AN EXPOSITION OF THE INFORMATION SECTOR APPROACH WITH SPECIAL REFERENCE TO AUSTRALIA*

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This paper provides an exposition of the information sector approach. Concept and measurement of the information sector are discussed in detail. Findings for Australia are reported, including so far unpublished data on the labour force employed in the primary and secondary information sector. The total information sector accounted for about 41.5 per cent of the Australian labour force and about 31 per cent of value added in 1981. More than half of all the people employed in informational occupations were employed in the secondary information sector. The need for the standardisation of the measurement of the information sector is emphasised. Improvements in input-output modelling and other avenues for research are suggested.

Keywords: information sector approach, information workers, information economy, primary and secondary information sector, Australia

INTRODUCTION

In recent years a shift in the allocation of resources towards activities associated with the creation, storage and dissemination of information has been noted for the United States[1] and other OECD countries.[2] This shift in resource allocation is explained by the fact that the more complex the economic system, the greater the 'information overhead' or information handling task which is associated with economic decision making compared to the production task.[3] This trend has been accelerated by the advent of telecommunications and computer technologies, which have led to such an increase in our information handling capacity (but not necessarily capability!) that many observers now speak of an 'information revolution'. But even as early as 1967, the information handling task accounted for about 50 per cent of GNP in the United States and about half of the American workforce was employed in

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'information' occupations.[4] Yet traditional neo-classical economics has little to say about the economics of allocating scarce resources to this area. It assumes perfect knowledge of decision makers, with the price system regarded as the optimal information system.

In this paper we report on a macro-economic approach to measure and quantify the 'information sector' in a way that is consistent with the national income accounts.[5] Besides providing checks on the information sector estimates, the approach enables the researcher to use the well known Leontief input-output technique to analyse the structure of the information sector and its interrelationship with the rest of the economy. The approach has sometimes been termed an industry approach to the measurement of the information sector,[6] in contrast to the occupation approach in which the information intensity of an economy is measured by the number of people employed in information occupations. It will, however, become clear that these are not two distinct approaches, but rather two aspects of the same approach, as the data generated by the occupation approach are needed to validate the information sector using the industry approach. Data which 'bridge' the two approaches are reported for Australia.

THE CONCEPT OF THE INFORMATION SECTOR

The information sector is assumed to comprise all goods and services associated with the creation, storage and dissemination of information. Information itself is defined in a restricted sense: only information relating to production as measured in the national accounts is included. For example, any conversation can be regarded as an exchange of information. However, we omit 'conversation' as distinct from business or government communication.[7]

To measure the contribution of information goods and services to the national accounts, the information sector is divided conceptually into two components, the 'primary information sector' (PRIS) and the 'secondary information sector' (SIS).

The PRIS comprises, first, goods and services which intrinsically convey information or which are directly useful in its production, processing and distribution and which, secondly, are transacted on established markets. The PRIS includes not only the communication and 'high-tech' sectors (electronics and computer industries), but a variety of other goods and services. In fact, it consists to a large extent of information service sectors, like banking and insurance, real estate and business services and education, which are normally classified as tertiary sectors. All these PRIS components are 'taken-out' of the conventional primary, secondary and tertiary sectors and are grouped into the 'quarternary' or PRIS.[8]

The PRIS underestimates the volume of information activities in the economy as it does not account for the large volume of information which is produced and consumed within those private and public industries which are not part of the PRIS. In other words, the PRIS does not account for the resources devoted to the private and public bureaucracies which produce and consume information which is not transacted on established markets. These information services are ancillary or secondary to the production of non-PRIS goods and services and are part of their production costs. To account for them, the non-PRIS industries are conceptually split into 'quasi-firms', which are assumed to produce these in-house information services, and the non-information firms proper. The information quasi-firms form the SIS; the non-information firms proper form the non-information sector (NIS).

The inclusion of the SIS in national income accounts would change to a large extent the perception of structural change in the economy. This becomes obvious when we consider shifts between the PRIS and SIS. Assume that a certain part of a (non-PRIS) manufacturing firm's in-house information services, e.g. data processing, is contracted out to a data processing firm. This would show up in the proposed accounting system as a shift from the SIS to the PRIS. The overall amount of resources devoted to the information sector has not changed,[9] nor has the relationship between the other macro-sectors (primary, secondary, tertiary sectors) in the economy. In the conventional accounting system, however, this shift would be recorded as an increase in the tertiary sector, i.e. the relative sizes of the macro-sectors in the economy would change.

MEASUREMENT

The size of the information sector in the economy can be measured in terms of value added, final demand or gross output. Value added is often regarded as the most appropriate measure, first, because it takes account of income creating activities at the intermediate and not just the final stage of demand, and, secondly, because value added statistics have proved to be available at a more detailed level than final demand statistics.[10] However, in practice researchers often find that even value added figures are not available at the required detail. Under such circumstances, data on gross outputs are used to approximate net outputs (value added).[11]

The measurement of the PRIS is relatively straightforward. It requires data on value added at the most detailed level available, usually from census and surveys of production and services, input-output tables and other data bases. Using a check-list of PRIS commodities and services compiled by the OECD from the Inter-

national Standard Industrial Classification,[12] the researcher can pick out the PRIS items and determine the percentage of total value added accounted for by PRIS information activities, by sector, and for the whole economy. These percentages are also referred to as information intensity coefficients.

The measurement of the SIS poses more problems. First of all there is the conceptual problem of how to measure the value added created by the fictitious quasi-firms making up the SIS. As it is unrecorded, it has to be measured indirectly. This is done by using informational factor costs as a proxy. The accurate measurement of the value added accounted for by the SIS requires the calculation of the following items: (i) the employee compensation of information workers, proprietors and unpaid family members employed by non-PRIS industries, and (ii) the depreciation on information capital goods used by non-PRIS industries. It involves the splitting-up of the non-PRIS industries' value added into two components, the 'informational' and 'non-informational' value added. Therefore, the total value added reported for the economy will not change.

The data requirements for the empirical validation of the SIS are formidable. To validate (i), we have to obtain the most detailed occupation by industry matrix, usually from the census of population and housing, distinguish information from non-information workers and PRIS industries from NIS industries and transform the matrix into an employee compensation matrix by premultiplying it with a vector of average wages. The resulting matrix then has to be adjusted to control totals from the national accounts.[13] Direct measurement of (ii) would require a capital flow matrix showing 'information' and 'non-information' machines by industry in order to split up depreciation allowances. Not only are the problems regarding a unified definition of information machines unresolved,[14] but capital matrices are simply not available for many countries, including Australia. Therefore, some indirect method to approximate the depreciation on information capital goods has to be devised. As employee compensation is normally by far the larger component of the SIS value added, any inaccuracies in the measurement of the depreciation allowance are not likely to bias our overall estimates much.[15]

The ideal approach to the measurement of the SIS's contribution to value added described above has been followed by Porat in his seminal work on the United States information economy.[16] A variant of this approach has also been used by Japanese researchers to produce time series data on Japan's PRIS and SIS for the 1960 to 1979 period.[17]

Countries other than Australia for which data on the sizes of both the PRIS and SIS are available are listed in Table 1. All PRIS data have been calculated as described above. However, except for the SIS

of the USA in 1967 and of Japan in 1960 and 1979, the SIS data are 'guestimates' which have been determined using a short-cut method by which the size of the SIS is estimated from the total number of information workers in the economy, the total labour force, total GDP and the GDP accounted for by the PRIS.[18] This method has the drawback of giving only the approximate total size of the SIS, whereas the 'ideal' approach provides estimates of the SIS by industry which might be more useful from an analytical and policy perspective. The author resists the temptation to speculate about possible reasons for the alleged decline of the SIS as shown in Table 1 for two reasons. First, if hypotheses are to be built upon data for the SIS, the 'ideal' approach of measurement should be followed.[19] Secondly, the author's (so far unpublished) research indicates that the SIS of Japan accounted for 22.1 per cent of the value added in 1980, which seems to confirm the findings of Komatsuzaki and Tanimitsu. If both these estimates and the OECD figures are correct, we are left to explain why Japan's SIS declined around 1970 and subsequently grew again.

The data in Table 1 indicate that there are sizable information sectors in the three countries. The data also seem to indicate a growth of the PRIS over time. This trend has also been confirmed for other developed countries,[20] and at least one developing country.[21]

TABLE 1

The Primary and Secondary Information Sector as Percentage of GDP at Factor Cost for Selected Countries

	Year	PRIS	SIS
USA	1958	19.6	23.1
	1967	23.8	24.7
	1972	24.8	—
	1974	—	24.4
UK	1963	16.0	13.8
	1972	22.0	10.9
Japan A	1960	8.4	—
	1965	14.4	21.8
	1970	18.8	16.2
Japan B	1960	14.0	15.0
	1979	15.0	21.0

Source: OECD, 1981, *op.cit.*, except for Japan B, which is taken from Komatsuzaki and Tanimitsu, *op.cit.*

THE INPUT-OUTPUT FRAMEWORK

Once the PRIS and SIS have been measured at the sector level used in the published input-output tables, they can be integrated into a consistent input-output framework. The techniques used to achieve this will be sketched here.

In contrast to the measurement phase, it is now the treatment of the PRIS that involves by far the largest amount of work. To obtain the PRIS interindustry flows, the original input-output table has to be substantially reorganised. Invoking the industry technology assumption we can dichotomise the transactions table into information and non-information components by pre- and post-multiplying it with information and non-information intensity coefficients which were obtained when measuring the PRIS.[22] The procedure involves the partitioning of every input-output table entry into its PRIS and its non-PRIS part. After consolidating the resulting matrix we obtain a re-arranged input-output table showing explicitly the PRIS alongside the more familiar primary, secondary and tertiary sectors. This input-output table provides a powerful tool for investigating the structure of the PRIS and its interaction with the rest of the economy. Structural analysis employing linkage and multiplier techniques has frequently been used to assess the interconnectedness and impact responses of PRIS and non-PRIS sectors.[23]

The incorporation of the SIS into the re-arranged input-output table involves doubling the rows and columns of the non-PRIS sectors to split them up into SIS and NIS. The 'intra-firm sales of information services', i.e. the imputed sales of the information side of non-PRIS sectors (SIS), to the NIS can easily be determined if we follow Porat[24] and take the sum of intermediate and primary inputs as a proxy. Some minor SIS intermediate inputs and final demand items (intra-industry royalty sales, net royalty exports and government purchases of R&D) can be evaluated from published statistics and inserted into the table.

The resulting input-output table explicitly shows the PRIS and SIS within a consistent input-output framework, thereby providing the data base needed to empirically investigate many of the assertions made about the new information age at the macro-economic level. However, like other macro-models, the input-output model has certain well-known limitations. It assumes, for example, linear production technologies and, in its simple form, provides a static, point-in-time picture of the economy. Moreover, it will be difficult to use the model for predictive purposes as this would require the modelling of technological change. It has been argued that the effect of the latter, particularly in the case of information technology, depends as much on the assumptions made about how the technology is used (i.e. the organisational aspect) as it does depend on the more technical dimension of usage or rates of diffusion.[25] While this

problem is encountered in the construction of any forecasting model, it is highlighted in the information sector approach because of the incorporation of the SIS.

The non-marketed transactions accounted in the SIS in a sense represent a quantitative measure of the organisational aspect of the economy. As such the information sector approach invites questions not only about the adequate size of the SIS, but also about the efficiency with which the resources devoted to this task are used:

> If information is a resource, there can be investment in it, it should be managed; it can depreciate (and appreciate); it can become obsolete; . . . The greatest myth of all is optimal use of information resources, for that would require organisational forms and management skills yet to be invented.[26]

The question of informational efficiency is of central importance in an information based economy. We cannot simply assume that investment in the SIS (or in the PRIS for that matter) will result in the more efficient use of information. These aspects would have to be modelled in any realistic attempt to use the input-output model for the forecasting of the medium or long term consequences of the ongoing information revolution.

FINDINGS FOR AUSTRALIA

In this section we review recent findings on the growth of the information economy in Australia in terms of both employment and contribution to value added. First, however, we present a brief general discussion of employment trends in Australia over the 1971-81 period — section (i). Some of our results in section (i) are directly comparable to those contained in a recent study of the Queensland Information Economy.[27] In section (ii), first preliminary estimates by the author of the number of people employed in the PRIS, SIS and NIS at industry division level in 1981 are discussed. These data provide the link between the occupation and industry approach to the information economy. PRIS and SIS value added estimates are discussed in section (iii).

(i) Employment Trends in Australia, 1971 to 1981

Employment during that period rose by 1,052,000 jobs, or by 20.1 per cent. Table 2 provides evidence on the industrial origins of this growth. From the data the clear picture of the (traditional) service sector as the major source of employment growth emerges, with community services, finance and insurance having the highest employment growth rates of any of the industry divisions. On the other hand, agriculture, manufacturing and construction experienced

TABLE 2

Employment Growth in the Australian Economy, Major Industry Groups, 1971-81.

Industry	ASIC[1] code	Number employed 1971	Share of labour force 1971 (per cent)	Numbers employed 1981	Share of labour force 1981 (per cent)	Change in labour force 1971-81	Percentage change	Equivalent change for Queensland[2]	Information Intensity[3] Australia 1981
Agriculture, Forestry & Fishery	A	386,407	7.4	379,388	6.0	−7,019	−1.8	−3.4	3.3
Mining	B	76,023	1.4	88,993	1.4	+12,970	+17.1	+45.6	25.4
Manufacturing	C	1,215,618	23.2	1,114,668	17.7	−100,950	−8.3	+6.1	30.8
Electricity, Gas & Water	D	91,252	1.7	125,620	2.0	+34,368	+37.7	+57.5	34.6
Construction	E	412,229	7.9	398,162	6.3	−14,067	−3.4	+7.8	22.9
Wholesale & Retail Trade	F	988,088	18.9	1,093,946	17.4	+105,858	+10.7	+22.1	35.2
Transport & Storage	G	271,713	5.2	329,696	5.2	+57,983	+21.3	+46.6	30.5
Communication	H	103,485	2.0	125,528	2.0	+22,043	+21.3	+49.3	65.1
Finance, Insurance, Real Estate and Business Services	I	363,418	6.9	531,413	8.4	+167,995	+46.2	+69.2	84.9
Public Administration & Defence	J	283,152	5.4	353,541	5.6	+70,389	+24.9	+29.8	57.6
Community Services	K	564,649	10.8	939,321	14.9	+374,672	+66.4	+75.1	51.7
Entertainment, Recreation, Hotels, Restaurants & Personal Services	L	267,511	5.1	329,109	5.2	+61,598	+23.0	+39.0	32.6
Non-classified/not stated	M+N	216,883	4.1	483,246	7.7	+266,363	+122.8	+177.7	8.4
Total Labour Force		5,240,428	100.0	6,292,631	100.0	+1,052,203	+20.1	+34.1	37.6

Sources: Calculated from ABS, 1971 and 1981 Census of Population and Housing.

1. Australian Standard Industrial Classification
2. Source: T. Mandeville, S. Macdonald, B. Thompson and D.M. Lamberton, *Technology, Employment and the Queensland Information Economy,* Report to the Department of Employment and Labour Relations, Queensland, Brisbane, 1983, Table 1, p. 5.
3. Percentage of economically active designated informational.

a decline in employment. In 1971, the primary and secondary sector (ASIC divisions A-C), which together might be called the 'goods producing' sector, provided about 32 per cent of jobs in Australia. By 1981 this had fallen to 25.2 per cent. Therefore, the conventionally defined tertiary sector accounted for almost 75 per cent of all employment in Australia in 1981.

Mandeville and Macdonald report for Queensland that — surprisingly — less than 5 per cent of total employment growth during the 1971 to 81 period was generated in the goods producing sector.[28] In light of the findings for Australia as a whole, which document a decline of employment in this sector of 95,000 jobs or almost 6 per cent over the 1971 level, we have to say that this was in fact a surprisingly high growth rate. The observed decline in relative importance of the goods producing sector in the Queensland economy was even more pronounced for the national economy. Table 2 also shows that in terms of employment growth, Queensland performed better than Australia on average.

The industrial employment trends are also mirrored in the occupational composition of the labour force. We used the same classification of information occupations as that which was used in the Queensland study to separate information from non-information occupations,[29] and found that many of the industries which exhibited high rates of employment growth are also relatively information intensive, i.e. they have a high percentage of information workers employed in their workforce (see Table 2).[30] This resulted in an increase in the overall information intensity of the labour force from 27.5 per cent in 1971 to 37.6 per cent in 1981.[31] This conforms to the historical trend of a steadily rising percentage of information workers in the total workforce which has been observed for the period 1911 to 1971.[32] The information intensity of the Queensland economy was 34 per cent in 1981,[33] i.e. it was slightly lower than the national average.

(ii) The Bridging of 'Occupation' and 'Industry' Approach

Table 3 provides insights into the structure of employment in the PRIS, SIS and NIS of Australia in 1981. It was constructed from a detailed industry by occupation matrix published in the 1981 census of population and housing by determining information and non-information workers in terms of occupation, and by dividing the 594 industry classes used in the census into PRIS and NIS industries. It should be noted that the PRIS is determined by designating *industries* as informational. Therefore the PRIS contains information and non-information workers (see Table 3). The SIS and NIS, however, express two aspects of the same industry. A more disaggregated version of Table 3 is the main table needed to bridge the occupation and industry

TABLE 3

Employed Labour Force in the PRIS, SIS and NIS, Australia 1981

Industry	PRIMARY INFORMATION SECTOR								SECONDARY INFORMATION SECTOR				NON-INFORMATION SECTOR				Total Employed Labour Force
	Information Workers			Non-Information Workers													
Division	Males	Females	Total	Males	Females	Total	Total (1)	%	Males	Females	Total (2)	%	Males	Females	Total (3)	%	(1) + (2) + (3)
A	—	—	—	—	—	—	—	—	6,045	6,381	12,426	3.3	265,673	101,289	366,962	96.7	379,388
B	2,795	1,190	3,985	2,389	161	2,550	6,535	7.3	13,803	4,791	18,599	20.9	62,039	1,820	63,859	71.8	88,993
C	55,208	30,516	85,724	30,223	10,044	40,267	125,991	11.3	171,458	85,643	257,101	23.1	573,229	158,347	731,576	65.6	1,114,668
D	—	—	—	—	—	—	—	—	33,686	9,763	43,449	34.6	80,573	1,598	82,171	65.4	125,620
E	—	—	—	—	—	—	—	—	52,205	38,974	91,179	22.9	302,281	4,702	306,983	77.1	398,162
F	20,276	12,781	33,057	12,444	12,621	25,067	58,124	5.3	188,603	163,928	352,531	32.2	412,414	270,879	683,291	62.5	1,093,946
G	—	—	—	—	—	—	—	—	62,550	37,922	100,472	30.5	216,546	12,678	229,224	69.5	329,696
H	53,832	27,832	81,664	39,795	4,069	43,864	125,528	100.0	—	—	—	—	—	—	—	—	125,528
I	230,723	214,595	445,318	34,855	11,644	46,499	491,817	92.5	2,999	2,803	5,802	1.1	17,681	16,113	33,794	6.4	531,413
J	—	—	—	—	—	—	—	—	123,031	80,770	203,801	57.6	131,830	17,910	149,740	42.4	353,541
K	134,678	210,618	345,296	34,527	38,527	73,054	418,350	44.5	51,418	88,634	140,052	14.9	127,926	252,993	380,919	40.6	939,321
L	21,870	13,540	35,410	4,796	3,242	8,038	43,448	13.2	31,791	40,201	71,992	21.9	90,069	123,600	213,669	64.9	3,291,091
M + N	—	—	—	—	—	—	—	—	19,030	21,826	40,856	8.5	229,000	213,390	442,390	91.5	483,246
Total	519,382	511,072	1,030,454	159,009	80,308	239,337	1,269,791		756,624	581,636	1,338,260		2,509,261	1,175,319	3,684,580		6,292,631

Source: Calculated from ABS, 1981 Census of Population and Housing.

approach and measure the SIS contribution to employee compensation. For this purpose the table has to be converted into a wage matrix. A detailed study of Australia's SIS is currently being undertaken by researchers at the University of Queensland. The data in Table 3 are summarised in Table 4.

TABLE 4

Composition of Australian Labour Force 1981 (in million people employed)

		Per Cent		
PRIS:	1.270	20.18	{ 1.030 m .239 m	information workers non-information workers
SIS:	1.338	21.27		information workers
NIS:	3.685	58.55		non-information workers
Total:	6.293	100.00		

Source: Table 3.

It is interesting to note that out of the total number of information workers, less than half (43.5 per cent) were employed in the PRIS. The SIS employed 56.5 per cent of all information workers in 1981. This is an indication of the substantial amount of information activity undertaken outside the PRIS.

Looking at Table 3 in detail, we see that information service sectors are the predominant sources of employment in the PRIS. Only .126 million people in the PRIS were employed in industry division C (manufacturing), which to a large extent comprises 'high-tech' industries. That is only about 10 per cent of all PRIS employment. PRIS employment is concentrated in the information service industries — finance, insurance and community services. The largest industry division in terms of employment in the SIS is wholesale and retail trade, followed by manufacturing and public administration and defence.

(iii) Estimates of the PRIS and SIS of Australia

The first measure of the PRIS of Australia in terms of value added, output and final demand was provided by Karunaratne and Cameron for 1968/9.[34] They estimated that the PRIS accounted for 16.6 per cent of output, 11.1 per cent of final demand and 16 per cent of value added in that year. They also provided a first 'guestimate' for the SIS

of 13 per cent of value added. Therefore, they concluded that the information economy represented about 30 per cent of total value added in 1968/9. By 1977-78, the PRIS's contribution to value added had risen to 24.5 per cent, its final demand to 15.7 per cent and PRIS output to 19.2 per cent of total output. The PRIS was the fastest growing macro-sector in Australia between 1968 and 1977, growing 18.4 per cent per annum (in comparison, the primary sector grew at 9.6 per cent per annum over the same period). Despite this, application of conventional linkage and multiplier criteria seems to indicate the pre-eminence of the non-information sector, showing the nascent character of the information sector in Australia.[35]

Estimates of the PRIS as a percentage of value added have also been provided by the ABS for the update of the OECD's 1981 report on the information sectors in the economies of its member countries (see Table 5).[36]

TABLE 5

The Primary Information Sector as a Percentage of GDP at Factor Costs, Australia

	1968/9	1977/8
Goods for information activities	1.72	1.94
Information handling services	23.07	34.17
PRIS total	24.79	36.11

Source: OECD, *Updating of the Data Base Contained in OECD Publication No. 6, Volume 1,* Note by Secretariat, Paris, February 1984.

The dominance of information service industries, which has already been observed in terms of employment, is even more apparent in the value added estimates. The percentage for goods for information activities is very low by OECD standards. They accounted for about 3.2 per cent of value added in many developed countries in the early 70s![37] This indicates a possible potential for local production of many information technology goods for which imports by far outstrip domestic output. The potential benefits of improving Australia's performance in the production of information goods is becoming increasingly realised. However, such an increase in production requires a shift in government spending towards information goods industries, which, given the present fiscal constraints, cannot be assumed to be easily forthcoming.[38]

There are reasons to believe that the ABS's PRIS estimates shown in Table 5 are an overestimate. The ABS reports a negative value for the SIS of about minus 2.8 per cent,[39] which would reduce the total percentage of PRIS plus SIS to just over 30 per cent of value added. This indicates that the ABS used a different method of calculating the information sector's contribution to value added from that employed in other studies quoted above. Karunaratne has provided estimates of the PRIS and SIS for the same year.[40] Althouth he obtained practically the same total for PRIS plus SIS (31.6 per cent), according to his results the PRIS contributed only 16.2 per cent, and the SIS 15.4 per cent, to the total value added.

SUMMARY AND SOME UNSOLVED QUESTIONS

This paper has attempted to provide an exposition of the information sector approach. The concept and the measurement of the PRIS and the SIS have been reviewed in detail. The data presented show the importance of the information sector in Australia, which accounted for about 41.5 per cent of the labour force (PRIS plus SIS) and about 31 per cent of value added in 1981. There can be no doubt that a large and increasing proportion of resources in the Australian economy is being devoted to the creation, storage and dissemination of marketed and non-marketed information goods and services needed to solve the information handling task in the economy. The information sector approach provides the analytical framework needed to investigate empirically many of the implications of the emerging information economy at the macro-economic level.

However, differences in measurement and pre-occupation with the aggregate estimates of the PRIS and SIS might be one of the reasons why the information sector approach has not yet found a wide acceptance amongst economists. There is a clear need to standardise, as far as possible, the measurement of the PRIS and SIS (both at the national and international level) and to provide information sector data at such a disaggregated level that they can be used for detailed policy analysis.[41] The problems involved in modelling technological and organisational change are formidable. However, policy oriented models of the ORANI type, for example, could benefit from the adoption of the information sector approach and incorporation of the non-marketed SIS transactions.[42]

Further research is also needed to clarify some basic issues concerning the growth dynamics of the information sector and the relationship between PRIS and SIS. First, we know little about the inter-relationships of the primary, secondary, tertiary and information sector in the growth process. It is often assumed that information sector growth depends on the growth of the

manufacturing sector. This belief cannot be easily reconciled with the fact that the information sector in Australia has increased rapidly despite a relatively small and, over the period 1971 to 1981, declining manufacturing sector. It has been observed in the Queensland study that information service sector growth does not depend mainly on the real goods sector but to a large extent originates from within the tertiary sector.[43] The author found a similar result when analysing the growth of the PRIS in the Republic of Korea. More research is needed into the relationship of service and information sector growth, particularly in the case of Australia.

Secondly, related to the question of growth dynamics of the information sector is the question of the balance between PRIS and SIS. This concerns to a large extent the 'buy or make' decisions of enterprises in regard to information services. It is assumed that if information services can be purchased more cheaply in the market (PRIS) than undertaken in-house (SIS), there will be an increasing willingness on the part of the enterprises to contract them out. Little information about such shifts is available at the macro level. In its 1981 publication, the OECD draws the tentative conclusion that there is a structural change underway towards the purchase of information goods and services on established markets.[44] A similar trend was observed in the Queensland study.[45] In its 1984 update of the same publication, the OECD, again tentatively, expresses the opposite view.[46] Given the non-availability of reliable SIS statistics for most countries, we simply cannot say much about the relative development trends of the PRIS and SIS. Moreover, the relationship of PRIS and SIS may tend to be industry and country specific, leaving little room for generalisations.

NOTES AND REFERENCES

1. Marc Porat, *The Information Economy,* OT Special Publication 77-12, US Department of Commerce, Washington DC, May 1977.
2. OECD, *Information Activities, Electronics and Telecommunications Technologies,* Paris, 1981.
3. See C. Jonscher, 'Information resources and economic productivity', *Information Economics and Policy,* 1, 1983, pp. 13-35.
4. Porat, *op.cit.*
5. The approach was developed by Porat, *op.cit.*, and taken up by the OECD, *op.cit.*
6. See T. Mandeville and S. Macdonald, 'Technological change and employment in the information economy: the example of Queensland', *Prometheus,* 3, 1, 1985, p. 72.
7. D.M. Lamberton, 'The theoretical implications of measuring the communication sector' in M. Jussawalla and D.M. Lamberton (eds), *Communication Economics and Development,* Pergamon Press, 1982, pp. 36-59.

8. It should therefore be noted that primary, secondary and tertiary sectors referred to in studies using the information sector approach are net of PRIS items. Moreover, construction, normally counted as a tertiary industry, is classified as part of manufacturing, i.e. as part of the secondary sector.
9. This assumes the same level of productivity in PRIS and SIS. Differences in productivity would result in different amounts of resources necessary for performing the same task in the PRIS and SIS.
10. OECD, *op.cit.*, pp. 34-5.
11. For a discussion of this short-cut method see S. Wall 'The measurement of information activities' in OECD, *Information Activities, Electronics and Telecommunications Technologies, Vol. II: Background Reports,* 1981, pp. 55-62.
12. OECD, *op.cit.*, appendix.
13. This is just a brief outline of the approach. For a detailed exposition see Wall, *op.cit.* pp. 58-61. The occupation by industry matrix contains wage and salary earners, certain 'informational' proprietors and unpaid family members. The income of the latter two categories is imputed by applying wages observed for similar wage earners.
14. For example, it has been reported that Japan possessed 98,800 installed industrial robots in 1981, which by far exceeded the number of robots in Western European countries. However, if one applies the more restrictive definition used in these countries to Japan, that country's lead in robot population almost vanishes. See P. Otto, 'How quickly will the robots arrive? Problems in forecasting technological development', International Institute for Comparative Social Research, Science Center Berlin, *Discussion Paper,* No. 116, 1983, p. 7.
15. However, in the long run the increasing importance of robotisation of manufacturing and service industries will necessitate an improvement in the measurement of depreciation on information machines.
16. Porat, *op.cit.*
17. Seisuke Komatsuzaki and Taro Tanimitsu, 'Japan's information industry: a structural analysis', *Economic Eye,* March 1983, pp. 12-5.
18. See Wall, *op.cit.*, p. 58.
19. This is pointed out in the OECD publication itself. See Wall, *op.cit.*, p. 58.
20. See OECD, *op.cit.*, Table I.8, p. 35. The slow growth of the PRIS reported by Komatsuzaki and Tanimitsu seems to be due to their narrow definition of PRIS activities.
21. In a recent study, the author analysed the PRIS of the Republic of Korea in both 1975 and 1980. The existence of a large PRIS and its rapid growth were found. During the period which is known for its industrial development, the PRIS contribution to value added grew from 14.7 to 19.9 per cent (see H-J. Engelbrecht, 'From newly industrialising to newly informatising country: the primary information sector of the Republic of Korea, 1975-1980', paper presented to the 14th Conference of Economists, University of New South Wales, Sydney, May 1985). A structural analysis also confirmed the dominant position of the PRIS for generating potential growth in that economy. Substantial PRIS have also been found in Singapore (M. Jussawalla and C.W. Cheah, 'Towards an information economy: the case of Singapore', *Information Economics and Policy,* 1, 1983, pp. 161-76); Taiwan (H-J. Engelbrecht, 'Measurement and structural analysis of the primary information sector of the Republic of China', paper presented to the Workshop on Measurement of the Primary Information Sectors of Ten Pacific Region Countries, East-West Center, University of Haiwaii, November 1984); the ASEAN countries and Fiji (N. Karunaratne, 'The information age and the larger ASEAN economies — Focuses on Indonesia, Malaysia and Thailand', and 'Pacific Islands and the information age — Focuses on Fiji and Papua New Guinea', papers presented to the Workshop on Measurement of the Primary Information Sectors of Ten Pacific Region Countries, East-West Center, University of Hawaii, 1984) and Venezuela (Rubin, quoted in Latin American

Economic Secretariat, 'The information sector in the Latin American economy', SP/LL/IX.O/DT No. 24, 1 August 1983).

22. The industry technology assumption implies that the information intensity of intermediate inputs is proportional to the information intensity of sectoral output. This and other assumptions which have to be made to reorganise the original input-output table are discussed in N. Karunaratne, 'A methodology for the input-output analysis of the information economy', paper presented at the Input-Output Workshop of the Regional Science Association of Australia and New Zealand, University of Melbourne, 1984 and Jussawalla and Cheah, *op.cit.* The technically minded reader is also referred to N. Karunaratne, 'Planning for the Australian information economy', *Information Economics and Policy,* 1, 1984, pp. 345-67, for a mathematical exposition of the methodology used to identify the PRIS.
23. All of the references given in footnote 21 and all of Karunaratne's studies quoted in this paper contain such an analysis.
24. Porat, *op.cit.*, p. 188. Porat was the first to develop an input-output table incorporating the PRIS and SIS.
25. For a discussion of the difficulties involved in using macro-economic models for predictive purposes see J. Bessant, 'Information technology and employment: some notes on the use of modelling techniques as a research tool', *Prometheus,* 2, 2, 1984, pp. 176-89.
26. D. Lamberton, 'Australia as an information society: who calls the shots?', *Search,* 15, 3-4, 1984, pp. 101-2.
27. Mandeville and Macdonald, *op.cit.*
28. *ibid.*
29. The list of information occupations is based on the OECD Inventory of Information Occupations (OECD, *op.cit.*, pp. 122-4). Readers interested in the informational or non-informational status of specific occupations are referred to the above publication. For a critique of the list of information occupations used in most information sector studies see J.R. Schement and L. Lievrouw, 'A behavioural measure of information work', *Telecommunications Policy,* December 1984, pp. 321-34.
30. We use the term 'information intensity of the labour force' in a macro-economic sense. It simply denotes the number of information workers as a percentage of the total number of workers either by industry or in the whole economy. The question of the degree of information intensity of occupations, i.e. what percentage of working time is devoted to informational tasks in a specific occupation, is an important but separate microeconomic issue which has to be addressed when determining the list of information occupations.
31. The 1971 figure is taken from Lamberton, *op.cit.*, 1982, table 3.2, p. 45 and the 1981 figure from H-J. Engelbrecht, 'Insights into the secondary information sector of Australia', paper presented to the Workshop of Measurement of the Primary Information Sectors of Ten Pacific Region Countries, East-West Center, University of Hawaii, November 1984, table 1, p. 2. There are conflicting estimates of the information intensity of the Australian labour force which are most likely due to different criteria used in delineating information from non-information workers. The ABS, for example, reports an information intensity of 39.4 per cent for 1971 and 41.5 per cent for 1981.
32. Lamberton, *op.cit.*, 1982, table 3.2.
33. The figure of about 36 per cent quoted in T. Mandeville and S. Macdonald, *op.cit.*, has been adjusted to include the 'inadequately described' category in order to make it comparable to the 1981 figure reported for Australia.
34. N. Karunaratne and A. Cameron, 'Input-output analysis and the Australian information economy', *Information & Management,* 3, 1980, pp. 191-206.
35. N. Karunaratne, 'Insights on the informatization of Australia and her developing neighbours', paper presented to the 13th Conference of Economists, Western Australian Institute of Technology, Perth, 1984.

36. Australia did not supply data for the original report (i.e. for OECD, *op.cit.*).
37. OECD, *op.cit.*, p. 37.
38. A study into the capabilities and opportunities of information technology in Australia commissioned by the Department of Science and Technology, for example, recommended a detailed plan of action for the promotion of selected information technology producing industries costing about $170 million over the next five years (see 'Technology development in Australia', *Ascent,* 5, November 1984, pp. 14-35). For a discussion of Australian government policies towards 'sunrise' industries see R. Joseph, 'Recent trends in Australian government policies for technological innovation', *Prometheus,* 2, 1, 1984, pp. 93-111.
39. Quoted in D.M. Lamberton, 'Secondary sector analysis: methodology and data requirements', paper presented to the Workshop on Measurement of the Primary Information Sectors of Ten Pacific Region Countries, East West Center, University of Hawaii, November 1984, p. 9.
40. Karunaratne, 'A methodology for the input-output analysis of the information economy', *op.cit.*, 1984.
41. The only study known to the author explicitly employing the information sector approach (although at an aggregated level) and investigating the policy implications of the increasing informatisation of the Australian economy is a study by Karunaratne, 'Planning for the Australian information economy', *op.cit.*, 1984. His analysis indicates that an accelerated growth rate of the PRIS would result in higher GDP than realisable under the present growth rate. However, the growth of the PRIS can only be achieved at the expense of fiscal restraint.
42. ORANI is a multisectoral general equilibrium model of the Australian economy which has been widely used for policy analysis. See P. Dixon, B. Parmenter, J. Sutton and D. Vincent, *ORANI: A Multisectoral Model of the Australian Economy,* North-Holland, Amsterdam, 1982.
43. T. Mandeville, S. Macdonald, B. Thompson and D.M. Lamberton, *Technology, Employment and the Queensland Information Economy,* Report to the Department of Employment and Labour Relations, Queensland, Brisbane, 1983.
44. OECD, *op.cit.*
45. Mandeville, *et al.*, *op.cit.*, 1983, pp. 66-8.
46. This view is based on an observed slow-down in PRIS growth and the fact that at least in one country, Norway, the PRIS seems to have contracted between 1975 and 1980 (OECD, *Updating of the Data Base Contained in OECD Publication No. 6, Volume 1,* Note by Secretariat, Paris, February 1984).