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A COMPARISON OF INPUT-OUTPUT AND SOCIAL ACCOUNTING METHODS FOR ANALYSIS IN AGRICULTURAL ECONOMICS

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A fundamental purpose of all applied agricultural economic analysis is to assist in the formation of farm policies. Thus it is important that in the process of choosing a particular methodological framework, modellers take into account not only theoretical and practical considerations but also the relevance of the results that can be obtained and the transparency and ease with which they can be interpreted in the policy forum. It is with respect to the latter two criteria that the use of Leontief models is as justified today as it ever has been.

Any casual observer of agricultural production in post war years will have noticed that the farm sector does not operate in isolation but has direct interfaces with the 'upstream' and 'downstream' industries in the food chain. Thus it can be surmised that changes in the operation of the agricultural sector will have repercussions or 'knock-on' effects on other production sectors in the economy. Given the current reform process of the CAP, the movement away from product price support to quantitative control mechanisms and the increased emphasis placed by the European commission on agriculture's role in supporting the rural economy, it is not surprising that input-output analysis has re-emerged as a suitable candidate for capturing the multiplier effects of alternative policy scenarios. That is, despite the strength of the assumptions, the time, cost and necessary compromises that have to be made during data preparation; input-output models are still unchallenged in terms of the way they capture both the direct and indirect effects arising from interindustry transactions. Moreover, because the mechanism driving Leontief models is straightforward, it is easy to trace the causality of particular results.

However, the farm sectors direct interfaces with other production sectors in the food chain mask other, less obvious but potentially equally important links between the farm sector and the general economy. If the attention of agricultural economists is to emulate changes occurring in the current policy debate:- to shift from analysis of product orientated farm policies to more broadly based rural policies; it is important that one recognises that agricultural production is but one facet of the farm sectors interconnections with the wider economy.

Josling (1985) lists a number of links which support this argument including: the importance of farm household consumption and savings in non-agricultural markets; the way in which hiring of factors of production by farmers is influenced by the degree of integration between rural and urban markets and the valuation of farm assets and debts which will reflect not only agriculture's prosperity but also non-farm valuations. Although the significance of such links are arguably more important in a developing country context, the evolution of part time farming as a long term phenomenon and the increasing level of off-farm incomes earned by farmers in advanced market economies such as the UK, substantiate the proposition that analysis which focuses solely on production linkages incurs the danger of ignoring the implications, in particular the distributional effects, arising from other types of links between the farm sector and the macro economy.

The purpose of this paper is to analyse the role of social accounting methods for agricultural analysis. Social accounting analysis will be promoted as a natural progression or extension of traditional input-output models, capable of focusing on a wider range of issues than those usually addressed by Leontief-type models.

The paper is split into three sections. The first simply describes the format of a social accounting matrix or "SAM". Although the description of a SAM will be based on a country level specification (in order to emphasise its consistency through the presentation of basic macro economic identities), the same style of format has been utilised at a more disaggregated level for regional analysis (see Bell and Hazell (1980), Buvinich (1985)). The second section discusses the use of SAM's for Leontief-type multiplier analysis. Since the behavioural and technical assumptions imposed in such a model are even more stringent than those invoked in input-output analysis, many analysts pre-empt criticism of the economic content of SAM Leontief models by calling their results "accounting" multipliers. Nevertheless, such multipliers reveal information on the structure and functioning of an economy which is undoubtedly relevant to the current policy debate. Specifically, SAM Leontief models capture the impact of varying patterns of factor ownership and transfer payments between different types of institutional categories and therefore include the distributional affects of an exogenous shock to the system. Further, the extended nature of the underlying data framework allow the analyst to investigate a wider range of policy scenarios in a more consistent and comprehensive manner. The analytic composition of the multipliers from a simple SAM model will be contrasted to those arising from more traditional forms of Leontief models.

The final section of the paper changes the direction of discussion. The major impetus for the surge of interest in social accounting during the last decade has not been due to its potential use in Leontief-type models. Instead most work on SAM's has concentrated on their role in applied or computable general equilibrium models (CGE's) where they act as benchmark data sets from which the parameters of the model can be calibrated (see Manser & Whalley, 1986). Because of the structure of CGE's, SAM's built for this purpose usually contain both commodity and industry accounts, showing their interconnections via the so called "use" and "make" matrices. It will be shown that if this form of presentation is maintained, but the SAM used instead as a basis for a Leontief model, the results will include both commodity by commodity and industry by industry multipliers plus two additional submatrices of multipliers - all based on the industry technology assumption. Whilst the industry technology assumption is only a very crude way of establishing a link between commodity and industry output, the simultaneous presentation of all the forms of multipliers will necessarily reveal more information than one set of 'symmetric'[1] multipliers alone.

The section thus helps to emphasise the main thrust of this paper:- that although the structure and analysis of Leontief models has traditionally been based on the information contained in an input-output table, this should not prevent modellers from recognising analytic and practical advantages offered by extending the underlying data framework to a SAM.

Section 1 : The Format of a SAM

Diagram 1 illustrates the way in which a traditional input output table can be integrated with a matrix presentation of the national accounts to form a fully disaggregated representation of the flow of income around the economy. Table 1 shows in schematic form the information that a SAM contains. Like an input output table, a SAM is a single entry accounting table wherein row entries reflect receipts, column entries, expenditure. Five sets or 'types' of accounts have been distinguished; the production accounts; two institutional accounts - split into three categories of current transactions and a combined capital account; the factor accounts and the 'Rest of the World' accounts.

[1]. The input-output terminology, the term "symmetric" is used solely to define input-output coefficients where the row and columns have the same output dimensions, i.e. it is used to denote either commodity by commodity or industry by industry coefficients.

DIAGRAM 1

THE CONSTRUCTION OF A SOCIAL ACCOUNTING MATRIX

(1)

INPUT-OUTPUT TABLE

	PRODUCTION	FINAL DEMAND	TOTAL
PRODUCTION	INTER-INDUSTRY TRANSACTIONS	ALL CATEGORIES OF FINAL DEMAND	GROSS OUTPUT
FACTORS OF PRODUCTION	VALUE ADDED		
TOTAL	GROSS OUTPUT		

NATIONAL ACCOUNTS STATISTICS IN MATRIX FORM

[* DENOTES TRANSFER PAYMENTS WITHIN A SET OF ACCOUNTS WHICH NET OUT IN CALCULATION OF THE NATIONAL ACCOUNTING AGGREGATES]

			INSTITUTIONS		
	PRODUCTION	FACTORS	CURRENT	CAPITAL	TOTAL
PRODUCTION	*	0	CAPITAL EXP.	INVESTMENT EXP.	FINAL
FACTORS	VALUE ADDED	0	0	0	NATIONAL PRODUCT
CURRENT	0	FACTOR PAYMENTS	*	0	NATIONAL SAVINGS
CAPITAL	0	0	SAVINTS	*	SAVINGS
TOTAL	NATIONAL PRODUCT	NATIONAL INCOME	NATIONAL EXP.	INVESTMENT	

THE COMBINATION OF BOTH TABLES

PLUS

- disaggregation of the institutional accounts
- addition of transactions with the "Rest of World"

SAM FORMAT SHOWN IN TABLE 1

Table 1 : The Form of A Social Accounting Matrix*

Institutional Current Accounts

Institutional Current Accounts

	Production Activities	Factors of Production	Households	Firms	Government	Combined Capital Account	Rest of World	TOTAL
Production Activities	Inter-industry transactions		Consumer-expenditure on domestic goods		Gvnt expenditure on domestic goods	GFCF plus changes in stocks	Exports of goods and services	Gross Output t_1
Factors of production	Value-added through production						Net factor incomes from abroad	Total Factor Incomes t_2
Firms		Gross profits						Total current receipt of firms t_3
Households		Wages, salaries, unincorporated business profits		Distributed profits	Government transfers to households		Net transfers from rest of world	Total current receipt of households t_4
Government	Indirect taxes on production		Household transfers to government			Indirect taxes on investment	Export duties etc.	Total current receipt of government t_5
Combined Capital			Savings of households (residual)	Savings of firms (residual)	Savings of government (residual)		Balance of payments deficit (residual)	Total acquisition of capital t_6
Rest of World	Imports of intermediate inputs		Consumer expenditure on imports		government expenditure on imports plus transfer overseas	Imports of investment goods		Total payments to Rest of World t_7
TOTAL	Total cost of production t'_1	Total factor incomes t'_2	Total Household expenditure t'_3	Total firm expenditure t'_4	Total government expenditure t'_5	Total capital expenditure t'_6	Total receipts from abroad t'_7	

* This format is based on the SAM built by Pyatt & Roe (1977) in their analysis of the Sri Lankan economy.

A SAM is characterised by the disaggregated treatment of the non-production orientated accounts, with inter-industry transactions confined to a single submatrix in this type of framework. Apart from the obvious extension of information, the most noteworthy difference between a SAM and in an input-output table is the inclusion of both row and column entries for the various types of factors of production. These serve to map value-added payments from the production sectors to the owners or providers of the factor services - the institutions. This distributive feature will re-emerge when the composition of SAM multipliers are contrasted to those of conventional input output multipliers. Thus unlike aggregate national accounts or input-output tables SAMs highlight the issue of income distribution.

This also raises the question of how best to disaggregate the institutional accounts. Various alternative classification systems have been suggested (see Stone, 1986) including disaggregating the private sector according to either income levels, demographic composition or on regional criteria. Ideally, to answer the more detailed questions posed in the introduction such as the importance of farm household transactions in non-agricultural markets and the significance of farm income arising from non-agricultural sources, one would like to have farm households represented as a separate institutional category but, given data limitations, this is infeasible. However, just as the distinction of transactions between the agriculture, manufacturing and service sectors can be used to reveal a crude picture of inter-industry dependence, even the most simplistic disaggregation of institutional categories will reveal more information on the structure of the economy at either a regional or macro level than conventional forms of macro-economic or input output analysis.

Before moving on to consider its role in Leontief modelling, one can justify the construction of a SAM simply because of its properties as a unifying and consistent data framework. Every row and column total in the matrix must balance leaving no room for statistical discrepancies. The construction process will identify either lack of data or data inconsistencies, whilst the finished SAM will offer a device for organising or monitoring changes in the economic environment.

Section2: SAM Multipliers

The transition from the accounting framework shown in Table 1 to a SAM Leontief model is strictly analogous to the derivation of multipliers in input output analysis. Having designated each account as being either endogenously or exogenously determined in the economic system, the endogenous accounts are normalised by dividing their elements by the column total in which they appear.

This gives rise to the two accounting equations

$$y_n = A_n\, y_n + Xi \qquad (1)$$

$$y_x = A_l\, y_n + Ri \qquad (2)$$

where y_n = vector of endogenous incomes

y_x = vector of exogenous incomes

A_n = matrix of average expenditure propensities between the endogenous accounts

A_l = matrix of average expenditure propensities to leak from the endogenous to the exogenous accounts

X = matrix of injections from the exogenous to endogenous accounts

R = matrix of transfers between the exogenous accounts

i = vector of ones

The subsequent assumption that each endogenous submatrix in the SAM has constant fixed elements leaves the modeller with a fully determinant system from which various policy scenarios can be investigated.

That is

$$y_n = (I-A_n)^{-1}\, \underline{x} \qquad (3)$$

$$y_x = A_l(I-A_n)^{-1}\, \underline{x} + \underline{r} \qquad (4)$$

where $\underline{x}$ and $\underline{r}$ are vector row sums of matrices X and R respectively.

In accordance with the ability of SAM based models to capture more than just the secondary effects arising from inter-industry transactions, the types of accounts specified as being endogenously determined extend beyond the production sectors. Typically, macro-level models treat only the government and rest of world accounts as exogenous thus allowing investigation into the impact on the economy of changes in government expenditures and export patterns. By bringing more elements into the matrix inversion process (at the core of all Leontief models) the modeller increases the interdependency of the system: the cost of extending the model in this manner is that the assumption of fixed expenditure coefficients now applies to a wider variety of accounts and does not manifest itself solely in the form of the production technology implied in the model.

The strength of the new assumptions depends on the types of accounts endogenised. With respect to the factor accounts of the SAM, the appropriation of endogenous institutional incomes depends on the structure of factor ownership. As this is unlikely to alter substantially, at least over the same period as the Leontief production technology is justifiable, there is no major problem in the assumption that the marginal and average propensities of factor outlays remains constant. On the other hand, basic economic theory implies that household expenditure patterns, tax and savings rates do change with income levels. Thus in closing the model with respect to the institutional accounts, the SAM modeller is making the same, inherently incorrect, assumption as the input-output modeller who wants to include the induced effect arising from shocks to the economy by presenting Type II multipliers. However, the SAM's disaggregation of institutions into various household types helps to alleviate the problem. As long as the classification system chosen is sufficient to give at least some variability between the coefficients in the institutional expenditure patterns, and provided only marginal changes are investigated, then doubts about the consistency of individual coefficients can be counterbalanced by the extra insight which the model can provide.

Returning to the extra interdependencies captured by a SAM based model, consider a system wherein only factors, institutions and production sectors are assumed endogenous. In this case, equation (I) above can be expressed as follows.

$$y_n \quad = \quad A_n \quad y_n \quad + \quad Xi$$

$$\begin{array}{l} \text{Production} \\ \text{Factors} \\ \text{Institutions} \end{array} \begin{bmatrix} t_1 \\ t_2 \\ t_3 \end{bmatrix} = \begin{bmatrix} B & O & C \\ V & O & O \\ O & Y & T \end{bmatrix} \begin{bmatrix} t_1 \\ t_2 \\ t_3 \end{bmatrix} + \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

With m production activities, n factors and k endogenous institutions: B, a matrix of input-output coefficients (mxm); V, a matrix of value-added coefficients (nxm); C a matrix of current account expenditure coefficients (mxk); Y a matrix of coefficients reflecting income distribution between institutional categories (kxn) and T a matrix of transfer coefficients (kxk).

Solution of this system yields three simultaneous equations

$t_1 = (I-B)^{-1} [Ct_3 + x_1]$

$t_2 = Vt_1 + x_2$

$t_3 = (I-T)^{-1}[Yt_2 + x_3]$

Thus even from this restricted form of SAM, the range and level of interdependencies captured by the model is extended beyond those identified in more traditional forms of Leontief models. An exogenous shock to the system alters the output and income levels of all the endogenous accounts simultaneously. Explicitly, the SAM model infers that t_1, the structure of production, depends on t_3, institutional income levels, which in turn depend on t_2, factor incomes, related to the output levels of the production sectors via the sub-matrix of value added coefficients V. The elements within the resulting vector y_n will all be mutually consistent.

Clearly, the different forms of Leontief models will produce different multipliers and hence different results. This is illustrated in figure 1 which contrasts the composition of the multipliers arising from 'open', 'closed' and SAM Leontief models respectively. In order to ease analytic comparison, the 'closed' and 'SAM' multipliers have been viewed as the inverses of 2x2 and 3x3 partitioned matrix respectively - the level of partitioning reflecting the number of types of endogenous accounts in the model. The interpretation of matrices B, C, V, Y and T are as defined above.

<u>Figure 1</u> **<u>The Composition of Multipliers</u>**

<u>"Open" Input-Output Multipliers</u>

$$\begin{array}{cc} & \text{Production} \\ \text{Production} & \begin{bmatrix} (I-B)^{-1} \end{bmatrix} \end{array}$$

<u>"Closed" Input-Output Multipliers</u>

$$\begin{array}{cc} & \begin{array}{cc} \text{Production} & \text{Households} \end{array} \\ \begin{array}{c} \text{Production} \\ \text{Households} \end{array} & \left[\begin{array}{c|c} Q+QCZVQ & QCZ \\ \hline ZVQ & Z \end{array}\right] \end{array}$$

where

$Q = (I-B)^{-1}$

$Z = [I-V(I-B)^{-1}C]^{-1}$

Figure 1 cont.

SAM Multipliers

$$
\begin{array}{l}
 \\
\text{Production} \\
\text{Factors} \\
\text{Institutions}
\end{array}
\begin{array}{c}
\begin{array}{ccc}
\text{Production} & \text{Factors} & \text{Institutions}
\end{array} \\
\left[\begin{array}{c|c|c}
Q+QCZYVQ & QCZV & QCZ \\
\hline
VQ+VQCZYVQ & I+VQCZY & VQCZ \\
\hline
ZYVQ & ZY & Z
\end{array}\right]
\end{array}
$$

where

$$Q = (I-B)^{-1}$$

$$Z = [(I-T) - YV(I-B)^{-1} C]^{-1}$$

Presenting the multipliers in this alternative format should not obscure their usual interpretation. For example, to analyse the impact of a unit increase in exogenous demand for output from industry 1, attention should focus on the first column of multipliers in the inverse matrices; the effects of a unit change in exogenous demand for output from industry 2 are indicated by the second column of multipliers in the inverse matrices etc.

This leads to the most obvious difference emerging from the three forms of multipliers: the more types of endogenous accounts in the Leontief system, the more varied the types of exogenous shocks that can be investigated. In particular, whilst the 'open' input-output model can be used only to investigate changes in exogenous demand for output from the production sectors, closed input-output models are also capable of analysing the effects of exogenous injections of income to households brought about, for example, through an increase in government transfers to households or a cut in income taxes. The SAM augments the analysis further still by being capable of showing the impact, on all endogenous variables, of exogenous injections to factor incomes. Although at first sight this may seem to offer limited practical advantages, suitable disaggregation of the factor accounts (e.g. into agricultural and non-agricultural categories of value-added) will allow for the analysis of various types of farm policy scenarios. For example, it makes it possible to investigate the effectiveness of policies such as set aside which aim to compensate farmers for "profit-forgone".

Turning to the actual composition of multipliers arising from each form of model, discussion will be confined to those elements arising from an exogenous shock in demand for output from industries, i.e. the most usual form of analysis carried out by input-output modellers.

Obviously, the 'open' input-output model captures the direct and indirect effects of such a shock with the ijth element of the matrix $(I-B)^{-1}$ showing the total requirements of output from the industry i needed to produce one unit of output from industry j. The closed input-output model further captures the induced effect of the shock as is shown by the addition of the term QCZVQ in the industry by industry submatrix of multiplies. This arises through the feedback mechanism incorporated in such a model whereby extra production activity increases household income, in turn creating extra consumption expenditure, thereby magnifying the impact of the original shock to the system. It allows for the calculation of "Type II" multipliers.

The SAM multipliers also include induced effects arising from this type of feedback mechanism but the form of the induced effect can be seen to be different. The SAM model takes into account that different production sectors use different combinations of factors, and that the factors themselves are provided by different categories of institutions. This gives rise to a distributional dimension of SAM models which changes the composition of the multipliers.

Further to this, the SAM model shows the effects of an exogenous increase in demand for industry output on factor incomes and institutional incomes separately. Thus the modeller is able to see how the demand for each factor is influenced by a particular production injection (via the elements contained in submatrix M_{21} of the SAM multiplier matrix). In addition, having allowed for the distributional pattern of factor incomes, one can identify the categories of institutions which stand to gain most from the injection (via elements in submatrix M_{31}).

In summary, figure 1 shows that extending the form of Leontief models to capture extra interdepencies changes the composition of the multipliers formed therein. Whilst a closed input-output model also reflects a system wherein the structure of production and income levels are determined simultaneously, only the multipliers derived from a SAM model are capable of capturing the distributional effects arising from a shock to the economy. Conventional Leontief models also exclude the effects of links between institutional categories. In general terms, the more diverse the types of endogenous accounts in a SAM model, the more extensive it's coverage of interdependencies which exist in the economy.

With respect to policy analysis, the SAM models ability to add distributional information may be of some importance. For example, if the factors of production, i.e. wages from employment, property income, and net taxes are categorised on both an agricultural and non agricultural basis, the data in the SAM will reveal that in developed countries such as the UK, total agricultural value added contains a larger proportion of property income than non-agricultural value added. Similarly, disaggregation of the institutional accounts on the basis of income levels will most likely reveal that property income itself is less equally distributed between household categories than salaried or wage income. One might therefore surmise that direct income payments to the farm sector would cause a more inequitable distribution of income in the economy than a similar type of policy directed towards the non-agricultural sectors. At a macro economic level, this type of impact will be dissipated through the relatively small size of the agricultural sector in aggregate terms. At a regional level, especially in areas where agricultural activity is still prominent, understanding of the knock-on or feedback effects of patterns of factor ownership may be important.

As well as clarifying the way in which the models differ, focusing attention on the composition of multipliers shown in Figure 1 emphasises the Keynesian nature of all Leontief models. For example, if there are no inter-industry flows (B=O), only one type of household which owns all the factors of production (T=O, Y=l, V=l) then all of the elements in both the 'closed' input-output and SAM-based models would collapse to $(I-C)^{-1}$ or 1/1- average propensity to consume (which also equals 1/(1 - mpc) given the models' implicit assumptions).

Section 3 : Technology Assumptions in a SAM Framework

The example SAM model above had inter-industry transactions depicted on an industry x industry, symmetric basis. The discussion thus avoided the problems inherent in producing such 'symmetric' data when raw industrial statistics only record intermediate input flows in the form of commodity purchases by industry groups and when the nature of production is such that industries are commonly involved in the production of more than one commodity.

As mentioned in the introduction, most SAM's constructed for their role in CGE modelling have the production system of the economy represented by separate industry and commodity accounts:- the commodity accounts collecting domestic production supplies from the industries in a so-called "make" matrix, the industries purchasing commodities for use as intermediate inputs in the so-called "use" matrix.

That is, transactions within the production system are represented as follows:

		Commodities (1)	Industries (2)
Commodities	(1)		"Use"matrix Intermediate input purchases
Industries	(2)	"Make"matrix Domestic commodity supplies	

This section shows how the inverse of a coefficient matrix which has both commodity and industry accounts produces the same multipliers as one would derive from symmetric input-output coefficients which have been formed using the industry technology assumption. The only caveat to this is that the former presentation is not restricted to producing either the commodity by commodity or industry by industry multipliers.

Again analysis draws on the algebraic representation of the inverse of a 2x2 partitioned matrix, (see Appendix).

$$\text{If} \quad A \quad = \quad \begin{array}{cc} & \begin{array}{cc} \text{Commodities} & \text{Industries} \\ (1) & (2) \end{array} \\ \begin{array}{c} (1) \\ (2) \end{array} & \left[\begin{array}{c|c} O & B \\ \hline D & O \end{array}\right] \end{array}$$

where B is the coefficient use matrix, D the coefficient make matrix under the constant market share assumption, (both formed by dividing the elements in the respective transactions matrices by the column totals in which they appear), then $(I-A)^{-1} = M$ can be shown to consist of the following four submatrices:

$$M \quad = \quad \begin{array}{cc} & \begin{array}{cc} \text{Commodities} & \text{Industries} \\ (1) & (2) \end{array} \\ \begin{array}{c} (1) \\ (2) \end{array} & \left[\begin{array}{c|c} (I-BD)^{-1} & (I-BD)^{-1}B \\ \hline (I-DB)^{-1}D & (I-DB)^{-1} \end{array}\right] \end{array}$$

The elements in symmetric submatrices M_{11} and M_{22} need little comment. They can easily be distinguished as the same multipliers one would derive from an input-output table constructed on the basis of industry technology assumptions. Since both sets of multipliers have their own advantages for policy analysis, their joint presentation is useful. M_{11}, the commodity by commodity multipliers, are appropriate for studies on changes in international trade or linkage analysis. On the other hand, M_{22}, the industry by industry multipliers are better used for studying employment issues or for sectoral planning.

The other two submatrices could be viewed as being of interest. M_{12} shows the direct and indirect effects on the commodity accounts of an exogenous change in demand for output from industrial sectors. Whilst M_{21} shows the converse - the total effect of change in demand for commodities on the industrial sectors depicted in the matrix. Unfortunately, rather than supplying the modeller with useful analytic information, close inspection of these multipliers tend to reflect more the inadequacy of imposing this form of technology conditions in the first place. Unlike the symmetric multipliers, which mask the assumptions implicit to their derivation, M_{12} in particular reveals the full implications of insisting that industrial sectors maintain a constant market share of each commodity that it produces. However, rather than being a critique of the mechanical procedures used in estimating symmetric input output coefficients, this section shows how exclusive reliance on conventional input-output formats may obscure modellers from some of the insights revealed by using a more general SAM framework for Leontief-type analysis.

Conclusion

The literature on SAM based Leontief models has evolved almost exclusively in a developing country context. This is not surprising given the acceptance by economists that interdependencies between rural and urban markets are central to the development process. On the other hand, the use of SAM multiplier models in advanced market economies has been disappointing, especially given the interest in constructing SAM's for use in more sophisticated forms of general equilibrium analysis.

This paper has indicated the way in which even the most simplistic SAM framework can be used to extend the area of analysis of Leontief models. Given that the farm sector's interactions with the wider economy are not confined solely to production linkages, applying Leontief techniques to a SAM framework is a straightforward method of capturing some of the other types of interdependencies which exist. In particular, SAM based models are capable of adding a distributional dimension to analysis, which is missing from more traditional forms of input-output models. Further to this, the SAM model produces a wider range of multipliers which allow for a broader variety of policy instruments to be investigated in a more comprehensive manner. Given the changing focus of the farm policy debate, and the emphasis which is being placed on agriculture's role in sustaining the rural economy, SAM Leontief models therefore offer potential for use in agricultural economic analysis.

There are costs of extending Leontief models in this manner:- as well as being more demanding in terms of data requirements, the SAM model extends the assumption of fixed coefficients beyond merely production technology. The economic interpretation of SAM multipliers must be treated with care. However, the use of social accounting methods for Leontief modelling could be viewed as a first step towards the development of more sophisticated CGE models which incorporate price responsive supply and demand behaviour and yield relative prices, as well as quantities in their solution.

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Appendix **The Inverse of a Partitioned Matrix**

If matrix A is partitioned such that

$$A = \left[\begin{array}{c|c} A_{11} & A_{12} \\ \hline A_{21} & A_{22} \end{array}\right]$$

where A_{11} and A_{22} are square non-singular matrices, the inverse, A^{-1}, can be expressed in two alternative forms:

Format 1:

$$A^{-1} = \left[\begin{array}{c|c} B_{11} & -B_{11} A_{12} A_{22}^{-1} \\ \hline -A_{22}^{-1} A_{21} B_{11} & A_{22}^{-1} + A_{22}^{-1} A_{21} B_{11} A_{12} A_{22-1} \end{array}\right]$$

where $B_{11} = (A_{11} - A_{12} A_{22}^{-1} A_{21})^{-1}$

Format 2

$$A^{-1} = \left[\begin{array}{c|c} A_{11}^{-1} + A_{11}^{-1} A_{12} B_{22} A_{21} A_{11}^{-1} & -A_{11}^{-1} A_{12} B_{22} \\ \hline -B_{22} A_{21} A_{11}^{-1} & B_{22} \end{array}\right]$$

where $B_{22} = (A_{22} - A_{21} A_{11}^{-1} A_{12})^{-1}$

For derivations of these formulas see Johnston, (1984). To invert a partitioned matrix of higher dimensions such as the 3 x 3 SAM model described in the paper, the procedure is straightforward but tedious as the formulas have to be applied at more than one stage.

With respect to the text, section 2 contrasting the composition of input-output and SAM multipliers, uses the 2nd form of presentation so as to elucidate the nature of intra-institutional multipliers. Section 3 which looks at the multipliers arising from a combined commodity and industry presentation of accounts draws information from both formats.