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Abstract

The conventional input-output model has been widely criticised, both justly and unjustly, for its limiting assumptions. One of these assumptions is homogeneity of degree one. This paper explores some approaches to minimise this limitation of traditional input-output analysis by removing the assumption of linear coefficients for the intermediate and household sectors. As is well documented in the literature, the household sector is the dominant component of multiplier effects in an input-output model, so using marginal income and expenditure coefficients for the household sector provides a more accurate estimate of the multiplier effects. A price model can then utilised to estimate the relative changes in local to imported inputs.

There are several implications arising from the use of this model, compared to the conventional input-output model. Firstly, while the output multipliers and impacts may not be significantly different between the two models, we would expect the income and employment impacts to be smaller in the marginal coefficient model. This is because many industries, especially those which are more capital intensive and can implement further productivity gains, can increase output, particularly in the short run, without corresponding proportional increases in employment and hence income payments. However, when price effects are incorporated into the model, the direction of change becomes less clear. Secondly, unlike the conventional input-output model in which the multiplier value is the same for all multiples of the initial shock, the multiplier values from the marginal coefficient model vary with the size of the initial impact. Thus larger changes in final demand will tend to be associated with smaller multipliers than small changes in final demand. Therefore, the differential impacts of the marginal coefficient model are not additive, unlike the conventional (linear) Leontief model and CGE model. While not attempting to be a substitute for a CGE model, the methods described in this paper could be used where construction of CGE models are impracticable due to cost and data considerations.

INTRODUCTION

Economic modeling at the regional and small area level is restricted by model and data availability. Often, resource and time limitations preclude the construction of complex models such as computable general equilibrium (CGE) models, and in fact there are arguments to suggest that building a CGE model for a small region, while not invalid, may not be a very efficient use of resources in the context of the tradeoff between increased complexity and increased data ‘fuzziness’.

In such cases, the old work horse of the regional modeler, input-output, is usually used, as it really provides the only practical option to planners. While many have forecast the end of the simple input-output model due to its inadequacies, it has proved surprisingly resilient.

The assumptions of the input-output model are concerned almost entirely with the nature of production. The model is based on the premise that it is possible to divide all productive activities in an economy into sectors or industries whose inter-relations can be meaningfully expressed as a set of input equations. The crucial assumption is that the money value of goods and services delivered by an industry to other producing sectors is a linear and homogeneous function of the output level of the purchasing industry with supply being infinitely elastic.

This assumption of linearity is clearly a valid criticism of the simple input-output model. It implies a strict proportional relationship between input coefficients and output; for example, income coefficients are average propensities and employment coefficients reflect average labour productivity rates. In impact studies, this property leads to an overestimation of the flow-on (multiplier) effects, particularly if the initial impacts are relatively modest. For example, many industries can increase output in the short term without corresponding proportional increases in wage costs and employment, particularly if there is slack capacity.

There have been various attempts to model non-linearities in the input demand structure. Evans (1954) was one of the first to generalise the input-output model by allowing the input coefficients to vary with the endogenous variables and utilising the usual power series expansion to obtain an iterative scheme for computing the solution of the nonlinear model. Lahiri (1976) extends Evans' analysis and provides theoretical justification of the procedure. Few empirical applications of marginal analysis have appeared, primarily as a result of data limitations. For example, Tilanus (1967) attempted to construct marginal input coefficient matrices from a series of consecutive input-output tables for the Netherlands from 1948 to 1960, but found that in a forecasting situation, the average input coefficient tables performed better. Tilanus postulated this was a result of data abnormalities and not as a result of theoretical deficiencies. Hamilton and Pongtanakron (1983) introduced marginal relationships into the analysis of the impact of irrigation in the state of Idaho by decomposing the industry input structure into marginal input coefficients for both existing and new firms. Estimating these marginal coefficients is, obviously, a daunting task.

Closer to the example in this paper, Bryden (1973) substituted average coefficients with marginal coefficients in the hotel sector and showed that the resultant multipliers were significantly lower than those obtained from the conventional model. Part of this effect is due to spare capacity in the hotel industry which rarely operates at 100% occupancy rate. West (1993, 1995), using an integrated input-output - econometric model of Queensland, which replaces the average coefficient household sector (both income and consumption) in the conventional input-output model with a set of marginal econometric relationships, derives a value added multiplier for total tourism expenditure that is 96.1% of the conventional input-output multiplier, and employment multiplier that is 72.4% of the conventional multiplier. Similarly, capacity constraints can also result in the overestimation of multipliers. In the Queensland study, if the marginal relationships are extended to all sectors and capacity (capital) constraints also introduced through a CGE - type framework, these figures become 71.4% and 60.4% respectively. The distribution of the impacts also changes. The integrated model produces relatively larger impacts in the manufacturing sectors and smaller impacts in the service sectors, as service-type industries are better able to absorb increases in tourism activity within existing resources, than manufacturing-type industries which have more rigid production structures and respond in a manner closer to that of the Leontief production system. Wanhill (1988), in a study of tourism in Mauritius, similarly showed that capacity constraint matrices reduces the multipliers derived using the conventional model by as much as 28.1% for income and 33.8% for employment.

In the following section, the structural form of a model is suggested which provides for non-linearities in both the primary inputs quadrant and intermediate quadrant. An application to the Gold Coast region of Queensland is then presented.

THE MODEL

The transactions flows in the input-output table can be expressed in matrix equation form as:

$$\mathbf{T}(\hat{\mathbf{X}}^{-1})\mathbf{X} + \mathbf{Y} = \mathbf{X} \tag{1}$$

where **T** = (n x n) matrix of industry transactions, **X** = (n x 1) vector of industry gross outputs, and **Y** = (n x 1) vector of industry final demands. n is the number of industries, and the caret denotes a diagonal matrix.

This equation simply states that, for each industry, total industry sales equals intermediate sales to other industries for further processing plus sales to final users. This can be rewritten as

$$\mathbf{AX} + \mathbf{Y} = \mathbf{X} \tag{2}$$

where **A** is the matrix of direct coefficients which represents the amounts of inputs requires from sector i per unit of output of sector j. Thus, for a given direct coefficient matrix, it is possible to solve the set of simultaneous equations to find the new sector production levels **X** which will be required to satisfy a potential or actual change in the levels of sector final demands **Y**. By rearranging and converting to differences, this equation can be rewritten as:

$$\Delta\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\Delta\mathbf{Y} \tag{3}$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is termed the total requirements table or Leontief inverse matrix, and represents the direct and indirect change in the output of each sector in response to a change in the final demand of each sector. $\Delta\mathbf{Y}$ can incorporate any element of final demand expenditure, including household expenditure, government expenditure, capital expenditure or exports.

This model is a linear model in which the **A** matrix represents a (constant) matrix of average input propensities. In many applications, the **A** matrix endogenises the household sector, that is household income varies with the level of intersectoral activity, so that household consumption induced effects can be measured. This is referred to as the type II model; the alternative type I model is where households are treated as exogenous to local economic activity. Generally speaking, the consumption-induced effects are the largest component of the total multipliers. This is because consumer driven consumption (and income) to a large extent dominates local economic activity.

Total inputs are equal to intermediate inputs plus primary inputs (labour and capital). In the conventional input-output model, the inputs purchased by each sector are a function only of the level of output of that sector. The input function is assumed linear and homogeneous of degree one, which implies constant returns to scale and no substitution between inputs.

The model described in this paper differs from the conventional model in that it replaces the average propensities with marginal propensities or elasticities within the major linkages in the model. The actual implementation and specifications of these linkages can vary between models and applications, but the general generic structure is described below and in Figure 1.

Primary Inputs

The first step is to allow for non-constant returns to scale and substitution between primary factors. Firstly, the change in employment is calculated based on marginal changes in labour productivity:

$$\Delta\mathbf{L} = \hat{\mathbf{X}}_0^{-1}(\Delta\hat{\mathbf{X}})\hat{\mathbf{G}}\,\mathbf{L}_0 \tag{4}$$

where **G** = (n x 1) vector of industry employment productivity elasticities, and **L** = (n x 1) vector of employees by industry. The zero subscript denotes the base level value. Secondly, the change in labour income is calculated based on marginal changes in real wage rates:

$$\Delta \mathbf{W} = \hat{\mathbf{L}}_0^{-1} (\Delta \hat{\mathbf{L}}) \hat{\mathbf{H}} \mathbf{W}_0 \quad (5)$$

where **H** = (n x 1) vector of industry wage rate elasticities with respect to labour demand, and **W** = (n x 1) vector of household income flows by industry.

The other value added expenditures, such as gross operating surplus, are similarly calculated based on marginal changes in output by industry:

$$\Delta \mathbf{O} = \hat{\mathbf{X}}_0^{-1} (\Delta \hat{\mathbf{X}}) \hat{\mathbf{U}} \mathbf{O}_0 \quad (6)$$

where **U** = (n x 1) vector of industry other value added elasticities of demand, and **O** = (n x 1) vector of other value added by industry.

Household Expenditure

The change in household expenditure is calculated based on marginal changes in household income:

$$\Delta \mathbf{C} = \hat{\mathbf{C}}_0 \mathbf{S} (\mathbf{i}' \Delta \mathbf{W}) (\mathbf{i}' \mathbf{W}_0)^{-1} \quad (7)$$

where **S** = (m x 1) vector of commodity household demand elasticities with respect to income, and **C** = (m x 1) vector of household expenditures by commodity. **i** is an (n x 1) vector of ones. These commodity demands are allocated to industries using a commodity-industry concordance matrix. In the application described later in this paper, $m = n$.

Intermediate Inputs

Intermediate input coefficients can vary because of substitution effects caused by relative price changes, or through changes in technology. In short run impact situations, price effects will be the main source of change. Technology change is more of a long run phenomenon.

Assume industry technology is fixed, i.e.

$$\frac{q_{ij,k}^{l}}{q_{j,k}} + \frac{q_{ij,k}^{m}}{q_{j,k}} = \frac{q_{ij}}{q_j} \quad (8)$$

where q_{ij} is the physical quantity purchased by sector j from i, the superscripts l and m refer to local and imported inputs and the subscript k = 0 or 1 refers to different time periods (or before and after a policy or economic change or stimulus).

The regional direct requirements coefficient is then $a_{ij,k}^{l} = \frac{p_{i,k}^{l} q_{ij,k}^{l}}{p_{j,k} q_{j,k}}$, where p_i^l is the price of locally sourced goods from industry i, and p_i is the (weighted local and imported) output price of industry i. The regional import requirements coefficient is similarly given by $a_{ij,k}^{m} = \frac{p_{i,k}^{m} q_{ij,k}^{m}}{p_{j,k} q_{j,k}}$, where p_i^m is the price of imported good i, and the regional technology flow coefficient is $a_{ij,k} = \frac{p_{i,k} q_{ij,k}}{p_{j,k} q_{j,k}}$. Note that the regional technology flow coefficient can change, even when industry technology is fixed, as a result of relative price changes.

It can be shown that the regional direct requirements coefficient in period 1 as a result of changes in local and import prices is given by:

$$a_{ij,1}^{l} = \frac{a_{ij,0} a_{ij,0}^{l} p_{i,1} \theta}{[a_{ij,0} + a_{ij,0}^{l}(\theta - 1)] p_{j,1}} \quad (9)$$

where

$$\theta = \frac{\sigma_{ij} dp_i^m + (1 - \sigma_{ij}) dp_i^l + 1}{1 + dp_i^m} \quad (10)$$

and where σ_{ij} = elasticity of substitution between locally produced and imported inputs from industry i to industry j.

The change in industry prices can be calculated using the price model:

$$\Delta \mathbf{P} = (\mathbf{I} - \mathbf{A}')^{-1} \Delta \mathbf{V} \quad (11)$$

where $\mathbf{V}$ = (n x 1) vector of primary inputs per unit of output by industry. Note that these prices refer to local industry prices in the case of the **A** matrix containing regional trade coefficients (that is, with direct allocation of imports), and industry output prices in the case of the **A** matrix containing regional technology flow coefficients (that is, with indirect direct allocation of imports). In the former case, the primary inputs vector contains competitive imports, that is:

$$\Delta \mathbf{V} = (\Delta \hat{\mathbf{W}} + \Delta \hat{\mathbf{O}} + \Delta \hat{\mathbf{M}})(\hat{\mathbf{X}}_0^{-1})\,\mathbf{i} \quad (12)$$

where $\mathbf{M}$ = (n x 1) vector of competitive imports by industry. In the latter case, the competitive imports are allocated to the intermediate quadrant, so that:

$$\Delta \mathbf{V} = (\Delta \hat{\mathbf{W}} + \Delta \hat{\mathbf{O}})(\hat{\mathbf{X}}_0^{-1})\,\mathbf{i} \quad (13)$$

These terms can then be used to update the intermediate direct requirements coefficients by calculating the substitution effect between locally produced and imported purchases. In practice, the usual approach is to set $p_{i,0}^{l} = p_{i,0}^{m} = p_{i,0} = 1$.

As a final step, the price-updated coefficients will no longer sum to unity so a bi-proportional RAS procedure can be applied to the intermediate flows to restore the row and column balance.

In this type of model, the structural equations cannot be solved analytically, because the input coefficients vary with the endogenous variables, and thus also become endogenous. The solution procedure requires the use of an iterative recursive algorithm, the simplest being the Gauss-Seidel method. Provided the elasticities lie between zero and one, convergence will be guaranteed (Sandberg 1973). Also, the elasticities can be either long-run or short-run (impact) elasticities, depending on the application.

CASE STUDY

The Gold Coast region of South East Queensland stands out as one of the fastest growing regions in Australia. The attractiveness of its weather, geography, diverse economy and strategic location in regards to Pacific and Asian markets combine to make it a desirable place to live and work. Global promotion of the region through innovative and aggressive private and public sector tourism marketing campaigns have contributed to raising awareness of the destination as being an exciting place both for those seeking a holiday and for those seeking a new place to live.

Population growth rates continue to be higher than most other regions in Australia. Over the past decade the total population of the region has grown by over 200,000 representing an average annual growth rate of over 3 percent. The Gold Coast City will continue to have a fast growth rate with the population of the coastal strip passing 500,000 over the next ten years and more than 675,000 by 2021 (DLGP, 2001). The key tourism market of South East Queensland, which currently contains 65.1% of the total Queensland population, will experience substantial population growth rates over that period, reaching some 3.4 million by 2021. (currently approx 2.3 million). While it can be expected there will be different rates of growth in visitors to the Gold Coast from individual market sources, given the appropriate planning, management and resourcing, there is every expectation that the Gold Coast should be a net beneficiary of long term global sustainable tourism growth.

The tourism industry in the Gold Coast attracts more than 4 million visitors per year (about 30% are international). It has been recognised for some time as a major industry on the Gold Coast, and various Government and private organisations have become increasingly aware of the potential of sustainable tourism, both for investment and as an instrument of Government policy to stimulate economic growth and generate employment opportunities. Fundamental questions relate to the economic and employment impacts of current, and future tourism. For example, tourism has ‘downstream effects’ on the Gold Coast economy. Visitor consumption has a direct impact on all the industries supplying the goods and services and an indirect impact on other industries supplying those industries and so on.

It is appreciated by the Gold Coast City Council and the Gold Coast Regional Economic Development Advisory Committee that the region’s current relatively narrow economic base, of which tourism is a vital part, will need to be expanded in order to meet the needs, dreams and aspirations of a rapidly growing population and the increasing visitor markets. The study of tourism can involve fundamental and very complex issues, involving significant social, economic, political and environmental consequences. Common questions often asked are what is the nature of tourism demand, is tourism desirable, and is it sustainable over time? Obviously, no one study can answer all these questions. This study, which focuses on the economic impact of tourism on the Gold Coast regional economy in the context of expenditures made by tourists as they interface with the suppliers of tourism commodities, adds one part of the overall insight into the way the destination addresses these complex tourism management issues.

Methodology and Data

This study focuses on the economic analysis of tourism, in the context of expenditures made by tourists as they interface with the suppliers of tourism commodities. This issue, in turn, can be approached from two main perspectives; either from the supply side in which the suppliers of goods and services to tourists can be viewed as a 'tourist' industry, or from a demand point of view in which tourism expenditures are basically demand oriented. The analysis used in this study uses the demand approach, for reasons which will become clear.

The supply approach, commonly used in studies of economic significance of firms or industries, is more complex in the case of tourism. For example, the tourist travels to the source of supply rather than the usual situation of goods and services being distributed to or near the consumers' usual place of residence. In addition, there is generally no such thing as a 'pure' tourist good or service; most suppliers sell to both local residents and visitors simultaneously. Although the presence of tourists may alter the mix of goods and services offered by some firms, in general they would still exist, albeit in a modified form, without tourism. The mix of goods and services may change, but employment may be less affected. Of course, there are some activities, such as some tour operators and resort complexes, which may be regarded as 'pure' tourism activity, and can be analysed in a supply framework, but here the emphasis will be on specific tourism related activities and not on tourism in general.

If, on the other hand, tourism activity is viewed from the point of view of the tourist, the analysis is better approached from a demand aspect. In this respect, the tourist is the dominating influence. The tourist has a virtually unlimited choice of destination, mode of travel, type of accommodation, recreational activity, leisure and sporting goods, and so on. The goods and services offered will vary in quality, price and availability, presumably being directed towards differing categories of tourists. Therefore the tourist can usually select with discretion, and the supplier has to try and anticipate the demand. It is dangerous for the supplier to assume that supply creates demand, as many tourist operators can attest.

This approach to tourism analysis is obviously a demand oriented approach. Purchases by tourists can be classified as purchases by final users, i.e. as part of final consumption expenditure by individuals[1], and is thus part of final demand in the input-output model. This is the approach taken in this study, since it is designed to estimate the economic impacts of visitor expenditures, not the expenditures of a select number of firms involved in tourism related (and other) activities.

Like the suppliers of goods and services to tourists and visitors, visitor demand is not homogeneous. Different categories of visitors to a region will have differing expenditure patterns. Even within a particular subgroup of visitor, for example holiday/recreation, there are different categories of tourists who stay in 4-5 star resorts, those who stay in rented flats and houses, and those who stay in caravan parks or camping grounds. Presumably, each of these tourist subgroups exhibit different expenditure patterns. Therefore one has to be careful that when undertaking an economic impact analysis of tourist or visitor expenditures, the expenditure profile used is representative of the class of visitor under study[2]. Although the assumption of homogeneity is less important when modelled in the context of final demand rather than in terms of intermediate producing firms, nevertheless we should ensure that the expenditure profiles are representative of the population group or subgroup.

To model the regional impacts of tourism, a three-way classification; average daily visitor expenditure profile x type of visitor x total visitor expenditure, is required. Information on visitor expenditures is available from several sources, including the Queensland Visitor Survey (QVS), International Visitor Survey (IVS) and National Visitor Survey (NVS) collected by the Bureau of Tourism Research (BTR). The latest data available for the Gold Coast Tourism Region has been collated by the Office of Economic and Statistical Research (OESR) at Queensland Treasury in the publication *The Contribution of International and Domestic Visitor Expenditure to the Queensland Regional Economies 1998-99* (OESR, 2002). The QVS visitor expenditure profiles, which gives the

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1 Some input-output tables, e.g. Tasmanian Input-Output Table 1985-86 (Department of Treasury and Finance, Hobart 1990), explicitly disaggregate the Private Consumption column of final demand into the two components, Expenditure by Households and Expenditure by Tourists.

2 The calculation of differential multipliers for tourism in an input-output framework was first introduced by Archer and Owen in 1971. Since then this model has been used in a wide range of studies (e.g. Henderson and Cousins, 1975; Archer and Jones, 1977; Liu and Var, 1983; Liu, Var and Timur, 1984; Milane, 1985; Var and Quayson, 1985; and Liu, 1986). Archer (1977), Fletcher (1989) and West and Bayne (1990) are three of the many who describe the use of input-output for measuring the economic impact of tourism expenditures.

average daily expenditure per visitor in each of the following expenditure categories: Food and beverage at place of accommodation, Food and beverage bought elsewhere, Pleasure shopping, Gambling, Entertainment, Transport fares, Vehicle expenses, Accommodation, and Other, is combined with the total visitor expenditure by type of visitor: Intrastate, Interstate, International and Day Visitor from the OESR report, to undertake the following analysis. This is summarised in Table 1.

The second step involves converting the expenditure amounts which have been allocated to the input-output sectors into basic prices consistent with the accounting format of the input-output model. The visitor expenditures are recorded in purchasers' prices, whereas basic prices are measured net of trade and transport margins. The conversion therefore requires the reallocation of the trade and transport margins included in the purchasers' prices back to the appropriate trade or transport sector. The margins used in this study are those used to convert purchasers' prices to basic prices in the national input-output tables (ABS, 5209). There are no sub-national margins tables available in Australia, and although there may be some regional variation in the various margins, it is assumed that this variation is minimal in this study.

The final step is to estimate the import component of each expenditure item on a regional basis. This was done by calculating the ratio of imports to total sales for each industry in the regional input-output table, and assuming that the same import ratio applies to consumer goods and services. This is the same approach used by the Bureau of Industry Economics study on Tourism Expenditure in Australia (BIE, 1984), and is not without some problems. The approach again assumes that the regional sectors are comprised of homogeneous outputs, but in fact the commodities purchased by tourists only comprise a part of the range of commodities offered for sale in any sector, with quite possibly a different import ratio for each commodity. Unfortunately, without specific interregional trade data on commodities between regions, it is difficult to estimate with any precision these individual import ratios. The resulting visitor expenditure profiles are given in Table 2.

The input-output table used in the study was based on the table in West and Bayne (2002). The elasticities used were derived from an input-output - econometric model under construction by the Centre for Economic Policy Modelling at the University of Queensland. Import prices were assumed to be constant over the range of the study.

Results

Tables 3 – 6 provide estimates of the contributions to gross output, gross regional product, household income and employment respectively. Table 7 also provides, as a comparison, the impacts obtained from the conventional linear model.

In total expenditure terms, visitors to the Gold Coast contribute, directly and indirectly, $4.3 billion to the local economy. However, gross production or output is a misleading indicator of economic performance due to double counting. A more reliable indicator is the contribution to gross regional product. Table 4 shows that day visitors, excluding other categories of tourists (that is, assuming that day visitors were the *only* visitors to the region), contributed approximately $146.7 million to the Gold Coast's gross regional product in 1998-9. Similarly, $414.2 million originated from intrastate (non-Gold Coast) visitors, $893.6 million from interstate and $483 million from international visitors. All visitors, collectively, contributed about $1.9 billion to the region's gross regional product. Note that this is not the simple sum of the separate impacts, as is the case of the conventional linear model, because of the synergistic interaction effects between different types of visitors. In other words, service providers exhibit economies of scale by servicing multiple categories of tourists.

Comparing these results with those obtained from the conventional linear model, the non-linear model shows a reduction in the contribution to gross regional product ranging from 15.6% for day visitors to 20.4% for interstate visitors. The cumulative effect over all visitors is about 22.5%.

A similar story occurs for household income and employment. Tourism activity can be linked to income of approximately $977.8 million paid to 29.2 thousand (fulltime equivalent) jobs on the Gold Coast region in 1998-9. This represents a reduction of about 18.3% in income and 34.1% in employment over the estimates obtained from the linear model. The lower value for income reflects the increase in labour productivity, with a smaller workforce working longer hours. Individually, the reduction in estimated income impacts ranges from 9.8% for day visitors to 15.3% for interstate tourists. The corresponding values for employment are 11% and 24.2%.

On point that needs to be remembered is that the multiplier values from this type of non-linear model are not constant. Unlike the conventional input-output model, in which the multiplier values are the same for all multiples of the initial change in final demand, the multiplier values from the non-linear model vary with the size of the initial impact. For that reason, comparison of multiplier values between linear and non-linear models is meaningless and thus multiplier values are not presented here.

The closest study with which these results can be compared is a comparison of input-output and integrated input-output - econometric models on tourism impacts in Queensland in 1985-6 and 1990-1 with a model calibrated to the 1985-6 state input-output table (West, 1996). In that study[3], the integrated model reduced total income effects by 10.7% and total employment effects by 26.1%. However, that model had greater closure (including a comprehensive labour market component which included, among other things, non-wage income) so the impacts would not be expected to decrease as much. Wanhill, in the study referred to earlier, quoted a 28.1% and 33.8% reduction in income and employment impacts respectively in his study of tourism in Mauritius, but it is unclear what assumptions were used so again a direct comparison is difficult.

CONCLUSION

Input-output is still widely used for regional impact analysis. The structure is ideal for these type of studies, but the limitations are widely recognised. The main limitations are linearity properties and lack of price effects.

The non-linear price responsive model provides one avenue for improving the performance of the input-output model in impact situations. The model described in this paper removes the linearity assumption, particularly with respect to the primary factors which is the main concern, and allows for price responsive substitutions between locally supplied and imported inputs. The benefits are two-fold; the flow-on effects are determined in part by marginal rather than average relationships, and the input distributions are determined by relative prices. Both factors should produce more reliable estimates in an impact situation.

What is of interest in this paper, however, is that the analysis demonstrates that the simple input-output model can overestimate the flow-on effects to value added, income and employment by a substantial amount. The non-linear income and employment impacts, for example, are only 81.7% and 65.9% respectively of the size of the impacts derived from the simple input-output model for

[3] The study only considered tourists staying in commercial accommodation, so excluded day visitors and visitors staying with friends and relatives.

total tourism. Although it is reasonable to expect that the substitution effects between labour and capital and between local and imported inputs is likely to be affected by the linearity restriction, the analysis does raise the question of how these can be adequately modelled. This is an important point to consider in future research. Although it has been addressed to some degree in the literature (e.g. Israilevich 1991), the work has generally been more of a theoretical nature. What is needed is more empirical evidence of industry and firm input structures, and particularly how they change at the margin. Studies along the lines of Jackson and West (1989) may provide a guide as to how the distribution of input shares changes in response to changes in the structure of final demand. Whether this information is available and can be integrated into the input-output modelling framework remains to be seen.

TABLE 1. Average Daily Expenditure by Visitors to Gold Coast by Place of Residence, 1998-9, Purchasers' Prices

Expenditure Category	Day Visitors	Intrastate	Interstate	International
Food & beverages at place of Accommodation		5.90	5.61	11.90
Food & beverages bought elsewhere	17.53	25.87	27.32	30.60
Pleasure shopping	19.32	28.51	27.68	64.04
Gambling	4.71	6.95	8.34	6.78
Entertainment	6.55	9.67	15.14	17.14
Transport fares	1.54	2.27	4.26	5.62
Vehicle expenses	5.18	7.65	8.97	7.88
Accommodation		33.22	36.46	54.22
Other	3.18	4.69	5.18	5.60
Total	**58.00**	**124.74**	**138.96**	**203.78**
Visitors ('000)	5,552	1,579	1,796	765
Visitor nights		5,147	10,226	3,548
Average length of stay (nights)		3.3	5.7	4.6

TABLE 2. Allocation of Visitor Expenditures to Gold Coast to Industry Sectors, 1998-9, $'000, Basic Prices

Industry Sector	Day Visitors	Intrastate	Interstate	International	Total
2101 Meat products	2,228	6,475	13,584	5,279	27,566
2102 Dairy products	2,789	8,105	17,004	6,608	34,505
2103 Fruit and vegetable products	1,315	3,822	8,019	3,116	16,273
2106 Bakery products	1,903	5,531	11,604	4,509	23,546
2107 Confectionary	794	2,307	4,840	1,881	9,822
2108 Other food products	3,257	9,465	19,858	7,717	40,296
2109 Soft drinks and cordials	1,723	5,006	10,504	4,082	21,315
2110 Beer	1,495	4,346	9,118	3,543	18,502
2111 Wine and spirits	1,293	3,759	7,887	3,065	16,005
2204 Clothing	7,531	21,886	42,217	33,888	105,521
2205 Footwear	1,904	5,535	10,676	8,569	26,684
2501 Petroleum products	315	917	2,136	651	4,019
2903 Other manufacturing	3,393	9,862	19,024	15,270	47,550
4501 Wholesale trade	6,869	19,963	41,096	23,237	91,165
5101 Retail trade	29,838	86,719	172,563	115,205	404,326
5701 Accommodation, cafes and restaurants	50,580	147,003	314,067	171,182	682,832
6101 Road transport	2,458	7,144	23,731	10,473	43,806
6201 Rail transport	728	2,116	7,777	3,540	14,160
6301 Water transport	80	233	820	364	1,497
6401 Air transport	1,556	4,521	16,630	7,693	30,400
6601 Services to transport	15	44	90	51	200
7401 Insurance	5	16	35	12	69
9301 Sport, gambling and recreational services	20,762	60,342	169,365	59,863	310,332
9501 Personal services	6,849	19,905	43,677	16,383	86,812
Taxes less subsidies on products & production	124,314	67,459	152,573	63,966	408,312
Imports	48,006	139,521	302,108	152,852	642,486
Total	**322,000**	**642,000**	**1,421,000**	**723,000**	**3,108,000**

TABLE 3. Contribution to Gross Output, Gold Coast, 1998-9, $'000

Sector	Day Visitors	Intrastate	Interstate	International	Total
Agriculture, forestry and fishing	3,735	9,793	18,601	10,098	32,009
Mining	775	2,031	3,862	2,303	6,609
Food manufacturing	27,632	78,069	161,502	72,253	319,749
Textiles, clothing and footwear	11,238	32,429	63,402	48,406	154,248
Wood and paper	4,975	13,335	26,082	15,651	48,551
Chemical products	5,465	14,824	30,610	16,830	58,263
Non-metallic mineral processing	1,021	2,718	5,281	3,065	9,602
Metals and metal products	1,782	4,755	9,277	5,441	17,076
Machinery, appliances and equipment	3,952	11,130	24,175	13,121	51,223
Other manufacturing	5,014	14,425	28,874	20,617	68,902
Utilities	2,431	6,612	13,591	7,597	26,682
Construction	2,585	6,812	13,242	7,849	23,618
Trade	66,012	188,775	389,306	234,739	869,521
Transport	19,420	52,952	126,271	67,679	230,070
Communication	7,159	19,467	39,825	22,760	78,057
Finance services	11,126	29,971	60,194	34,599	115,624
Property and business services	69,712	190,838	393,388	223,134	791,523
Government administration and defence	1,194	3,301	6,987	3,889	14,307
Community services	2,967	8,442	18,577	9,873	41,303
Cultural and recreational services	103,828	298,243	677,079	329,197	1,390,511
Total	**352,023**	**988,919**	**2,110,124**	**1,149,101**	**4,347,451**

TABLE 4. Contribution to Gross Regional Product, Gold Coast, 1998-9, $'000

Sector	Day Visitors	Intrastate	Interstate	International	Total
Agriculture, forestry and fishing	1,981	5,171	9,761	5,331	16,663
Mining	339	886	1,682	1,004	2,874
Food manufacturing	6,576	18,765	39,322	17,349	79,175
Textiles, clothing and footwear	3,962	11,275	21,723	16,692	51,612
Wood and paper	1,864	4,998	9,781	5,867	18,222
Chemical products	842	2,279	4,690	2,586	8,881
Non-metallic mineral processing	293	780	1,514	879	2,748
Metals and metal products	517	1,379	2,687	1,577	4,939
Machinery, appliances and equipment	996	2,808	6,109	3,311	12,980
Other manufacturing	2,214	6,338	12,605	9,032	29,688
Utilities	1,415	3,853	7,926	4,427	15,587
Construction	1,086	2,864	5,570	3,300	9,941
Trade	28,352	80,449	164,093	99,768	359,235
Transport	7,566	20,700	49,696	26,495	91,269
Communication	3,689	10,004	20,385	11,688	39,702
Finance services	6,016	16,152	32,280	18,632	61,519
Property and business services	29,103	79,325	162,433	92,646	323,167
Government administration and defence	515	1,423	3,006	1,676	6,135
Community services	2,346	6,678	14,701	7,810	32,716
Cultural and recreational services	47,029	138,118	323,611	152,924	689,341
Total	**146,703**	**414,242**	**893,575**	**482,995**	**1,856,394**

TABLE 5. Contribution to Household Income, Gold Coast, 1998-9, $'000

Sector	Day Visitors	Intrastate	Interstate	International	Total
Agriculture, forestry and fishing	897	2,349	4,455	2,422	7,652
Mining	86	224	424	254	720
Food manufacturing	2,781	7,748	15,733	7,181	30,372
Textiles, clothing and footwear	2,876	8,002	15,047	11,687	34,296
Wood and paper	1,025	2,734	5,308	3,204	9,766
Chemical products	362	976	1,995	1,107	3,737
Non-metallic mineral processing	156	413	799	466	1,442
Metals and metal products	306	813	1,579	930	2,884
Machinery, appliances and equipment	582	1,630	3,507	1,919	7,294
Other manufacturing	1,534	4,395	8,756	6,269	20,690
Utilities	273	745	1,536	857	3,029
Construction	484	1,274	2,475	1,468	4,409
Trade	20,188	57,265	116,749	71,008	255,365
Transport	3,143	8,504	19,974	10,834	35,733
Communication	1,277	3,433	6,899	4,001	13,133
Finance services	2,054	5,521	11,048	6,370	21,099
Property and business services	8,085	22,093	45,423	25,821	90,988
Government administration and defence	392	1,081	2,281	1,273	4,645
Community services	1,670	4,753	10,456	5,558	23,237
Cultural and recreational services	30,491	87,531	198,541	96,608	407,313
Total	**78,662**	**221,485**	**472,985**	**259,236**	**977,804**

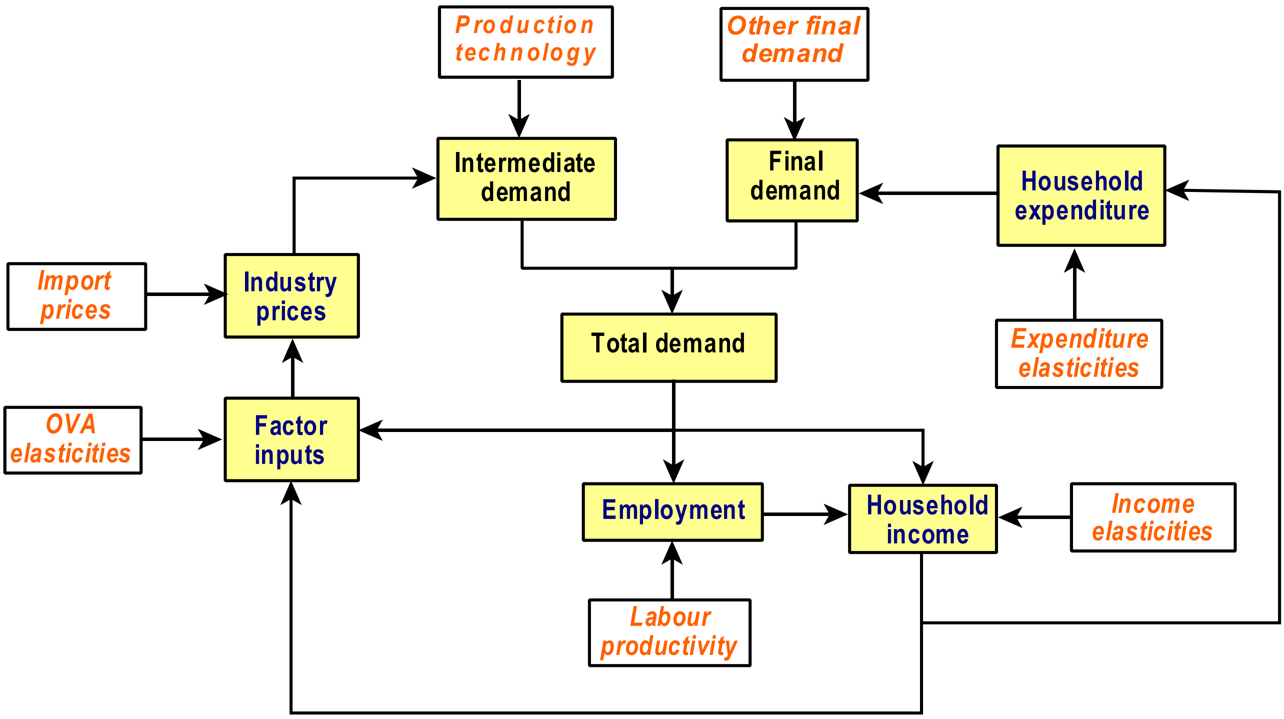
TABLE 6. Contribution to Employment, Gold Coast, 1998-9, FTE

Sector	Day Visitors	Intrastate	Interstate	International	Total
Agriculture, forestry and fishing	38	96	173	99	276
Mining	2	6	10	6	17
Food manufacturing	99	254	461	238	738
Textiles, clothing and footwear	109	235	298	281	104
Wood and paper	36	94	172	109	287
Chemical products	11	29	58	33	103
Non-metallic mineral processing	5	13	25	15	44
Metals and metal products	11	28	54	32	96
Machinery, appliances and equipment	18	51	106	60	208
Other manufacturing	62	175	342	248	774
Utilities	8	21	37	23	57
Construction	16	41	79	47	140
Trade	789	2,146	4,109	2,622	7,904
Transport	99	258	566	324	923
Communication	38	101	195	117	349
Finance services	66	171	324	196	563
Property and business services	260	697	1,393	811	2,652
Government administration and defence	12	33	69	39	139
Community services	53	149	325	174	709
Cultural and recreational services	1,139	3,160	6,807	3,471	13,075
Total	**2,871**	**7,758**	**15,602**	**8,943**	**29,159**

TABLE 7. Comparison Between Linear and Non-Linear Model Impacts

Impact	Day Visitors	Intrastate	Interstate	International	Total
Gross Output $'000					
Linear	380,226	1,105,064	2,468,917	1,277,925	5,232,133
Non-Linear	352,023	988,919	2,110,124	1,149,101	4,347,451
(% of linear)	(92.6)	(89.5)	(85.5)	(89.9)	(83.1)
Value Added $'000					
Linear	173,885	505,367	1,122,276	593,341	2,394,868
Non-Linear	146,703	414,242	893,575	482,995	1,856,394
(% of linear)	(84.4)	(82.0)	(79.6)	(81.4)	(77.5)
Household Income $'000					
Linear	87,169	253,343	558,369	297,926	1,196,807
Non-Linear	78,662	221,485	472,985	259,236	977,804
(% of linear)	(90.2)	(87.4)	(84.7)	(87.0)	(81.7)
Employment FTE					
Linear	3,226	9,375	20,596	11,038	44,235
Non-Linear	2,871	7,758	15,602	8,943	29,159
(% of linear)	(89.0)	(82.8)	(75.8)	(81.0)	(65.9)

Figure 1. Simplified Schematic of Nonlinear Price Model



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