years). Results for the four quarters of 1977-78 are shown in Table 3.23.

3.4.9 Total WSSQ by Industry and Quarter

It should be clear that while the official WSSQ figure from NIE provides an overall measure of size, the payroll tax tabulation, WS estimates by industry, serves as a skeleton of the structure. It remains to "flesh out" the remaining parts.

Table 3.21 indicates a discrepancy of $2903m between WSSQ ($7148m) and WSPTQ ($4245m) for 1977-78. This discrepancy had three sources,

(a) coverage error because certain industries or parts of industries are exempt from the payment of payroll tax, and their wages and salaries figures do not appear in the tabulations. These errors have been accounted for by the construction of estimates of WSPAQ, WSDQ, WSCWIQ and WSPMGQ;

(b) supplements are not included in payroll tax wage and salary totals. This was accounted for by the estimation of SUPQ;

(c) coverage error exists because small establishments are not required to pay payroll tax. Exemption limits of wage and salaries paid are shown in Table 3.24.

So the remaining discrepancy, (for 1977-78),

		$m
	WSSQ	7148
less	WSPTQ	4245
		2903
less	WSPADQ	619
less	WSPMGQ	160
less	WSCWIQ	62
less	SUPQ	372
		1690
less	WSSFQ (part)	115
	WSSBQ	1575

Table 3.23: Wages and salaries measured by payroll tax tabulations, by industry and quarter, Queensland, 1977-78
($m)

	Quarter				Year
Industry	III	IV	I	II	1977-78
PRIMARY - FARM	12.06	10.18	7.82	10.19	40.26
PRIMARY - NON-FARM	2.50	2.49	2.07	2.40	9.46
MINING	59.72	62.54	57.21	66.41	245.88
MANUFACTURING	260.38	269.66	234.03	255.98	1020.05
ELECTRICITY	26.49	31.05	29.65	32.29	119.47
CONSTRUCTION	106.69	120.21	102.69	118.69	448.28
TRADE	205.28	206.68	192.28	202.90	807.14
TRANSPORT	116.56	107.32	110.00	107.39	441.27
FINANCE	97.73	103.29	96.49	103.47	400.98
PAD	0.00	0.00	0.00	0.00	0.00
COMMUNITY	179.35	185.04	159.48	188.55	712.41
TOTAL INDUSTRY	1066.76	1098.45	991.72	1088.27	4245.20
ALLOCATOR	25.13	25.88	23.36	25.64	100.00

Table 3.24: Exemption limits for payroll tax, Queensland

Period	Amount ($)[a]	Taxing body
1 Sep 57 to 30 Aug 71	20800	Commonwealth
1 Sep 71 to 31 Dec 75	20800	State
1 Jan 76 to 31 Dec 76	41600	State
1 Jan 77 to 30 Jun 77	62400	State
1 Jul 77 to 31 Dec 77	83200	State
1 Jan 78 to 30 Jun 78	100000	State
1 Jul 78 on	125000	State

[a] Maximum tax exemption level on wages and salaries paid or payable per annum.

which is due to small business, has to be allocated out to industry. It can be calculated by quarter, since all other variables were known by quarter.

Allocators for small business wages and salaries were constructed by comparing payroll tax employment levels by industry in June 1971 and 1976 with the 1971 and 1976 Census of Population and Housing employment levels by industry. All total employment levels were calculated in male equivalent units. The 1976 allocator was also derived using information available from the ABS Integrated Register at 30 June 1976 since employment estimates in establishments of small size (i.e., 1-10 employees) by industry were made available by the ABS. With adjustments made for PAD and "Others and not stated", the allocators in Table 3.25 emerged.

Table 3.25: Small business allocators

Industry	Year 1971 (%)	Year 1976 (%)
AGRICULTURE	19.5	13.3
MINING	0.0	0.4
MANUFACTURING	5.3	5.3
ELECTRICITY	0.0	0.2
CONSTRUCTION	18.6	14.5
TRADE	22.8	29.7
TRANSPORT	6.9	6.1
FINANCE	4.3	7.5
COMMUNITY	22.6	23.0
TOTAL	100.0	100.0

Table 3.26: Detailed WSSQ estimation, September quarter 1977

D E T A I L E D   I N D U S T R Y   E S T I M A T I O N

W A G E S   S A L A R I E S   A N D   S U P P L E M E N T S

Q U E E N S L A N D

($ MILLION)

YEAR: 1977-78   QUARTER: III

INDUSTRY	PAYROLL	DEFENCE	C'WLTH	PMG	FARM	PAD	SUP	SUM	S.B.A.	DISCREP	WSSQ
PRIMARY - FARM	12.06		0.01		46.16		1.32	46.16			46.16
PRIMARY - NONFARM	2.50		0.01				0.11	2.62	1.16	4.36	6.98
MINING	59.72						1.85	61.57	0.42	1.57	63.14
MANUFACTURING	260.38		0.91				24.36	285.66	6.13	22.97	308.62
ELECTRICITY	26.49		0.01				2.86	29.36	3.73	13.97	43.33
CONSTRUCTION	106.69		3.11				9.59	119.39	16.70	62.56	181.95
TRADE	205.28		0.13				8.40	213.82	34.25	128.31	342.13
TRANSPORT	116.56		2.77	41.24			13.59	174.16	7.10	26.60	200.76
FINANCE	97.73		4.13				14.12	115.98	8.60	32.22	148.20
P.A.D.		43.39				111.47	8.23	163.09			163.09
COMMUNITY	179.35		3.86				9.06	192.27	26.58	99.58	291.84
TOTAL INDUSTRY	1066.76	43.39	14.95	41.24	46.16	111.47	93.48	1404.05	104.67	392.14	1796.20

Note: the S.B.A. (small business allocator) column is in percent, not millions of dollars.

These were applied to the periods 1969 III to 1975 II and 1975 III to 1979 II respectively. Since farm industry wages, salaries and supplements are estimated elsewhere, only that part of primary industry pertaining to non-farm had to be allocated out to small business. This was calculated using the farm to non-farm ratio described above.

Table 3.26 which is a computerized version of an old worksheet, shows the final method of derivation of WSSQ by industry for the September quarter of 1977.

3.4.10 Ownership of Dwellings Estimation

The ABS explains this concept:

> Services provided by dwellings to their owner-occupiers are included by analogy with rented dwellings which provide a marketed service which is regarded as part of production. Imputation of a rent to owner-occupied dwellings enables all dwellings to be treated in a similar manner. This prevents any change in the scope of production from occurring as a result of changes in the proportion of owner-occupied houses. In effect, owner-occupiers (like other owners of dwellings) are regarded as operating businesses; they receive rents (from themselves as consumers), pay expenses, and make a net contribution to the value of production which accrues to them as owners.[64]

The gross operating surplus of the industry ownership of dwellings has to be estimated directly. This was done with a simple allocation procedure, whereby it was assumed that, for that year, the ratio of GOSODW to total gross rent[65] (TGR) is the same as the ratio of GOSODWQ to private final consumption expenditure on rent in Queensland (PFCERQ). This assumption is permissible since total gross rent equals private final consumption expenditure on rent. PFCERQ is published in NIE.

In 1977-78,

$$\text{GOSODWQ} = \left(\frac{\text{GOSODW}}{\text{TGR}}\right)\text{PFCERQ} = \left(\frac{6292}{8865}\right)1152 = \$817.6\text{m.}$$

---

[64] NIE, 1976-77, p. 2.

[65] NIE, 1978-79, *Table 27*, p. 21.

This annual total is then split into quarters using the national split of private final consumption expenditure on rent into quarters, as published in the quarterly estimates of national income and expenditure.[66] The allocators and allocation for 1977-78 are shown in Table 3.27.

3.4.11 Imputed Bank Service Charge Estimation

The ABS explains this concept:

> Banks and similar financial institutions receive by way of direct charges to their customers less than their costs of operation, the balance of their expenses being met from the difference between interest receipts and payments. A portion of their interest receipts is therefore treated as though it was a charge. It is impracticable to allocate this imputed charge to all the banks' and other institutions' customers. It is treated as intermediate consumption in a 'nominal industry' which accordingly has a negative operating surplus of this amount.[67]

This amount of gross operating surplus has to be estimated directly. This was done in a straightforward way.

Firstly, imputed bank service charge for Australia, since it is published only annually, had to be estimated quarterly. This was done using the interpolation procedure of Lisman and Sandee (1964).

Secondly, the quarterly imputed bank service charge was allocated to Queensland on the simple basis of population share.

These quarterly IBSCQ figures were then seasonalized into a Queensland pattern by using an index of quarterly seasonal variation computed from an indicator of bank activity in Queensland (viz, average weekly debits to bank customer accounts, Queensland).[68]

Quarterly IBSC, the seasonal index and both non-seasonalized and seasonalized IBSCQ are shown, for 1977-78, in Table 3.28.

---

[66]ABS, Catalogue No. 5206.0.

[67]ABS, Catalogue No. 5204.0, 1976-77, p. 90.

[68]See ABS, Catalogue No. 1304.3.

Table 3.27: Quarterly allocation of gross operating surplus of ownership of dwellings, Queensland, 1977-78

Quarter and Year	Private final consumption expenditure for rent (a) ($m)	Allocator (%)	Gross operating surplus, ownership of dwellings Queensland ($m)
III	2077	23.27	140.3
IV	2200	24.65	201.6
I	2281	25.56	209.0
II	2366	26.51	216.8
1977-78	8924	100.00	817.6

(a) Source: ABS, Catalogue No. 5206.0.

Table 3.28: Imputed bank service charge estimation, Queensland, 1977-78

Quarter and Year	IBSC ($m)	Allocated IBSCQ ($m)	Seasonal index	Seasonalized IBSCQ ($m)
III	517	78.5	101.05	79.4
IV	525	79.9	102.99	82.3
I	539	82.0	95.17	78.0
II	557	84.8	100.78	85.4
1977-78	2138	325.2		325.1

3.4.12 Allocation of GOS by National Ratios

Once wages, salaries and supplements were determined by industry for each quarter, it remained to estimate gross operating surplus by industry for each quarter to obtain gross state product at factor cost.

This was done in this study by allocating national gross operating surplus in each industry to Queensland on the basis of the national versus Queensland proportions of wages, salaries and supplements. That is, industry gross operating surpluses in Queensland were determined by assuming that the national industry returns-to-capital-share to returns-to-labour-share ratios applied in Queensland. Each industry ratio was adjusted, whenever possible, to incorporate specific Queensland information or bias.

Formally,

$$GOSQ_{iq} = \left(\frac{GOS_{iy}}{WSS_{iy}} \right) \cdot WSSQ_{iq}$$

where i = industry,
q = quarter,
y = year.

This procedure, of course, did not apply in the case of the farm part of agriculture etc., since the ABS already provide estimates of gross farm product. The industry public administration and defence does not produce operating surplus, since its product, by definition, equals wages, salaries and supplements paid. That is, its output is measured solely by the labour component.

The industries for which this procedure is followed are therefore:

Primary Non-farm
Mining
Manufacturing
Electricity
Construction
Trade
Transport
Finance
Community

In the case of mining, manufacturing and electricity however, information provided by the Integrated Economic Censuses of the ABS allow for adjustment to be made to the national ratios to allow for a state differential. This adjustment is made by weighting the national ratio by the state to nation differential of Integrated Economic Census *value added less wages and salaries* to *wages and salaries* ratios.

For example, for mining,

$$GOSMINQ_q = \left(\frac{GOSMIN_y}{WSSMIN_y} \cdot \left(\frac{\frac{VAIMINQ - WSIMINQ}{WSIMINQ}}{\frac{VAIMIN - WSIMIN}{WSIMIN}} \right)_y \right) \cdot WSSMINQ_q$$

In years when no Integrated Economic Census was held for that industry, adjustment ratios were estimated by linear interpolation.

Table 3.29 shows the unadjusted and adjusted ratios for mining, manufacturing and electricity for the 10 years, 1969-70 to 1978-79.

For the other industries, primary non-farm, construction, trade, transport, finance and community, GOS was estimated simply by using unadjusted national ratios as the allocator. These ratios are shown in Table 3.30.

In all cases, except construction, quarterly allocation was implicit in applying the ratio to WSSQ in that industry in that quarter. GOSCONQ was estimated, firstly, for the year, by applying the ratio to annual WSSCONQ. It was then split into quarters by using a quarterly allocator based on value of work done on buildings in Queensland.[69]

3.4.13 GSP at Factor Cost Estimates by Industry, Quarter and Principal Component

The quarterly estimates by industry of Queensland gross state product, wages, salaries and supplements and gross operating surplus are shown in Tables 3.31, 3.32 and 3.33 respectively.

Figure 3.4 shows a plot of total GSP, WSSQ and GOSQ over the forty quarters from 1969 III to 1979 II.

---

[69] ABS, Catalogue No. 8704.3.

Table 3.29: National and IEC-adjusted GOS to WSS ratios for mining, manufacturing and electricity, 1969-70 to 1978-79

Year	Mining		Manufacturing		Electricity	
	National	Adjusted	National	Adjusted	National	Adjusted
1969-70	1.62	1.38	0.50	0.64	1.46	1.58
1970-71	1.62	1.39	0.48	0.55	1.34	1.42
1971-72	1.75	1.17	0.44	0.55	1.31	1.35
1972-73	1.74	1.41	0.45	0.59	1.31	1.43
1973-74	1.78	1.92	0.38	0.48	1.16	1.26
1974-75	1.75	1.91	0.32	0.48	0.93	1.02
1975-76	1.78	1.81	0.32	0.44	1.03	1.06
1976-77	1.91	2.09	0.34	0.45	1.01	0.98
1977-78	1.90	2.23	0.35	0.46	1.02	0.94
1978-79	1.92	2.14	0.36	0.45	1.03	0.95

Table 3.30: National ratios for other industries, 1969-70 to 1978-79

Year	Industry					
	NF	CON	TRD	TRN	FIN	COM
1969-70	1.00	0.37	0.69	0.68	1.02	0.28
1970-71	0.92	0.37	0.62	0.56	1.02	0.25
1971-72	0.99	0.36	0.61	0.58	1.02	0.24
1972-73	0.86	0.39	0.63	0.52	1.08	0.24
1973-74	0.87	0.39	0.61	0.42	0.98	0.22
1974-75	0.53	0.37	0.53	0.32	0.86	0.19
1975-76	0.59	0.41	0.51	0.39	0.99	0.20
1976-77	0.78	0.43	0.52	0.39	0.98	0.19
1977-78	0.72	0.42	0.51	0.38	0.92	0.18
1978-79	1.60	0.43	0.51	0.38	0.93	0.19

Table 3.31: GSP at factor cost by industry, Queensland, 1969 III to 1979 II, $ million

YEAR	QTR	FARM	N-F	MIN	MAN	ELEC	CON	TRADE	TRANS	FIN	PAD	COMM	ODWEL	SUB T	IBSC	TOTAL
1969-70	III	129.82	3.35	37.98	158.19	28.54	73.03	138.32	94.15	59.72	40.66	82.96	44.62	891.33	21.85	869.49
1969-70	IV	126.34	3.65	40.09	165.97	31.60	77.65	152.96	97.17	67.80	41.81	90.36	46.22	941.62	23.10	918.52
1969-70	I	107.84	3.41	39.39	139.25	29.32	71.18	144.11	94.88	64.52	38.30	84.24	47.74	864.17	22.06	842.11
1969-70	II	96.00	4.03	55.12	155.78	31.59	84.21	159.09	100.48	70.30	41.61	96.43	49.17	943.82	24.04	919.78
1970-71	III	123.11	4.21	46.92	155.96	30.52	84.61	152.83	100.20	70.76	46.99	95.92	51.92	963.96	24.71	939.25
1970-71	IV	116.50	4.54	51.54	166.44	33.93	91.88	168.00	103.06	76.80	49.38	106.80	53.54	1022.42	25.83	996.59
1970-71	I	103.14	4.14	51.02	153.05	32.58	85.90	157.90	100.99	75.50	46.97	94.73	55.08	961.00	24.67	936.33
1970-71	II	93.21	4.94	70.26	172.10	34.78	99.06	175.93	111.21	81.92	51.49	109.60	56.70	1061.22	27.23	1033.99
1971-72	III	143.31	5.13	51.52	191.08	35.44	90.41	170.31	111.57	86.04	55.88	110.72	62.34	1112.75	28.11	1084.64
1971-72	IV	150.03	5.31	55.87	186.88	35.18	104.15	181.98	118.34	88.41	59.53	118.85	64.35	1168.86	29.42	1139.45
1971-72	I	120.62	5.10	55.06	171.82	36.15	97.46	177.83	111.04	88.41	56.85	113.96	66.26	1100.56	28.52	1072.04
1971-72	II	107.70	5.91	70.14	194.16	38.22	112.81	198.53	122.46	96.53	59.80	127.98	67.99	1202.24	32.28	1169.96
1972-73	III	195.42	4.75	65.81	208.90	40.72	115.62	202.01	121.71	101.50	63.07	128.47	73.48	1321.45	34.18	1287.26
1972-73	IV	187.68	5.16	67.71	220.13	43.34	121.83	216.34	132.74	109.95	65.80	137.36	75.30	1383.32	36.44	1346.88
1972-73	I	135.58	5.12	67.08	205.67	43.10	121.50	216.48	124.64	114.22	60.99	136.50	77.49	1308.39	35.88	1272.51
1972-73	II	129.00	5.63	91.28	240.23	44.57	135.71	236.84	135.92	123.60	72.38	151.71	79.69	1446.54	41.05	1405.50
1973-74	III	191.03	5.23	92.66	235.14	43.77	143.70	246.05	137.95	129.61	74.24	157.75	85.45	1542.58	44.48	1498.10
1973-74	IV	231.33	5.50	100.85	254.33	46.93	154.04	266.21	153.17	136.03	78.46	161.78	90.34	1678.98	48.42	1630.55
1973-74	I	169.24	5.75	85.47	231.39	48.62	154.66	269.47	148.36	141.83	76.72	173.60	93.16	1598.27	47.18	1551.09
1973-74	II	137.71	6.71	102.92	272.58	54.38	180.53	310.89	160.42	157.41	84.68	194.48	97.33	1760.03	52.17	1707.85
1974-75	III	214.02	5.29	106.53	302.30	52.01	177.68	337.76	170.94	182.22	98.43	207.59	102.49	1957.25	54.54	1902.71
1974-75	IV	309.74	5.79	119.98	333.85	60.25	192.35	358.39	184.15	195.66	109.62	233.05	108.69	2201.52	58.20	2143.32
1974-75	I	179.25	5.39	136.32	286.24	59.39	165.24	342.65	167.09	190.66	104.99	226.08	114.35	1977.66	55.72	1921.94
1974-75	II	148.99	5.84	165.58	315.64	64.32	177.91	375.67	165.74	203.21	110.60	236.28	120.37	2105.14	60.98	2044.16
1975-76	III	203.07	6.51	131.68	329.25	63.28	188.11	384.84	202.39	224.26	120.20	246.06	125.94	2225.55	62.96	2162.58
1975-76	IV	316.31	6.79	145.73	371.09	69.34	192.02	412.80	224.17	244.95	132.17	258.56	132.80	2506.73	66.21	2440.52
1975-76	I	153.79	6.76	153.23	334.65	67.91	184.65	408.33	204.25	236.46	120.13	258.37	138.93	2267.47	63.17	2204.30
1975-76	II	150.88	8.21	174.53	394.98	71.84	213.35	460.99	237.75	261.03	130.85	300.36	144.89	2539.65	69.46	2470.19
1976-77	III	230.53	10.35	190.73	402.73	75.79	224.52	469.64	238.25	270.48	145.80	311.36	156.37	2732.56	72.41	2660.15
1976-77	IV	303.97	9.81	187.11	411.96	73.78	222.48	472.28	233.16	273.68	151.36	304.73	165.21	2809.53	76.47	2733.06
1976-77	I	195.78	9.98	178.95	381.23	76.09	217.85	467.02	235.89	267.42	137.35	306.98	172.95	2647.49	72.55	2574.93
1976-77	II	167.72	11.54	179.32	428.18	79.07	234.02	501.93	241.81	290.97	147.84	338.59	180.23	2801.23	78.17	2723.06
1977-78	III	255.42	11.99	204.03	451.05	84.06	265.00	515.48	276.30	284.18	163.09	345.66	190.30	3046.56	79.36	2967.20
1977-78	IV	306.57	12.08	213.38	466.17	93.43	274.57	520.48	262.15	296.86	167.20	354.49	201.57	3168.97	82.27	3086.69
1977-78	I	163.35	10.73	195.17	407.74	87.94	245.36	481.72	262.61	275.73	157.48	313.33	208.99	2810.14	77.99	2732.15
1977-78	II	164.66	12.36	226.14	447.84	97.39	280.42	526.12	293.36	300.59	164.11	365.54	216.78	3065.30	85.43	2979.86
1978-79	III	371.19	18.56	199.33	455.13	98.77	279.46	524.32	291.50	297.82	173.69	359.00	214.30	3283.07	88.11	3194.97
1978-79	IV	493.84	19.73	235.88	479.91	107.75	295.92	544.97	279.49	313.25	173.85	380.22	221.40	3541.22	92.04	3449.18
1978-79	I	403.04	19.26	223.06	447.92	103.04	278.81	531.93	281.68	310.54	170.47	364.66	228.50	3362.91	88.19	3274.72
1978-79	II	274.94	22.73	260.88	491.01	109.04	313.24	577.11	306.36	331.81	177.96	409.55	235.07	3508.70	97.75	3410.95

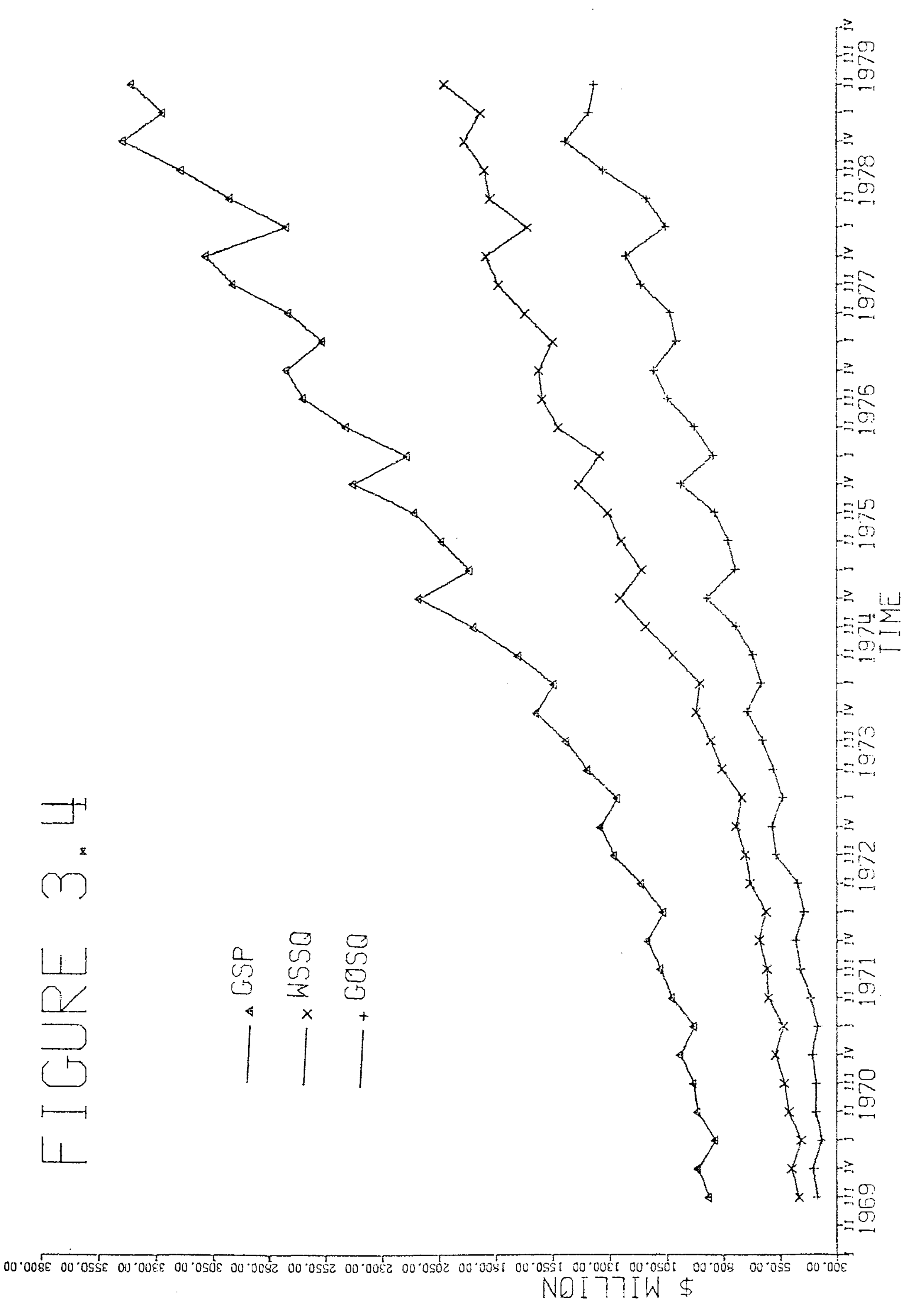
Table 3.32: Wages, salaries and supplements by industry, Queensland, 1969 III to 1979 II, $ million

YEAR	QTR	FARM	N-FARM	MIN	MAN	ELEC	CON	TRADE	TRANS	FIN	PAD	COMM	TOTAL
1969-70	III	23.81	1.68	15.96	96.64	11.06	51.74	82.04	56.18	29.57	40.66	64.99	474.32
1969-70	IV	23.17	1.83	16.85	101.39	12.25	56.37	90.73	57.98	33.57	41.81	70.79	506.72
1969-70	I	19.78	1.70	16.55	85.06	11.37	52.59	85.47	56.61	31.94	38.30	66.00	465.38
1969-70	II	17.61	2.02	23.17	95.16	12.21	62.10	94.36	59.95	34.80	41.61	75.55	518.57
1970-71	III	24.04	2.19	19.62	100.61	12.60	62.05	94.59	64.14	35.10	46.99	76.79	538.73
1970-71	IV	22.75	2.37	21.55	107.38	14.01	68.32	103.98	65.97	38.09	49.38	85.50	579.30
1970-71	I	20.14	2.16	21.33	98.74	13.45	63.98	97.73	64.65	37.44	46.97	75.83	542.42
1970-71	II	18.21	2.58	29.37	111.03	14.36	74.07	108.89	71.19	40.63	51.49	87.74	609.54
1971-72	III	21.55	2.59	23.79	117.17	15.07	71.78	106.11	70.47	42.59	55.88	89.30	616.30
1971-72	IV	22.56	2.67	25.80	120.92	14.96	75.49	113.38	74.74	43.76	59.53	95.86	649.69
1971-72	I	18.14	2.57	25.43	111.18	15.37	73.92	110.79	70.13	43.76	56.85	91.91	620.07
1971-72	II	16.20	2.97	32.39	125.63	16.25	83.65	123.69	77.35	47.78	59.80	103.22	688.95
1972-73	III	27.86	2.56	27.34	131.76	16.78	83.61	123.82	89.05	48.75	63.07	103.81	709.41
1972-73	IV	26.75	2.77	28.13	138.84	17.85	88.25	132.61	87.31	52.80	65.80	110.99	752.13
1972-73	I	19.33	2.75	27.87	129.72	17.76	88.18	132.70	81.99	54.86	60.99	110.30	726.45
1972-73	II	18.39	3.03	37.93	151.52	18.36	96.88	145.18	89.40	59.36	72.38	122.59	815.01
1973-74	III	28.20	2.61	31.78	159.00	19.35	102.91	152.76	97.25	65.64	74.24	129.17	863.09
1973-74	IV	34.15	2.95	34.58	171.98	20.74	110.09	165.27	107.98	68.88	78.46	132.46	927.57
1973-74	I	24.98	3.08	29.31	156.46	21.49	112.02	167.30	104.60	71.82	76.72	142.14	909.93
1973-74	II	20.33	3.60	35.29	184.32	24.03	132.11	193.01	113.09	79.71	84.68	159.23	1029.41
1974-75	III	30.83	3.45	36.61	204.13	25.74	128.48	221.34	129.19	97.85	98.43	174.01	1150.00
1974-75	IV	44.62	3.78	41.24	225.44	29.83	133.96	234.86	139.17	105.06	109.62	195.35	1262.92
1974-75	I	25.82	3.51	46.85	193.29	29.40	120.93	224.54	125.28	102.36	104.99	189.51	1107.51
1974-75	II	21.46	3.80	56.91	213.15	31.84	129.79	246.19	135.59	109.12	110.60	198.06	1257.50
1975-76	III	33.60	4.09	46.93	229.35	30.72	133.63	254.31	145.79	112.79	120.20	205.43	1316.85
1975-76	IV	52.35	4.27	51.94	258.49	33.66	138.07	272.78	161.48	123.20	132.17	215.87	1444.28
1975-76	I	25.45	4.25	54.62	233.11	32.97	130.44	269.83	147.13	118.93	120.13	215.71	1352.56
1975-76	II	21.97	5.16	62.21	268.16	34.87	150.15	304.63	171.26	131.28	130.85	250.76	1534.31
1976-77	III	39.70	5.81	61.72	278.64	38.25	155.79	309.27	171.83	136.38	145.80	261.95	1605.13
1976-77	IV	51.02	5.51	60.55	288.02	37.23	154.27	311.00	168.16	137.99	151.36	256.37	1618.49
1976-77	I	32.86	5.61	57.91	263.76	38.40	151.74	307.54	170.13	134.83	137.35	258.27	1558.39
1976-77	II	28.15	6.48	58.03	296.25	39.90	166.86	330.53	174.40	146.71	147.84	284.86	1680.00
1977-78	III	46.16	6.98	63.14	308.62	43.33	181.95	342.13	200.76	148.20	163.09	291.84	1796.20
1977-78	IV	55.40	7.04	66.03	318.97	48.17	196.73	345.45	190.47	154.81	167.20	299.30	1849.56
1977-78	I	29.52	6.25	60.40	278.99	45.33	173.01	319.72	190.81	143.79	157.48	264.55	1669.84
1977-78	II	22.76	7.20	69.98	306.42	50.20	198.82	349.19	191.35	156.75	164.11	308.62	1832.40
1978-79	III	[illegible]	7.13	63.56	314.70	50.68	193.97	345.42	210.91	154.60	173.69	331.67	1857.31
1978-79	IV	53.30	7.59	75.21	331.83	52.73	217.82	360.03	202.13	162.00	173.85	319.51	1946.64
1978-79	I	43.50	7.40	71.13	309.71	52.87	196.51	351.42	203.72	161.20	170.47	306.43	1874.39
1978-79	II	29.67	8.73	83.18	339.50	55.95	220.22	381.27	221.56	172.24	177.96	343.32	2033.66

Table 3.33: Gross operating surplus by industry, Queensland, 1969 III to 1979 II, $ million

YEAR	QTR	FARM	N-F	MIN	MAN	ELEC	CON	TRADE	TRANS	FIN	PAD	COMM	ODWEL	SUB T	IBSC	TOTAL
1969-70	III	106.01	1.68	22.01	61.56	17.48	21.29	56.28	37.98	30.15	0.00	17.96	44.62	417.01	21.85	395.17
1969-70	IV	103.17	1.63	23.24	64.59	19.35	21.28	62.24	39.19	34.23	0.00	19.57	46.22	434.90	23.10	411.80
1969-70	I	88.07	1.70	22.83	54.19	17.96	18.59	59.64	38.27	32.57	0.00	18.24	47.74	398.79	22.06	376.73
1969-70	II	78.40	2.02	31.95	60.62	19.35	22.12	64.73	40.53	35.49	0.00	20.88	49.17	425.25	24.04	401.21
1970-71	III	99.08	2.01	27.30	55.34	17.92	22.56	58.24	36.06	35.67	0.00	19.13	51.92	425.23	24.71	400.53
1970-71	IV	93.76	2.17	30.00	59.07	19.92	23.55	54.02	37.09	39.71	0.00	21.30	53.54	443.12	25.83	417.29
1970-71	I	83.00	1.98	29.69	54.31	19.13	21.92	60.17	36.34	38.05	0.00	18.89	55.08	418.58	24.67	393.91
1970-71	II	75.04	2.36	40.89	61.07	20.42	24.99	67.04	40.02	41.29	0.00	21.86	56.70	451.68	27.23	424.45
1971-72	III	121.76	2.55	27.73	63.91	20.37	27.63	64.20	41.11	43.45	0.00	21.42	62.34	495.46	28.11	468.35
1971-72	IV	127.46	2.64	30.07	65.96	20.22	29.65	68.60	43.60	44.65	0.00	22.99	64.35	519.18	29.42	489.77
1971-72	I	102.48	2.53	29.63	60.64	20.77	23.54	67.04	40.91	44.65	0.00	22.04	66.25	480.50	28.52	451.98
1971-72	II	91.50	2.93	37.75	68.53	21.96	29.17	74.84	45.12	48.75	0.00	24.76	67.99	513.30	32.28	481.02
1972-73	III	167.56	2.19	38.47	77.14	23.94	32.01	78.18	41.65	52.75	0.00	24.65	73.48	612.05	34.18	577.86
1972-73	IV	160.33	2.38	39.58	81.29	25.48	33.58	83.73	45.43	57.14	0.00	26.37	75.30	631.20	36.44	594.76
1972-73	I	116.26	2.36	39.21	75.95	25.34	33.32	83.78	42.66	59.36	0.00	26.20	77.49	581.94	35.88	546.06
1972-73	II	110.51	2.60	53.36	88.71	26.21	38.83	91.66	46.51	64.24	0.00	29.12	79.69	631.54	41.05	590.49
1973-74	III	162.83	2.43	60.89	76.14	24.42	40.79	93.30	40.70	63.98	0.00	28.59	85.45	679.50	44.48	635.02
1973-74	IV	197.19	2.55	66.27	82.36	26.19	43.95	100.94	45.19	67.14	0.00	29.32	90.34	751.42	48.42	703.00
1973-74	I	144.26	2.67	56.16	74.93	27.13	42.63	102.18	43.77	70.01	0.00	31.46	93.16	688.34	47.18	641.16
1973-74	II	117.38	3.11	67.63	88.27	30.34	48.42	117.88	47.32	77.70	0.00	35.24	97.33	730.62	52.17	678.45
1974-75	III	183.19	1.84	69.92	98.16	26.26	49.20	116.42	41.75	84.37	0.00	33.58	102.49	807.18	54.54	752.65
1974-75	IV	265.13	2.02	78.74	108.41	30.43	48.39	123.53	44.98	90.59	0.00	37.70	108.69	938.60	58.20	880.41
1974-75	I	153.43	1.88	89.47	92.95	29.99	44.31	118.10	40.81	88.28	0.00	36.57	114.35	810.15	55.72	754.42
1974-75	II	127.53	2.03	108.07	102.49	32.48	48.12	129.49	44.14	94.09	0.00	38.22	120.37	847.64	60.98	786.66
1975-76	III	169.42	2.42	84.74	99.90	32.56	54.48	130.53	56.60	111.47	0.00	40.63	125.94	908.70	62.96	845.74
1975-76	IV	263.96	2.52	93.79	112.60	35.68	53.95	140.01	62.69	121.76	0.00	42.69	132.30	1062.45	66.21	996.24
1975-76	I	128.34	2.51	96.52	101.54	34.94	54.21	135.50	57.12	117.54	0.00	42.66	138.93	914.91	63.17	851.74
1975-76	II	125.91	3.05	112.32	116.81	36.97	63.20	156.36	66.48	129.75	0.00	49.59	144.69	1005.34	69.46	935.88
1976-77	III	196.83	4.53	129.01	124.09	37.54	68.73	160.38	66.41	134.11	0.00	49.41	156.37	1127.43	72.41	1055.02
1976-77	IV	252.95	4.30	126.56	126.94	36.55	68.21	161.29	65.00	135.69	0.00	48.36	165.21	1191.04	76.47	1114.57
1976-77	I	162.92	4.37	121.04	117.47	37.69	66.12	159.48	65.75	132.59	0.00	48.72	172.95	1089.10	72.55	1016.55
1976-77	II	139.57	5.06	121.30	131.94	39.17	67.16	171.40	67.41	144.27	0.00	53.73	180.23	1121.23	78.17	1043.07
1977-78	III	209.26	5.01	141.89	142.43	40.73	83.05	173.35	75.55	135.98	0.00	53.82	190.30	1250.36	79.36	1171.00
1977-78	IV	251.17	5.05	147.35	147.21	45.27	77.84	175.03	71.68	142.05	0.00	55.19	201.57	1319.41	82.27	1237.14
1977-78	I	133.83	4.48	134.77	128.75	42.61	72.34	162.00	71.80	131.94	0.00	48.79	208.99	1140.30	77.99	1062.32
1977-78	II	131.90	5.16	156.15	141.42	47.18	81.60	176.93	72.01	143.83	0.00	56.91	216.78	1232.89	85.43	1147.46
1978-79	III	331.13	11.43	135.77	140.44	48.09	85.49	177.93	80.68	143.22	0.00	57.32	214.30	1425.80	88.11	1337.69
1978-79	IV	440.54	12.15	150.67	143.09	50.03	88.09	184.93	77.36	150.64	0.00	60.71	221.40	1594.61	92.04	1502.57
1978-79	I	359.54	11.86	151.94	138.21	50.16	82.30	180.51	77.97	149.34	0.00	58.23	228.50	1488.55	88.19	1400.36
1978-79	II	245.27	13.99	177.69	151.51	53.08	93.02	195.84	64.80	159.57	0.00	65.24	235.07	1475.08	97.75	1377.33

Figure 3.4: GSP, WSSQ and GOSQ, Queensland, 1969 III to 1979 II



3.5 VALIDATION AND CRITICISMS OF THE ESTIMATES

3.5.1 Direct versus Indirect Estimation

It is interesting to note the proportions of GSP computed through direct versus indirect (i.e., estimated entirely by allocation of a ratio) methods.

Table 3.34 shows the proportions for 1977-78, given that both WSSQ and GFPQ in their entirety, as well as GOSODWQ and GOSNOMQ, are estimated directly.

Kendrick and Jaycox (1965), in their quite different US situation, achieved proportions of 68.3% direct and 31.7% indirect.

3.5.2 Queensland as a Proportion of Australia

The ABS do not estimate quarterly GDP by industry, so industry comparisons between the gross product (and its components) of Queensland and of Australia are only possible on an annual basis. Table 3.35 lists Queensland GSP as a proportion of Australian GDP, by industry (as defined in Table 3.16), for the ten years 1969-70 to 1978-79.

However, since WSS, GOS and GDP are estimated quarterly for total industry, it is possible to compare them with Queensland figures from 1969 III to 1979 II. These comparisons are shown in Table 3.36.

Table 3.35 shows that Queensland has generally increased its share of Australian gross product. In only one industry was the proportion of Queensland in Australia less in 1978-79 than in 1969-70. In this industry - community - the proportion fell from 11.5% in 1969-70 to 11.1% in 1978-79.

Overall, i.e., for all industries, Queensland's share increased from 13.0% in 1969-70 to 15.0% in 1978-79.

The shares of mining, manufacturing and nominal industry all grew steadily over the period. Mining grew from 18.9% in 1969-70 to 24.8% in 1978-79, manufacturing from 8.9% to 10.4% and nominal industry from 14.4% to 15.7%.

Agriculture's share fluctuated between a low of 18.1% in 1973-74 and a high in 1974-75 and 1978-79 of 24.1%, but was generally around 23%.

Table 3.34: Proportions of direct versus indirect estimation of GSP, Queensland, 1977-78

		Amount ($m)	Proportion (%)
Direct estimation		9040	74.9
of which	WSSQ	7148	59.2
	GOSFQ	749	6.2
	GOSODWQ	818	6.8
	GOSNOMQ[a]	325	2.7
Indirect estimation		3025	25.1
Total		12065	100.0

[a] The absolute value is used for this exercise.

Table 3.35: Queensland GSP as a proportion of Australian GDP, by industry, 1969-70 to 1978-79

Industry	1969-70 %	1970-71 %	1971-72 %	1972-73 %	1973-74 %	1974-75 %	1975-76 %	1976-77 %	1977-78 %	1978-79 %
Agriculture	21.9	22.5	23.3	21.6	18.1	24.1	23.3	23.0	23.3	24.1
Mining	18.9	20.9	18.4	21.0	22.9	23.8	23.9	24.0	24.5	24.8
Manufacturing	8.9	8.5	9.0	9.7	9.5	10.2	10.4	10.6	10.7	10.4
Electricity	12.7	12.6	12.4	13.1	13.1	13.9	13.5	13.1	13.9	14.6
Construction	13.7	14.4	14.8	15.9	17.4	15.1	14.4	15.0	16.8	17.0
Trade	13.7	14.0	14.3	15.0	15.7	17.0	17.4	17.6	17.4	17.2
Transport	17.0	16.5	16.7	17.2	17.1	16.5	17.1	16.8	17.3	17.4
Finance	10.7	10.7	10.9	11.6	12.5	14.2	14.2	14.0	13.9	13.9
Public administration and finance	15.0	15.0	15.6	15.5	15.0	15.2	15.6	15.9	15.8	15.6
Community	11.5	11.3	11.2	11.6	11.7	11.3	11.0	11.2	11.0	11.1
Ownership of dwellings	12.4	12.1	12.6	12.8	13.0	12.9	12.7	12.9	13.0	13.2
Nominal industry	14.4	14.5	14.6	14.8	15.0	15.1	15.2	15.2	15.1	15.7
Total	13.0	12.9	13.2	13.8	13.9	14.5	14.5	14.6	14.7	15.0

Electricity also showed considerable volatility - falling from 12.7% in 1969-70 to 12.4% in 1971-72, rising to 13.9% in 1974-75, then falling to 13.1% in 1977-78, and then rising to 14.6% in 1978-79.

Construction was also volatile, rising from 13.7% in 1969-70 to 17.4% in 1973-74, falling to 14.4% in 1975-76 and rising again to 17.0% in 1978-79.

Trade and finance rose to a plateau by the mid seventies. Trade increased from 13.7% in 1969-70 to 17.0% in 1974-75 and remained at around 17%, while finance rose from 10.7% in 1969-70 to 14.2% in 1974-75 and then remained at around 14%.

Transport, public administration and defence and ownership of dwellings maintained a steady share throughout the ten years - transport around 17%, public administration and defence between 15% and 16% and ownership of dwellings around 12% and 13%.

In Table 3.36, the means of the proportions are 13.2% for WSS, 15.5% for GOS and 14.0% for gross product.

It is possible to calculate per capita values of the principal components of GSP and GDP, and so compare Queensland per capita WSSQ, GOSQ and GSP with the corresponding national per capita values. This is shown for the ten years 1969-70 to 1978-79 in Table 3.37. Relativities, i.e., the ratio of Queensland per capita to Australian per capita figures, are also shown. The meaning of these per capita comparisons is not clear, since the economic characteristics of the populations of Queensland and Australia may not be identical. For example, should the proportion of persons in the age group 15-64 be different in Queensland and Australia, then the use of total population to standardize a measure of economic size and performance may be inappropriate.[70] Furthermore, there is little point in calculating per capita WSS and GOS, since the mix of income of unincorporated incomes in gross operating surplus is quite different in Queensland and Australia, largely owing to the importance of the farm sector in Queensland.

---

[70]At 30 June 1976, the proportion of persons aged between 15 and 64 in Queensland was 62.6%, while it was 64.1% for Australia.

Table 3.36: Queensland's principal components of gross product as a proportion of Australia's, 1969 III to 1979 II

Year and Quarter	Principal component of GSP		
	WSS (%)	GOS (%)	GSP (%)
1969 III	12.4	14.6	13.3
1969 IV	12.2	12.4	12.3
1970 I	12.1	13.8	12.8
1970 II	12.3	15.7	13.6
1970 III	12.5	13.6	12.9
1970 IV	12.3	12.2	12.3
1971 I	12.1	13.7	12.7
1971 II	12.4	15.9	13.7
1971 III	12.5	14.3	13.2
1971 IV	12.3	12.6	12.4
1972 I	12.5	14.5	13.3
1972 II	12.8	16.1	14.0
1972 III	13.2	15.7	14.2
1972 IV	12.8	12.9	12.8
1973 I	13.1	14.9	13.8
1973 II	13.2	16.6	14.4
1973 III	13.5	14.6	13.9
1973 IV	13.0	12.7	12.9
1974 I	13.3	14.8	13.9
1974 II	13.3	18.7	15.0
1974 III	13.6	17.8	15.0
1974 IV	13.4	14.8	13.9
1975 I	13.3	16.8	14.5
1975 II	13.3	18.2	14.8
1975 III	13.6	16.7	14.7
1975 IV	13.4	14.0	13.6
1976 I	13.3	16.3	14.3
1976 II	14.0	17.9	15.3
1976 III	14.1	16.5	15.0
1976 IV	13.4	13.9	13.6
1977 I	13.8	16.4	14.7
1977 II	13.8	17.6	15.1
1977 III	14.3	16.8	15.2
1977 IV	14.0	14.8	14.3
1978 I	13.2	16.4	14.3
1978 II	13.9	17.4	15.1
1978 III	13.9	17.5	15.2
1978 IV	13.8	15.1	14.4
1979 I	13.6	16.8	14.8
1979 II	14.2	18.1	15.6

Table 3.37: Per capita principal components of gross product, Queensland and Australia, 1969-70 to 1978-79

Year	Wages, salaries and supplements per capita		Qld as % of Aust.	Gross operating surplus per capita		Qld as % of Aust.	Gross Product per capita		Qld as % of Aust.
	Queensland $	Australia $	%	Queensland $	Australia $	%	Queensland $	Australia $	%
1969-70	1183	1290	91.7	954	910	104.9	2137	2200	97.2
1970-71	1228	1442	85.1	885	932	94.9	2112	2374	89.0
1971-72	1351	1574	85.8	992	1016	97.6	2342	2590	90.4
1972-73	1531	1729	88.6	1177	1169	100.7	2708	2898	93.5
1973-74	1849	2085	88.7	1317	1323	99.6	3166	3408	92.9
1974-75	2340	2637	88.8	1535	1386	110.8	3875	4022	96.3
1975-76	2691	3000	89.7	1729	1631	106.0	4421	4631	95.5
1976-77	3044	3354	90.7	1992	1888	105.5	5036	5242	96.1
1977-78	3320	3639	91.2	2145	2021	106.1	5464	5660	96.6
1978-79	3536	3872	91.3	2576	2342	110.0	6112	6214	98.4

3.5.3 The Structure of Queensland Industry

Table 3.38 shows the percentage contribution of each industry to total GSP in Queensland for the ten years 1969-70 to 1978-79.

Ranked, in order of size of their percentage contribution to gross product in 1978-79, the industries are,

Trade	(16.3%)
Manufacturing	(14.1%)
Agriculture	(12.2%)
Community	(11.4%)
Finance	(9.4%)
Construction	(8.8%)
Transport	(8.7%)
Mining	(6.9%)
Ownership of dwellings	(6.8%)
Public administration and defence	(5.2%)
Electricity	(3.1%)
Nominal industry	(2.8%)

This ranking has not been constant over the whole period. Table 3.39 shows the rankings of the industries over the ten year period. Examination of these rankings shows that the relative positions of finance and transport should be transposed, if the full ten year period is considered.

Relative specialization quotients for gross product for the industries, over the ten years 1969-70 to 1978-79, have been calculated and are presented in Table 3.40 (these are calculated in the same way as location quotients and show the relative (to Australia) specialization of Queensland industries). These quotients show that, for gross product, Queensland specialized relatively more in the following industries:

Agriculture
Mining
Construction
Trade
Transport
Public administration and defence
Nominal industry.

Table 3.38: Percentage industry contribution to gross product, Queensland, 1969-70 to 1978-79

Industry	1969-70 %	1970-71 %	1971-72 %	1972-73 %	1973-74 %	1974-75 %	1975-76 %	1976-77 %	1977-78 %	1978-79 %
Agriculture	13.4	11.6	12.2	12.6	11.8	10.9	9.2	8.9	8.0	12.2
Mining	4.9	5.6	5.2	5.5	6.0	6.6	6.5	6.9	7.1	6.9
Manufacturing	17.4	16.6	16.4	16.5	15.6	15.5	15.3	15.2	15.1	14.1
Electricity	3.4	3.4	3.3	3.2	3.0	3.0	2.9	2.9	3.1	3.1
Construction	8.6	9.3	9.3	9.3	9.9	8.8	8.4	8.4	9.1	8.8
Trade	16.8	16.8	16.3	16.4	17.1	17.7	18.0	17.9	17.4	16.3
Transport	10.9	10.6	10.4	9.7	9.4	8.8	9.4	8.9	9.1	8.7
Finance	7.4	7.8	8.1	8.5	8.8	9.6	10.4	10.3	9.8	9.4
PAD	4.6	5.0	5.2	4.9	4.9	5.3	5.4	5.5	5.5	5.2
Community	10.0	10.4	10.6	10.4	10.8	11.3	11.5	11.8	11.7	11.4
Ownership of dwellings	5.3	5.6	5.8	5.8	5.7	5.6	5.9	6.3	7.0	6.8
Nominal industry	2.6	2.6	2.7	2.8	3.0	2.9	2.8	2.8	2.8	2.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 3.39: Rankings of relative size of Queensland industries, 1969-70 to 1978-79

Industry	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79
Trade	2	1	2	2	1	1	1	1	1	1
Manufacturing	1	2	1	1	2	2	2	2	2	2
Agriculture	3	3	3	3	3	4	6	6	7	3
Community	5	5	4	4	4	3	3	3	3	4
Finance	7	7	7	7	7	5	4	4	4	5
Construction	6	6	6	6	5	6	7	7	5	6
Transport	4	4	5	5	6	7	5	5	5	7
Mining	8	8	9	9	8	8	8	8	8	8
Ownership of dwellings	9	9	8	8	9	9	9	9	9	9
PAD	10	10	10	10	10	10	10	10	10	10
Electricity	11	11	11	11	11	11	11	11	11	11
Nominal industry	12	12	12	12	12	12	12	12	12	12

Table 3.40: Industry relative specialization quotients for gross product Queensland, 1969-70 to 1978-79

Industry	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79
Agriculture	1.69	1.75	1.76	1.57	1.30	1.65	1.61	1.58	1.59	1.61
Mining	1.46	1.62	1.40	1.52	1.64	1.64	1.65	1.65	1.67	1.66
Manufacturing	0.68	0.66	0.68	0.70	0.68	0.70	0.72	0.73	0.73	0.70
Electricity	0.98	0.98	0.94	0.95	0.94	0.95	0.93	0.90	0.94	0.98
Construction	1.05	1.12	1.12	1.15	1.25	1.04	0.99	1.03	1.14	1.14
Trade	1.06	1.09	1.08	1.09	1.13	1.17	1.20	1.21	1.19	1.15
Transport	1.31	1.28	1.27	1.24	1.23	1.14	1.18	1.15	1.18	1.16
Finance	0.82	0.83	0.83	0.84	0.90	0.98	0.98	0.96	0.94	0.93
PAD	1.15	1.17	1.18	1.12	1.08	1.05	1.08	1.09	1.07	1.04
Community	0.89	0.88	0.85	0.84	0.84	0.78	0.76	0.77	0.75	0.74
Ownership of dwellings	0.95	0.94	0.95	0.92	0.94	0.89	0.88	0.88	0.89	0.88
Nominal industry	1.11	1.12	1.11	1.07	1.08	1.04	1.05	1.04	1.03	1.05

Queensland does not specialize in the following industries:

Manufacturing
Electricity
Finance
Community
Ownership of dwellings.

3.5.4 Real Growth in Queensland

Table 3.41 shows annual percentage growth of gross product for Queensland. As a measure of growth of the Queensland economy, however, these figures are deficient, since inflation, i.e., the increase in prices of the goods and services making up gross product, makes the growth appear higher than it is in real terms. In order to determine real growth, it is necessary to apply a price deflator to the series in current prices. This converts the valuation of the items making up gross product to that prevailing at some base year so that the series is now valued in terms of constant prices. For the Australian National Accounts, the ABS have constructed implicit price deflators to determine estimates of GDP in real terms.

No corresponding implicit price deflators exist for Queensland gross product.

The national implicit price deflators are determined for the expenditure side of the Domestic Production Account, and are not available for gross product by industry.

Consequently, only total gross product - a single series - can be deflated for Queensland, and this can only be done by using national price indexes. However, it is possible to make a minor adjustment to introduce some degree of state differential by applying state information on the consumer price index.[71]

Since the main components of the implicit price deflator for private final consumption expenditure are based on the consumer price index, it is reasonable to apply the difference in the Queensland and national consumer price indexes to that proportion of GSP covered by

---

[71] Strictly, of course, the consumer price index is measured only for metropolitan areas, and not for states, or the nation.

Table 3.41: Annual percentage growth in GSP at current prices by industry, Queensland, 1970-71 to 1978-79

	Farm (%)	Non-farm (%)	Mining (%)	Manufacturing (%)	Electricity (%)	Construction (%)
1970-71	-5.2	23.5	27.3	4.6	8.9	18.1
1971-72	19.6	20.3	5.8	13.3	10.0	14.5
1972-73	24.2	-3.7	25.5	19.2	18.4	19.5
1973-74	12.6	12.2	30.8	13.5	12.8	28.0
1974-75	16.8	-3.8	38.4	24.6	21.8	11.1
1975-76	-3.3	26.7	14.5	14.7	15.4	10.7
1976-77	9.7	47.4	21.6	14.4	11.9	15.5
1977-78	-1.5	13.1	13.9	9.2	19.1	18.5
1978-79	73.4	70.2	9.6	5.7	14.0	9.6

	Trade (%)	Transport (%)	Finance (%)	PAD (%)	Community (%)	Ownership of Dwellings (%)	IBSC (%)	Total (%)
1970-71	10.1	7.4	16.3	20.0	15.0	15.7	12.5	10.0
1971-72	11.3	11.5	17.8	19.1	15.8	20.1	15.5	14.3
1972-73	19.6	11.1	25.0	13.0	17.5	17.3	24.7	18.9
1973-74	25.3	16.5	25.7	19.8	24.1	19.7	30.3	20.2
1974-75	29.5	17.2	36.6	34.9	31.3	21.7	19.3	25.4
1975-76	17.9	23.6	25.3	18.8	17.8	21.7	14.1	15.8
1976-77	14.6	9.3	14.1	15.7	18.6	24.4	14.4	15.2
1977-78	7.0	12.2	5.0	11.9	9.3	21.2	8.5	10.1
1978-79	6.6	8.9	8.3	6.8	9.7	10.0	12.6	13.3

state private final consumption expenditure. Formally,

$$\Delta IPDQ = \Delta IPD \left(1 + \left(\frac{\Delta CPIQ - \Delta CPIA}{\Delta CPIA}\right) \cdot \left(\frac{PFCEQ}{GSP}\right)\right)$$

where

IPD = implicit price deflator for gross product,
CPI = consumer price index, all groups,
PFCE = private final consumption expenditure,
Q = Queensland,
A = Australia, and,
Δ = percentage annual change

The implicit price deflator for Queensland GSP determined by this formula is shown in Table 3.42 for the ten years 1969-70 to 1978-79. This table also shows GSP at average 1974-75 prices.

Annual real growth of GSP is shown in Table 3.43. Over the period 1969-70 to 1978-79, the average annual rate of increase of real GSP was 4.7%, compared to 3.1% for real GDP at factor cost.

3.5.5 Comparison with Naive Estimates

The estimates constructed in this study can be contrasted with those which could be constructed simply by,

$$GSP = WSSQ \left(1 + \frac{GOS}{WSS}\right)$$

These can be called Method I naive estimates. They are not constructed at an industry level, since WSSQ by industry is not produced by the ABS, but can quickly give an annual total gross product figure. (Quarterly naive estimates are not possible because WSSQ is not produced on a quarterly basis by the ABS).

A modification, creating Method II naive estimates, can be made to incorporate published information on gross farm product, i.e.,

$$GSP = GFPQ + GNFPQ$$

$$GNFPQ = (WSSQ - WSSFQ) \cdot \left(1 - \frac{(GOS - GOSF)}{(WSS - WSSF)}\right)$$

Table 3.42: Implicit price deflators for Queensland and Australia and GSP at average 1974-75 prices, 1969-70 to 1978-79

Year	Implicit price deflators: Queensland	Implicit price deflators: Australia	GSP at average 1974-75 prices ($m)
1969-70	60.1	59.9	5903
1970-71	63.5	63.0	6150
1971-72	67.8	67.4	6587
1972-73	74.3	74.1	7146
1973-74	85.0	84.4	7514
1974-75	100.0	100.0	8012
1975-76	114.9	114.8	8072
1976-77	127.8	127.4	8367
1977-78	138.0	137.7	8528
1978-79	148.8	148.5	8956

Source: NIE, 1978-79, Table 3.

Table 3.43: Annual percentage growth in GSP and GDP at average 1974-75 prices, 1970-71 to 1978-79

Year	Annual growth rate of GSP at average 1974-75 prices (%)	Annual growth rate of GDP at average 1974-75 prices (%)
1970-71	4.2	5.3
1971-72	7.1	4.3
1972-73	8.5	3.4
1973-74	5.1	4.9
1974-75	6.6	1.1
1975-76	0.7	1.4
1976-77	3.7	3.1
1977-78	1.9	1.0
1978-79	5.0	3.1

Source: NIE, 1978-79, Tables 1 and 3.

Table 3.44 compares the estimates for total gross product produced by this study with the naive estimates. Of course, the differences are underestimated in gross product comparisons, since the differences accrue only to gross operating surplus. (In 1978-79, the percentage difference between the gross operating surplus produced by this study and that produced by naive method II was -6.4%).

This indicates that the complexity of this method has produced quite different estimates from those which can be produced by naive methods. This is in addition of course to the disaggregation by quarter and industry produced by the method of this study.

3.5.6 Other Validation

3.5.6.1 Other Measures of Queensland's Share

Table 3.45 shows several other measures of Queensland's share in Australia. Of these, the household income measures and private final consumption expenditure series come from NIE. The measure of wage and salary earners in civilian employment is not a good measure because it excludes workers in agriculture, defence and private domestic service. The two measures of population, total population and those persons aged between 15 and 65, are particularly interesting, since in 1978-79, the measures straddled the GSP measure. This adds emphasis to the point mentioned above, that per capita values are not appropriate when expressed with total population as the base. Seen in this light, Queensland's economic performance, measured against the potential from population, is sound.

3.5.6.2 Comparison with IEC Estimates

It is possible to compare the estimates for wages, salaries and supplements of this study with estimates of wages and salaries determined by the annual Integrated Economic Censuses of the ABS of the industries, mining, manufacturing, and electricity, gas and water.

This comparison is presented in Table 3.46. There are large differences, which cannot be explained entirely by the inclusion of estimates of supplements. The difference is also found in the national accounts. This is also revealed in Table 3.46.

Table 3.44: Comparison with naive estimates, GSP, Queensland, 1969-70 to 1978-79

Year	Crossman estimates ($m)	Method I naive estimates ($m)	Percentage difference (%)	Method II naive estimates ($m)	Percentage difference (%)
1969-70	3550	3350	-5.6	3494	-1.6
1970-71	3906	3737	-4.3	3878	-0.7
1971-72	4466	4238	-5.1	4434	-0.7
1972-73	5312	5033	-5.3	5234	-1.5
1973-74	6388	6096	-4.6	6236	-2.4
1974-75	8012	7381	-7.9	7712	-3.8
1975-76	9278	8719	-6.0	9007	-2.9
1976-77	10691	10099	-5.5	10381	-2.9
1977-78	11766	11117	-5.5	11399	-3.1
1978-79	13330	12375	-7.2	12965	-2.7

Table 3.45: Queensland's share in Australia

Measure	Queensland as a percentage of Australia (%)	Period or date of measurement
Total population	15.2	1978-79
Household income	14.6	1978-79
Household disposable income	14.4	1977-78
Income tax paid	12.9	1977-78
Private final consumption expenditure	14.1	1978-79
Wage and salary earners in civilian employment (excluding agriculture and private domestic service)	13.2	June 1978
Population aged 15-64	14.8	June 1976
GSP	15.0	1978-79

Sources: ABS, Catalogue Nos. 1301.0, 1301.3 and 5204.0.

Table 3.46: Comparison with IEC results

		Queensland			Australia		
Industry	Year	WSSQ from Crossman ($m)	WSQ from IEC ($m)	WSSQ/WSQ (%)	WSS from ABS ($m)	WS from IEC ($m)	WSS/WS (%)
Mining	1969-70	72.5	48.2	150.5	335.0	275.6	121.6
	1974-75	181.6	159.4	113.9	807.0	675.4	119.5
	1977-78	259.6	228.1	113.8	1181.0	1018.4	116.0
Manufacturing	1969-70	378.3	332.1	113.9	4652.0	4329.0	107.5
	1974-75	836.0	740.8	112.9	9214.0	8533.0	108.0
	1977-78	1213.0	1034.5	117.3	12307.0	11135.8	110.5
Electricity, gas and water	1969-70	46.9	34.1	137.6	388.0	294.0	132.0
	1974-75	116.8	81.9	142.6	880.0	616.0	142.9
	1977-78	187.0	122.8	152.3	1294.0	866.5	149.3

3.5.6.3 Comparison with Transactions Matrix

Since a Transactions (or Input-Output) Matrix has been produced for Queensland[72] it should be possible to compare estimates of gross product by industry from this study with those available from the Primary Input quadrant of the Transactions Matrix.

Such a comparison has been made for Tasmania, by the author of the 1968-69 Transaction Matrix of Tasmania (Edwards (1977)) comparing his estimate of GSP with that of Hudson (1976). The comparison was in this case remarkably close - \$802m by Edwards and \$806m by Hudson.

The comparison for Queensland is given in Table 3.47. This shows that the close matching of GSP in the Tasmanian case is not repeated for Queensland. Indeed, the results are significantly different.

Gross operating surplus is lower in the Transactions Matrix, but the difference in WSSQ is very large and indicates that wages, salaries and supplements are underestimated by about one thousand million dollars in the Transactions Matrix. (It should be remembered that the figure of \$3730m for WSSQ for 1973-74 is an ABS estimate.)

3.6 A GENERAL ASSESSMENT OF THE QUALITY OF THE ESTIMATES

The estimates produced by this study cannot be regarded as being final. The method will bear much more work, and there will always be revisions as further data are made available, and existing data are updated.

The most that can be claimed for the accuracy of these estimates is that they are tolerably close to the accuracy of the Australian figures produced by the Australian Bureau of Statistics. They cannot be superior, since they are built upon the foundations of the Australian figures; and they cannot be very much worse, since they depend upon the Australian figures so heavily.

Improvements can be made, however. Certain parts of the estimation are still weak. Those parts include small business allocation of

---

[72] Jensen *et al.* (1977).

Table 3.47: Comparison with Queensland Transactions Matrix results, 1973-74

Transactions Matrix estimates		Crossman estimates	
	$m		$m
WSSQ	2783	WSSQ	3730
GOSQ ITLS (a)	2602	GOSQ	2658
GSP at market prices	5385	GSP at factor cost	6388
GSP as a percentage of GDP	10.5%		13.9%

(a) It is assumed that the row "Other Value Added" is conceptually equivalent to the sum of gross operating surplus and indirect taxes less subsidies.

Sources: Jensen *et al.* (1977, p. 97), and ABS, Catalogue No. 5204.0.

wages and salaries by industry and the use of national ratios to estimate gross operating surplus. This latter point provides also the main criticism which can be made of these estimates, i.e., the assumption of identical return-to-labour/return-to-capital shares in the state and the nation. However, since this assumption is not used (or is negated by IEC corrections) in the four industries, farm, mining, manufacturing, and electricity, the problem is minimized in this study. Niemi (1972) has claimed that "the bias resulting from the assumption of similar factor proportions within industries in the nation and all states is likely to be much lower in those industries with high relative labour inputs and those industries producing services".[73] Whether or not this is true, there is very little that can be done in practice about the problem.

---

[73]Niemi (1972, p. 128).

CHAPTER 4

DATA FOR A QUARTERLY ECONOMETRIC MODEL OF QUEENSLAND

4.1 INTRODUCTION

In Chapter 2, it was said that two important data construction exercises were necessary for the feasible development of a quarterly econometric model of the State of Queensland. The first was the estimation, from primary sources, of quarterly GSP. The second was the construction of quarterly data, i.e., consistent quarterly estimates from annual, or mixed quarterly and annual, data. The problem can be characterized as interpolation in the case of stock variables (e.g. employment), and distribution in the case of flow variables (e.g. gross state product).

This is a vitally important section of work which seems to be lacking in the field of regional econometric models in the USA (and elsewhere). This is particularly surprising in view of the comments made in Ratajczak (1974, p. 52) about the use of annual data:

> Unfortunately, annual data do not provide many degrees of freedom for statistical estimation ... Furthermore, the hypothesis that regional differences in response to national stimuli are partially caused by differing speeds of adjustment cannot be effectively tested with annual data ...;

and the availability of state quantity data in the USA;

> At the state level substantial data are now available on a quarterly or even monthly basis.

The method of construction of quarterly data is detailed in the next section.

The task of developing any econometric model, of more than trivial size, is complicated by the search for data and the management of data. The search for data usually consists of creating and maintaining a collection of data publications. The management of data has two aspects: the transfer to computer files and the subsequent control of quantities of data on a computer.

These problems are discussed in the last two sections of this chapter.

4.2 CONSTRUCTION OF QUARTERLY DATA ESTIMATES

4.2.1 Previous Work

The problem of re-estimating an economic variable in a higher frequency domain was first approached by Friedman (1962):

> Most economic time series are highly manufactured products, constructed out of many bits and pieces that must be shaped and rearranged to yield the final series. One of the commonest operations performed in this process is interpolation: estimation of some component for dates for which it is not directly available from known values of that component for other dates ... This kind of interpolation is used at some stage in the construction of the great majority of comprehensive economic time series currently published, although it is frequently described not as interpolation but as the reverse, namely, *adjustment* of series for monthly or other shorter time units to *key* or *benchmark* data.[1]

Interestingly enough, Friedman (1962) distinguished between interpolation (of stocks) and distribution (of flows), but found that he could not "encompass them in full in the same analysis" even though they were "closely related operations".[2]

Following this, a strand of work, predominantly European, appeared on the derivation of quarterly estimates consistent with annual data. A crude interpolation technique was published by Lisman and Sandee (1964). This was followed by an article by Boot *et al.* (1967) which reduced the arbitrariness of Lisman and Sandee (1964). Neither method introduced any related data series, and so remain purely mathematical methods.

---

[1] Friedman (1962, pp. 729-730). Friedman's emphasis.

[2] Friedman (1962, p. 730).

This limitation was eliminated by Vangrevelinghe (1966), who suggested mathematical interpolation followed by modulation by a related data series. Ginsburgh (1973), who noted that this method had been used in the French quarterly national accounts, combined the methods of Vangrevelinghe (1966) and Boot *et al.* (1967) to construct a more consistent method.

This work of Ginsburgh (1973) was followed by an article by Somermeyer *et al.* (1976) which did not refer to Ginsburgh (1973) yet performed a similar, if more complex, task.

Almost simultaneously (due to journal publication lags) with Ginsburgh (1973), an article by Chow and Lin (1971) appeared which drew on the work of Friedman (1962) and some earlier work by Chang and Liu (1951) on monthly national accounts estimates. This article can be considered the most powerful of the work to date. The method devised by these researchers forms the basis of the method described below.

An unpublished paper, Spahn (1976), has outlined a numerical interpolation technique for distributing flow variables using spline-functions. However, this technique does not use related series, and so suffers from the problems of arbitrariness and inability to create degrees of freedom. On the other hand it has the desirable properties of smoothness and minimum curvature.

A major article has subsequently appeared by Gilbert (1977), but it concentrates on the case of mixed annual and quarterly data and on "obtaining satisfactory forecasting relationships".[3] In this approach emphasis is placed on the estimation of regression equations and the derivation of regression coefficients, rather than on producing an interpolated vector of data. The emphasis on using acceptable economic relationships to produce an interpolated vector is laudable and necessary, but it is not evident that the more complex methods of Gilbert (1977) are superior to the simpler expansion and refinement, outlined below, of Chow and Lin (1971). Since Gilbert (1977) uses the data and results of Ginsburgh (1973) as a base for determination of superiority of method, comparisons can be made, and are detailed below.

---

[3]Gilbert (1977, p. 222).

4.2.2 Outline of the Method

The method detailed below is a modification of the method of Chow and Lin (1971), who produced a method of determining monthly figures from quarterly data, using a regression model, and unified the treatment of distribution, interpolation and extrapolation in one framework. The method produces best linear unbiased estimates of a monthly series, which are consistent with the quarterly series, and which are determined by a relationship with related monthly series.

Three changes to the method outlined by Chow and Lin (1971) are made here, together with a simplification of notation. The three changes are:

(i) the trivial change of going from the monthly/quarterly estimation to quarterly/annual;

(ii) the partitioning of the method, to allow for a mix of quarterly and annual data availability of the dependent variable; and,

(iii) the inclusion of a workable algorithm to allow for an autoregressive variance-covariance matrix of the quarterly residuals.

The general method is a GLS framework. It is assumed that, for n years,

$$y = X\beta + u$$

where y is the unknown vector of quarterly dependent variable values of length 4n

X is a known matrix, $4n \times k$, of exogenous variables

β is a vector of coefficients of length k

u is a vector of length 4n of random disturbances with $E(u) = 0$ and some variance covariance matrix $E(u\,u')$.

Without loss of generality, y can be partitioned into two vectors, the first, of length $4n_1$, containing unknown quarterly values, and the second, of length $4n_2$, containing known quarterly values. The n_1 annual values of the unknown portion of y are known. No loss of generality results by assuming n_2 whole years of quarterly data are held, or that the known quarterly data come second in the sequence.

The following aggregation matrices are now defined, $(n - n_1 + n_2)$

$$C = \left(\begin{array}{c|c} C_{I \text{ or } D} & 0 \\ (n_1 \times 4n_1) & (n_1 \times 4n_2) \\ \hline 0 & I \\ (4n_2 \times 4n_1) & (4n_2 \times 4n_2) \end{array}\right) \qquad (n_1 + 4n_2) \times 4n$$

where, for interpolation,

$$C_I = I_{n_1} \otimes e_I'$$

where,

$$e_I' = (1, 0, 0, 0),$$

and, for distribution,

$$C_D = I_{n_1} \otimes e_D'$$

where,

$$e_D' = (\tfrac{1}{4}, \tfrac{1}{4}, \tfrac{1}{4}, \tfrac{1}{4}).$$

It is clear then that Cy results in a vector of length $n_1 + 4n_2$ containing n_1 quarterly averages of the n_1 annual values of y, and $4n_2$ actual quarterly values of y.

Similarly, CX forms a $(n_1 + 4n_2) \times k$ matrix, with n_1 quarterly averages and $4n_2$ actual quarterly values, and Cu forms a $n_1 + 4n_2$ vector of random disturbances.

If n_1 is zero, the method is useless, since no problem of unknown quarterly data exists. If n_2 is zero, the aggregation matrix dissolves into C_I or C_D.

It is possible to define

$$\begin{aligned} y. &= Cy \\ X. &= CX \\ u. &= Cu, \quad \text{so that,} \\ y &= X\beta + u \\ Cy &= CX\beta + Cu \\ y. &= X.\beta + u. \end{aligned}$$

so that the aggregated forms are denoted by a dot.

The data should then satisfy the regression model,

$$y. = X.\beta + u. \; .$$

Similarly, it is possible to define

$$E(u\,u') = V$$

so,

$$\begin{aligned} E(u.\,u.') &= E[Cu(Cu)'] \\ &= C\,E(u\,u')C' \\ &= C\,VC' \; . \end{aligned}$$

The problem is to estimate a vector $\hat{y}$, which will be the BLUE of $\hat{y}$. This $\hat{y}$ will satisfy

$$\hat{y} = A\,y.$$

where A is a disaggregation matrix $4n\ x(n_1 + 4n_2)$.

Now,

$$\hat{y} = A(X.\beta + u.)$$

and,

$$\begin{aligned} E(\hat{y}-y) &= E[A(X.\beta + u.) - (X\beta + u)] \\ &= (AX. - X)\beta. \end{aligned}$$

Since $E(\hat{y}-y)$ must equal zero,

$$AX. - X = 0,$$

so that,

$$\begin{aligned} \hat{y}-y &= A(X.\beta + u.) - (X\beta + u) \\ &= (AX. - X)\beta + Au. - u \\ &= Au. - u \; . \end{aligned}$$

The covariance matrix of $(\hat{y}-y)$ is then

$$cov(\hat{y}-y) = E[(Au. - u)(Au. - u)'] \; .$$

Since,

$$E(u.\,u') = CV,$$

and

$$E(u\,u.') = VC',$$

then,

$$cov(\hat{y}-y) = ACVC'A - ACV - VC'A' + V \; .$$

The BLUE of y, $\hat{y}$, can be determined by minimizing the trace of

$cov(\hat{y}-y)$, with respect to A, subject to the 4n x k constraints $AX. - X = 0$.

The Lagrangian for this problem, using a 4n x k matrix Λ of Lagrangian multipliers, is,

$$L(A, \Lambda) = \tfrac{1}{2}\, tr[ACVC'A' - ACV - CV'A' + V] - tr\,[\Lambda' (AX. - X)].$$

Differentiating, and setting the partials equal to zero, gives,

$$\frac{\partial L}{\partial A} = ACVC' - VC' - \Lambda X.' = 0 \quad ..... \quad 4.1$$

$$\frac{\partial L}{\partial \Lambda} = AX. - X = 0 \quad ..... \quad 4.2$$

Solving for A in 4.1 gives,

$$A = \Lambda\, X.' (CVC')^{-1} + VC'(CVC')^{-1}$$

which when substituted in 4.2 gives,

$$\Lambda = X(X.'(CVC')^{-1} X.)^{-1} - VC'(CVC')^{-1} X.(X.' (CVC')^{-1} X.)^{-1}$$

So the solution for A is,

$$A = X(X.' (CVC')^{-1} X.)^{-1} X.' (CVC')^{-1}$$
$$- (VC'(CVC')^{-1} X.)(X.'(CVC')^{-1} X.)^{-1} X.' (CVC')^{-1}$$
$$+ VC' (CVC')^{-1}$$
$$= X(X.'(CVC')^{-1} X.)^{-1} X.' (CVC')^{-1}$$
$$+ VC'(CVC')^{-1} [I - X.(X.(CVC')^{-1} X.)^{-1} X.'(CVC')^{-1}]$$

and the BLUE of y is,

$$\hat{y} = Ay.$$
$$= X(X.'(CVC')^{-1} X.)^{-1} X.'(CVC')^{-1} y.$$
$$+ VC'(CVC')^{-1} [I - X.(X.(CVC')^{-1} X.)^{-1} X.'(CVC')^{-1}]y.$$

If we let

$$\Omega = (CVC')^{-1}$$

then $\hat{\beta}$ is easily seen to be a GLS estimator,

$$\hat{\beta} = (X.' \,\Omega\, X.)^{-1} X.' \,\Omega\, y. \;.$$

So

$$\hat{y} = X\hat{\beta} + VC' \,\Omega\, [y. - X.\hat{\beta}]$$

$$= X\hat{\beta} + VC'\Omega\hat{u}. \;.$$

The method ensures that, for interpolation, the first quarter estimated value must equal the annual observed value, since all of the estimated residual is allocated to the first quarter value. Similarly, for distribution, the allocation, $VC'\Omega$, of the residual accomplishes the same effect, that the sum of the four quarterly values must equal the annual total. This is easily shown,

$$\hat{y} = X\hat{\beta} + VC' \,\Omega\, \hat{u}.$$

$$C\hat{y} = CX\hat{\beta} + CVC' \,\Omega\, \hat{u}.$$

$$= X.\hat{\beta} + \hat{u}.$$

$$= y. \;.$$

So by calculating the coefficients, $\hat{\beta}$, the residuals, $\hat{u}.$, and the allocator, $VC'\Omega$, the vector of unknown quarterly values can be found. Of course, the second partition set of known quarterly values is unchanged by the application of the method.

Chow and Lin (1971) suggest a modification to the assumption of spherical disturbances for V to allow for autoregressive disturbances. That is, the quarterly residuals might follow the first order autoregression

$$u_t = \rho\, u_{t-1} + \varepsilon_t.$$

As they point out, the structure of V is well known to be,

$$V = E(u\, u')$$

$$= \frac{\sigma_E{}^2}{1 - \rho^2} \begin{pmatrix} 1 & \rho & \rho^2 & \cdots & \rho^{4n-1} \\ \rho & 1 & \rho & \cdots & \rho^{4n-2} \\ \rho^2 & \rho & 1 & \cdots & \rho^{4n-3} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \rho^{4n-1} & \rho^{4n-2} & \rho^{4n-3} & & 1 \end{pmatrix}$$

and, since CVC' is known (E(u.u'.)) ρ can be determined as the ratio of the second to the first elements of the first row of CVC'. While this may work for the case of quarterly to monthly estimation, the procedure suggested by Chow and Lin breaks down for the annual to quarterly estimation. There is no guarantee that the ratio will be modulus less than one, and the polynomial for the case of distribution,

$$\rho^7 + 2\rho^6 + 3\rho^5 + 4\rho^4 + \left(3 - 2\frac{\hat{u}_{.2}}{\hat{u}_{.1}}\right)\rho^3 + \left(2 - 4\frac{\hat{u}_{.2}}{\hat{u}_{.1}}\right)\rho^2 + \left(1 - 6\frac{\hat{u}_{.2}}{\hat{u}_{.1}}\right)\rho - 4\frac{\hat{u}_{.2}}{\hat{u}_{.1}} = 0$$

has no real root between -1 and 0, regardless of the value of the ratio, and a real root between 0 and +1 only if the ratio falls between 0 and +1. In any case, the sign pattern for the correlation of residuals, in the most favourable arrangement for a possible negative ρ, is,

+	+
+	+
+	+
-	+
-	-
-	-
-	-
+	-
+	+
+	+
+	+
-	+
-	-
.	.
.	.
.	.

giving 3n same-signs to n-1 different-signs, and making a negative ρ unlikely.

The method of determining ρ suggested by Chow and Lin (1971) should then be abandoned and may be replaced by a Cochrane-Orcutt type search procedure. This is done by determining the first order autocorrelation coefficient between $\hat{u}_t$ (i.e., $(VC' \Omega \hat{u}.)_t$) and $\hat{u}_{t-1}$, after having initially assumed

$$E(u\,u') = \sigma^2 I.$$

This estimate of ρ is then inserted in the autoregressive specification of E(u u'), the estimation is re-run, and another estimate of ρ is determined. The procedure is run until the estimate of ρ converges to an acceptable stability (viz, $| \hat{\rho}^r - \hat{\rho}^{r-1} | \leq 0.001$).

The method has been coded into a FORTRAN program, QUARTO, on the University Dec System 1091. The test run described below for $n_1 = 10$ and $n_2 = 0$, took fourteen iterations and seventeen seconds of c.p.u. time.

4.2.3 Comparison With Other Methods

Ginsburgh (1973) tabulated data for the problem of generating quarterly GNP for the USA from an index of industrial production for the period 1955-64, and he compared his method with the methods of Lisman and Sandee (1964), Boot, Feibes and Lisman (1967), and Vangrevelinghe (1966) using Theil's inequality coefficient U,[4]

$$U = \frac{\sqrt{\sum_{i=2}^{4n} (\Delta\hat{y}_i - \Delta y_i)^2}}{\sqrt{\sum_{i=2}^{4n} (\Delta\hat{y}_i)^2} + \sqrt{\sum_{i=2}^{4n} (\Delta y_i)^2}}$$

"It is easy to see that $0 \leq U \leq 1$, small U's being indications of good predictions".[5]

Gilbert (1977) also uses this example to compare his methods with Ginsburgh (1973), and it is therefore appropriate to present all the results and compare them with those obtained from the method of this study. This is done in Table 4.1. The results which are truly comparable are those of Ginsburgh, Gilbert I, Spahn, Crossman I and Crossman II. There is not much difference in the U statistic between the first four of these. Gilbert's IV and V have the lowest U's, but his expansion of the sample period by eight years (without tabulating

[4]Theil (1958, p. 32).

[5]Ginsburgh (1973, p. 372).

Table 4.1: Comparison of interpolated data statistics

Author	Model	Period	Theil's U	MAPE[a]	Source	Notes
Lisman and Sandee	-	1955-64	0.42	-	Ginsburgh (1973)	Loses eight data values. Purely numerical interpolation.
Boot *et al.*	-	1955-64	0.36	-	Ginsburgh (1973)	Purely numerical interpolation.
Vangrevelinghe	-	1955-64	0.34	-	Ginsburgh (1973)	Loses eight data values.
Ginsburgh	-	1955-64	0.36	-	Ginsburgh (1973)	
Gilbert	I	1955-64	0.34	-	Gilbert (1977)	Similar to Chow and Lin (1971).
	II	1955-72	0.31	-	Gilbert (1977)	Same as I; but n_1 = 10 and n_2 = 8.
	III	1955-72	0.31	-	Gilbert (1977)	TSLS
	IV	1955-72	0.13	-	Gilbert (1977)	With lagged dependent variable.
	V	1955-72	0.14	-	Gilbert (1977)	As IV with autoregressive disturbances.
Spahn	-	1955-64	0.33	0.65		Purely numerical interpolation.
Crossman	I	1955-64	0.33	0.73		Similar to Chow and Lin (1971) and Gilbert I.
	II	1955-64	0.18	0.30		Uses autoregressive correction.
	III	1955-64	0.27	0.41		Mixed; n_1 = 5 and n_2 = 5.
	IV	1955-64	0.11	0.10		As III, with autoregression correction.

[a] Mean Absolute Percent Error

the additional data) makes comparison with other models inappropriate. It is clear, however, that Crossman II outperforms the other 1955-64 sample period estimations. For this reason the method outlined above will be used in this study, since Gilbert IV and V are in any case only suitable for a lagged dependent variable specification.

Table 4.2 lists the actual GNP, Ginsburgh's estimates and the Crossman II estimates.

4.2.4 Use in the Queensland Model

It must be emphasized that the value of this method of constructing quarterly estimates depends upon the choice of the related series. The related series may be other economic variables, dummy variables or lagged or leading variables. The choice must be *ad hoc*, and is constrained by which related data are held to be appropriate and which data are available.

In this study, the usual method of selection of related series for the estimation of a quarterly series for Queensland, was to choose two series; a national quarterly counterpart, and a related Queensland quarterly series. For example, private final consumption expenditure on food in Queensland was estimated using national quarterly figures for private final consumption expenditure on food, and quarterly figures for the value of retail sales of food in Queensland.

A listing of the quarterly data constructed for this study and the associated related series used are given in Appendix C.

4.3 GENERAL SOURCES OF DATA

Almost all of the data required for this study came from official sources, viz, the Australian Bureau of Statistics. The main exceptions are the gross state product estimates of Chapter 3 above, although they were heavily based on official sources.

The major publications of the ABS which were useful can be listed. This is done in Table 4.3.

Table 4.2: US quarterly GNP and its estimates

Year	Quarter	Actual GNP ($m)	Ginsburgh's estimates ($m)	Crossman II estimates ($m)
1955	1	428.0	419.0	426.6
	2	435.4	435.9	436.4
	3	442.1	445.5	442.3
	4	446.4	451.6	446.5
1956	1	443.6	446.1	444.4
	2	445.6	446.2	445.5
	3	444.5	439.7	442.9
	4	450.3	452.0	451.2
1957	1	453.4	452.9	453.0
	2	453.2	452.8	453.3
	3	455.2	458.1	455.9
	4	448.2	446.2	447.8
1958	1	437.5	429.1	435.8
	2	439.5	433.2	437.7
	3	450.7	458.1	453.3
	4	461.6	468.9	462.6
1959	1	468.6	474.6	470.6
	2	479.9	491.5	484.1
	3	475.0	469.9	474.3
	4	480.4	467.9	474.9
1960	1	490.2	496.3	492.0
	2	489.8	491.6	489.8
	3	487.4	488.2	488.3
	4	483.8	475.1	481.1
1961	1	482.7	469.6	478.2
	2	492.9	492.9	493.0
	3	501.6	508.0	504.1
	4	511.9	518.6	513.9
1962	1	519.7	523.6	521.5
	2	527.9	530.1	529.0
	3	533.6	533.4	533.8
	4	538.5	532.6	535.4
1963	1	541.2	537.2	539.1
	2	544.9	551.2	549.0
	3	553.7	555.0	553.8
	4	560.0	556.4	557.9
1964	1	567.1	563.3	566.0
	2	575.9	574.7	575.5
	3	582.6	583.5	582.5
	4	584.7	588.8	586.3

Source: Ginsburgh (1973, p. 374).

Table 4.3: ABS publications used as data sources

Office	Catalogue No.	Title
Central	1301.0	Year Book Australia
	1311.0	Time Series Data on Magnetic Tape and Microfiche
	5202.0	Australian National Accounts (Preliminary Statement No. 2) - Household Income by States
	5203.0	Australian National Accounts (Preliminary Statement No. 3) - Gross Domestic Product at Factor Cost by Industry
	5204.0	Australian National Accounts - National Income and Expenditure
	5206.0	Quarterly Estimates of National Income and Expenditure, Australia
	5207.0	Historical Series of Quarterly Estimates of National Income and Expenditure, Australia
	5504.0	State and Local Government Finance, Australia
	5506.0	Taxation Revenue, Australia
	6204.0	The Labour Force, Australia
	6302.0	Average Weekly Earnings, Australia
	6401.0	Consumer Price Index
Queensland	1301.3	Queensland Year Book
	1304.3	Monthly Summary of Statistics, Queensland
	3101.3	Demography - Queensland
	5402.3	Overseas and Interstate Trade - Queensland
	5503.3	Public Finance: Government Authorities - Queensland
	6201.3	The Labour Force - Queensland

Source: ABS, Catalogue No. 1101.0

The ABS Time Series Data file available on magnetic tape and microfiche was of some assistance since the data were in machine-readable form and were presented as a consistent historical series. The Time Series Data file contains over 1300 different time series for either monthly or quarterly frequencies and contains data on:

Agricultural production
Building
New fixed capital expenditure by private enterprises
Demography
Manpower
Other finance
Housing finance to individuals
Stocks owned by private enterprises
Manufacturing and mining production
National accounts
Prices
Transport
Retail sales
Overseas transactions
Other internal trade
Wages and salaries.

Unfortunately, the great majority of the data series available on this file is for Australia, and not for the states. Indeed, only about 50 of the 1300 series pertained to Queensland.

Most of the individual publications necessary for this study were obtained from the data library collection of the Department of Economics. The ABS have been most cooperative in supplying publications for this collection.

4.4 COMPUTERIZED DATA MANAGEMENT

Since most of the work in specifying and estimating an econometric model is done using a computer, it is possible and appropriate to use computer software to store and organize the data library constructed for modelling purposes.

It is likely that most data libraries of economic statistics will be held, at some time in the near future, in some form of computer memory such as magnetic disks or tapes. To a small experimental extent, this is already happening in the Time Series Data file supplied by the ABS. At James Cook University, usage of this file is still in its preliminary stages, but currently it can be used. The method is to transfer the contents of the magnetic tape supplied by the ABS to ASCII files on disk memory. These ASCII files are then converted to binary data bases suitable for input to a Software House proprietary Data Base Management System called System-1022. The data are then accessed by running the System-1022 software, or by executing particular FORTRAN programs which interact with System-1022 and which have been written to save casual users from having to learn System-1022.

Unfortunately, most of the variables needed for this study, particularly the Queensland variables, are not available on the current version of the Time Series Data file. This means that the input of most of the data required for the development of the Queensland econometric model had to be performed by the laborious procedure of punching and verifying.

Ideally, data banks of variables should interact with both estimation and simulation programs. No estimation or simulation software held at James Cook University could interact with System-1022. However, the software library at James Cook University Computer Centre does include PLANETS (Programming Language for the Analysis of Economic Time Series). This package was developed at the Brookings Institution (Social Science Computation Center) for the Brookings model. (The style of presentation of results in Schink (1975) is one of the PLANETS regression output styles.) Bracy (1973, p. 6) describes PLANETS as:

... a program designed for analyzing and managing data without the need of computer programming languages. It is primarily designed for time series data but can be used for small sets of cross sectional data (typically less than 1000 observations on any one variable).

The present system, Version 13, includes the following basic capabilities:

(1) Data Management

PLANETS can build and manipulate large databanks containing both variables and documentation for these variables. All of the normal file maintenance capabilities are available, such as:

(a) Insertion and deletion of variables
(b) Replacement of data values and documentation
(c) Updating of variables
(d) Transfer of variables from one databank to another
(e) Production of indices and complete printout of databank contents.

(2) Variable Transformation

New variables may be created from existing variables by specifying the appropriate formulas. Most commonly used algebraic and trigonometric functions are available.

(3) Data Analysis

Ordinary least squares and two-stage least squares multiple linear regressions may be performed, with options for specifying sample periods, lags, and observation weights. First and second order autoregressive corrections and almon lags may also be specified. Regression results may be saved in permanent form, and used to re-estimate an equation with modified specifications. In addition, elementary statistics such as means, standard deviations, correlation coefficients, and covariances may be displayed.

(4) Data Input

Data may be entered into PLANETS for analysis in the current run or saved for more permanent storage in a databank. The data may be entered from teletype or from existing files created from cards or tape. These data may be in a wide range of alternate forms.

(5) Output

Data and the results of analysis can be output in a number of different forms to the teletype, line printer, or disk.

PLANETS was designed to permit the researcher to operate in an interactive mode by entering commands from a terminal, and determining successive courses of action based on the program's response. PLANETS can, however, be used in batch mode if the researcher is certain of the exact sequence of commands to be executed.

The databank facility of PLANETS was of considerable value in the development of this model, since data series could be stored consistently together, with documentation, on the computer, and transformed as required with flexibility and ease. Estimation, but not simulation, can be performed interactively using PLANETS regression software and databanks.

An index of the databank constructed for the final version of the Queensland econometric model is given in Appendix to Chapter Five.

CHAPTER 5

THE SPECIFICATION AND ESTIMATION OF THE QUEENSLAND ECONOMETRIC MODEL

5.1 TOWARDS THE QUEENSLAND MODEL

At the close of Chapter Two above it was suggested that a Klein-type regional econometric model could be specified and estimated for the State of Queensland. It was noted that, primarily due to lack of certain necessary data, it has not yet been possible to develop regional econometric models which approximate the original macro-econometric specification of Klein (1969).

While certain data are still missing however, it is argued here that a model can be specified for Queensland (and possibly Western Australia and Tasmania) which is a reasonable approximation of that of Klein (1969).

The model of Klein (1969), which was described in Figure 2 above, can be dissected to examine the data availability constraints. The model relies on the Keynesian income determination structure. This is shown by equation (6) of Klein (1969):[1]

$$p_c c_i + pI_i + G_i^{SL} + G_i^F + p_i^e E_i - p_i^m Im_i = p_i X_i$$

X_i, gross regional (or state) product, is estimated for Queensland in Chapter Three above. p_i, a regional GDP deflator, can be calculated

[1]The regional subscript, i, is retained, even though only one region (Queensland) is relevant in this study, since Klein's notation requires the subscript to distinguish between a regional variable (with subscript i) and the corresponding national variable (without subscript i). Also, the original article contains a number of inconsistencies, which can only be printing errors. q in equations (6) and (12) are taken to be p, the GNP deflator, while q_i^m in equations (14) and (15) are taken to be p_i^m, the import price index.

from the national implicit GDP deflator. p_c, the consumer price index, is known for Queensland from the ABS. (Klein's specification of p_c rather than p_{c_i} is inexplicable.) c_i, private final consumption expenditure, is known for Queensland from the ABS. p, the GDP deflator is known, but, I_i, regional capital formation is not known, and, as was suggested above, cannot be estimated in this study. G^{SL}, state and local government expenditure, is known from the ABS, but G_i^F, federal government expenditures in the region, is not known. p_i^e, the export price index, is known only nationally. E_i, exports, are known from the ABS. p_i^m, the import price index, is known only nationally. Im_i, imports, are known from the ABS.

The missing data in this cornerstone equation of Klein's specification, for the case of Queensland, are investment expenditures and federal government expenditures. These are not unimportant, and, as work proceeds on developing the Queensland model, efforts will be made to estimate these variables. However, the lack of these data, at this stage, is not crippling, since they can be both treated as an exogenous factor.

The equation (6) above can be re-written for the Queensland model as,

$$GSP\$ = C\$ + SLG\$ + X\$ - M\$ + A\$$$

where the $ indicates average 1974-75 prices, and,

GSP$ = gross state product,

C$ = private final consumption expenditure,

SLG$ = state and local government expenditures, comprising final consumption expenditure and expenditure on new fixed assets,

X$ = exports,

M$ = imports, and,

A$ = residual exogenous variable comprising federal government expenditures, private gross fixed capital expenditure and increase in stocks.

Since GSP is estimated above and a suitable deflator can be found, and since all RHS variables except A$ can also be found, A$ can be calculated as a residual.

While again emphasizing that it is not held that this treatment of the variables comprising A$ is perfectly satisfactory, it is a reasonable temporary solution to a vexing data constraint which may be resolved in the future. Certainly there are precedents for such variables. In Klein's Model I,[2] " ... net exports of goods and services are combined with government expenditure to form an exogenous variable".[3] The Morishima-Saito model of the US economy specified investment (both private and government) and overseas trade as exogenous.[4]

This equation above will form the cornerstone of this model. This equation can be matched by an equation determining gross state product at current prices. The differences, or mismatch, is then absorbed by price level changes, giving an equation which can determine the gross state product deflator. This is different from Klein (1969), where the "regional price level" is determined by other price levels and wage rates.

The Queensland model is disaggregated in industry structure and has a more complex set of equations concerning state and local government. Also, exports are exogenous in the Queensland model, since the market for Queensland exports is mainly overseas, and is mainly for non-manufacturing products. In such a case, the familiar Klein (1969) relationship of regional exports to gross domestic product of the nation is inappropriate.

The industry classification used for the model contains eleven industries. Finance and community services, which were treated separately in Chapter Three above, have been aggregated for modelling purposes, since it was found that the disaggregation contributed little in explanatory power in the estimation of industry variables, compared to the aggregated industry, Services. Table 5.1 lists the industries used in the Queensland model.

---

[2]Klein (1950).

[3]Rhomberg and Boissonneault (1965, p. 375).

[4]See Intriligator (1978, pp. 436-440).

Table 5.1: Industry classification of the Queensland model

Model industry (abbreviation)	ASIC division	GSP industry
AGRICULTURE (AGR)	A	AGRICULTURE (FARM and NONFARM)
MINING (MIN)	B	MINING
MANUFACTURING (MAN)	C	MANUFACTURING
ELECTRICITY (ELE)	D	ELECTRICITY
CONSTRUCTION (CON)	E	CONSTRUCTION
TRADE (TRD)	F	TRADE
TRANSPORT (TRN)	G, H	TRANSPORT
PUBLIC ADMINISTRATION AND DEFENCE (PAD)	J	P.A.D.
SERVICES (SER)	I, K, L	FINANCE and COMMUNITY
OWNERSHIP OF DWELLINGS (ODW)	n.a.	OWNERSHIP OF DWELLINGS
IMPUTED BANK SERVICE CHARGE (IBSC)	n.a.	NOMINAL INDUSTRY

5.2 THE OVERALL STRUCTURE OF THE QUEENSLAND MODEL

The Queensland model can be divided into thirteen blocks of equations. These blocks, and their component equations, are listed in Table 5.2. This table shows that there are 110 equations in all, with sixty-one stochastic equations and forty-nine identities. There are twenty-seven national and regional exogenous variables. The number of identities is inflated by including logarithms and changes of variables, as well as the actual level variables. That is, if the logarithm of a variable is explained by a stochastic equation then there will be a corresponding identity to transform the logarithm to the level. Since the two equations may be combined in a solution statement, the identity may be regarded as superfluous. If these identities were disregarded, the overall number of equations would be eighty-two, with only twenty-one identities. However, it is convenient to include the identities in a listing, since it allows the stochastic equations to be written in the form in which they were estimated.

All variables and equations are quarterly, and no seasonal adjustment was made to the data. Instead, quarterly dummy variables for the second, third and fourth quarters were included in all stochastic equations. In some cases, multiplication dummies were used, rather than additive. The reasons for using quarterly dummies and seasonally unadjusted data rather than seasonally adjusted data are:

(i) seasonal adjustment of data implicitly involves loss of degrees of freedom, while use of dummies to explain seasonal variation makes this loss explicit; and,

(ii) as Norton and Broadbent (1970, p. 7) put it, the use of dummy variables " ... permits seasonal, as well as other, movements in the dependent variable to be explained by economic variables. The seasonal dummy variables may explain any remaining seasonal variation in the dependent variable".

The Appendix to Chapter Five gives an alphabetical listing of all the variables in the Queensland model, and their documentation and sources. This includes the method of construction of many of the

Table 5.2: Equation blocks of the Queensland model

Block number	Block	Number of equations: Stochastic	Identities	Total	Equation numbers
1	CONSUMPTION	4	1	5	# 1- 5
2	STATE AND LOCAL GOVERNMENT	16	2	18	# 6- 23
3	EXTERNAL TRADE	1	1	2	# 24- 25
4	GSP$ (AVERAGE PRICES)	0	2	2	# 26- 27
5	GSP BY INDUSTRY	7	7	14	# 28- 41
6	GSP (CURRENT PRICES)	1	4	5	# 42- 46
7	PRICES	4	2	6	# 47- 52
8	EMPLOYMENT BY INDUSTRY	7	8	15	# 53- 67
9	LABOUR FORCE AND DEMOGRAPHY	3	4	7	# 68- 74
10	AVERAGE WAGES AND EARNINGS	1	1	2	# 75- 76
11	WAGE RATES BY INDUSTRY	7	7	14	# 77- 90
12	WSS BY INDUSTRY	7	7	14	# 91-104
13	INCOME	3	3	6	#105-110
		61	49	110	

variables of the Queensland model, since some variables were only available as annual estimates, rather than quarterly. Where this was the case, the method of interpolation and distribution discussed in Chapter Four above was used. Appendix C lists the variables constructed using this method, and the details of each particular construction.

Several notational features of the meaning of variables can be noted. Firstly, a dollar sign, at the end or towards the end of a variable name indicates that the variable is measured at average 1974-75 prices. This is different from many USA model notations, where the dollar sign indicates current price measurement. However, since the use of the dollar sign in the ABS Time Series Data file is for average prices, that usage is adopted in this study to be consistent with official Australian convention. Secondly, the letter P at the end of the variable name indicates that the variable is measured per capita, i.e., per head of population. Thirdly, the letters PD at the beginning of a variable name indicate percentage difference or change e.g.,

$$PDGSP_t = \frac{GSP_t - GSP_{t-1}}{GSP_{t-1}} \cdot 100.$$

Fourthly, the letter D followed by an integer, n, at the beginning of a variable name indicates an nth order difference, e.g.,

$$D4CPI_t = CPI_t - CPI_{t-4} .$$

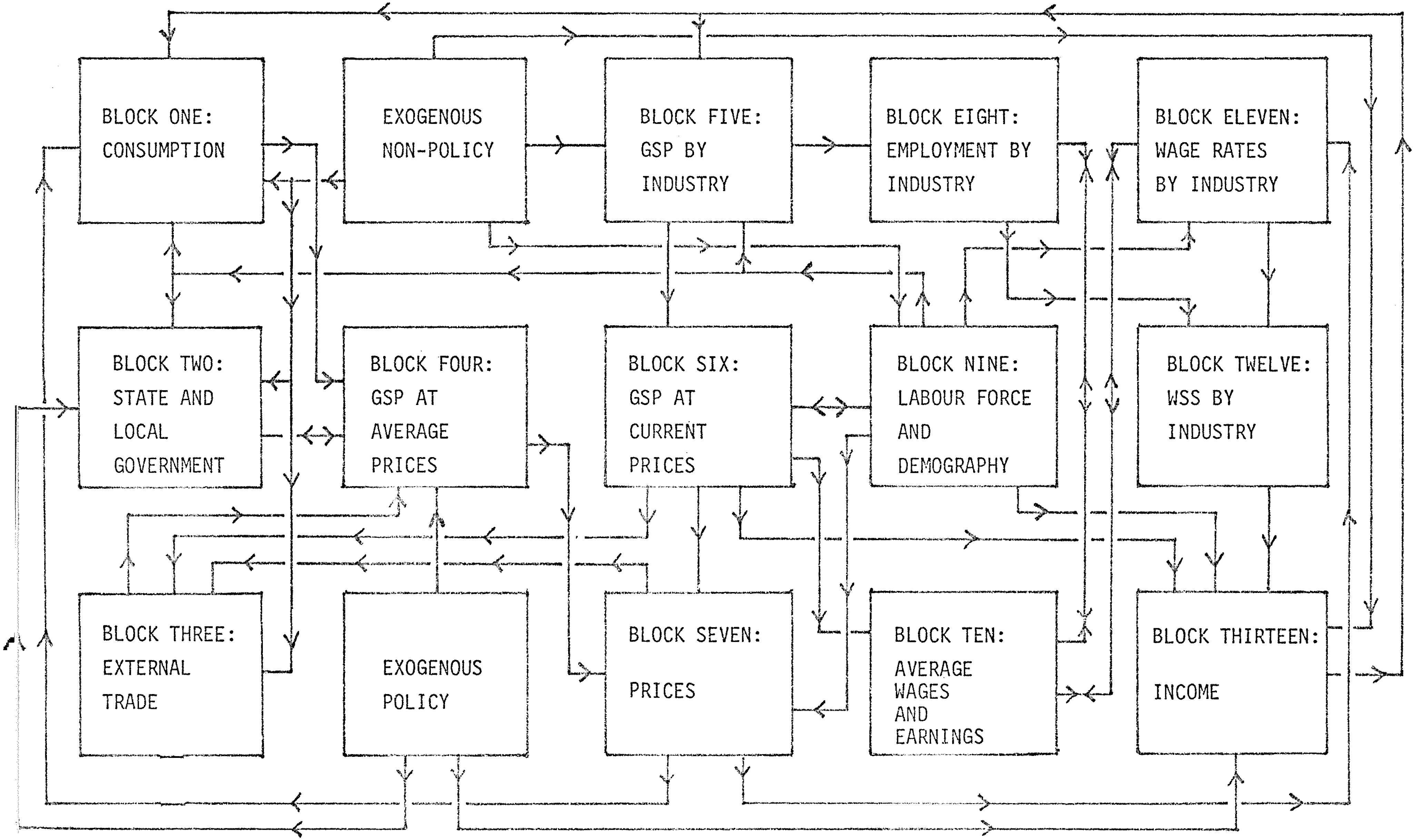
Fifthly, the letters LN preceding a variable name, indicate the taking of natural logarithms.

Variable names were chosen to be as mnemonic as possible.

Figure 5.1 describes the causal flows of the Queensland model. The model has a high degree of simultaneity. No blocks of equations are isolated, i.e., have only incoming causal flows, as were a number of blocks in Glickman (1977). It was not necessary to sort the blocks into a recursive system for model solution, since no difficulties occurred in solving the model.

The model was estimated with both Ordinary Least Squares (OLS)

Figure 5.1: Causal flows of the Queensland model



and Two Stage Least Squares with principal components (TSPC). The equations discussed in this chapter are OLS estimates. The period of estimation is 197003 (i.e., September quarter, 1970) to 197802 (i.e., June quarter, 1978). The range over which GSP was estimated in Chapter Three above is 196903 to 197902. Estimation could not use all of these forty quarters, since four quarters were needed initially for lags, and it was decided to use the four quarters of 1978-79 for an ex post forecast experiment.

5.3 THE DETAILED STRUCTURE OF THE QUEENSLAND MODEL

This discussion will concentrate on each of the thirteen blocks in turn.

5.3.1 Block One: Consumption

Figure 5.2 contains the four estimated equations of this block. Private final consumption expenditure (PFCE), disaggregated by expenditure item, for Queensland, is published in NIE annually. The twelve expenditure item categories listed in NIE were aggregated to four item categories: food (FD), household durables (HD), dwelling rent (RT) and all others (AO).

Equation 5 is an identity, which aggregates the four consumption expenditure item categories and converts to level, rather than per capita, terms,

5) $$PFCE\$ = (PFCEFD\$P + PFCEHD\$P + PFCERT\$P + PFCEAO\$P)\,\frac{POP}{1000}\ .$$

The specification of the equations determining per capita private final consumption expenditure at average 1974-75 prices is that of the familiar partial adjustment hypothesis, i.e.,

$$C_t^* = \alpha + \beta\, y_t, \text{ and,}$$

$$C_t - C_{t-1} = \gamma\,[C_t^* - C_{t-1}], \text{ where,}$$

Figure 5.2: Block One (Consumption) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:17  26-May-81   PAGE 1
                                                                                     R-SQUARED      SEE      DW      RHO1
                                                                                    (CORRECTED)

0001) PFCEFD$P  =  -6.7943  +  10.459 Q02  +  7.4030 Q03  +  13.381 Q04  +  0.74563E-02 HDY$P   0.988   2.17149   2.137  -0.407
                  (-1.1353)   (7.2362)       (5.8198)       (7.3325)       (1.3842)

                  +  0.94635 PFCEFD$P(-1)
                    (13.106)

0002) PFCEHD$P  =  -22.834  +  17.901 Q02  +  13.568 Q03  +  21.332 Q04  +  0.31896E-01 HDY$P   0.981   2.13613   1.927  -0.308
                  (-7.2762)   (12.842)       (7.6539)       (8.5738)       (3.3348)

                  +  0.77101 PFCEHD$P(-1)
                    (12.013)

0003) PFCERT$P  =  59.610  +  0.10017 Q02  -  0.32866 Q03  -  0.24175 Q04  +  0.88053 TIME      0.999   0.57451   1.451   0.804
                  (75.126)   (0.54505)      (-1.5366)      (-1.3137)       (25.279)

0004) PFCEAO$P  =  30.197  +  58.091 Q02  +  33.170 Q03  +  54.950 Q04  +  0.78724E-01 HDY$P    0.949   5.92473   1.830
                  (1.0777)   (10.745)      (5.1337)       (5.6632)       (2.1061)

                  +  0.65299 PFCEAO$P(-1)
                    (4.9069)

0005) PFCE$   = ( PFCEFD$P + PFCEHD$P + PFCERT$P + PFCEAO$P ) * POP / 1000.
```

C^*_t = target level of real per capita consumption expenditure in period t,

C_t = actual real per capita consumption expenditure,

y_t = per capita real household disposable income, and,

α, β, γ = parameters.

By substituting for C_t in the second equation above, the consumption function is obtained,

$$C_t = \gamma\alpha + \gamma\beta\, y_t + (1 - \gamma)\, C_{t-1} .$$

Reasonable results were obtained using this specification for all expenditure item categories except dwelling rent. The low t value for the disposable household income variable in the food equation indicates the non-discretionary nature of food expenditures. The dwelling rent expenditures proved to be a time trend.

Examination of Durbin's h statistic for the food and household durables equations, and the Durbin-Watson statistic (DW) for dwelling rent, showed that autocorrelation was present. The Cochrane-Orcutt first-order autoregressive correction was applied to the equation in each case. The values of rho used are shown with each equation.

This technique for correcting for autocorrelation, when revealed by Durbin's h or the DW statistic, was usually followed throughout the following equation blocks, except when application of the technique resulted in poor statistical fit or wrong signs. The numbers in parentheses are t values.

5.3.2 Block Two: State and Local Government

The treatment of state and local government revenues and expenditures in the Queensland model is unusual compared with other regional econometric models. The specification is based on the analysis of Spahn (1976), which originated in Gramlich and Galper (1973). The main features of this specification are listed below.

(i) Revenues and expenditures of state and local government are assumed to be endogenous. That is, state and local governments are assumed to have very little discretion in determining the levels of expenditure they must make, and very little flexibility in raising revenue. This seems to be a reasonable approximation to the current case in Australia. Most state taxes are not growth taxes. It can be argued that the main exogenous influences on state and local government expenditures and revenues are the income-tax revenue sharing grants from the federal government. As well, state governments in particular have the ability to obtain additional revenue from natural resource activity, e.g., mineral royalties, railway freight and resources rent taxes.

(ii) State and local governments are subject to a budget constraint which is more important than that facing a federal government with access to monetary policy instruments. State and local governments cannot borrow beyond certain limits, generally imposed by federally coordinated national economic management objectives, and approved by the Loan Council.

(iii) The behaviour of state and local government decision makers is rational and seeks to maximize some utility function. They would prefer to maximize both current and capital real per capita expenditures, and minimize both real per capita taxation and financial burden.

The analysis in this section is taken from Spahn (1976). There are certain differences between this analysis and that of Spahn (1976) and, indeed, between Spahn (1976) and the original US study, Gramlich and Galper (1973). The main objectives of state and local governments which are specified in a utility function are, according to Spahn (1976, p. 5):

> (i) to increase real current expenditures as a proxy for higher standards in the provision of public services;
> (ii) to increase real expenditures on fixed capital formation as a proxy for higher standards in the use of public capital and equipment;
> (iii) to increase after-tax income of citizens in the local polity as a proxy for the level of services to be consumed privately; and
> (iv) to increase the flow of services from the stock of net financial assets.

This fourth objective is modified in Spahn (1976) so that " ... the level of outstanding debt does not matter at all.

Politicians are myopic in that they are concerned only with the current deficit; State-local debt 'sticks' and no political disability is attached to it ... "[5]

The four objectives may be expressed in a utility function, which, subject to the budget constraint, may be maximized. Table 5.3 shows the national accounting description of state and local government activity. This table also shows how the variables are further aggregated to conform to the equation,

$$FCE + ENFA = TAX + RESINC + GCW + ADDEBT,$$

where,

FCE = final consumption expenditure by state and local government,

ENFA = expenditure on new fixed assets by state and local government,

TAX = taxation revenue of state and local government,

RESINC = resource income of state and local governments, defined as income from public enterprises and

GCW = grants from the federal (Commonwealth) government to state and local governments, and,

ADDEBT = additions to debt, or the balancing item, called the budget deficit in Spahn (1976).

In this study, *state and local governments* are in fact the Queensland State Government and its authorities, and the local authorities of Queensland.

Given this framework, the optimization of the utility function[6] results in the following four equations,

$$\begin{aligned} FCE &= f\,(RESINC, GCW, \hat{e}) \\ ENFA &= f\,(RESINC, GCW, \hat{e}) \\ -TAX &= f\,(RESINC, GCW, \hat{e}) \\ -ADDEBT &= f\,(RESINC, GCW, \hat{e}) \end{aligned}$$

where $\hat{e}$ represents some vector of additional exogenous variables.

---

[5] Spahn (1976, p. 10).

[6] See Spahn (1976, p. 9)and Gramlich and Galper (1973, Appendix A).

Table 5.3: National accounting framework for the state and local government sector

Queensland, state and local authorities, outlay and receipts accounts, 1978-79

Outlay	$m	Receipts	$m
Final consumption expenditure (FCE)	1571	Receipts -	
		Taxes etc. (TAX)	725
Expenditure on new fixed assets (ENFA)	1085	Income from public enterprises (IPE)	160
Other gross capital formation (OGCF)	-8	Property income -	
Transfer payments (TP)	454	Interest (PYI)	116
Net advances (NA)	13	Land rent, royalties (PYR)	67
		Grants from the Commonwealth, (GCW)	
		current -	1299
		capital -	262
		Total receipts	2629
		Financing items (FI)	486
Total outlay	3115	Total funds available	3115

Algebraically,

FCE + ENFA + OGCF + TP + NA = TAX + IPE + PYI + PYR + GCW + FI

which when ADDEBT is defined as PYI + FI - NA - TP - OGCF and

IPE + PYR is redefined as RESINC, gives

$$FCE + ENFA = TAX + ADDEBT + RESINC + GCW.$$

Source: ABS, Catalogue No. 5504.0, State and Local Government Finance, 1978-79, Table 40.

Spahn (1976) experimented with a range of additional exogenous variables, with varying success. Only one is used in this study, viz, gross state product.[7] This is appropriate, since state and local government activity can be expected to grow or decline with gross state product, and gross state product less, in turn, taxation and addition to debt, is necessary in the specification of the utility function. A major difference between Spahn (1976) and this study is the treatment of grants from the Commonwealth Government. While the distinction between grants for current and capital purposes is maintained in this study, the important distinction between general and specific purpose is not. This is reserved for future work since the effort of gathering the data for this distinction was not judged to be necessary in this preliminary version of the Queensland model.

By regressing the four endogenous variables on the same set of exogenous variables, the coefficients can be made to force the accounting identity above. That is, the sum of the coefficients of RESINC and also GCW will equal one, while the sum for each of the other exogenous variables (including intercept terms) will equal zero.

The categories FCE, ENFA and TAX can all be further disaggregated. This was done in this analysis, so that FCE has been divided into: law and order, health, education, economic services and all other. ENFA has been divided into: water, road transport, rail transport, housing, electricity and all other. TAX has been disaggregated into: local government rates, motor taxes, payroll tax and all other state and local government taxes. This means that sixteen different variables (and thus equations) were estimated in this study by regression on quarterly dummy variables, resource income, grants from the Commonwealth for both current and capital purposes, and gross state product. All variables were estimated in per capita average 1974-75 price terms. These equations are presented in Figure 5.3.

The coefficients of the resource income and grants variables measure the policy reactions of the state and local government sector of Queensland to changes in those variables. For example, a $1

---

[7] Of course, gross state product is endogenous in the Queensland model.

Figure 5.3: Block Two (State and Local Government) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:09  26-May-81    PAGE 1
                                                                                  R-SQUARED       SEE        DW       RHO1
                                                                                 (CORRECTED)

0006) FCELAW$P  =  1.7283  +  0.83403 Q02  -  0.94125 Q03  -  0.71136 Q04          0.872     0.52257    1.852
                  (0.86490)  (3.1238)       (-1.7592)       (-1.2636)

                   +  0.65819E-02 RESINC$P  +  0.41311E-01 GCWCUR$P  -  0.40468E-01 GCWCAP$P
                     (0.19300)                (4.4802)                 (-1.3882)

                   +  0.67361E-02 GSP$P
                     (3.1195)

0007) FCEHLTH$P  =  -16.326  +  3.6973 Q02  -  1.8448 Q03  -  1.1802 Q04            0.935     1.52153    1.885
                   (-2.8059)   (4.7561)       (-1.1842)      (-0.72006)

                    +  0.13428E-02 RESINC$P +  0.19475 GCWCUR$P  -  0.10850 GCWCAP$P
                      (0.13523E-01)           (7.2540)             (-1.2783)

                    +  0.24054E-01 GSP$P
                      (3.8259)

0008) FCEED$P  =  -24.343  +  4.2259 Q02  +  0.57930 Q03  +  1.1983 Q04  -  0.12389 RESINC$P   0.941   2.30334   1.956
                 (-2.7637)   (3.5910)       (0.24565)       (0.48291)      (-0.82419)

                  +  0.28007 GCWCUR$P  -  0.10016 GCWCAP$P  +  0.42960E-01 GSP$P
                    (6.8911)             (-0.77954)           (4.5136)

0009) FCEALO$P  =  -10.444  +  0.84729 Q02  -  2.6532 Q03  -  2.0324 Q04            0.831     1.39800    1.896
                  (-1.9537)   (1.1862)        (-1.8536)      (-1.3495)

                   +  0.74134E-01 RESINC$P +  0.78483E-01 GCWCUR$P  -  0.96312E-01 GCWCAP$P
                     (0.81256)               (3.1816)                 (-1.2350)

                   +  0.22010E-01 GSP$P
                     (3.8102)

0010) FCEECS$P  =  7.3344  +  0.93060 Q02  +  3.0223 Q03  +  1.9348 Q04             0.668     0.72025    1.864
                  (2.6630)   (2.5289)        (4.0984)       (2.4937)

                   -  0.95061E-01 RESINC$P  +  0.66269E-02 GCWCUR$P  -  0.16972 GCWCAP$P
                     (-2.0224)                (0.52144)                (-4.2241)

                   +  0.61998E-02 GSP$P
                     (2.0831)

0011) ENFAWAT$P  =  9.9684  +  3.8155 Q02  +  0.51726 Q03  +  2.2701 Q04            0.766     1.00003    0.637
                   (2.6067)   (7.4677)      (0.50519)       (2.1072)

                    +  0.27687E-02 RESINC$P -  0.51355E-01 GCWCUR$P  +  0.19880 GCWCAP$P
                      (0.42424E-01)           (-2.9104)                (3.5636)
```

Figure 5.3 (continued)

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:09  26-May-81    PAGE 2
                                                                                        R-SQUARED     SEE       DW      RHO1
                                                                                       (CORRECTED)

0012) ENFAROAD$P  =  24.645   +  4.7962 Q02  +  1.7330 Q03  +  4.0674 Q04               0.847     0.95386    0.852
                    (6.7566)    (9.8414)       (1.7745)       (3.9583)

                   -  0.74470E-01 RESINC$P -  0.54814E-01 GCWCUR$P
                     (-1.1963)                (-3.2568)

                   +  0.64683E-01 GCWCAP$P  -  0.12616E-02 GSP$P
                     (1.2156)                 (-0.32007)

0013) ENFARAIL$P  =  7.5778   +  4.6328 Q02  -  0.74493 Q03  +  0.75210 Q04             0.506     1.65518    0.614
                    (1.1972)    (5.4783)       (-0.43957)      (0.42180)

                   +  0.68780E-01 RESINC$P +  0.40045E-01 GCWCUR$P
                     (0.63674)                (1.3711)

                   -  0.55930E-01 GCWCAP$P  -  0.47630E-02 GSP$P
                     (-0.60575)               (-0.69640)

0014) ENFAOTH$P  =  -7.2791   +  5.7395 Q02  +  4.2355 Q03  +  5.0032 Q04  -  0.19784 RESINC$P   0.627   3.12911   1.458
                   (-0.60833)   (3.5900)       (1.3220)       (1.4842)        (-0.96880)

                  +  0.12110E-01 GCWCUR$P  +  0.13779 GCWCAP$P  +  0.25273E-01 GSP$P
                    (0.21933)                (0.78941)            (1.9546)

0015) ENFAHOUS$P  =  3.6846   +  0.65351 Q02  +  1.1074 Q03  +  1.4400 Q04              0.113     1.15822    0.798
                    (0.83191)   (1.1043)       (0.93385)      (1.1541)

                   -  0.66211E-02 RESINC$P  +  0.16395E-01 GCWCUR$P  +  0.13627 GCWCAP$P
                     (-0.87596E-01)           (0.80222)                (2.1091)

                   -  0.59674E-02 GSP$P
                     (-1.2469)

0016) ENFAELEC$P  =  0.98222  +  3.2372 Q02  +  0.91334 Q03  +  1.6447 Q04              0.838     0.90707    1.588
                    (0.28317)   (6.9852)       (0.98345)      (1.6831)

                   -  0.10957 RESINC$P  -  0.28327E-01 GCWCUR$P  -  0.67157E-01 GCWCAP$P
                     (-1.8509)            (-1.7698)                 (-1.3272)

                   +  0.16331E-01 GSP$P
                     (4.3570)
```

Figure 5.3 (continued)

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:09  26-May-81   PAGE 3
                                                                                   R-SQUARED     SEE      DW     RHO1
                                                                                  (CORRECTED)

0017) MTAXLGR$P  =  -11.514   -  5.0447 Q02  +  6.0125 Q03  +  6.5768 Q04           0.933    1.13933   1.477
                   (-2.6427)    (-8.6663)      (5.1543)       (5.3585)

                 -  0.84641E-01 RESINC$P -  0.41130E-01 GCWCUR$P  +  0.84334E-01 GCWCAP$P
                   (-1.1384)                (-2.0459)                (1.3269)

                 +  0.42636E-03 GSP$P
                   (0.90563E-01)

0018) MTAXMOT$P  =  -14.536   -  0.87072 Q02  +  0.27753 Q03  +  0.62954E-01 Q04    0.845    0.45872   1.258
                   (-8.2868)    (-3.7152)       (0.59091)       (0.12739)

                 -  0.85398E-01 RESINC$P  +  0.34210E-02 GCWCUR$P  +  0.87615E-01 GCWCAP$P
                   (-2.8526)                 (0.42265)                (3.4239)

                 +  0.55292E-02 GSP$P
                   (2.9170)

0019) MTAXPAYR$P  =  44.249  +  2.6514 Q02  -  0.36933 Q03  +  3.2205 Q04           0.878    2.02556   0.837
                    (5.7127)   (2.5620)       (-0.17809)      (1.4759)

                  +  0.22654 RESINC$P  +  0.31289E-01 GCWCUR$P  -  0.25635 GCWCAP$P
                    (1.7137)              (0.87543)                (-2.2687)

                  -  0.54295E-01 GSP$P
                    (-6.4869)

0020) MTAXALO$P  =  -13.779  -  2.2863 Q02  +  0.65855 Q03  -  0.34606 Q04          0.299    2.13365   0.532
                   (-1.6888)   (-2.0973)      (0.30146)       (-0.15056)

                 +  0.42108E-01 RESINC$P +  0.20575E-01 GCWCUR$P  +  0.19626 GCWCAP$P
                   (0.30240)                (0.54651)                (1.6490)

                 -  0.12416E-01 GSP$P
                   (-1.4083)

0021) MADDEBT$P  =  -2.2422        -  27.852 Q02  -  12.572 Q03  -  23.990 Q04      0.818    7.64760   1.257
                   (-0.76669E-01)  (-7.1281)      (-1.6056)       (-2.9119)

                 +  1.3567 RESINC$P  +  0.44815 GCWCUR$P  +  0.98675 GCWCAP$P
                   (2.7184)            (3.3210)              (2.3130)

                 -  0.70236E-01 GSP$P
                   (-2.2226)
```

Figure 5.3 (continued)

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:10  26-May-81    PAGE 4

0022) SLFCE$  = ( FCELAW$P + FCEHLTH$P + FCEED$P + FCEALO$P + FCEECS$P ) * POP / 1000.

0023) SLENFA$  = ( ENFAWAT$P + ENFAROAD$P + ENFARAIL$P + ENFAOTH$P + ENFAHOUS$P + ENFAELEC$P ) * POP / 1000.
```

increase in real per capita grants for current purposes will increase real per capita final consumption expenditure on law and order, by state and local government in Queensland, by four cents. The effect on real per capita payroll tax would be a reduction of three cents (a reduction since the left hand side is negative, and the sign of the coefficient in equation #19 is positive). This means, as Spahn (1976, p. 22) says, the coefficients " ... can be interpreted as per capita propensities to use grant funds for the increase or reduction of taxes, for the varying of expenditure categories and for the marginal increase or decrease of debt outstanding. It would be expected that general revenue funds would leak into tax reductions to some extent, since they are largely substitutes for own revenue raising of State-local authorities". This is important in appreciating the policy implications of a reduction in grants which has to be financed by either an increase in resource income or a surcharge on income tax. In either case, the additional revenue, so long as it is replacement for grants, should be directed to the grant variable, and not resource income, which has different effects on expenditure and taxation. The main policy use of the resource income variable is in assessing the fiscal impact of resource developments in the states, although it must be noted that the overall level of *resource* income is currently low, with most of resource income being the income of public enterprises of state government.

Table 5.4 summarizes the policy response effects coefficients displayed in Figure 5.3, which contains a listing of the sixteen estimated equations and two identities of this block. The high coefficient for resource income in the addition to debt equation indicates a higher than unity propensity to reduce debt for a unit change in resource income. This result arises because of the nature of resource income, which is not large and which mainly comprises income of public enterprises. This income, according to this analysis, is strongly directed to reducing debt, slightly directed to reducing taxes, and is associated with a propensity to reduce expenditures. Also, grants for capital purposes are strongly associated with a reduction of debt and a propensity to reduce taxes overall (with increases in payroll tax), reductions in final consumption expenditure

Table 5.4: Policy response effects in the state and local government sector

Dependent variable	Explanatory variables regression coefficients			
	RESINC$P	GCWCUR$P	GCWCAP$P	GSP$P
FCELAW$P	0.01	0.04	-0.04	0.01
FCEHLTH$P	0.00	0.19	-0.11	0.02
FCEED$P	-0.12	0.28	-0.10	0.04
FCEALO$P	0.07	0.08	-0.10	0.02
FCEECS$P	-0.10	0.01	-0.17	0.01
ENFAWAT$P	0.00	-0.05	0.20	0.00
ENFAROAD$P	-0.07	-0.05	0.06	0.00
ENFARAIL$P	0.07	0.04	-0.06	-0.01
ENFAOTH$P	-0.20	0.01	0.14	0.03
ENFAHOUS$P	-0.01	0.02	0.14	-0.01
ENFAELEC$P	-0.11	-0.03	-0.07	0.02
-TAXLGR$P	-0.08	-0.04	0.08	0.00
-TAXMOT$P	-0.08	0.00	0.09	0.01
-TAXPAYR$P	0.23	0.03	-0.26	-0.05
-TAXALO$P	0.04	0.02	0.20	-0.01
-ADDEBT$P	1.36	0.45	0.99	-0.07

Note: totals may not sum to one or zero because of rounding.

Source: Figure 5.3.

and increases in expenditure on new fixed assets.

The two identities, equations #22-3, are required to calculate the two state and local government expenditure items for the national accounting identity which determines real gross state product.

5.3.3 Block Three: External Trade

Only one stochastic equation was estimated in this block, imports. Klein (1969) suggests that both exports and imports should be estimated, with regional exports assumed to be a function of both the gross domestic product of the nation and relative prices. In the case of Queensland, such a specification is inappropriate, since most of Queensland's exports are overseas, and not interstate.[8] The specification is only suitable for smaller regions with an important manufacturing industry specialization. A number of equations for exports were estimated, but the statistical results were so poor that they could not be included in the model. Attempts were also made to disaggregate imports by origin (overseas and interstate), but the best statistical results were obtained for the aggregated quantity.[9] The final preferred equation for imports (M) is shown in Figure 5.4, with the identity converting current price imports to real terms. Imports are specified, following Klein (1969) and Norton and Henderson (1972), to be a function of lagged gross state product and relative prices (RELPR = IPDM/IPDNONFARM), with multiplicative quarterly dummies.

5.3.4 Block Four: Gross State Product at Average 1974-75 Prices

This block consists only of two identities,

26) $GSP\$ = PFCE\$ + SLFCE\$ + SLENFA\$ + X\$ - M\$ + A\$$

and

---

[8]In 1976-77, for example, overseas exports from Queensland totalled \$2816m. Of this total, \$1178m was for food and live animals commodities, and \$750m was for coal etc. commodities. Interstate exports in the same period from Queensland totalled only \$972m.

[9]This may be partly because interstate imports are not satisfactorily classified as interstate, since they may in fact be overseas imports routed to Queensland through southern ports of entry to Australia.

Figure 5.4: Block Three (External Trade) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 17:04  26-May-81    PAGE 3
                                                                                          R-SQUARED      SEE       DW      RHO1
                                                                                         (CORRECTED)

0024) M  =  468.85  +  0.35181E-01 G2  +  0.58241E-01 G3  +  0.37926E-01 G4                   0.980     29.82355    1.677   0.766
          (3.0055)    (6.9817)            (10.178)            (8.0650)

          +  0.19284 GSP(-1)  -  390.79 RELPR(-1)
            (9.3212)             (-2.6307)

0025) M$  = M * 100. / IPDM
```

27) GNAP$ = GSP$ - GSPAGR$.

Equation #26 is the familiar Keynesian national accounting identity discussed above. Real private final consumption expenditure (PFCE$), real state and local government final consumption expenditure (SLFCE$), real state and local government expenditure on new fixed assets (SLENFA$) and real imports (M$) have been determined in blocks one to three above, and real exports (X$) and the real residual (A$) are exogenous.

Equation #27, determining real gross non-agricultural product (GNAP$), is necessary, since the farm, or agricultural, industry has been made exogenous in this model. Due to the volatility of farm product, it was decided to delay modelling such an important section of the Queensland economy, since the effort required is beyond the resources available for this study. The development of a farm sector module is delayed to a later stage in the progression of the Queensland model.

The industry, public administration and defence, is also exogenous in this model.

5.3.5 Block Five: Gross State Product by Industry

This block contains the supply-side set of equations, which determine gross state product at current prices. The overall specification used is that of economic base, which is not entirely satisfactory, since most explanatory variables in the equations are exogenous to the model and probably more closely reflect demand relationships. This is, however, a familiar and well-tried technique in regional econometric modelling. A typical equation is that for manufacturing, which contains only gross domestic product as the explanatory variable.

A logarithmic specification is used for all seven industry variables. (The industries agriculture, public administration and defence and ownership of dwellings are exogenous.) The statistical fit of the equations is reasonable, given that all originally were autocorrelated, and have been corrected for first order autocorrelation. The equation (#28) for mining gross state product has little theoretical justification, even though the statistical fit is reasonable, except for the high standard error of the coefficient for coal production. The same can be said for a number of the other six equations. The general state of production functions in regional econometric modelling is poor. Engle (1974) has commented on this, and suggested that supply be determined by industry output prices, industry labour costs, rental costs, capital stock and technology indexes. The only variable available, however, is industry labour costs. This is not suitable as a sole explanatory variable specification, since employment is determined by the inverse production function method (see below). The introduction of satisfactory industry production functions will have to await the development of sufficiently accurate capital stock estimates for Queensland.

The seven identities (equations #35-41) are simply transformation equations, e.g.,

35) $$GSPMIN = e^{LNGSPMIN}$$

The equations of this block are listed in Figure 5.5.

5.3.6 Block Six: GSP at Current Prices

This block contains five equations, only one of which is stochastic. This equation (#42) is for the imputed bank service charge, which is calculated as a function of population and gross state product. Given IBSC and gross product by industry, it is possible to calculate gross state product at factor cost.

42) $$\begin{aligned} IBSC = & -122.13 + 1.67Q02 + 1.21Q03 \\ & \;(-4.34)\quad (4.08) \qquad (2.36) \\ & + 0.92Q04 + 0.0715POP + 0.0142GSP \\ & \quad (1.70) \qquad (4.52) \qquad\quad (6.59) \end{aligned}$$

$$\bar{R}^2 = 0.998 \qquad SEE = 1.0965$$

$$DW = 1.904 \qquad RHO1 = 0.88$$

43) $$\begin{aligned} GSPFC = & \; GSPMIN + GSPMAN + GSPELE + GSPCON + GSPTRD + GSPTRN \\ & + GSPSER - GSPAGR + GSPODW + GSPPAD - IBSC \end{aligned}$$

44) $$GOS = GSPFC - WSS$$

Figure 5.5: Block Five (GSP by Industry) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:55  26-May-81    PAGE 1
                                                                                     R-SQUARED      SEE       DW      RHO1
                                                                                    (CORRECTED)

0028) LNGSPMIN  =  2.6158  +  0.13772 Q02  +  0.46677E-01 Q03  +  0.56053E-01 Q04        0.992     0.08931   1.925   0.436
                  (3.3237)   (3.6483)        (1.1932)             (1.5494)

                +  0.11877 LNPRODCOAL  +  0.48015E-01 TIME
                  (1.1723)               (12.150)

0029) LNGSPMAN  =  -3.6843  +  0.85170E-01 Q02  +  0.67305E-01 Q03  -  0.17530E-02 Q04   0.999     0.02634   1.709   0.550
                  (-16.535)   (8.8986)             (6.1370)             (-0.17417)

                +  0.97071 LNGDP
                  (41.142)

0030) LNGSPELE  =  -2.4074  -  0.58169E-01 Q02  -  0.11708 Q03  -  0.93327E-01 Q04       0.998     0.03853   1.801   0.490
                  (-2.4539)   (-3.9018)            (-4.6656)        (-6.1550)

                +  0.88455 LNGSPMAN  +  0.19445 LNPRODELEC
                  (7.8094)             (0.94350)

0031) LNGSPCON  =  -37.905  +  0.75284E-01 Q02  +  0.69141E-01 Q03  +  0.66048E-01 Q04   0.999     0.03279   2.080   0.791
                  (-10.374)   (6.2249)             (4.7091)             (5.0662)

                +  0.19482 LNBVWDOTH  +  5.5304 LNPOP
                  (3.1248)              (10.943)

0032) LNGSPTRD  =  -1.4750  +  0.76028E-01 Q02  -  0.23952E-01 Q03  -  0.13106 Q04       0.999     0.03114   2.138   0.544
                  (-8.5503)   (3.1051)             (-1.6817)            (-9.9878)

                +  0.60535 LNRSTOTAL  +  0.47235 LNHDY
                  (3.5772)              (3.0976)

0033) LNGSPTRN  =  -1.0368  +  0.30941E-02 Q02  +  0.32607E-03 Q03  -  0.10120E-01 Q04   0.999     0.03507   2.214   0.309
                  (-7.2737)   (0.21545)            (0.20580E-01)        (-0.70364)

                +  0.81244 LNGSP
                  (42.624)

0034) LNGSPSER  =  -6.6833  +  0.46942E-01 Q02  -  0.47005E-02 Q03  -  0.12047 Q04       0.999     0.03590   2.151   0.331
                  (-31.037)   (3.2385)             (-0.29165)           (-8.1595)

                +  1.3163 LNGDP
                  (57.782)
```

Figure 5.5 (continued)

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:55  26-May-81   PAGE 2

0035) GSPMIN  = EXP( LNGSPMIN )

0036) GSPMAN  = EXP( LNGSPMAN )

0037) GSPELE  = EXP( LNGSPELE )

0038) GSPCON  = EXP( LNGSPCON )

0039) GSPTRD  = EXP( LNGSPTRD )

0040) GSPTRN  = EXP( LNGSPTRN )

0041) GSPSER  = EXP( LNGSPSER )
```

45) $$GSP = GSPFC + ITLS$$

46) $$ITLS = \frac{(MTAXPAYR\$P)(POP)(IPDSLG)}{100\ 000} + OITLS$$

The identities #43-45 are self-explanatory, with only #46, which determines indirect taxes less subsidies, being unusual. This is calculated as payroll tax (converted from real per capita terms) plus other indirect taxes less subsidies, which are exogenous.

5.3.7 Block Seven: Prices

Figure 5.6 presents the equations in this block. The four stochastic equations are for four separate groups of the consumer price index, viz, food, housing, household supplies and equipment, and all other groups. These equations were all originally specified as each index group being a function of indirect taxes less subsidies, the lagged group price index and the unemployment rate. This specification emphasizes the effect of indirect taxes on price levels. The unemployment rate was not significant in three of the equations and was dropped.

The all groups consumer price index is formed, in equation #51, as a weighted average of the four separate groups, using private final consumption expenditure category proportions as weights.

Equation #52 for the non-farm deflator is based on a similar specification in the Wharton-EFU model; where "the GNP deflator is defined as the ratio between current and constant dollar GNP and is not estimated directly".[10]

5.3.8 Block Eight: Employment by Industry

This block contains seven stochastic equations and eight identities. Seven of the identities are transformations, since the stochastic employment equations for the seven industries are in logarithmic terms. The remaining identity (#67) aggregates employment by industry, and exogenous industry employment, to form total employment.

---

[10] Evans (1969, p. 432).

Figure 5.6: Block Seven (Prices) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 17:04  26-May-81   PAGE 1
                                                                                   R-SQUARED      SEE        DW      RHO1
                                                                                  (CORRECTED)

0047) CPIFD74  =  3.8202  -  2.2229 Q02  -  1.1874 Q03  -  1.4753 Q04  +  0.33806E-01 ITLS    0.996    1.58080    1.986
                 (1.1195)   (-2.5173)      (-1.2907)      (-1.8318)      (2.0470)

                 +  0.95232 CPIFD74(-1)  -  0.99084 UR
                   (13.736)                (-2.3575)

0048) CPIHO74  =  2.9511  -  0.30739 Q02  +  2.2378 Q03  +  1.0647 Q04  +  0.32847E-01 ITLS   0.998    1.15172    1.495
                 (1.5134)   (-0.54833)      (3.9289)       (1.9502)       (2.8305)

                 +  0.91560 CPIHO74(-1)
                   (20.286)

0049) CPIHS74  =  10.834  -  0.37860 Q02  +  1.8461 Q03  +  0.57417 Q04  +  0.49182E-01 ITLS  0.998    1.18052    1.846   0.461
                 (1.9396)   (-0.74675)      (3.2369)       (1.2252)        (2.4328)

                 +  0.78750 CPIHS74(-1)
                   (7.5172)

0050) CPIAO74  =  8.3348  -  0.34522 Q02  +  0.84905 Q03  +  2.1337 Q04  +  0.61282E-01 ITLS  0.997    1.57929    2.233
                 (2.7572)   (-0.44509)      (1.0700)        (2.8624)       (3.4428)

                 +  0.79262 CPIAO74(-1)
                   (11.214)

0051) CPI74  = ( CPIFD74 * PFCEFD$P + CPIHO74 * PFCERT$P + CPIHS74 * PFCEHD$P + CPIAO74 * PFCEAO$P ) * POP / ( PFCE$ * 1000. )

0052) IPDNONFARM  = ( GSP - GSPAGR ) * 100. / GNAP$
```

The general specification of the employment equations shown in Figure 5.7 is an inverse production function or labour demand function. This is a familiar treatment which can be found in most regional econometric models.[11] As well, relative wage rates and productivity variables have been included as explanatory variables. This is seen by examining the employment in manufacturing (NEMIN) equation,

54) $$\ln(NEMIN) = \underset{(10.28)}{2.86} - \underset{(-3.03)}{0.052Q02} - \underset{(-2.02)}{0.026Q03} - \underset{(-4.27)}{0.065Q04} + \underset{(6.19)}{0.3697} \ln\left(\frac{GSPMANIPDNONFARM)}{100}\right) - \underset{(-1.32)}{0.1244} \ln\left(\frac{WRMAN}{WRMEAN}\right) - \underset{(-2.56)}{0.2062} \ln\left(\frac{GSPMAN(-1)}{NEMAN(-1)}\right)$$

In the equations as listed in Figure 5.7, real gross product by industry, relative industry wage rates, and industry productivity (gross output per employed person) are given individual mnemonic names. For manufacturing, these are,

$$GSPMAN\$ = \frac{(GSPMAN)(IPDNONFARM)}{100}$$

$$RWMAN = \frac{WRMAN}{WRMEAN}$$

$$PRODMAN = \frac{GSPMAN}{NEMAN}$$

Several of the estimated equations indicated the presence of autocorrelation. The standard autoregressive correction was applied but did not significantly reduce the autocorrelation, while reducing the significance of the explanatory variable.

---

[11] See, for example, Engle (1974, pp. 262-3), Glickman (1977, pp. 86-87) and Rubin and Erickson (1980, pp. 22-3).

Figure 5.7: Block Eight (Employment by Industry) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:17  26-May-81    PAGE 1
                                                                                   R-SQUARED     SEE       DW      RHO1
                                                                                  (CORRECTED)

0053) LNNEMIN  =  1.1850  -  0.45235E-01 Q02  -  0.12524E-01 Q03  +  0.15079E-02 Q04      0.833     0.04010    0.847
                 (7.9263)   (-1.9685)           (-0.60964)          (0.61590E-01)

                + 0.32254 LNGSPMIN$  +  0.23837 LNRWMIN
                 (10.329)              (1.8996)

0054) LNNEMAN  =  2.8639  -  0.52427E-01 Q02  -  0.26357E-01 Q03  -  0.64938E-01 Q04      0.665     0.01635    1.425
                 (10.284)   (-3.0282)           (-2.0229)           (-4.2687)

                + 0.36974 LNGSPMAN$  -  0.12437 LNRWMAN  -  0.20618 LNPRODMAN(-1)
                 (6.1921)              (-1.3242)            (-2.5621)

0055) LNNEELE  =  0.98029  -  0.29940E-01 Q02  +  0.92385E-02 Q03  -  0.11706E-01 Q04    0.593     0.03618    1.898
                 (2.6741)    (-1.3042)            (0.45712)            (-0.44308)

                + 0.57616 LNGSPELE$  -  0.50470 LNPRODELE(-1)  +  0.47303 LNRWELE
                 (6.1595)              (-4.5444)                  (2.5296)

0056) LNNECON  =  1.8122  -  0.66487E-01 Q02  -  0.31914E-01 Q03  -  0.51186E-01 Q04      0.513     0.04145    1.222
                 (4.2105)   (-2.2110)           (-1.3313)           (-2.2387)

                + 0.54134 LNGSPCON$  -  0.35420 LNPRODCON(-1)
                 (5.1327)              (-2.4914)

0057) LNNETRD  =  2.9770  -  0.33530E-01 Q02  -  0.24995E-01 Q03  -  0.42136E-01 Q04      0.911     0.01480    1.271
                 (25.052)   (-3.3242)           (-2.8103)           (-3.2107)

                + 0.33467 LNGSPTRD$  -  0.29195 LNRWTRD
                 (18.174)              (-2.7290)

0058) LNNETRN  =  0.62486  -  0.83357E-02 Q02  -  0.14274E-01 Q03  +  0.29654E-01 Q04    0.747     0.03100    1.654
                 (1.1962)    (-0.46871)           (-0.80711)           (1.2807)

                + 0.69614 LNGSPTRN$  +  0.78229 LNRWTRN
                 (6.9576)              (5.2115)

0059) LNNESER  =  1.4985  -  0.46748E-01 Q02  -  0.46132E-01 Q03  -  0.51313E-01 Q04      0.969     0.02291    1.423
                 (13.296)   (-4.2704)           (-4.2650)           (-4.7262)

                + 0.63505 LNGSPSER$
                 (33.046)
```

Figure 5.7 (continued)

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 15:47  26-May-81    PAGE 2

0060) NEMIN  = EXP( LNNEMIN )

0061) NEMAN  = EXP( LNNEMAN )

0062) NEELE  = EXP( LNNEELE )

0063) NECON  = EXP( LNNECON )

0064) NETRD  = EXP( LNNETRD )

0065) NETRN  = EXP( LNNETRN )

0066) NESER  = EXP( LNNESER )

0067) TE  =  NEMIN + NEMAN + NEELE + NECON + NETRD + NETRN + NESER + NEEXOG
```

5.3.9 Block Nine: Labour Force and Demography

Population is calculated by the identity,

72) $$POP = POP(-1) + NMIG + NATI$$

i.e., population change is the sum of net in-migration and natural increase.

Both net in-migration and natural increase are determined in stochastic equations. These are shown in Figure 5.8. Natural increase is specified as a function of population size. Net migration is a function of lagged population size and the rate of change of gross state product.

The number of persons registered as unemployed is estimated in equation #70, as a function of the size of the labour force and the level of unemployment in Australia. This reflects the mobility of labour across state borders which makes state and national unemployment conditions similar. The estimation of unemployment as a residual from the labour force and employment was initially tried, but such specification generally results in high simulation errors which can, when occurring in sensitive variables such as the unemployment rate, cause model instability. Kuh and Schmalensee (1973, p. 193) reported a similar problem:

> Unemployment and the unemployment rate had large relative errors; the latter had an RMS relative error of 18%. This derived magnitude, however important it may be for policy purposes, is always predicted in the long run with large relative errors, because it is the difference between two very similar magnitudes. Independent 1% errors in employment and labor force estimates will produce errors of 40% in forecasts of unemployment when it in turn is 5% of the labor force. Some positive correlation among the errors in the two original magnitudes would bring the average relative error down to the observed vicinity of 20%.

Labour force is estimated by applying an exogenous activity rate to population, while the unemployment rate is calculated in the familiar way.

73) $$LF = \frac{(AR)(POP)}{100}$$

74) $$UR = \frac{(NRU)(100)}{LF}$$

Figure 5.8: Block Nine (Labour Force and Demography) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 15:47  26-May-81   PAGE 3
                                                                                   R-SQUARED      SEE      DW     RHO1
                                                                                  (CORRECTED)

0068) LNNATI  =  9.5518   -  0.56863E-01 Q02  -  0.28367 Q03  -  0.17323 Q04  -  1.0268 LNPOP    0.948   0.07151   2.308   0.460
                (3.6331)    (-2.0965)            (-9.1882)        (-6.3711)        (-2.9690)

0069) NMIG  =  47.779   -  7.2030 Q02   -  3.8098 Q03   -  2.4512 Q04   -  0.20161E-01 POP(-1)    0.467   3.06849   1.581
              (5.1466)    (-2.0510)       (-1.3399)       (-0.78987)      (-4.5012)

              +  0.48862 PDGSPPC
                (2.3531)

0070) NRU   =  15.369   -  2.7217 Q02   -  4.5073 Q03   -  3.4002 Q04   +  0.17040 NRUAUS          0.987   2.20979   1.346
              (2.4823)    (-2.5795)       (-4.2417)       (-3.2443)       (25.175)

              -  0.19001E-01 LF
                (-2.1542)

0071) NATI  = EXP( LNNATI )

0072) POP  = POP(-1) + NMIG + NATI

0073) LF  = AR * POP / 100.

0074) UR  = NRU * 100. / LF
```

5.3.10 Block Ten: Average Wages and Earnings

This block calculates the average wage rate from the seven endogenous industry wage rates, using employment by industry as weights. Average weekly earnings per employed male unit (which includes overtime and loadings, in addition to normal wage rates) is estimated in equation #75 as a function of mean wages and gross product, as a measure of overall economic activity.

75) $$AWEEMU = \underset{(5.39)}{11.47} + \underset{(3.85)}{4.13Q\emptyset 2} + \underset{(0.95)}{1.17Q\emptyset 3} + \underset{(2.96)}{4.35Q\emptyset 4} + \underset{(2.58)}{0.3405\,WRMEAN} + \underset{(7.63)}{0.0418\,GSP}$$

$$\bar{R}^2 = 0.998 \qquad SEE = 2.26$$
$$DW = 2.086 \qquad RHO1 = 0.211$$

76) $$WRMEAN = \frac{1}{TE-NEEXOG}\Big((NEMIN)(WRMIN) + (NEMAN)(WRMAN) + (NEELE)(WRELE) + (NECON)(WRCON) + (NETRD)(WRTRD) + (NETRN)(WRTRN) + (NESER)(WRSER)\Big)$$

5.3.11 Block Eleven: Wage Rates by Industry

Weekly wage rates for the seven endogenous industries are estimated as four-quarter changes in wage rates, which are a function of similar changes in both average weekly earnings per employed male unit (D4AWEEMU) and the all groups consumer price index (D4CPI74), and the unemployment rate (UR).

This specification worked quite well, with the unemployment rate coefficient showing the correct negative sign throughout.

Seven transformation identities are required, e.g.,

84) $$WRMIN = WRMIN(-4) + D4WRMIN.$$

The estimated equations for the industry wage rates are shown in Figure 5.9.

Figure 5.9: Block Eleven (Wage Rates by Industry) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:21  26-May-81   PAGE 1

                                                                                      R-SQUARED      SEE       DW      RHO1
                                                                                     (CORRECTED)

0077) D4WRMIN  =  -2.4644  -  1.7863 Q02  -  1.3648 Q03  -  1.7583 Q04  -  0.95044 UR      0.671     5.93966   1.916
                (-0.73543) (-0.58504)     (-0.42699)     (-0.57254)      (-1.1886)

                 +  0.89299 D4AWEEMU  +  0.79736 D4CPI74
                   (3.7623)             (1.8145)

0078) D4WRMAN  =  0.86588E-01  -  1.5587 Q02  -  1.5773 Q03  -  1.6758 Q04  -  1.0419 UR   0.776     3.31556   1.478
                (0.46291E-01)   (-0.91456)     (-0.88403)     (-0.97753)     (-2.3342)

                 +  0.66710 D4AWEEMU  +  0.60208 D4CPI74
                   (5.0351)             (2.4545)

0079) D4WRELE  =  -0.23285  -  1.4660 Q02  -  1.3028 Q03  -  1.5565 Q04  -  0.91164 UR    0.785     3.31579   1.579
                (-0.12448)   (-0.86011)     (-0.73014)     (-0.90785)     (-2.0423)

                 +  0.68363 D4AWEEMU  +  0.58034 D4CPI74
                   (5.1594)             (2.3657)

0080) D4WRCON  =  0.58555  -  1.5479 Q02  -  1.4560 Q03  -  1.6395 Q04  -  0.91099 UR     0.686     4.06021   1.650
                (0.25563)   (-0.74161)     (-0.66638)     (-0.78095)     (-1.6667)

                 +  0.72716 D4AWEEMU  +  0.44610 D4CPI74
                   (4.4818)             (1.4851)

0081) D4WRTRD  =  0.31937  -  1.2997 Q02  -  1.2640 Q03  -  1.3834 Q04  -  0.88585 UR     0.837     2.64209   2.081
                (0.21426)   (-0.95694)     (-0.88905)     (-1.0126)      (-2.4906)

                 +  0.52623 D4AWEEMU  +  0.74764 D4CPI74
                   (4.9842)             (3.8249)

0082) D4WRTRN  =  0.81718  -  1.8177 Q02  -  1.6504 Q03  -  1.8241 Q04  -  1.0959 UR      0.705     4.10030   1.692
                (0.35326)   (-0.86239)     (-0.74800)     (-0.86039)     (-1.9854)

                 +  0.73420 D4AWEEMU  +  0.55465 D4CPI74
                   (4.4809)             (1.8284)

0083) D4WRSER  =  -0.28293  -  1.2904 Q02  -  1.0041 Q03  -  1.3209 Q04  -  0.73175 UR    0.785     3.16997   1.599
                (-0.15820)   (-0.79189)     (-0.58861)     (-0.80587)     (-1.7147)

                 +  0.63666 D4AWEEMU  +  0.55516 D4CPI74
                   (5.0260)             (2.3672)
```

Figure 5.9 (continued)

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:21  26-May-81    PAGE 2

0084) WRMIN  = WRMIN(-4) + D4WRMIN

0085) WRMAN  = WRMAN(-4) + D4WRMAN

0086) WRELE  = WRELE(-4) + D4WRELE

0087) WRCON  = WRCON(-4) + D4WRCON

0088) WRTRD  = WRTRD(-4) + D4WRTRD

0089) WRTRN  = WRTRN(-4) + D4WRTRN

0090) WRSER  = WRSER(-4) + D4WRSER
```

5.3.12 Block Twelve: Wages, Salaries and Supplements by Industry

Wages, salaries and supplements by industry are estimated by the general specification of

$$WSS = A \cdot NE^{\alpha} \cdot WR^{\beta}$$

where A is a term for the intercept and the quarterly dummy variables, α and β are parameters, and NE and WR are employment and wage rates respectively.

Since the estimated equations are logarithmic, seven transformation identities are required. The stochastic equations are shown in Figure 5.10.

5.3.13 Block Thirteen: Income

This block completes the model by estimating the variables of the household income account (see NIE, Table for *Household Income, by States*). The following identity (#109) defines total household income,

$$109) \qquad HHY = WSS + YUE + \frac{(YTGG\$)(CPI74)}{100} + YAOHY$$

in which YUE, income of farm unincorporated enterprises, is exogenous and WSS, YTGG$ and YAOHY are estimated endogenously.

Wages, salaries and supplements (WSS) are found by the identity #108,

$$108) \qquad WSS = WSSMIN + WSSMAN + WSSELE + WSSCON + WSSTRD + WSSTRN + WSSSER + WSSAGR + WSSPAD$$

where the wages, salaries and supplements of the industries, agriculture and public administration and defence, are exogenous.

Transfer income from general government (YTGG) was estimated in real terms, i.e., deflated by the all groups consumer price index, as a function of population (a proxy variable for the number of pensionable persons) and number of persons registered as unemployed, (a proxy variable for persons receiving unemployment benefits). The specification in real terms indicates that real transfers per receipt may not have varied significantly over the estimation period.

Figure 5.10: Block Twelve (WSS by Industry) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:22  26-May-81   PAGE 5
                                                                                      R-SQUARED      SEE        DW       RHO1
                                                                                     (CORRECTED)

0091) LNWSSMIN  =  -4.1686  +  0.18717 Q02  +  0.38987E-01 Q03  +  0.69136E-01 Q04            0.989     0.08190    2.067    0.335
                  (-5.1877)   (5.6476)        (1.0544)            (2.0902)

                 + 0.63108 LNWRMIN  +  1.7883 LNNEMIN
                  (5.7241)             (3.8549)

0092) LNWSSMAN  =  -3.8269  +  0.61422E-01 Q02  +  0.80934E-01 Q03  +  0.13152 Q04            0.999     0.02666    1.944    0.377
                  (-3.0126)   (5.1030)             (5.7393)             (12.147)

                 + 1.0277 LNWRMAN  +  0.90328 LNNEMAN
                  (54.304)            (3.3143)

0093) LNWSSELE  =  -3.4640  +  0.26131E-01 Q02  +  0.15698E-01 Q03  +  0.56035E-01 Q04        0.997     0.03963    2.106    0.154
                  (-8.9984)   (1.5044)             (0.84789)            (3.2041)

                 + 1.1056 LNWRELE  +  0.71187 LNNEELE
                  (35.886)            (3.3661)

0094) LNWSSCON  =  -2.2689  +  0.63282E-01 Q02  +  0.49709E-01 Q03  +  0.84176E-01 Q04        0.997     0.04737    2.104    0.774
                  (-1.5325)   (3.6252)             (2.6063)             (5.4373)

                 + 0.92969 LNWRCON  +  0.64352 LNNECON
                  (13.173)             (1.7845)

0095) LNWSSTRD  =  -4.5902  +  0.45727E-01 Q02  +  0.34952E-01 Q03  +  0.59258E-01 Q04        0.997     0.02663    1.840
                  (-5.6333)   (3.5981)             (2.7680)             (4.6647)

                 + 1.1695 LNWRTRD  +  0.90618 LNNETRD
                  (50.427)            (4.9788)

0096) LNWSSTRN  =  -3.9002  +  0.19718E-01 Q02  +  0.46991E-01 Q03  +  0.60366E-01 Q04        0.991     0.03984    1.907
                  (-2.4457)   (1.0420)             (2.4969)             (3.1331)

                 + 0.89795 LNWRTRN  +  1.1017 LNNETRN
                  (12.216)             (2.3243)

0097) LNWSSSER  =  -4.4151  +  0.60990E-01 Q02  +  0.62146E-01 Q03  +  0.77674E-01 Q04        0.996     0.03209    2.082
                  (-6.8761)   (4.0300)             (4.0903)             (5.1267)

                 + 0.98358 LNWRSER  +  1.0325 LNNESER
                  (17.999)             (6.1524)
```

Figure 5.10 (continued)

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 16:22  26-May-81    PAGE 6

0098) WSSMIN  = EXP( LNWSSMIN )

0099) WSSMAN  = EXP( LNWSSMAN )

0100) WSSELE  = EXP( LNWSSELE )

0101) WSSCON  = EXP( LNWSSCON )

0102) WSSTRD  = EXP( LNWSSTRD )

0103) WSSTRN  = EXP( LNWSSTRN )

0104) WSSSER  = EXP( LNWSSSER )
```

All other household income (YAOHY) was estimated as a function of gross operating surplus and gross state product in ownership of dwellings, since all other household income includes dividends, interest and income from dwellings.

These two estimated equations are given in Figure 5.11, along with the equation (#107) for personal income tax (FYTX). This federal tax is calculated as a function of wages, salaries and supplements, and following Norton and Henderson (1972), with multiplicative quarterly dummy variables.

The final equation is the identity (#110) for household disposable income,

110) $HDY = HHY - FYTX - OTHDED,$

where other deductions (OTHDED) are exogenous.

Figure 5.11: Block Thirteen (Income) equations

```
PLANETS 13    [3006,3003]    TTY11 * QUEENSLAND ECONOMETRIC MODEL PROJECT  -  JAMES COOK UNIVERSITY * 17:05  26-May-81   PAGE 5
                                                                                          R-SQUARED      SEE       DW      RHO1
                                                                                         (CORRECTED)

0105) YTGG$  =  -433.39   +  13.179 Q02  +  18.733 Q03  +  14.019 Q04  +  0.27708 POP        0.962    11.62017   2.244   0.453
               (-4.7486)    (2.6373)       (3.1302)       (2.8187)       (5.5761)

                +  0.98612E-03 NRU
                  (3.1689)

0106) YAOHY  =  -25.791   +  82.224 Q02  -  1.3268 Q03  +  47.804 Q04  +  0.23828 GOS        0.989    15.04181   1.672  -0.498
               (-3.0574)    (7.6241)       (-0.18879)     (4.1653)       (6.1905)

                +  1.1719 GSPODW
                  (5.8315)

0107) FYTX  =  -52.735  +  0.12866 S602  -  0.88721E-01 S603  -  0.64096E-01 S604            0.988    17.29898   1.339
              (-7.2616)    (17.932)          (-11.931)             (-8.8170)

               +  0.25693 WSS
                 (31.682)

0108) WSS   = WSSMIN + WSSMAN + WSSELE + WSSCON + WSSTRD + WSSTRN + WSSSER + WSSAGR + WSSPAD

0109) HHY   = WSS + YUE + YTGG$ * CPI74 / 100. + YAOHY

0110) HDY   = HHY - FYTX - OTHDED
```

APPENDIX TO CHAPTER 5

QUEENSLAND MODEL DATABANK INDEX

This appendix lists the index of the variables appearing in the equations of the Queensland model described in Chapter Five above. The endogenous variables are held in databank ENDOG.QTR, and the exogenous variables in EXOG.QTR.

PLANETS 13 [3006,3003] TTY13 * QUEENSLAND ECONOMETRIC MODEL DATA BANK - JAMES COOK UNIVERSITY * 09:03 15-Jun-81 PAGE 1

INDEX TO ENDOG.QTR

VARIABLE	FROM - TO	DESCRIPTION	LAST CHANGE	NR
AWEEMU	196903 - 197902	AVERAGE WEEKLY EARNINGS PER EMPLOYED MALE UNIT , QUEENSLAND UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 07:13	1
CPI74	196903 - 197902	CONSUMER PRICE INDEX , BRISBANE BASE ADJUSTED TO BE : YEAR 1974-75 = 100.0 ALL GROUPS SOURCE : 1304.3	13-Jun-81 14:44	2
CPIAO74	196903 - 197902	CONSUMER PRICE INDEX , BRISBANE , ALL OTHER GROUPS BASE ADJUSTED TO BE : YEAR 1974-75 = 100.0 ALL OTHER GROUPS CALCULATED BY FORCING CPI74 TO BE AN AVERAGE OF THE FOUR GROUPS USED IN THE MODEL , WEIGHTED BY PRIVATE FINAL CONSUMPTION EXPENDITURE	13-Jun-81 14:57	3
CPIFD74	196903 - 197902	CONSUMER PRICE INDEX , BRISBANE , FOOD GROUP BASE ADJUSTED TO BE : YEAR 1974-75 = 100.0 FOOD GROUP SOURCE : 1304.3	13-Jun-81 14:45	4
CPIHO74	196903 - 197902	CONSUMER PRICE INDEX , BRISBANE , HOUSING GROUP BASE ADJUSTED TO BE : YEAR 1974-75 = 100.0 HOUSING GROUP SOURCE : 1304.3	13-Jun-81 14:46	5
CPIHS74	196903 - 197902	CONSUMER PRICE INDEX , BRISBANE , HH. SUPP. AND EQUIP. GROUP BASE ADJUSTED TO BE : YEAR 1974-75 = 100.0 HOUSEHOLD SUPPLIES AND EQUIPMENT GROUP SOURCE : 1304.3	13-Jun-81 14:48	6
ENFAELEC$P	196903 - 197902	ENFAELEC$P = ENFAELEC * 100000 / (POP * IPDSLENFA) EXPENDITURE ON NEW FIXED ASSETS , ELECTRICITY PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:16	7
ENFAHOUS$P	196903 - 197902	ENFAHOUS$P = ENFAHOUS * 100000 / (POP * IPDSLENFA) EXPENDITURE ON NEW FIXED ASSETS , HOUSING PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:18	8
ENFAOTH$P	196903 - 197902	ENFAOTH$P = ENFAOTH * 100000 / (POP * IPDSLENFA) EXPENDITURE ON NEW FIXED ASSETS , ALL OTHER PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09.20	9

INDEX TO ENDOG.QTR

VARIABLE	FROM - TO	DESCRIPTION	LAST CHANGE	NR
ENFARAIL$P	196903 - 197902	ENFARAIL$P = ENFARAIL * 100000 / (POP * IPDSLENFA) EXPENDITURE ON NEW FIXED ASSETS , RAIL TRANSPORT PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:24	10
ENFAROAD$P	196903 - 197902	ENFAROAD$P = ENFAROAD * 100000 / (POP * IPDSLENFA) EXPENDITURE ON NEW FIXED ASSETS , ROAD TRANSPORT PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:23	11
ENFAWAT$P	196903 - 197902	ENFAWAT$P = ENFAWAT * 100000 / (POP * IPDSLENFA) EXPENDITURE ON NEW FIXED ASSETS , WATER PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:26	12
FCEALO$P	196903 - 197902	FCEALO$P = FCEALO * 100000 / (POP * IPDSLFCE) FINAL CONSUMPTION EXPENDITURE , ALL OTHER PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:28	13
FCEECS$P	196903 - 197902	FCEECS$P = FCEECS * 100000 / (POP * IPDSLFCE) FINAL CONSUMPTION EXPENDITURE , ECONOMIC SERVICES PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:29	14
FCEED$P	196903 - 197902	FCEED$P = FCEED * 100000 / (POP * IPDSLFCE) FINAL CONSUMPTION EXPENDITURE , EDUCATION PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:31	15
FCEHLTH$P	196903 - 197902	FCEHLTH$P = FCEHLTH * 100000 / (POP * IPDSLFCE) FINAL CONSUMPTION EXPENDITURE , HEALTH PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:33	16

INDEX TO ENDOG.QTR

VARIABLE	FROM TO	DESCRIPTION	LAST CHANGE	NR
FCELAW$P	196903 - 197902	FCELAW$P = FCELAW * 100000 / (POP * IPDSLFCE) FINAL CONSUMPTION EXPENDITURE , LAW AND ORDER PURPOSES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:35	17
FYTX	196903 - 197902	PERSONAL INCOME TAX PAID , QUEENSLAND UNITS . DOLLARS MILLION SOURCE : 5204.0 , 5206.0 , AND SEE APPENDIX C	14-Jun-81 07:12	18
GNAP$	196903 - 197902	GROSS NON-AGRICULTURAL PRODUCT AT AVERAGE 1974-75 PRICES CALCULATED BY SUBTRACTION UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES	14-Jun-81 07:14	19
GOS	196903 - 197902	GROSS OPERATING SURPLUS , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 07:15	20
GSP	196903 - 197902	GROSS STATE PRODUCT , QUEENSLAND AT MARKET PRICES UNITS : DOLLARS MILLION	14-Jun-81 07:20	21
GSP$	196903 - 197902	GROSS STATE PRODUCT AT AVERAGE 1974-75 PRICES UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES DEFLATION METHOD OUTLINED IN CHAPTER THREE	14-Jun-81 07:17	22
GSPCON	196903 - 197902	GROSS STATE PRODUCT , CONSTRUCTION INDUSTRY , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 07:20	23
GSPELE	196903 - 197902	GROSS STATE PRODUCT , ELECTRICITY INDUSTRY , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 07:19	24
GSPFC	196903 - 197902	GROSS STATE PRODUCT , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 07:21	25
GSPMAN	196903 - 197902	GROSS STATE PRODUCT , MANUFACTURING INDUSTRY , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 07:22	26
GSPMIN	196903 - 197902	GROSS STATE PRODUCT , MINING INDUSTRY , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 07:22	27
GSPSER	196903 - 197902	GROSS STATE PRODUCT , SERVICE INDUSTRY , QUEENSLAND AT FACTOR COST SERVICE COMPRISES FINANCE , COMMUNITY AND ENTERTAINMENT ETC UNITS : DOLLARS MILLION	14-Jun-81 07:24	28
GSPTRD	196903 - 197902	GROSS STATE PRODUCT , WHOLESALE & RETAIL TRADE INDUSTRY , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 07:25	29

INDEX TO ENDOG.QTR

VARIABLE	FROM	TO	DESCRIPTION	LAST CHANGE	NR
GSPTRN	196903	197902	GROSS STATE PRODUCT , TRANSPORT ETC INDUSRTY , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 07:26	30
HDY	196903	197902	HOUSEHOLD DISPOSABLE INCOME , QUEENSLAND UNITS : DOLLARS MILLION SOURCE : 5204.0 AND SEE APPENDIX C	14-Jun-81 07:33	31
HHY	196903	197902	TOTAL HOUSEHOLD INCOME , QUEENSLAND UNITS : DOLLARS MILLION SOURCE : WSS , 5204.0 AND SEE APPENDIX C	14-Jun-81 07:34	32
IBSC	196903	197902	IMPUTED BANK SERVICE CHARGE , QUEENSLAND NOMINAL INDUSTRY UNITS : DOLLARS MILLION	14-Jun-81 07:35	33
IPDNONFARM	196903	197902	IPDNONFARM = 1 IMPLICIT PRICE DEFLATOR FOR GROSS NON-AGRICULTURAL PRODUCT QUEENSLAND BASE : YEAR 1974-75 = 100.0	14-Jun-81 07:39	34
ITLS	196903	197902	INDIRECT TAXES LESS SUBSIDIES , QUEENSLAND UNITS : DOLLARS MILLION ALLOCATED BY ANNUAL INDUSTRY WEIGHTS	14-Jun-81 07:41	35
LF	196903	197902	LABOUR FORCE , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : ABS TSD FILE EFLQLD ; PERIOD 196903 197203 ESTIMATED BY LF = F(LFAUS , POPQLD)	14-Jun-81 07:44	36
M$	196903	197902	LNM$ = LOG(M$) IMPORTS , QUEENSLAND AT AVERAGE 1974-75 PRICES DEFLATED BY THE NATIONAL IMPORT PRICE DEFLATOR UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES (TOTAL IMPORTS - BOTH OVERSEAS AND INTERSTATE) SOURCE : 5402.3	14-Jun-81 11:28	37
MADDEBT$P	196903	197902	MADDEBT$P = - ADDEBT * 100000 / (POP * IPDSL) NEGATIVE ADDITIONS TO DEBT QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:37	38
MTAXALO$P	196903	197902	MTAXALO$P = - TAXALO * 100000 / (POP * IPDSL) NEGATIVE ALL OTHER TAXATION QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 , 5506.0 AND SEE APPENDIX C	14-Jun-81 09:39	39

INDEX TO ENDOG.QTR

VARIABLE	FROM - TO	DESCRIPTION	LAST CHANGE	NR
MTAXLGR$P	196903 - 197902	MTAXLGR$P = - TAXLGR * 100000 / (POP * IPDSL) NEGATIVE LOCAL GOVERNMENT RATES QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 , 5506.0 AND SEE APPENDIX C	14-Jun-81 09:41	40
MTAXMOT$P	196903 - 197902	MTAXMOT$P = - TAXMOT * 100000 / (POP * IPDSL) NEGATIVE MOTOR VEHICLE TAXATION QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 , 5506.0 AND SEE APPENDIX C	14-Jun-81 09:43	41
MTAXPAYR$P	196903 - 197902	MTAXPAYR$P = - TAXPAYR * 100000 / (POP * IPDSL) NEGATIVE PAYROLL TAXATION QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 , 5506.0 AND SEE APPENDIX C	14-Jun-81 09:47	42
NATI	196902 - 197902	NATURAL INCREASE IN POPULATION , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : 1304.3	14-Jun-81 07:48	43
NECON	196903 - 197902	NUMBER OF PERSONS EMPLOYED , CONSTRUCTION INDUSTRY , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : 6214.0	14-Jun-81 07:51	44
NEELE	196903 - 197902	NUMBER OF PERSONS EMPLOYED , ELECTRICITY INDUSTRY , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCF : 6214.0	14-Jun-81 07:53	45
NEMAN	196903 - 197902	NUMBER OF PERSONS EMPLOYED , MANUFACTURING INDUSTRY , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : 6214.0	14-Jun-81 07:53	46
NEMIN	196903 - 197902	NUMBER OF PERSONS EMPLOYED , MINING INDUSTRY , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : 6214.0	14-Jun-81 07:54	47
NESER	196903 - 197902	NUMBER OF PERSONS EMPLOYED , SERVICE INDUSTRY , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : 6214.0	14-Jun-81 07:55	48
NETRD	196903 - 197902	NUMBER OF PERSONS EMPLOYED , WHOLESALE & RETAIL TRADE INDUSTRY QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : 6214.0	14-Jun-81 07:56	49
NETRN	196903 - 197902	NUMBER OF PERSONS EMPLOYED , TRANSPORT ETC INDUSTRY , QUEENSLAND UNITS : THOUSANDS OF PERSONS SOURCE : 6214.0	14-Jun-81 07:57	50

INDEX TO ENDOG.QTR

VARIABLE	FROM - TO	DESCRIPTION	LAST CHANGE	NR
NMIG	196903 - 197902	NET MIGRATION INTO QUEENSLAND UNITS : THOUSANDS OF PERSONS CALCULATED BY SUBTRACTION OF NATI FROM POP CHANGE	14-Jun-81 07:58	51
NRU	196903 - 197902	NUMBER OF REGISTERED UNEMPLOYED , QUEENSLAND UNITS : THOUSAND OF PERSONS SOURCE : 1304.3	14-Jun-81 07:59	52
PFCE$	196903 - 197902	PFCE$ = PFCE * 100 / CPI74 PRIVATE FINAL CONSUMPTION EXPENDITURE AT AVERAGE 1974-75 PRICES QUEENSLAND UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES SOURCE : 5204.0 , 5206.0 , 1304.3 AND SEE APPENDIX C	14-Jun-81 09:07	53
PFCEAO$P	196903 - 197902	PFCEAO$P = PFCEAO * 100000 / (POP * CPIAO74) PRIVATE FINAL CONSUMPTION EXPENDITURE ON ALL OTHER GOODS AND SERVICES PER CAPITA AT AVERAGE 1974-75 PRICES , QUEENSLAND UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5204.0 , 5206.0 , 1304.3 AND SEE APPENDIX C	14-Jun-81 09:13	54
PFCEFD$P	196903 - 197902	FD PRIVATE FINAL CONSUMPTION EXPENDITURE ON FOOD PER CAPITA AT AVERAGE 1974-75 PRICES , QUEENSLAND UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5204.0 , 5206.0 , 1304.3 AND SEE APPENDIX C	14-Jun-81 09:08	55
PFCEHD$P	196903 - 197902	PFCEHD$P = PFCEHD * 100000 / (POP * CPIHS74) PRIVATE FINAL CONSUMPTION EXPENDITURE ON HOUSEHOLD DURABLES PER CAPITA AT AVERAGE 1974-75 PRICES , QUEENSLAND UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5204.0 , 5206.0 , 1304.3 AND SEE APPENDIX C	14-Jun-81 09:10	56
PFCERT$P	196903 - 197902	PFCERT$P = PFCERT * 100000 / (POP * CPIHO74) PRIVATE FINAL CONSUMPTION EXPENDITURE ON DWELLING RENT PER CAPITA AT AVERAGE 1974-75 PRICES , QUEENSLAND UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5204.0 , 5206.0 , 1304.3 AND SEE APPENDIX C	14-Jun-81 09:14	57
POP	196903 - 197902	POPULATION , QUEENSLAND UNITS : THOUSAND OF PERSONS SOURCE : 1304.3	14-Jun-81 08:00	58
SLENFA$	196903 - 197902	SLENFA$ = (ENFAWAT$P + ENFAROAD$P + ENFARAIL$P + ENFAOTH$P + ; ENFAHOUS$P + ENFAELEC$P) * POP / 1000. EXPENDITURE ON NEW FIXED ASSETS , QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES , AT AVERAGE 1974-75 PRICES UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:48	59

INDEX TO ENDOG.QTR

VARIABLE	FROM - TO	DESCRIPTION	LAST CHANGE	NR
SLFCE$	196903 - 197902	SLFCE$ = (FCELAW$P + FCEHLTH$P + FCEED$P + FCEALO$P + FCEECS$P) ; * POP / 1000. FINAL CONSUMPTION EXPENDITURE , QUEENSLAND STATE AND LOCAL GOVERNMENT AUTHORITIES , AT AVERAGE 1974-75 PRICES UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 09:50	60
TE	196903 - 197902	TOTAL NUMBER OF PERSONS EMPLOYED , QUEENSLAND UNITS : THOUSANDS OF PERSONS CALCULATED BY SUBTRACTION OF NRU FROM LF	14-Jun-81 08:02	61
UR	196903 - 197902	TEST = NETOT + NEEXOG + (NRU / 1000) UNEMPLOYMENT RATE , QUEENSLAND UNITS : PERCENT CALCULATED USING NRU AND LF	14-Jun-81 08:03	62
WRCON	196903 - 197902	WAGE RATE , WEEKLY , CONSTRUCTION INDUSTRY , QUEENSLAND ADULT MALES UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 08:07	63
WRELE	196903 - 197902	WAGE RATE , WEEKLY , ELECTRICITY INDUSTRY , QUEENSLAND ADULT MALES UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 08:06	64
WRMAN	196903 - 197902	WAGE RATE , WEEKLY , MANUFACTURING INDUSTRY , QUEENSLAND ADULT MALES UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 08:09	65
WRMEAN	196903 - 197902	WAGE RATE , WEEKLY , INDUSTRY AVERAGE , QUEENSLAND UNITS : DOLLARS CALCULATED BY WEIGHTED (EMPLOYMENT) AVERAGE OF INDUSTRY WAGE RATES	14-Jun-81 08:15	66
WRMIN	196903 - 197902	WAGE RATE , WEEKLY , MINING INDUSTRY , QUEENSLAND ADULT MALES UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 08:09	67
WRSER	196903 - 197902	WAGE RATE , WEEKLY , SERVICE INDUSTRY , QUEENSLAND ADULT MALES UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 08:10	68
WRTRD	196903 - 197902	WAGE RATE , WEEKLY , WHOLESALE & RETAIL TRADE , QUEENSLAND ADULT MALES UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 08:11	69
WRTRN	196903 - 197902	WAGE RATE , WEEKLY , TRANSPORT ETC INDUSTRY , QUEENSLAND ADULT MALES UNITS : DOLLARS SOURCE : 1304.3	14-Jun-81 08:12	70

PLANETS 13 [3006,3003] TTY13 * QUEENSLAND ECONOMETRIC MODEL DATA BA3 15-Jun-8 AG 8

INDEX TO ENDOG.QTR

VARIABLE	FROM - TO	DESCRIPTION	LAST CHANGE	NR
WSS	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 08:13	71
WSSCON	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , CONSTRUCTION INDUSTRY , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 08:14	72
WSSELE	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , ELECTRICITY INDUSTRY , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 08:16	73
WSSMAN	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , MANUFACTURING INDUSRTY , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 08:17	74
WSSMIN	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , MINING INDUSTRY , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 08:18	75
WSSSER	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , SERVICE INDUSTRY , QUEENSLAND UNITS : DOLLARS MILLION SERVICE COMPRISES FINANCE AND COMMUNITY AND ENTERTAINMENT ETC	14-Jun-81 08:19	76
WSSTRD	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , WHOLESALE & RETAIL TRADE INDUSTRY QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 08:20	77
WSSTRN	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , TRANSPORT ETC INDUSTRY , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 08:21	78
YAOHY	196903 - 197902	ALL OTHER HOUSEHOLD INCOME , QUEENSLAND UNITS : DOLLARS MILLION SOURCE : 5204.0 AND SEE APPENDIX C COMPRISES INCOME OF UNINCORPORATED ENTERPRISES, INCOME FROM DWELLINGS AND ALL OTHER INCOME	14-Jun-81 08:23	79
YTGG	196903 - 197902	HOUSEHOLD INCOME FROM TRANSFERS FROM GENERAL GOVERNMENT , QUEENSLAND UNITS : DOLLARS MILLION SOURCE : 5204.0 AND SEE APPENDIX C	14-Jun-81 08:25	80
YTGG$	196903 - 197902	YTGG$ = YTGG * 100 / CPI74 YTGG AT AVERAGE 1974-75 PRICES , QUEENSLAND UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES DEFLATED USING CPI74	14-Jun-81 08:33	81

INDEX TO EXOG.QTR

VARIABLE	FROM TO	DESCRIPTION	LAST CHANGE	NR
A$	196903 - 197902	A$ = GSP$ - SLFCE$ - SLENFA$ - PFCE$ - X$ + M$ STATE PRODUCTION ACCOUNT - EXPENDITURE SIDE RESIDUAL COMPRISES AUSTRALIAN GOVERNMENT EXPENDITURES IN QUEENSLAND , GROSS FIXED CAPITAL EXPENDITURE (PRIVATE) AND INCREASE IN STOCKS UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES CALCULATED AS A RESIDUAL	14-Jun-81 10:37	1
AR	196903 - 197902	LABOUR FORCE ACTIVITY RATE , QUEENSLAND UNITS : PERCENT CALCULATED AS THE RATIO OF LABOUR FORCE TO TOTAL POPULATION	14-Jun-81 10:38	2
BVWDOTH	196903 - 197902	LNBVWDOTH = LOG(BVWDOTH) VALUE OF WORK DONE ON OTHER BUILDINGS , QUEENSLAND UNITS : DOLLARS MILLION SOURCE : ABS TSD FILE	14-Jun-81 10:54	3
GCWCAP$P	196903 - 197902	GCWCAP$P = GCWCAP * 100000 / (POP * IPDSL) GRANTS FROM THE COMMONWEALTH GOVERNMENT FOR CAPITAL PURPOSES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 10:40	4
GCWCUR$P	196903 - 197902	GCWCUR$P = GCWCUR * 100000 / (POP * IPDSL) GRANTS FROM THE COMMONWEALTH GOVERNMENT FOR CURRENT PURPOSES PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 10:41	5
GDP	196903 - 197902	LNGDP = LOG(GDP) GROSS DOMESTIC PRODUCT AT MARKET PRICES , AUSTRALIA UNITS : DOLLARS MILLION SOURCE : ABS TSD FILE	14-Jun-81 10:55	6
GSPAGR	196903 - 197902	GROSS STATE PRODUCT , AGRICULTURE INDUSTRY , QUEENSLAND AT FACTOR COST UNITS : DOLLARS MILLION	14-Jun-81 10:42	7
GSPAGR$	196903 - 197902	GROSS STATE PRODUCT , AGRICULTUE INDUSTRY , QUEENSLAND AT AVERAGE 1974-75 PRICES AT FACTOR COST UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES DEFLATED USING NATIONAL GROSS FARM PRODUCT DEFLATOR	14-Jun-81 10:47	8
GSPODW	196903 - 197902	GROSS STATE PRODUCT , OWNERSHIP OF DWELLINGS , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 10:48	9
IPDM	196903 - 197902	IMPORT PRICE DEFLATOR , AUSTRALIA BASE : YEAR 1974-75 = 100.0 SOURCE : ABS TSD FILE	14-Jun-81 10:51	10
IPDSL	196903 - 197902	IMPLICIT PRICE DEFLATOR FOR STATE AND LOCAL GOVERNMENT EXPENDITURE AUSTRALIA BASE : YEAR 1974-75 = 100.0 SOURCE : ABS TSD FILE	14-Jun-81 10:50	11

INDEX TO EXOG.QTR

VARIABLE	FROM TO	DESCRIPTION	LAST CHANGE	NR
NEEXOG	196903 - 197902	NUMBER OF PERSONS EMPLOYED IN EXOGENOUS INDUSTRIES , QUEENSLAND COMPRISES AGRICULTURE , PUBLIC ADMINISTRATION AND DEFENCE AND PRIVATE DOMESTIC SERVICE UNITS : THOUSANDS OF PERSONS CALCULATED BY SUBTRACTION	14-Jun-81 11:00	12
NRUAUS	196903 - 197902	NUMBER OF REGISTERED UNEMPLOYED , AUSTRALIA UNITS : THOUSANDS OF PERSONS SOURCE : CES BULLETINS	14-Jun-81 11:01	13
OITLS	196903 - 197902	OITLS = ITLS - TAXPAYR OTHER INDIRECT TAXES LESS SUBSIDIES , QUEENSLAND TOTAL INDIRECT TAXES LESS SUBSIDIES LESS PAYROLL TAX UNITS : DOLLARS MILLION CALCULATED BY SUBTRACTION	14-Jun-81 11:03	14
OTHDED	196903 - 197902	OTHDED = CDITO + ODTXFF OTHER DEDUCTIONS FROM HOUSEHOLD INCOME , QUEENSLAND COMPRISES OTHER DIRECT TAXES ETC , CONSUMER DEBT INTEREST AND TRANSFERS OVERSEAS UNITS : DOLLARS MILLION SOURCE : 5204.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 11:06	15
PRODCOAL	196903 - 197902	LNPRODCOAL = LOG(PRODCOAL) PRODUCTION OF COAL , QUEENSLAND UNITS : THOUSANDS OF TONNES SOURCE : 1304.3	14-Jun-81 10:56	16
PRODELEC	196903 - 197902	LNPRODELEC = LOG(PRODELEC) PRODUCTION OF ELECTRICITY , QUEENSLAND UNITS : MILLIONS OF KILO-WATT HOURS SOURCE : 1304.3	14-Jun-81 10:58	17
Q02	196903 - 197902	Q02 = 1 QUARTERLY SEASONAL DUMMY VARIABLE FOR THE JUNE QUARTER	14-Jun-81 11:12	18
Q03	196903 - 197902	Q03 = 1 QUARTERLY SEASONAL DUMMY VARIABLE FOR THE SEPTEMBER QUARTER	14-Jun-81 11:13	19
Q04	196903 - 197902	Q04 = 1 QUARTERLY SEASONAL DUMMY VARIABLE FOR THE DECEMBER QUARTER	14-Jun-81 11:13	20
RESINC$P	196903 - 197902	RESINC$P = RESINC * 100000 / (POP * IPDSL) RESOURCE INCOME OF STATE AND LOCAL GOVERNMENT AUTHORITIES , QUEENSLAND (LARGELY INCOME OF PUBLIC ENTERPRISES) PER CAPITA AT AVERAGE 1974-75 PRICES UNITS : DOLLARS AT AVERAGE 1974-75 PRICES SOURCE : 5504.0 , 5206.0 AND SEE APPENDIX C	14-Jun-81 11:10	21
RSTOTAL	196903 - 197902	LNRSTOTAL = LOG(RSTOTAL) TOTAL RETAIL SALES , QUEENSLAND UNITS : DOLLARS MILLION SOURCE : 1304.3	14-Jun-81 10:58	22

INDEX TO EXOG.QTR

VARIABLE	FROM - TO	DESCRIPTION	LAST CHANGE	NR
TIME	196903 - 197902	TIME = 1 TIME TREND	14-Jun-81 11:13	23
WSSAGR	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , AGRICULTURE INDUSTRY , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 11:18	24
WSSPAD	196903 - 197902	WAGES , SALARIES AND SUPPLEMENTS , PUBLIC ADMINISTRATION AND DEFENCE INDUSTRY , QUEENSLAND UNITS : DOLLARS MILLION	14-Jun-81 11:19	25
X$	196903 - 197902	X$ = XIS$ + XOS$ EXPORTS AT AVERAGE 1974-75 PRICES , QUEENSLAND UNITS : DOLLARS MILLION AT AVERAGE 1974-75 PRICES SOURCE : 5402.3 DEFLATED USING NATIONAL EXPORT PRICE DEFLATOR	14-Jun-81 11:17	26
YUE	196903 - 197902	YUE = YFUE INCOME OF FARM UNINCORPORATED ENTERPRISES , QUEENSLAND UNITS : DOLLARS MILLION SOURCE : 5204.0 , 5206.0 AND SEE APPENDIX C	15-Jun-81 09:00	27

CHAPTER 6

SIMULATION OF THE QUEENSLAND MODEL

6.1 SIMULATION OF NON-LINEAR ECONOMETRIC MODELS

Since it is not possible to calculate the reduced form of a non-linear econometric model (see 2.3(iii) above), numerical methods must be used to obtain solution values of the endogenous variables of the model in terms of the exogenous and lagged endogenous variables, and the estimated coefficients. This procedure is necessary to understand and evaluate the complete structure of the model, rather than the equation-by-equation structure described in the examination of the estimation process.

The numerical technique used commonly in econometrics to solve these systems of simultaneous non-linear equations is the Gauss-Seidel iterative algorithm. This has been in standard use since the mid-1960s after the development of the Brookings model and the increased attention then paid to non-linearities in modelling. A number of computer programs using the Gauss-Seidel algorithm have been written. Among the most widely known and used are Holt *et al.* (1967), Klein and Evans (1969) and Norman (1967a). The program used in this study is the SIM program of Norman (1967a).[1] This program was used for the solution of the Treasury-ABS model (see 2.1 above).

The size of the Queensland model was not large enough to cause any programming difficulty. It was not necessary to sort the equations into model solution blocks of recursive and simultaneous equations (see Holt (1965)); nor was renormalization (see Norman (1967b)) necessary, since the model converged easily. The average number of iterations per quarter for solution in the historical simulation period was eleven.

No statistical tests of significance are available for the

---

[1]See Crossman (1979).

evaluation of the solution properties of models. Instead, analysis must proceed by comparing actual values of the endogenous variables with the solution values using a number of summary statistics.

These summary statistics, over a simulation horizon T (where Y_t^s is the solution value of the endogenous variable Y in time period t, and Y_t^a is the actual value) include:

ME (Mean Error) $$= \frac{1}{T} \sum_{t=1}^{T} (Y_t^s - Y_t^a)$$

MPE (Mean Percent Error) $$= \frac{1}{T} \sum_{t=1}^{T} \left(\frac{Y_t^s - Y_t^a}{Y_t^a} \right)$$

RMSE (Root Mean Square Error) $$= \sqrt{\frac{1}{T} \sum_{t=1}^{T} (Y_t^s - Y_t^a)^2}$$

RMSPE (Root Mean Square Percent Error) $$= \sqrt{\frac{1}{T} \sum_{t=1}^{T} \left(\frac{Y_t^s - Y_t^a}{Y_t^a} \right)^2}$$

MAE (Mean Absolute Error) $$= \frac{1}{T} \sum_{t=1}^{T} |Y_t^s - Y_t^a|$$

MAPE (Mean Absolute Percent Error) $$= \frac{1}{T} \sum_{t=1}^{T} \left| \frac{Y_t^s - Y_t^a}{Y_t^a} \right|$$

The model was estimated with both OLS and TSPC.

Simulation runs were of four different types:

(i) historical validation runs, over the period of estimation, viz, 197003 to 197802;

(ii) ex post forecast runs, over the period 197803 to 197902;

(iii) dynamic multiplier derivation runs, over the benchmark period 197601 to 197902; and,

(iv) policy experimentation runs, over the benchmark period 197601 to 197902.

While the first three types of simulation runs above are useful in examining the properties of the model as specified and estimated in Chapter Five, it must be emphasized that the three policy experiments should not be regarded as being useful for immediate consideration for practical policy uses and have been included for demonstration purposes. On the other hand, these simulation results are, as far as is known, the only policy simulation results from an econometric model of any state of Australia, and therefore have some claim to importance. The policy experiments include:

(a) an increase in the rate of personal income tax,

(b) a boom in the national economy, and,

(c) a freeze of Commonwealth government grants.

6.2 OLS HISTORICAL VALIDATION DYNAMIC SIMULATION

The model was simulated using program SIM over the full estimation period, 197003 to 197802, using the values of the endogenous variables for 196903 to 197002 as starting values and initial lagged values.

Figures 6.1 to 6.14 show the actual and simulated values of fourteen selected endogenous variables. These are gross state product (GSP), gross state product at average 1974-75 prices (GSP$), private final consumption expenditure at average 1974-75 prices (PFCE$), state

Figure 6.1: Actual and simulated values of gross state product

Figure 6.2: Actual and simulated values of gross state product at average 1974-75 prices (GSP$)

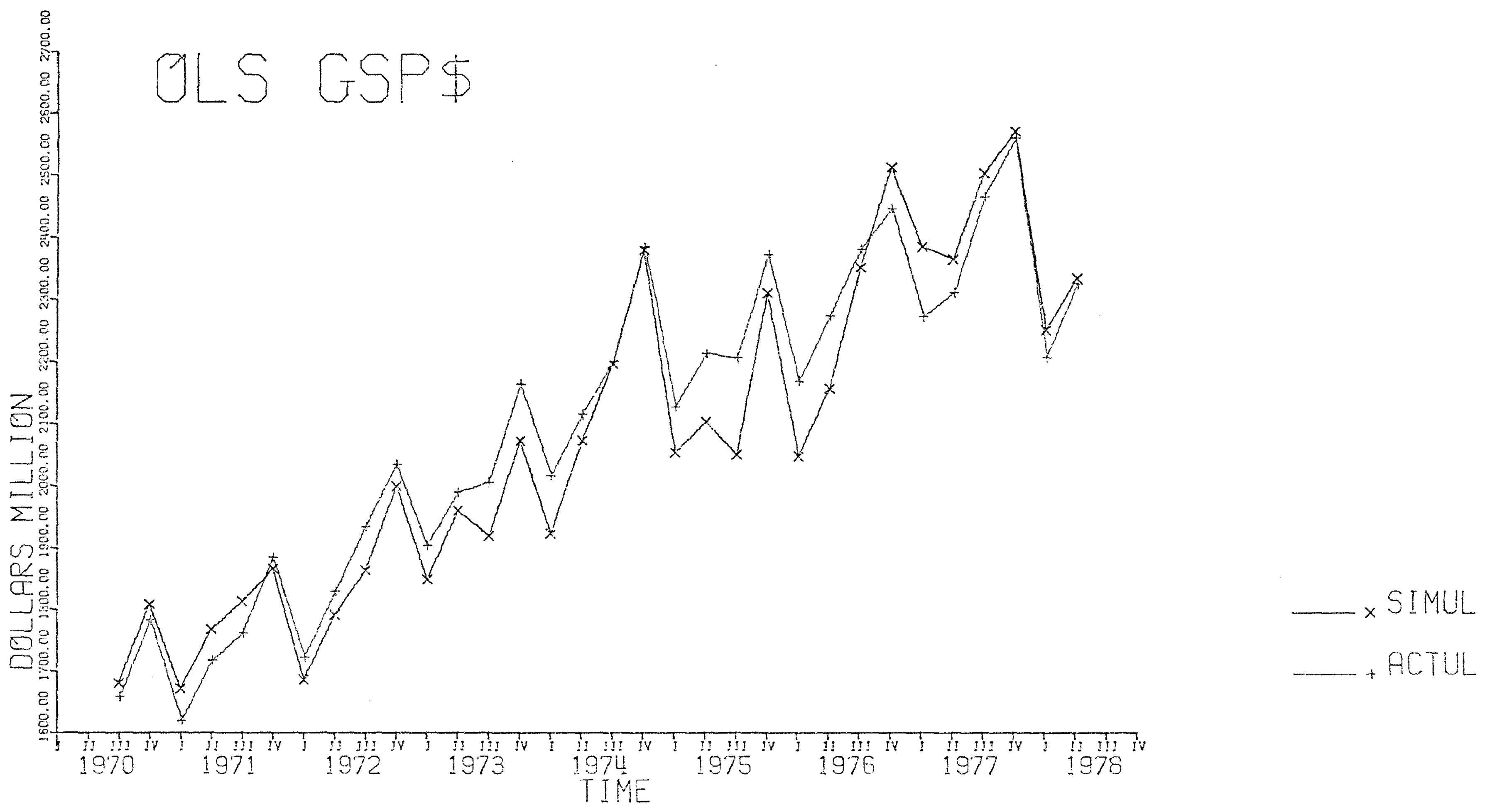


Figure 6.3: Actual and simulated values of private final consumption expenditure at average 1974-75 prices (PFCE$)

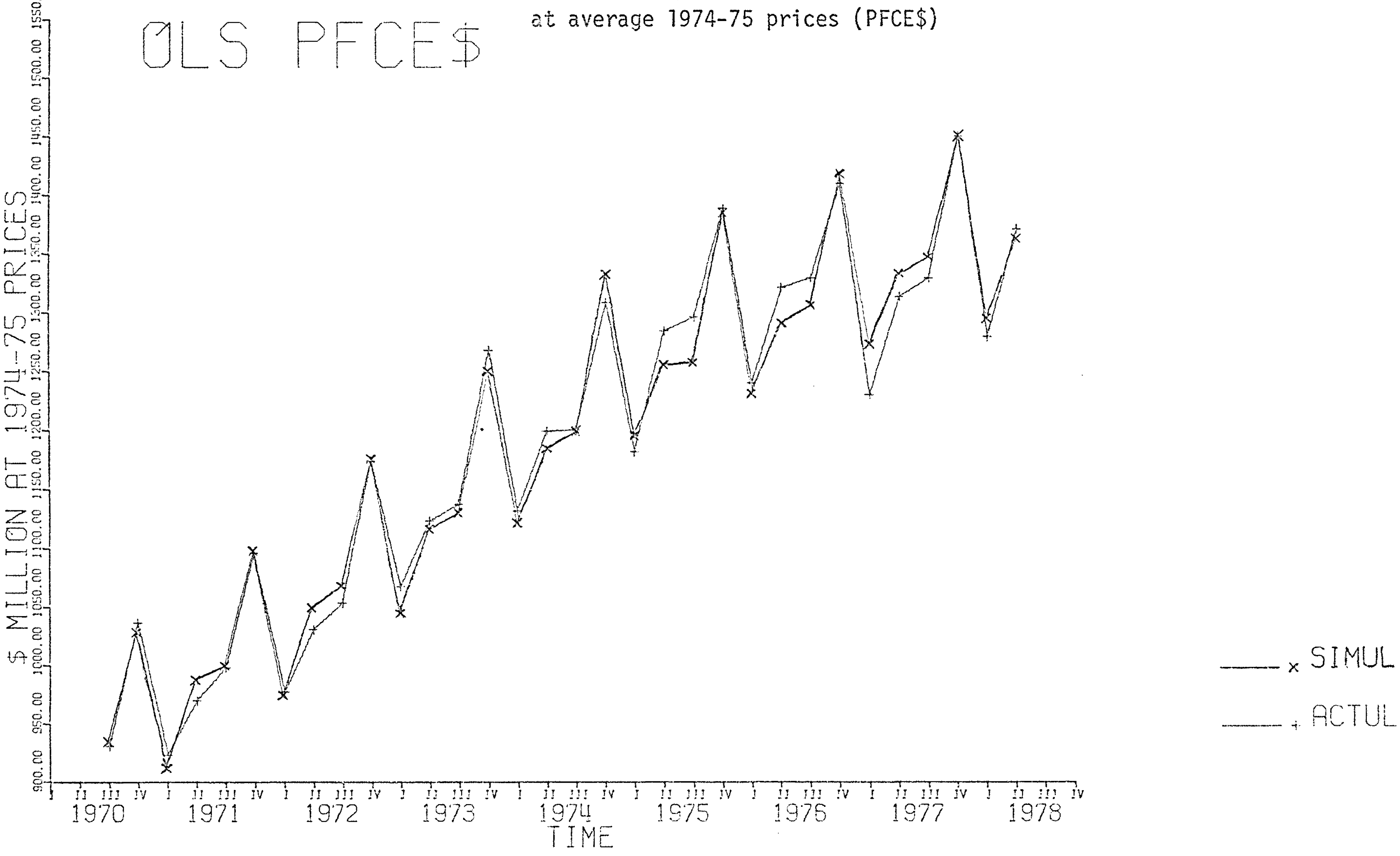


Figure 6.4: Actual and simulated values of state and local government final consumption expenditure at average 1974-75 prices (SLFCE$)

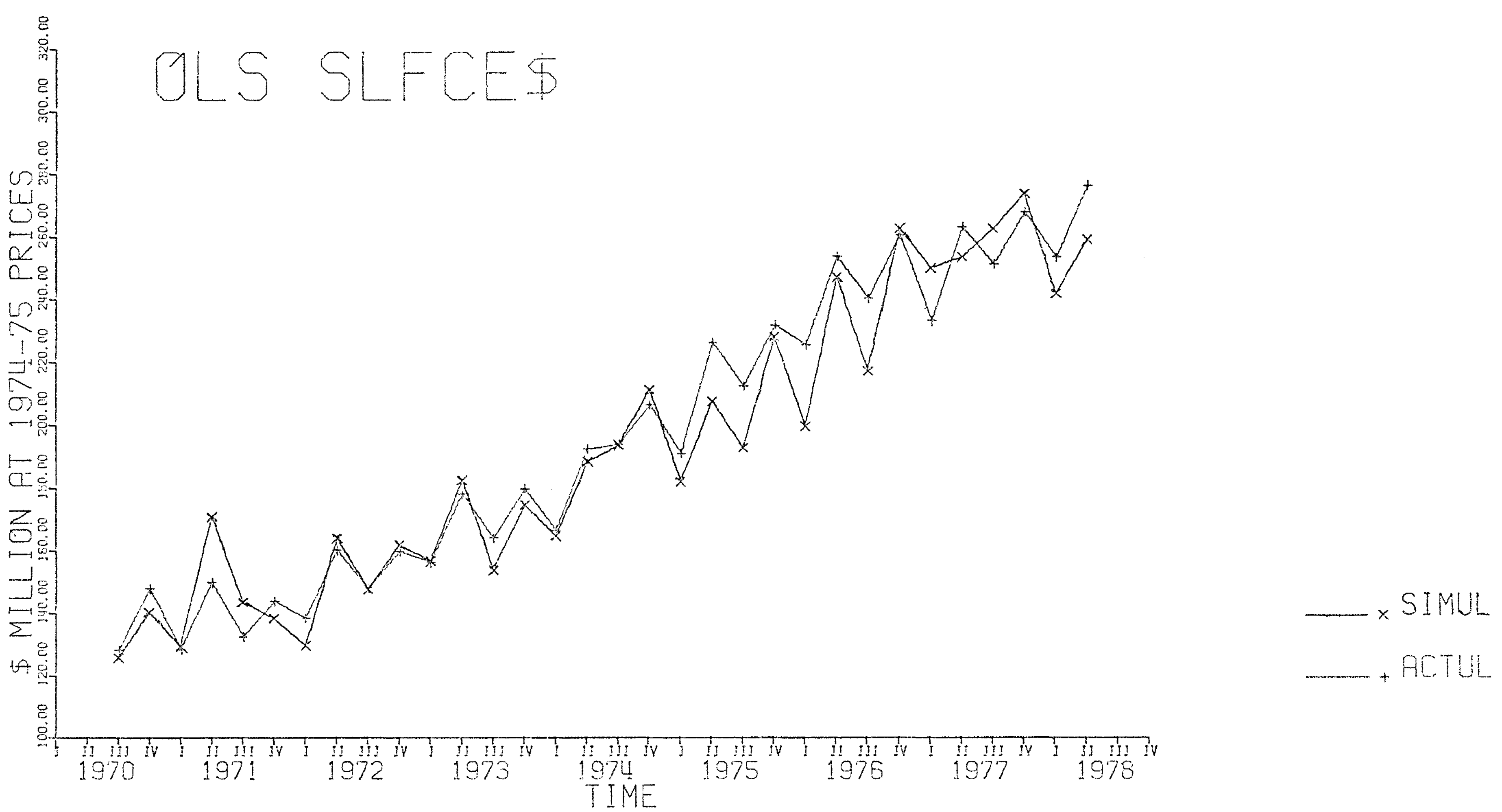


Figure 6.5: Actual and simulated values of state and local government expenditure on new fixed assets at average 1974-75 prices (SLENFA$)

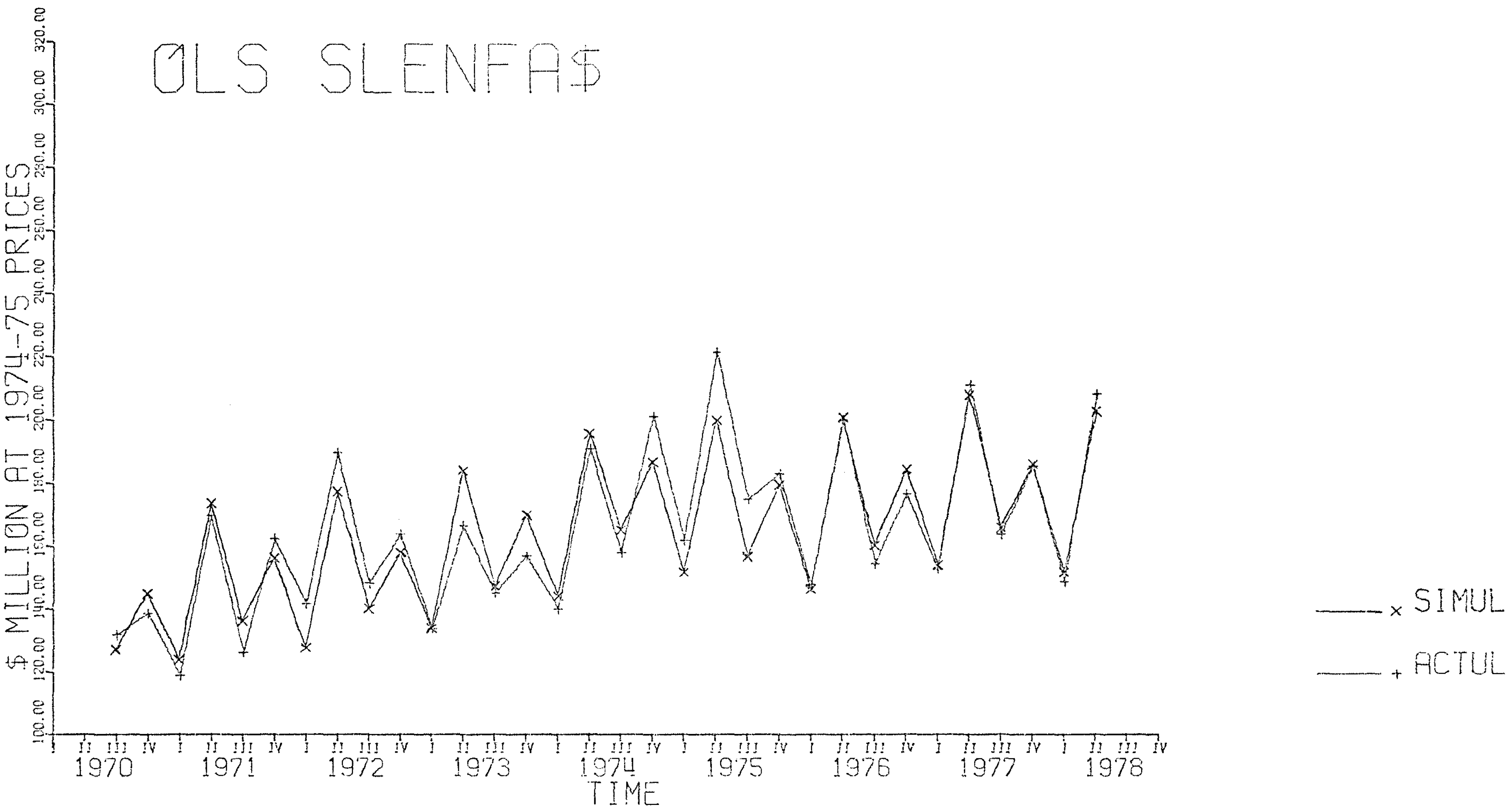


Figure 6.6: Actual and simulated values of imports (M$)

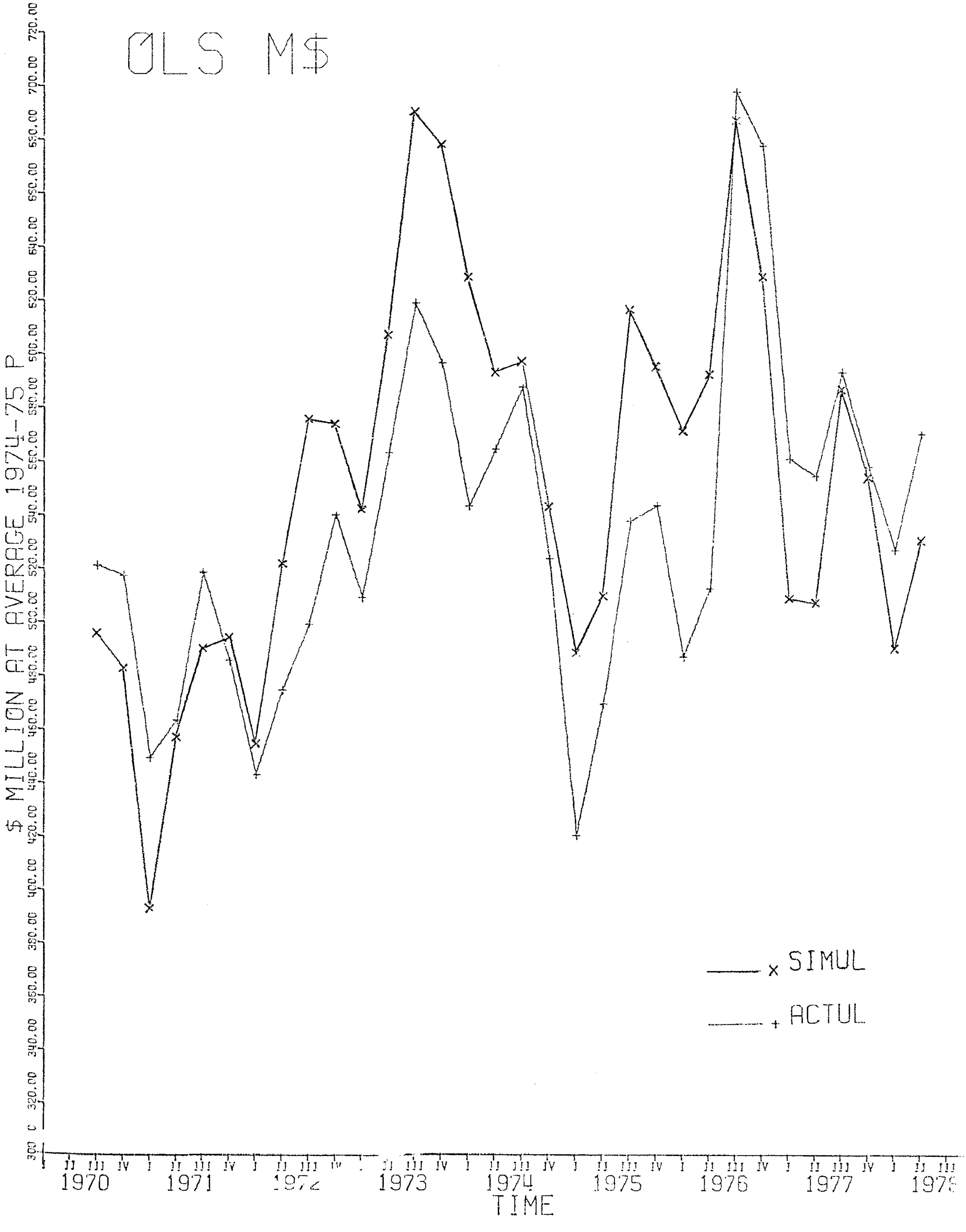


Figure 6.7: Actual and simulated values of implicit price deflator for gross non-agricultural product (IPDNONFARM)

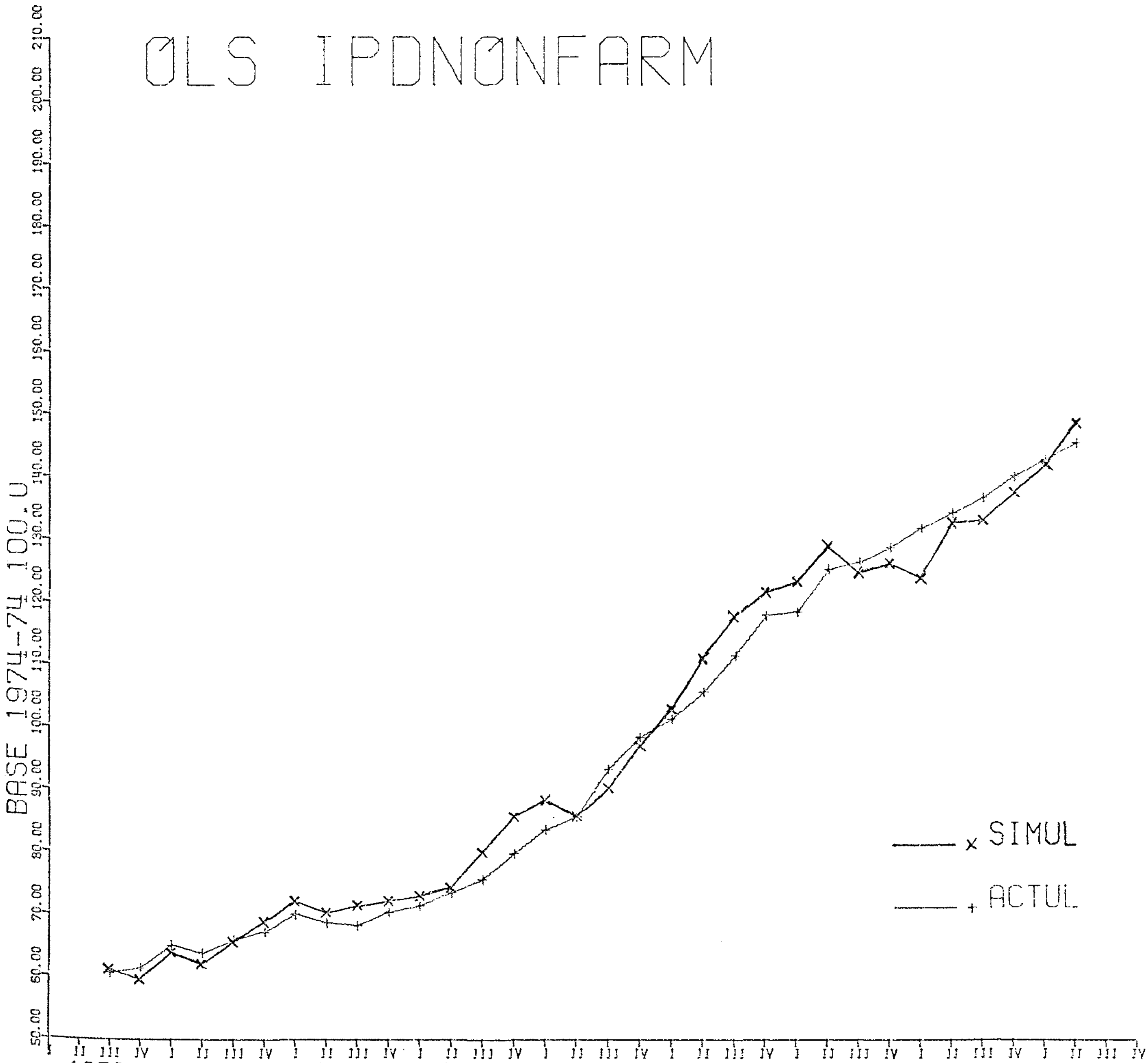


Figure 6.8: Actual and simulated values of consumer price index (CPI74)

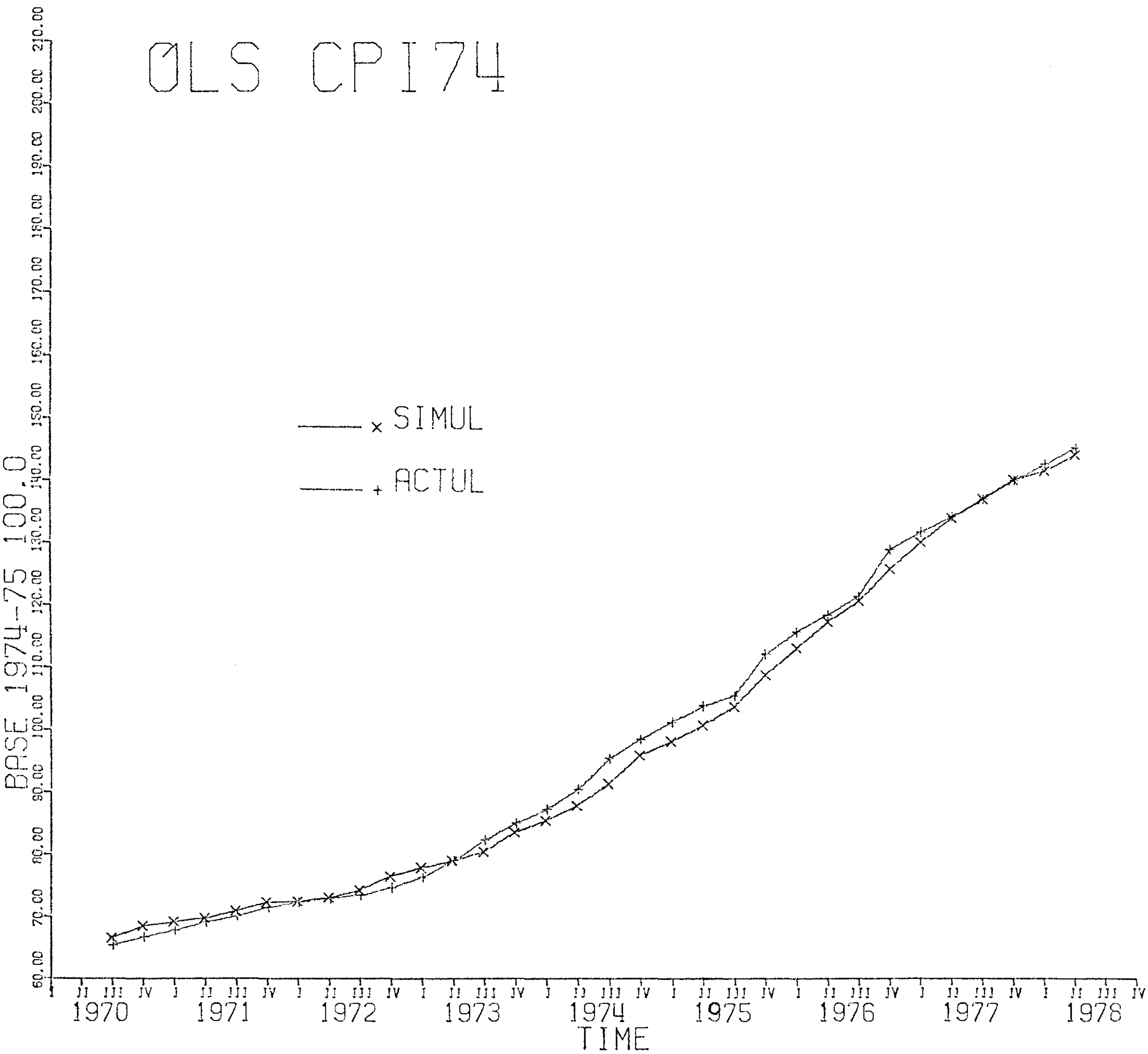


Figure 6.9: Actual and simulated values of population (POP)

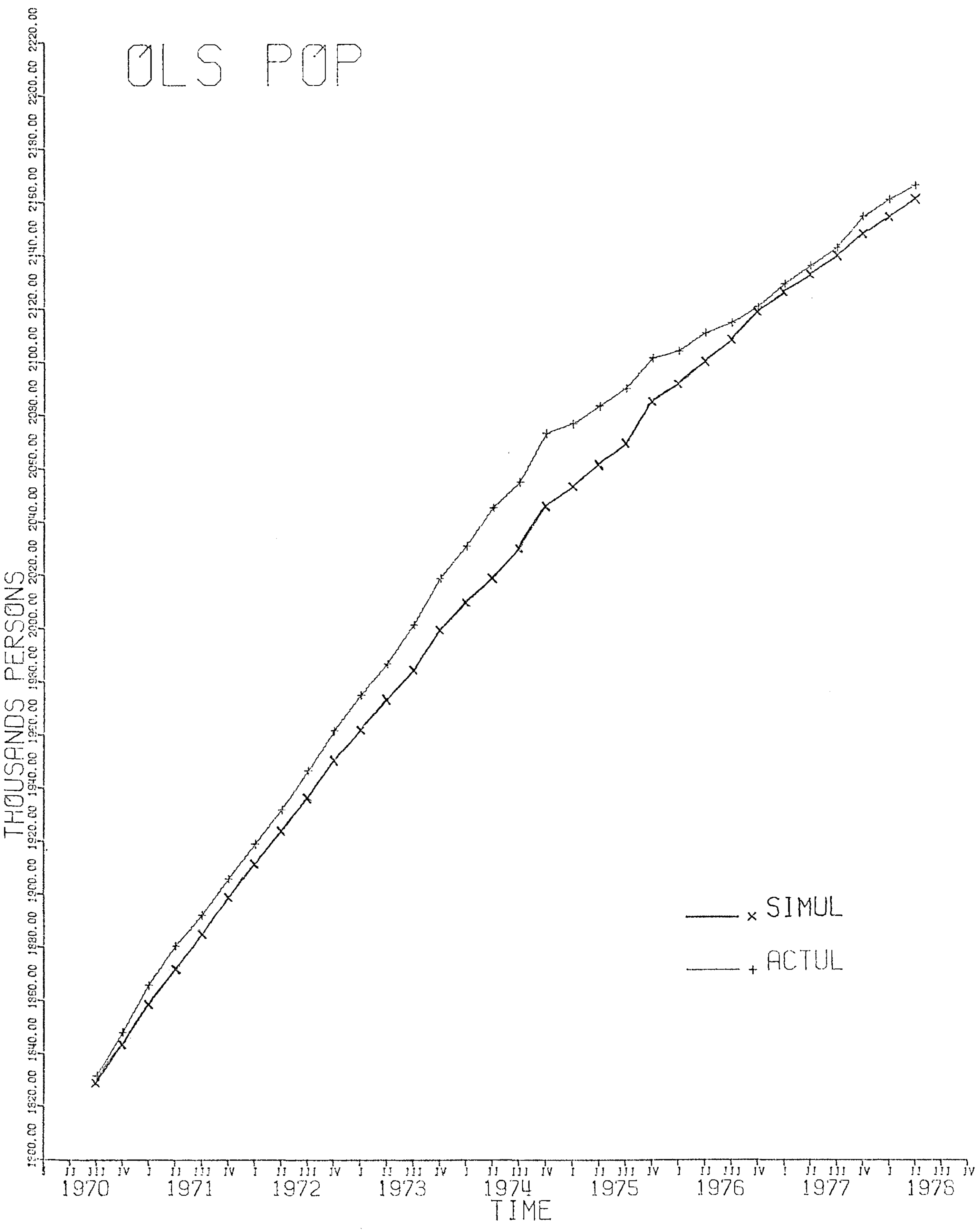


Figure 6.10: Actual and simulated values of unemployment rate (UR)

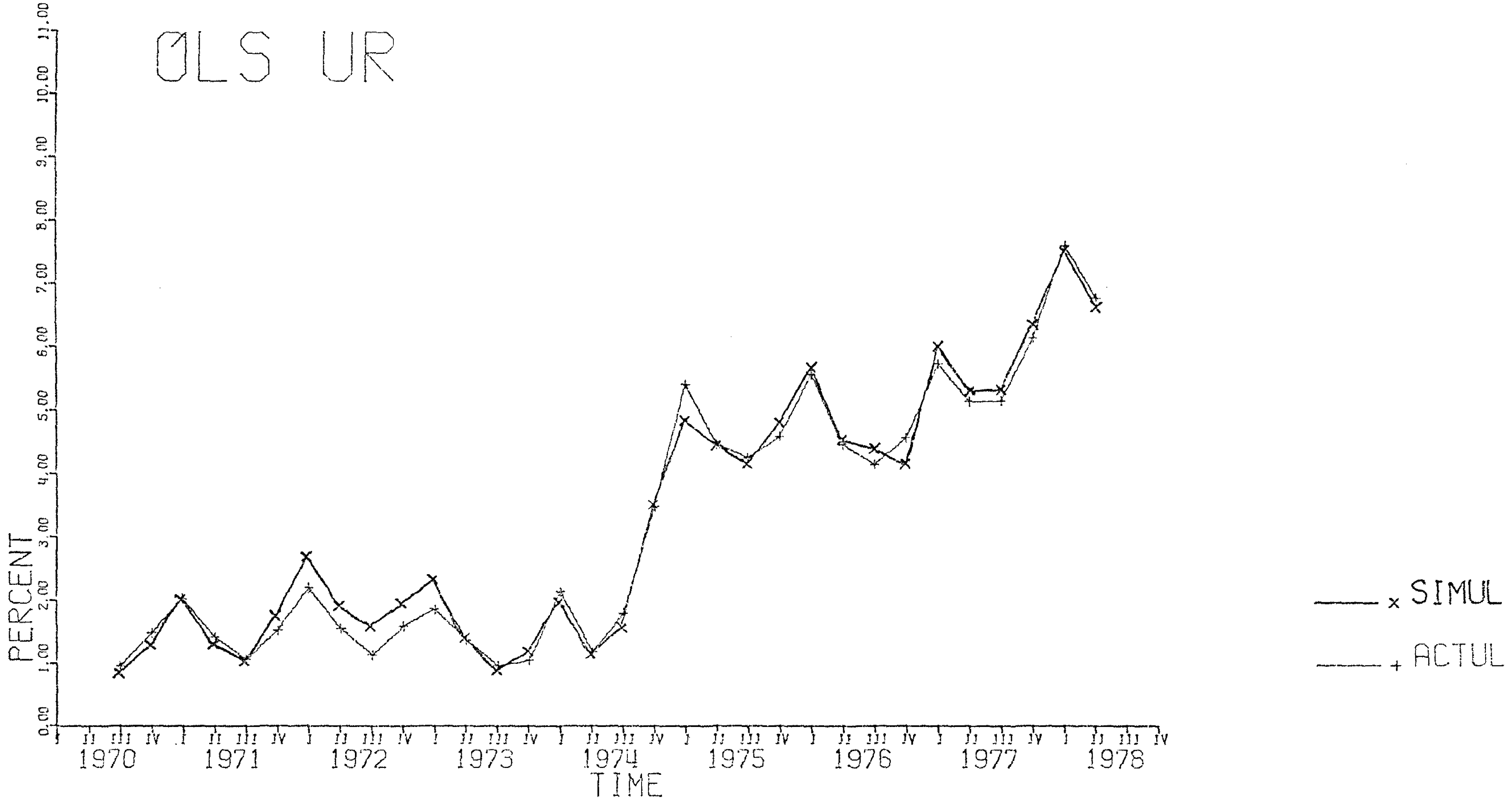


Figure 6.11: Actual and simulated values of wages, salaries and supplements (WSS)

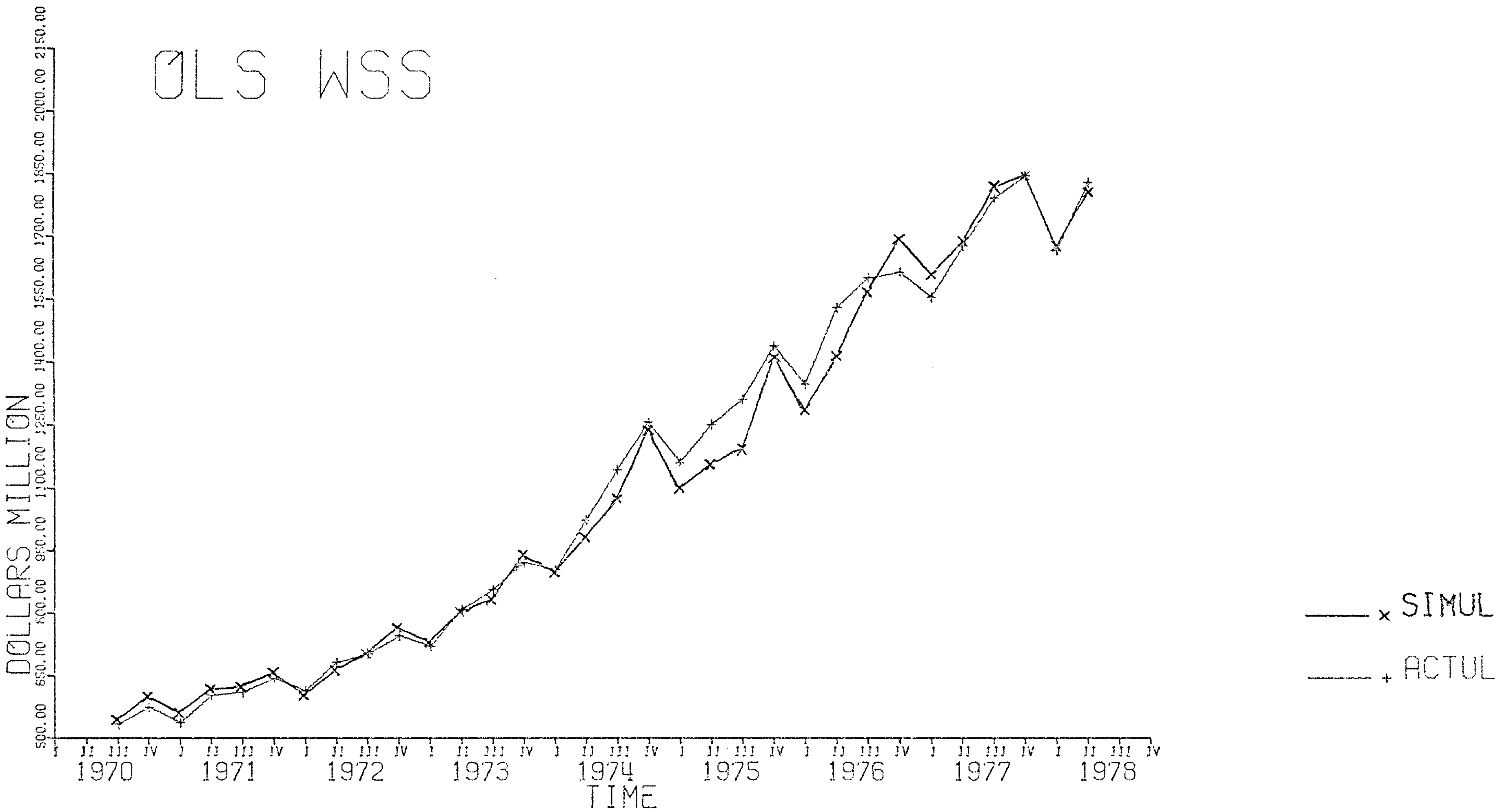


Figure 6.12: Actual and simulated values of average weekly earnings per employed male unit (AWEEMU)

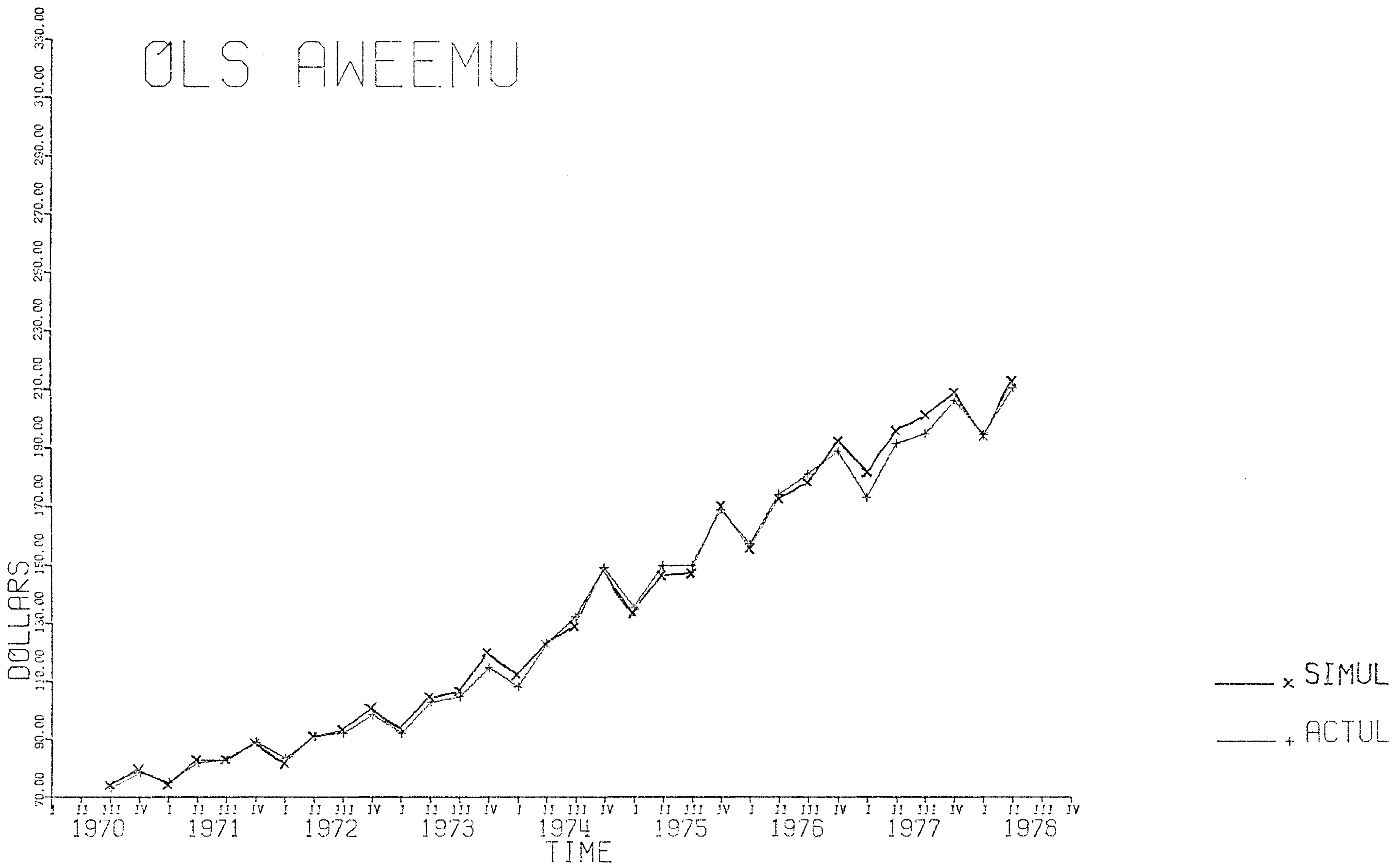


Figure 6.13: Actual and simulated values of federal income taxes (FYTX)

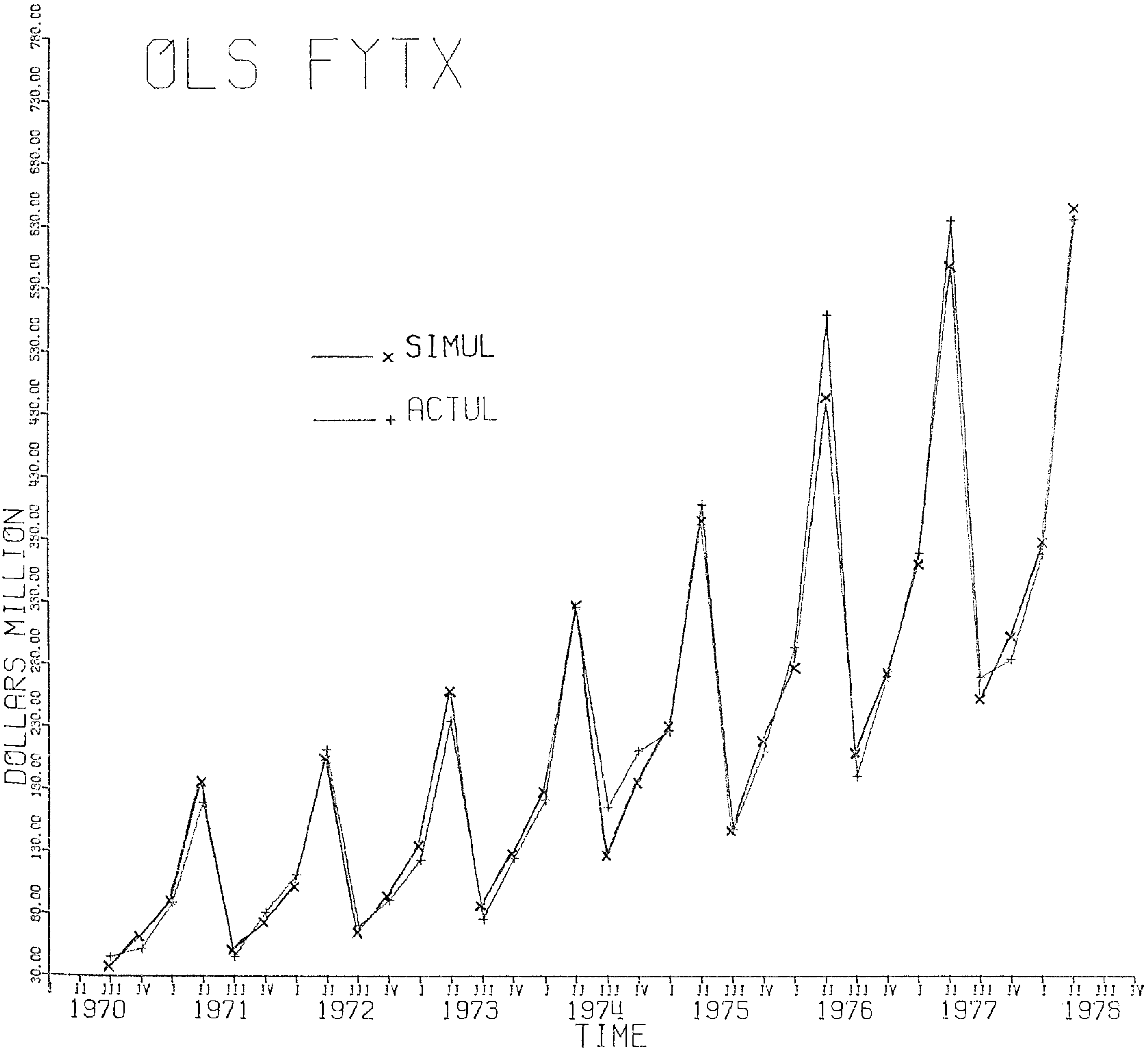
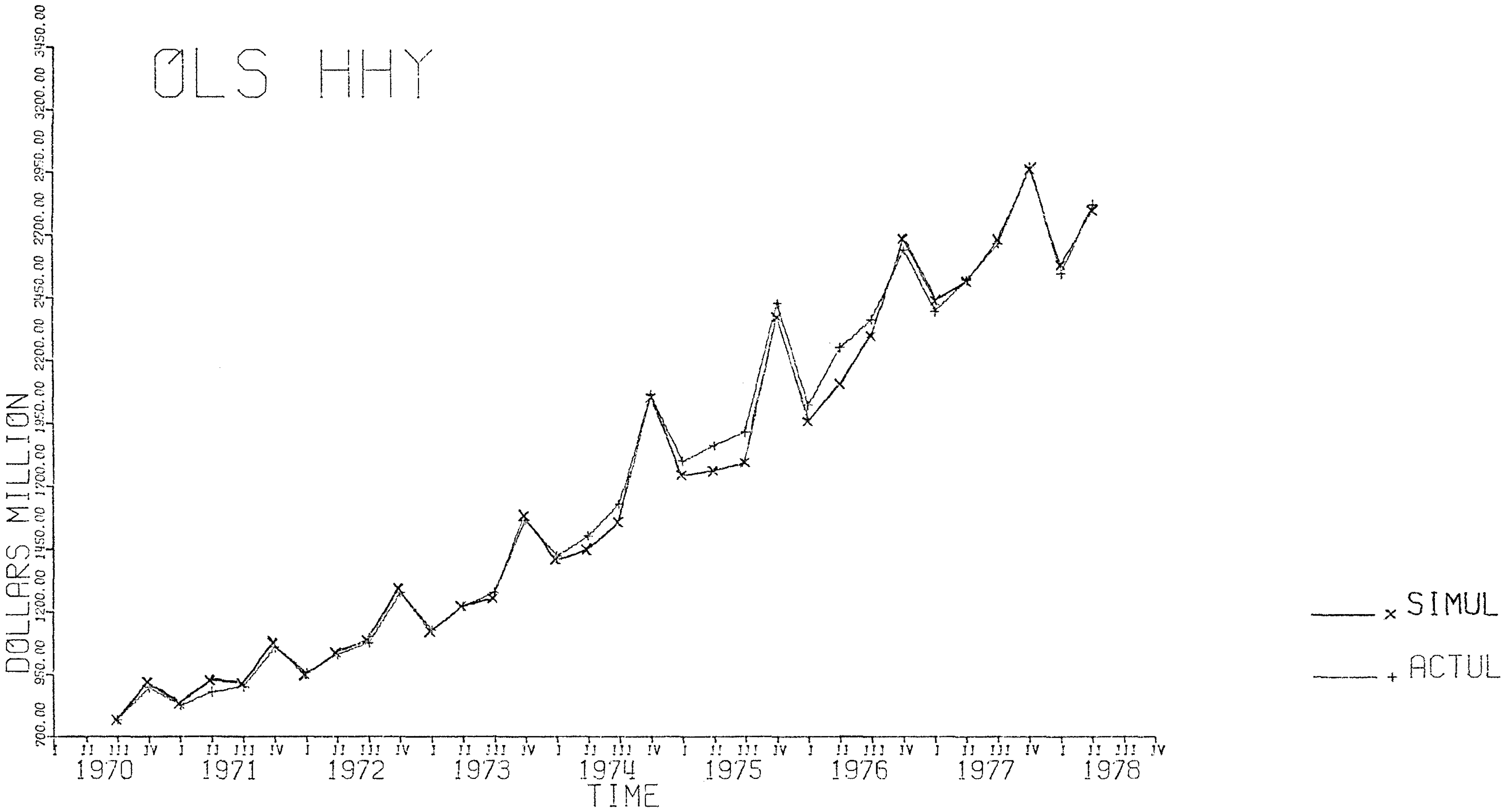


Figure 6.14: Actual and simulated values of household income (HHY)



and local government final consumption expenditure at average 1974-75 prices (SLFCE$), state and local government expenditure on new fixed assets at average 1974-75 prices (SLENFA$), imports (M$), implicit price deflator for gross non-agricultural product (IPDNONFARM), consumer price index (CPI74), population (POP), unemployment rate (UR), wages, salaries and supplements (WSS), average weekly earnings per employed male unit (AWEEMU), federal income taxes (FYTX) and household income (HHY).

Table 6.1 lists the summary statistics for the major endogenous variables from the run using OLS coefficients. Endogenous variables are defined as major if they are not logarithmic or difference variables, i.e., LNNEMIN, say, is not included, whereas NEMIN is. This actually has the effect of raising the average MAPE level, since the logarithmic and difference variables have smaller percent errors (and, of course, level errors) than the transformed, original variables.

Glickman (1977, p. 142) claims that " ... econometricians are generally satisfied if their models record a sample period MAPE of less than 2 or 3%". Rubin and Erickson (1980, pp. 28-29) on the other hand, claim that " ... error values falling below 10 percent are generally considered acceptable while those under five percent are perceived as being quite good". Of the eighty-one OLS MAPE's in Table 6.1, six, or 7.4%, are greater than 10%, while fiftysix, or 69.1%, are less than 5%. This can be compared to the results of Glickman (1977) where 18.1% were greater than 5% and the results of Rubin and Erickson (1980) where 2% were greater than 10% and 76% were less than 5%. These were both annual models. About 31% of the MAPE's in the quarterly model of Latham *et al.* (1979) were greater than 5%, and 31% were smaller than 3%. The Queensland model had 37.1% of its MAPE's below 3%.

Table 6.2 shows the distribution of MAPE's for the Queensland model. There is no absolute standard, but the distribution seems reasonably satisfactory for a preliminary model such as this Queensland model.

It is worth noting that the Reserve Bank RBI model had a high root mean square percent error (RMSPE) for unemployment (22%).[2] Also,

[2]See Norton and Henderson (1972, p. 20).

Table 6.1: OLS historical validation dynamic simulation run summary statistics

			Summary Statistics					
			Level Errors			Percent Errors		
Variable	Units	Mean Value	ME	RMSE	MAE	MPE	RMSPE	MAPE
PFCEFD$P	1974-75$	107.5	1.2	2.6	2.1	1.1	2.4	2.0
PFCEHD$P	1974-75$	53.6	0.4	2.6	2.2	0.9	4.9	4.1
PFCERT$P	1974-75$	77.5	0.0	1.0	0.8	0.0	1.3	1.1
PFCEAO$P	1974-75$	349.5	1.0	7.3	6.0	0.3	2.1	1.7
PFCE$	1974-75$m	1189.3	-1.8	17.7	14.1	-0.2	1.5	1.2
FCELAW$P	1974-75$	10.7	-0.1	0.5	0.4	-0.9	4.7	3.7
FCEHLTH$P	1974-75$	20.6	-0.3	1.6	1.2	-1.5	7.7	5.9
FCEED$P	1974-75$	37.9	-0.5	2.7	2.1	-1.3	7.0	5.6
FCEALO$P	1974-75$	16.0	-0.3	1.3	1.0	-1.8	9.0	6.9
FCEECS$P	1974-75$	9.9	0.0	0.6	0.5	0.0	6.5	5.5
ENFAWAT$P	1974-75$	12.6	-0.0	1.0	0.8	-0.2	7.8	6.3
ENFAROAD$P	1974-75$	22.2	0.1	0.9	0.7	0.3	3.9	3.0
ENFARAIL$P	1974-75$	6.6	0.2	1.3	1.1	2.1	20.1	17.7
ENFAAOTH$P	1974-75$	23.5	-0.4	2.8	2.4	-1.4	13.1	10.8
ENFAHOUS$P	1974-75$	2.8	0.1	1.0	0.8	2.1	33.0	25.6
ENFAELEC$P	1974-75$	13.6	-0.0	1.0	0.8	-0.2	7.5	6.0
MTAXLGR$P	1974-75$	-11.6	-0.1	1.1	0.8	0.8	12.7	8.9
MTAXMOT$P	1974-75$	-8.0	-0.0	0.4	0.3	0.7	5.1	4.0
MTAXPAYR$P	1974-75$	-10.4	0.5	2.9	2.6	-2.4	46.2	35.4
MTAXALO$P	1974-75$	-20.0	0.4	2.1	1.7	-1.9	10.4	8.5
MADDEBT$P	1974-75$	-10.1	0.4	7.3	6.1	129.8	847.4	270.5
SLFCE$	1974-75$m	193.0	-3.5	11.2	8.7	-1.8	5.7	4.4
SLENFA$	1974-75$m	164.4	-1.2	8.9	7.0	-0.7	5.4	4.3

Table 6.1 (continued)

Variable	Units	Mean Value	Summary Statistics: Level Errors			Percent Errors		
			ME	RMSE	MAE	MPE	RMSPE	MAPE
M$	1974-75$m	552.7	17.4	49.2	42.1	2.6	8.7	7.6
GSP$	1974-75$m	2076.1	-23.8	68.0	56.8	-1.2	3.3	2.8
GNAP$	1974-75$m	1880.3	-23.8	68.0	56.8	-1.3	3.6	3.1
GSPMIN	$m	119.2	-0.6	12.1	9.1	-0.2	9.3	7.7
GSPMAN	$m	290.6	-0.2	7.8	6.6	0.2	2.9	2.4
GSPELE	$m	56.9	0.1	2.7	1.9	0.4	3.9	3.1
GSPCON	$m	163.8	-3.3	9.7	6.8	-1.8	4.9	3.8
GSPTRD	$m	321.2	-3.3	14.7	11.1	-0.6	4.0	3.3
GSPTRN	$m	173.6	-0.7	7.3	5.4	-0.1	3.5	2.8
GSPSER	$m	387.0	-0.6	16.7	11.2	-0.5	3.7	2.8
IBSC	$m	52.5	0.1	1.8	1.5	1.3	4.7	3.5
GSPFC	$m	1860.5	-8.9	37.4	29.4	-0.4	1.8	1.5
GSP	$m	2078.4	-10.1	37.8	29.2	-0.4	1.6	1.3
ITLS	$m	217.9	-1.2	5.3	4.8	-0.5	2.9	2.6
GOS	$m	759.1	4.6	41.0	31.2	0.4	4.8	3.9
CPIFD74	100.0	96.1	-1.2	2.7	2.1	-1.0	2.9	2.3
CPIHO74	100.0	99.0	-0.9	2.2	1.8	-0.6	2.2	1.8
CPIHS74	100.0	96.4	-0.3	2.6	2.0	-0.3	2.6	2.0
CPIAO74	100.0	97.8	-0.8	1.8	1.4	-0.7	1.9	1.5
CPI74	100.0	97.4	-0.9	1.9	1.6	-0.8	2.0	1.7
IPDNONFARM	100.0	97.4	0.7	3.3	2.7	0.8	3.2	2.8

Table 6.1 (continued)

			Summary Statistics					
			Level Errors			Percent Errors		
Variable	Units	Mean Value	ME	RMSE	MAE	MPE	RMSPE	MAPE
NEMIN	'000 persons	14.4	-0.1	0.7	0.5	-1.0	4.6	3.5
NEMAN	'000 persons	119.8	-0.3	2.3	1.9	-0.2	1.9	1.6
NEELE	'000 persons	9.6	-0.1	0.5	0.3	-1.2	5.1	3.4
NECON	'000 persons	68.7	-1.1	3.3	2.7	-1.6	4.8	4.0
NETRD	'000 persons	144.6	-0.6	2.6	2.2	-0.4	1.8	1.5
NETRN	'000 persons	57.1	-1.0	2.5	1.8	-1.7	4.4	3.2
NESER	'000 persons	186.9	-1.7	6.1	4.6	-1.0	3.2	2.4
TE	'000 persons	804.4	-4.8	14.5	11.2	-0.6	1.8	1.4
NATI	'000 persons	5.0	-0.1	0.3	0.3	-0.9	7.2	5.4
NMIG	'000 persons	5.7	-0.1	2.5	2.1	11.3	86.6	54.8
POP	'000 persons	2015.6	-12.0	14.2	12.0	-0.6	0.7	0.6
LF	'000 persons	832.7	-4.9	5.9	4.9	-0.6	0.7	0.6
NRU	'000 persons	28.8	0.2	2.1	1.6	1.0	10.8	8.2
UR	%	3.3	0.0	0.2	0.2	1.6	10.8	8.1
WRMEAN	$	98.8	4.1	5.6	4.9	4.4	5.7	5.1
AWEEMU	$	134.3	0.8	2.9	2.2	0.5	1.9	1.6
WRMIN	$	119.3	-0.4	5.7	4.1	0.5	5.0	3.8
WRMAN	$	97.3	-0.5	4.0	2.8	-0.2	4.1	3.0
WRELE	$	99.7	-0.6	3.9	2.7	-0.3	3.9	2.8
WRCON	$	99.1	-0.4	4.2	3.1	0.0	4.3	3.3
WRTRD	$	97.9	-0.7	3.3	2.4	-0.5	3.4	2.5
WRTRN	$	106.3	-0.5	4.7	3.3	-0.1	4.5	3.2
WRSER	$	96.3	-0.6	3.7	2.7	-0.3	3.8	2.8

Table 6.1 (continued)

			Summary Statistics					
			Level Errors			Percent Errors		
Variable	Units	Mean Value	ME	RMSE	MAE	MPE	RMSPE	MAPE
WSSMIN	$m	41.1	-1.0	4.5	3.2	-2.1	9.8	7.6
WSSMAN	$m	195.2	-1.0	6.8	5.3	-0.3	3.5	2.9
WSSELE	$m	26.3	-0.6	2.1	1.4	-1.6	6.3	4.7
WSSCON	$m	118.5	-1.2	7.9	5.9	-1.4	6.0	4.7
WSSTRD	$m	207.7	-2.1	12.6	9.5	-0.9	5.3	4.2
WSSTRN	$m	119.4	-3.6	9.8	6.8	-2.1	7.2	5.2
WSSSER	$m	261.0	-3.9	15.6	11.3	-1.4	5.5	4.2
WSS	$m	1101.3	-13.5	45.9	33.3	-1.0	3.9	3.0
YTGG$	1974-75$m	165.0	-1.8	11.1	8.6	-0.5	6.4	5.3
YTGG	$m	171.6	-4.8	13.6	9.7	-1.2	7.1	5.6
YAOHY	$m	320.3	-0.4	11.1	9.1	-0.6	4.3	3.3
FYTX	$m	225.4	-3.3	18.6	13.1	-1.3	9.6	7.2
HHY	$m	1699.7	-18.7	50.6	35.4	-0.9	2.8	2.1
HDY	$m	1431.1	-15.4	45.4	35.2	-0.9	3.0	2.4

Table 6.2: Distribution of OLS MAPE's

MAPE range	Number of MAPE's	Percent of MAPE's
10% or higher	6	7.4
9 - 9.99%	0	0
8 - 8.99%	4	4.9
7 - 7.99%	4	4.9
6 - 6.99%	3	3.7
5 - 5.99%	8	9.9
4 - 4.99%	9	11.1
3 - 3.99%	17	21.0
2 - 2.99%	16	19.8
1 - 1.99%	12	14.8
smaller than 1%	2	2.5
	81	100.0

variables which are near zero or which change sign frequently are not appropriately described by percent error summary statistics. This applies to such variables in the Queensland model as MADDEBT$P (addition to debt), which has an absurd MAPE of 270%, but a mean error of $0.4 out of a mean of $-10.1, and NMIG (net in-migration), which has a MAPE of 55% but a mean error of -0.1 thousand persons out of a mean of 5.7 thousand persons over the estimation period. The other four variables with MAPE's greater than 10% were three variables defining state and local government expenditures on new fixed assets, and payroll tax. That these high MAPE's do not affect the model solution significantly is seen from an examination of the MAPE's of total expenditure on new fixed assets (4.3%) and indirect taxes less subsidies (2.6%). Federal income taxes (FYTX) had a relatively high MAPE of 7.2%. A similar MAPE of 8.2% was reported in the quarterly model of Latham *et al.* (1979) for personal income taxes. This is a consequence of using a simple specification of the income tax equation, which neglects to consider base and rate changes which have been important during the estimation period.

6.3 TSPC HISTORICAL VALIDATION DYNAMIC SIMULATION

The model was estimated using two-stage least squares with four principal components, since ordinary least squares estimation can be shown to be biassed and inconsistent in estimating equations in a simultaneous-equation system.[3] The results for equation #4, for private final consumption expenditure on all other commodity items, and for the wage rate equations, #77-83, were not used for the TSPC simulations, because of the presence of wrong signs of coefficients and their poor statistical fit. OLS estimates were used instead. Equations #24, 28-9 and 34 were not estimated by TSPC, since OLS and

[3] See Johnston (1972).

TSPC estimates are identical when the set of explanatory variables in an equation include only exogenous model variables.

The SHAZAM package[4] was used to compute the TSPC estimates. TSLS is an estimation technique which can be used to estimate overidentified equations in a system of simultaneous equations, and since these overidentified equations often occur in larger econometric models, where the estimation period generally contains fewer than fifty observations, principal components are necessary to permit the first stage estimation of the reduced form. SHAZAM calculates the "correct" TSLS coefficient of determination, uses Theil's divisor, and computes the "correct" asymptotic variance-covariance matrix. Four principal components were created from the set of model exogenous variables, following the experience of Klein in estimating the Klein-Goldberger model.[5] These were used, with the quarterly dummy variables, as instrument variables.

While TSPC, being a simultaneous-equation estimator, is commonly expected to result in lower MAPE's and generally improved simulation accuracy, it is by no means clear that this is an invariable result. Some techniques for correction for autocorrelation in TSLS are available but are not widely used in practice, especially in equations containing lagged dependent variables. Roberts and Fishkind (1979), for instance, while using TSLS, did not correct for autocorrelation. This is evident in many of the estimated equations listed in their model appendix.

In fact, the gain in simulation accuracy of TSLS over OLS with autoregressive corrections is not firmly established in empirical work. Glickman (1977) reports the MAPE valuation for the ten most important variables of the Philadelphia model for five estimation methods: OLS, OLS with the Cochrane-Orcutt technique applied (OLS2), TSLS with five principal components, Iterated TSLS, and Iterated Instrumental Variables. The comparison of OLS2 and TSLS with five principal components showed that OLS2 had lower MAPE's for five of the ten "most important" variables.

Rubin and Erickson (1980, p. 13) claim that, compared to TSLS,

---

[4]White (1978).

[5]See Johnston (1972, p. 395).

" ... OLS has been shown to result in smaller mean absolute percent errors and is less sensitive to misspecification. Furthermore there are no theoretical grounds favouring TSLS over OLS in small samples (see Johnston (1972))."

The model of Latham *et al.* (1979) was estimated by OLS, TSLS and OLS with the Cochrane-Orcutt autocorrelation correction. Latham *et al.* (1979, p. 8) claim that, " ... comparison of the coefficient estimates and backcasts reveals that the results differ little for any equation among the three techniques, confirming the work of others including Glickman [(1976)] and Adams *et al.* [(1975)] ... OLS estimates ... are used below to discuss the models' performance and simulations. The coefficient estimators are generally significant and by and large have the expected signs and magnitudes".

Adams *et al.* (1975, p. 291) report that, "In an attempt to overcome the well-known disadvantages of bias and inconsistency of ordinary least squares (OLS) in simultaneous models, iterated instrumental variables (IIV) estimates were computed.... An analysis of the results indicates that there is very little gain, measured by reduced root mean square error, to be found by using IIV. In addition, some of the coefficients produced by the IIV method exhibit perverse signs or magnitudes. Thus the model presented ... and used ... consists of coefficients estimated by OLS."

Results of historical dynamic simulations runs with the Queensland model using the TSPC coefficients, compared to corresponding OLS results, show similar findings to those represented above. Of the eighty-one variables listed in Table 6.1, seventy-seven can be estimated by TSPC (the other four are functions of only exogenous variables). Table 6.3 shows a summary comparison of MAPE's for the two estimation methods. OLS had lower MAPE's than TSPC for nearly half of the variables; while for 13% of the variables, no differences could be observed (at one decimal place). Corresponding results for the ex post forecast were even worse for TSPC, with OLS MAPE's being lower for 82% of the variables.

It is for this reason that only OLS coefficients, and simulation results, are reported in detail for this model.

Table 6.3: Comparison of OLS and TSPC MAPE's

	Number of variables with lower MAPE's	Percent
OLS	38	49
TSPC	29	38
(No difference	10	13)
Total	77	100

6.4 EX POST FORECAST DYNAMIC SIMULATION

Using the actual value of the variables in the period 197703 to 197802 as initial starting values, an ex post forecast was run for the four quarters, 197803 to 197902. Results for twelve of the more interesting variables of the model are given in Table 6.4.

While a number of important variables, such as GSP$, M$, SLENFS$ and UR, seem to forecast well, with forecast MAPE's lower than the historical MAPE's, it is doubtful whether the forecast errors are low enough for recommendation for practical use. Several variables do not forecast well, e.g., GSP, FYTX and AWEEMU. It is clear that additional work, and fine tuning adjustments,[6] will be necessary before the model can be used for forecasting.

It can be noted that the size of the errors reported here are not greatly different from those reported in other regional econometric models. The MAPE's for the four variables reported in the model forecast results table of Latham *et al.* (1979, p. 11), for six quarters, were 3.5% for total employment, 1.5% for personal income, 1.4% for real personal income and 13.0% for state tax revenues.

6.5 IMPACT AND POLICY SIMULATIONS

A number of impact and policy simulations have been run with the Queensland model, largely to investigate the properties of the model and demonstrate the potential policy investigation uses of the model. These simulation runs, for convenience in discussion, have been termed experiments.

A simulation period of 197601 to 197902, using the 197501 to 197504 values as starting values, has been used in all experiments. This period was chosen because it avoids the instability of the 1974-75 period, and coincides with a change of federal government,

---

[6] See Pindyck and Rubinfeld (1976, pp. 355-60).

Table 6.4: Ex post forecast results for selected variables

Variable name	Units	ME	MAPE (HISTORICAL MAPE)	Forecast value (Actual value)			
				197803	197804	197901	197902
GSP	$m	188	4.7 (1.3)	3579 (3710)	3879 (4060)	3744 (4005)	3881 (4062)
GSP$	1974-75$m	66	2.5 (2.8)	2451 (2469)	2692 (2790)	2537 (2649)	2486 (2523)
FYTX	$m	51	9.8 (7.2)	272 (273)	314 (362)	422 (493)	690 (774)
POP	'000 persons	3	0.2 (0.6)	2172 (2175)	2180 (2186)	2190 (2194)	2197 (2196)
PFCE$	1974-75$m	18	1.3 (1.2)	1385 (1390)	1492 (1516)	1368 (1386)	1424 (1449)
SLFCE$	1974-75$m	14	5.2 (4.4)	262 (272)	279 (294)	251 (283)	284 (282)
SLENFA$	1974-75$m	1	2.2 (4.3)	162 (163)	185 (189)	155 (160)	215 (209)
M$	1974-75$m	-33	5.9 (7.6)	607 (605)	652 (596)	583 (526)	601 (582)
CPI74	100.0	2	1.6 (1.7)	148 (147)	153 (153)	154 (159)	157 (162)
AWEEMU	$	22	9.0 (1.6)	209 (224)	220 (245)	214 (242)	229 (247)
UR	%	0.2	2.8 (8.1)	6.3 (6.3)	6.7 (6.7)	7.9 (8.2)	6.8 (7.2)
HDY	$m	144	5.0 (2.4)	2533 (2646)	2989 (3159)	2681 (2919)	2491 (2547)

with the implication of changes in federal economic policy. The experimental period includes the period 197803 to 197902, which was not in the estimation period, and so cannot be considered as accurate as the 197601 to 197802 period experimental results.

A control, or benchmark, run was performed with the actual or historical values of coefficients and exogenous variables. Disturbed solutions were then obtained from experimental runs with changes in either coefficients or exogenous variables. These were compared with the benchmark solutions to give a measure of changes in important endogenous variables due to the experimental changes.

Also, most simulation studies of econometric models have included the derivation of dynamic multipliers. Two sets of dynamic multipliers have been determined. The first set is for gross state product at average 1974-75 prices, for a sustained $1m increase in A$, the exogenous residual variable comprising federal government expenditure, private gross fixed capital expenditure and increase in stocks. The other set is for household disposable income, for a sustained increase of 10% in the rate (coefficient) of personal income tax (FYTX). The dynamic multiplier values for these runs are listed in Table 6.5.

Since state and local government expenditures are endogenized in this model, it is not feasible to determine their multipliers.

The change in the personal income tax rate (the coefficient of FYTX) was multiplied by the tax base (WSS) in the benchmark run, to form the denominator for the multiplier calculation.[7]

Experiment 1: 10% increase in personal income tax rate

> This experiment is a more detailed set of results from the run necessary to calculate the tax multipliers above. Since the New Federalism arrangement allows for states to impose a surcharge on personal income tax rates, this is a pertinent simulation. Table 6.6 lists the changes in the experimental run from the benchmark run for a number of selected variables.

[7]See Klein and Evans (1969, p. 27).

Table 6.5: Dynamic multipliers for changes in government expenditures and tax rate

	Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ΔGSP$ for $1m increase in A$ (1974-75$m)	1.17	1.36	1.38	1.36	1.35	1.35	1.34	1.33	1.33	1.32	1.29	1.29	1.27	1.25
ΔHDY for 10% increase in FYTX coefficient[a]	-1.07	-1.08	-1.11	-1.11	-1.12	-1.11	-1.15	-1.15	-1.16	-1.13	-1.17	-1.16	-1.16	-1.14

[a]Change from 0.25693 to 0.282623. Calculated using change in rate (.025693) multiplied by the tax base (WSS), as the denominator.

Table 6.6: Tax rate policy simulation results

Changes in experimental from benchmark values

	FYTX		HDY		GSP$		CPI74		TE		PFCE$	
	$m	%	$m	%	1974-75$m	%	100.0	%	'000 persons	%	1974-75$m	%
197601	34	11.5	-37	-2.2	-4.4	-0.2	0.0	0.0	-0.7	-0.1	-3.8	-0.3
2	37	7.0	-42	-2.6	-6.8	-0.3	-0.1	0.0	-1.0	-0.1	-6.7	-0.5
3	43	18.3	-48	-2.3	-9.6	-0.4	-0.1	-0.1	-1.3	-0.2	-9.3	-0.7
4	42	15.4	-48	-2.0	-12.1	-0.5	-0.1	-0.1	-1.6	-0.2	-10.9	-0.8
197701	40	10.9	-48	-2.3	-13.9	-0.6	-0.2	-0.1	-1.9	-0.2	-11.9	-0.9
2	42	6.7	-51	-2.7	-15.0	-0.6	-0.2	-0.1	-1.9	-0.2	-12.8	-1.0
3	48	17.5	-58	-2.3	-15.7	-0.6	-0.2	-0.2	-2.0	-0.2	-13.9	-1.1
4	45	15.0	-54	-2.1	-16.5	-0.6	-0.3	-0.2	-2.1	-0.2	-14.2	-1.0
197801	41	10.6	-51	-2.4	-17.0	-0.8	-0.3	-0.2	-2.3	-0.3	-14.2	-1.1
2	44	6.5	-55	-2.6	-17.2	-0.7	-0.3	-0.2	-2.1	-0.2	-14.6	-1.1
3	50	17.3	-62	-2.3	-17.3	-0.7	-0.3	-0.2	-2.2	-0.3	-15.2	-1.1
4	52	14.6	-63	-2.0	-18.1	-0.6	-0.4	-0.2	-2.2	-0.2	-15.5	-1.0
197901	52	10.3	-64	-2.2	-18.6	-0.7	-0.4	-0.2	-2.3	-0.3	-15.7	-1.1
2	51	6.4	-65	-2.5	-18.6	-0.7	-0.4	-0.3	-2.2	-0.2	-15.9	-1.1

The results are standard, with maximum impact on personal income tax collections (FYTX), household disposable income (HDY) and private final consumption expenditure at average 1974-75 prices (PFCE$). The effect on inflation, as measured by the level of the consumer price index (CPI74) is significant. While price levels decline with the tax rate increase, it seems, from the evidence in Table 6.6, that increasing tax as a method of lowering average price levels is not likely to be particularly effective.

Experiment 2: national economic boom

This experiment was designed to investigate the responsiveness of the Queensland economy to changes in the national economy. The chosen changes in national economic exogenous variables were a 10% increase in gross domestic product and a 10% decrease in the national number of registered unemployed. These changes reflect a substantial improvement in national economic conditions.

Table 6.7 lists the changes from this experiment for selected Queensland endogenous variables. The low range of values of the percentage difference for GSP, around 4.5%, for the 10% changes in the national variables, indicates the self dependency of the Queensland economy, as expressed in the specification of this model. The major impacts of the national economy do not affect much of the Queensland economy, with its specialization in agriculture and mining, both of which are largely unresponsive to national economic conditions, and in local industries, such as transport and wholesale and retail trade.

Unemployment results reflect the model specification, which strongly relates Queensland unemployment conditions to national unemployment conditions. The results for employment and population are plausible, with the stability of population, and thus the labour force, and the income in employment matched by the fall in the unemployment rate. As would be expected, the price level, as measured by

Table 6.7: National economic conditions simulation experiment.

Changes in experimental from benchmark values

	GSP		UR		WSS		IPDNONFARM		TE		POP		M$	
	$m	%	%	%	$m	%	100.0	%	'000 persons	%	'000 persons	%	1974-75$	%
197601	116	4.7	-0.6	-10.5	62	4.6	5.6	4.6	9.6	1.1	2.0	0.1	0	0.0
2	127	4.6	-0.5	-11.1	54	3.6	8.5	6.6	3.2	0.4	1.9	0.1	37	6.2
3	132	4.5	-0.5	-11.9	58	3.4	8.6	6.8	3.0	0.4	1.9	0.1	45	6.5
4	139	4.5	-0.5	-11.6	64	3.8	8.4	6.6	4.3	0.5	1.8	0.1	44	7.0
197701	131	4.5	-0.6	-10.4	72	4.4	7.4	6.0	6.4	0.7	1.8	0.1	37	7.3
2	147	4.6	-0.6	-11.2	78	4.4	8.1	6.1	5.9	0.7	1.8	0.1	39	7.6
3	150	4.5	-0.6	-11.5	81	4.2	8.3	6.2	5.5	0.6	1.7	0.1	42	7.1
4	151	4.4	-0.7	-11.1	84	4.6	8.3	6.1	5.7	0.7	1.6	0.1	41	7.3
197801	146	4.6	-0.8	-10.4	89	5.2	8.3	5.9	6.7	0.8	1.7	0.1	36	7.4
2	162	4.7	-0.7	-10.9	98	5.2	8.7	5.9	6.4	0.7	1.7	0.1	37	7.0
3	165	4.4	-0.7	-11.2	98	4.8	9.4	6.1	5.5	0.6	1.5	0.1	41	6.6
4	173	4.3	-0.7	-11.1	111	5.2	8.8	5.7	6.7	0.7	1.4	0.1	38	6.4
197901	175	4.4	-0.9	-10.4	123	5.7	8.6	5.5	8.0	0.9	1.4	0.1	34	6.5
2	184	4.5	-0.8	-10.9	126	5.7	8.9	5.6	7.4	0.8	1.5	0.1	36	6.2

the implicit deflator for gross non-farm product rises considerably. Imports also rise considerably, with zero effect in the first period, due to the lag structure of the import equation in the model.

Experiment 3: reduced level of Commonwealth grants

This experiment consists of maintaining the levels of real per capita grants from the Commonwealth Government to the Queensland State Government at 90% of the 1975 levels throughout the experiment period. This is a crude implementation of a scenario which imposes restrictions on grants following the change of federal government in late 1975. The 197501 to 197504 levels of GCWCUR$P and GCWCAP$P, less 10%, were sustained (on a quarterly basis) from 197601 to 197902. Table 6.8 summarizes the results of this experiment for selected variables.

The new grants policy means a reduction for grants for current purposes, but not for capital purposes. Table 6.9 lists the experimental and benchmark values of GCWCUR$P and GCWCAP$P.

No unexpected results emerged. Gross state product at average 1974-75 prices declines, because of the reduction in SLFCE$, the total state and local government final consumption expenditure at average 1974-75 prices. State and local government expenditures on new fixed assets actually increase by small amounts throughout the period. Federal personal income taxes decline, since employment reductions force wages, salaries and supplements, the tax base, down.

Table 6.8: Freezing of real per capita grants policy simulation experiment.

Changes in experimental from benchmark values

	GSP$		SLFCE$		SLENFA$		FYTX		WSS		TE	
	1974-75$m	%	1974-75$m	%	1974-75$m	%	$m	%	$m	%	'000 persons	%
197601	-27	-1.3	-29	-14.2	3	1.7	-2	-0.7	-8	-0.6	-4	-0.5
2	-48	-2.2	-44	-17.9	2	1.0	-6	-1.1	-16	-1.0	-7	-0.8
3	-11	-0.5	-5	-2.5	1	0.7	0	-0.2	-2	-0.1	-1	-0.1
4	-29	-1.2	-26	-10.1	0	-0.2	-2	-0.7	-10	-0.6	-4	-0.4
197701	-49	-2.1	-49	-19.4	4	2.3	-4	-1.2	-17	-1.0	-7	-0.8
2	-32	-1.4	-28	-11.3	4	1.8	-4	-0.6	-10	-0.6	-4	-0.4
3	-40	-1.6	-38	-14.3	3	1.9	-2	-0.9	-14	-0.7	-5	-0.6
4	-36	-1.4	-32	-11.7	3	1.3	-2	-0.8	-12	-0.6	-5	-0.5
197801	-53	-2.3	-53	-22.0	7	4.4	-4	-1.1	-17	-1.0	-8	-0.9
2	-42	-1.8	-39	-15.1	7	3.3	-4	-0.6	-11	-0.6	-5	-0.6
3	-55	-2.2	-52	-19.4	6	3.5	-3	-1.1	-19	-0.9	-7	-0.8
4	-35	-1.3	-31	-10.7	5	2.7	-2	-0.5	-8	-0.4	-4	-0.5
197901	-53	-2.0	-55	-19.5	9	5.7	-4	-0.8	-16	-0.7	-8	-0.8
2	-44	-1.7	-43	-15.2	9	4.2	-3	-0.4	-9	-0.4	-6	-0.6

Table 6.9: Experimental and benchmark values of GCWCUR$P and GCWCAP$P

	Benchmark values		Experimental values	
	GCWCUR$P	GCWCAP$P	GCWCUR$P	GCWCAP$P
	$	$	$	$
197501	74.76	29.37	74.76	29.37
197502	73.09	28.26	73.09	28.26
197503	89.39	28.59	89.39	28.59
197504	93.54	27.30	93.54	27.30
197601	87.28	25.81	67.28	26.43
197602	97.88	26.54	65.78	25.43
197603	82.65	24.39	80.45	25.73
197604	104.72	27.17	84.19	24.57
197701	100.85	26.13	67.28	26.43
197702	82.92	22.79	65.78	25.43
197703	105.71	24.94	80.45	25.73
197704	105.56	23.96	84.19	24.57
197801	100.84	22.56	67.28	26.43
197802	88.08	20.03	65.78	25.43
197803	113.53	22.84	80.45	25.73
197804	102.00	20.71	84.19	24.57
197901	99.30	19.83	67.28	26.43
197902	88.48	18.07	65.78	25.43

CHAPTER 7

CONCLUSION

7.1 AN OVERVIEW OF THIS STUDY

In simple terms, the objective of this thesis has been two-fold, seeking answers to the following questions:

(i) From existing sources of data, published and unpublished, is it possible to construct an acceptable set of estimates of gross state product for Queensland on a quarterly basis, and with what degree of disaggregation?

(ii) Assuming the answer to the first question is in the affirmative, within the existing methodology of econometric modelling, can an acceptable quarterly econometric model of the Queensland economy be specified?

By acceptable is meant a degree of rigour which improves on recent work in the field and is sufficient to warrant further development of the work done.

In the preceding chapters the ways in which these questions have been answered, and the methods employed in this regard, have been discussed in detail. Briefly, the first part of the objective was attained by developing a set of quarterly estimates of the gross state product at factor cost of Queensland, for forty quarters from September 1969 to June 1979, disaggregated by ASIC industry division and by principal component. The second part of the objective was attained by specifying, estimating and simulating a macro-econometric type regional econometric model of Queensland, which has the following features: 110 equations, 49 identities, and twenty-seven exogenous variables; quarterly from September 1969 to June 1979; and estimated by ordinary least-squares and two stage least squares with four principal components.

The major contributions of this study are listed below:

(i) This thesis has reintroduced the use of primary data sources in GSP estimation in Australia.

(ii) The estimates presented in this thesis are the first specifically for Queensland since Colin Clark's pioneering work in the late 1930s and 1940s, and are the most disaggregated estimates, in recent times, for any Australian state.

(iii) A method of constructing quarterly estimates from annual data has been described, and improved. This should be of considerable interest to many regional model builders particularly in the USA, who have been restricted to annual models.

(iv) As far as is known, this macro-econometric type regional econometric model of Queensland is the first of its type to be developed for a state in the Australian federation (or for any other smaller Australian region). This thesis has demonstrated the potential of official data collections in Australia for the construction of regional econometric models of states of the federation.

(v) This regional econometric model is one of the few in the world to be specified and estimated on a quarterly basis.

(vi) An attempt, one of only several in the world, has been made to implement the Keynesian specification of regional econometric models outlined in Klein (1969).

(vii) A behavioural specification, new to regional econometric models, of the important state and local government sector has been incorporated in this regional econometric model of Queensland.

While the gross state product estimates in this thesis are at a sufficiently accurate or satisfactory stage of development to be used in further analyses of the structure and performance of the Queensland economy,[1] the model developed in this thesis cannot be regarded as being at more than a preliminary stage, even though it is acceptable in terms of the objective of this thesis. In particular, the policy experiments briefly outlined in Chapter Six can at best be viewed as

---

[1]See Appendix B.

a modest glimpse of what could be expected from the continued development of the work of this study.

Latham *et al.* (1979) has commented on the necessity to interact with users, if a model is not to be limited to being a scholarly toy and is to be used for practical policy analyses and forecasts. There has been no interaction, as yet, between this model builder and eventual users of the model. While the main group of users can be identified as State Government officials concerned with and responsible for the economic development of Queensland and the economic relationships between Queensland and the rest of the federation and overseas countries, it is conceivable that other groups of users could emerge. These might include mining companies, electricity boards and authorities, and major manufacturing and wholesaling and retailing enterprises.

This interaction should take the form of revising model specification to incorporate new or revised data variables and relationships, evaluating the simulation properties and results of the model in the light of the "inside" knowledge of users about events, trends and possibilities, and suggesting and criticizing policy scenarios for simulation experiments. None of these can be satisfactorily undertaken within an academic study such as this.

The accuracy of gross product estimates can always be improved, further national accounting variables can be estimated and revision made over time. Constant and close liaison with the ABS should be maintained to allow for changes in statistical concepts and the nature and availability of data.

Perhaps the most important of the virtues of models, mentioned earlier in this thesis, is that models are dynamic, in a philosophical, rather than technical, sense. They should be continually re-estimated and refined, because of access to new and revised data and theoretical ideas, if they are not to decay into obsolescence. In this sense, it is doubtful whether projects such as that begun by this study can be ever really finished.

7.2 DIRECTIONS FOR FURTHER RESEARCH

During the course of this study, it was felt that there is scope for further work and development in the following areas, in addition to the updating process:

(i) A method of obtaining up-to-date quarterly gross product estimates should be developed, by which is meant the provision of estimates with a delay of from six to twelve weeks between the elapse of a quarter and the publication of data pertaining to that quarter. This is a problem similar to that faced by the ABS in providing accurate up-to-date quarterly estimates. Since the method developed in this study relies heavily on ABS estimates, how to develop an independent method of obtaining recent quarterly estimates for Queensland is not obvious.

(ii) An effort must be made to estimate a number of further aggregate economic statistics for Queensland, particularly on the expenditure side of the Domestic Production Account. In particular, gross fixed capital expenditure, federal government expenditures and increases in stocks should be estimated separately. A capital stock series would also be useful and informative.

(iii) Re-examination of interstate and overseas trade statistics is necessary, in view of the reservations of the ABS about their quality, and the uncritical acceptance of these data in this study.

(iv) In due course this Queensland model should be integrated with a Queensland transactions (or input-output) table. This will result in improved structural specification overall, and will permit the dynamic operation of the transactions table. It may then be possible to develop medium term as well as short term forecasts and simulation scenarios, since the incorporation of the input-output framework allows an explicit consideration of structural inter-industry relationships which is important for medium term modelling. The medium term model of the UK economy[2]

---

[2] See Barker (1976).

is based on an input-output framework. As L'Esperance *et al.* (1977, p. 54) says, " ... conjoining an I/O model with an econometric model ... combines a theory of production with a theory of aggregate demand".

A suitable transactions table for Queensland is currently being developed at James Cook University,[3] since no sufficiently accurate table is yet available.[4] Re-specification of this Queensland model will follow the completion of this transactions table, and should result in some improvement.

(v) This study should encourage the development of similar work for both gross state product estimation and model building in other Australian states, particularly Western Australia and Tasmania.

(vi) A possibility exists for the development not just of separate state models, but, given cooperation and liaison between researchers in the different states, for a truly multiregional (or multi-state) model of the Australian economy. A necessary prerequisite for this is the provision of adequate and appropriate funding and cooperation from the State Governments. It may be possible to have teams from each state develop individual state models and link these models together in a manner similar to the linkage of national economies in Project LINK.

(vii) The farm or agriculture industry is important in the Queensland economy, and should be explicitly modelled. This is a task beyond the resources of this study, but must be developed in the future.

Given the body of work in this thesis, and the further work outlined above, if aggregate economic analysis is not to remain restricted to the notion of a single point economy, it seems clear that developing operational statistical frameworks and models of the economies of the states is an important and worthwhile field of research. Once again without wishing to limit the scope of

---

[3]See Finselbach (1981).

[4]See Section 3.5.6.3 above.

applications, problems in fiscal federalism can be emphasized. In the words of the Queensland Under-Treasurer:

> The States are now facing the very real prospect of existing avenues of taxation and revenue, including payments from the Commonwealth, not being sufficient to meet the growing demands and expectations of the community for Government services. If these demands and expectations are to be met, either new taxes must be found, existing taxes increased or, in the ultimate, serious consideration given to some form of State income tax.[5]

---

[5]Hielscher (1980, p. 13), quoted in Groenewegen (1981, p. 14).