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The Application of General Equilibrium Models to Analyze U. S. Agriculture

by

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Abstract

This study starts from a Social Accounting Matrix (SAM) based on 1982 U.S. data, using a sector aggregation designed for examining agriculture. Multipliers are derived which measure the impact on demand and institutional incomes of changes in government expenditure and exports. To explore the nature of intersectoral and inter-institutional structure, a multiplier decompositon is derived which separates the total multiplier into components measuring the contribution of input-output linkages and net-SAM linkages. The decomposition calculations indicate that leakages from agriculture to the rest of the economy are very large and that leakages back into agriculture from the rest of the economy are very small. Input-output effects typically account for only 15 percent of the overall multiplier on agricultural gross output. Policy experiments with increases in agricultural exports, income increases in agriculture resulting from transfers, increases in nonagricultural exports, and increases in economywide household incomes are presented. We find that increases in agricultural value added are most sensitive to transfers, next most to agricultural exports, and least to measures designed to improve economywide prosperity. Extensions of the SAM framework to a Computable General Equilibrium model are discussed. We conclude that such an extension is a desireable next step in the research agenda.

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1. Introduction

Agriculture in the United States has undergone a number of shocks in the past decade, many of them emanating from conditions external to the sector. Such external shocks include: changes in major input prices due to the oil price shocks, changes in real interest rates arising from shifts in macro policy, changes in the real exchange rate, changes in world market conditions, and changes in U.S. Government agricultural policies. In many cases, agriculture was affected by, and was forced to adjust to, policies whose major focus was on macro stabilization, balance of payments adjustment, changes in the government deficit, and changes in the size and structure of government expenditure.

For example, consider the role of international trade. Since the early 1970s, the agricultural sector has become heavily "internationalized," with agricultural exports playing an increasing role. In the past five years, there has been a major decline in U.S. agricultural exports, both in volume and dollar terms. A variety of explanations have been offered for this shift, ranging from policy failures within the agricultural sector to external shocks

completely outside the control of farmers.[1] In attempting to sort out the relative impact of internal and external shocks, it is important to use a model framework that captures the links between the agricultural sector, the rest of the economy, and the rest of the world.

Traditionally, the analysis of U.S. agricultural policy has been carried out in a partial equilibrium framework. It has thus ignored the linkages of the agricultural sector with the rest of the U.S. economy. It is only recently that the importance of various economic linkages has started being recognized in work on U.S. agriculture. The importance to the agricultural sector of exchange rates and other instruments of monetary and fiscal policies was first emphasized by Schuh (1974). His seminal work sparked other studies of the interaction between agricultural production and incomes and traditional instruments of macroeconomic policy. Integrated sectoral and macroeconomic models to study the impact on U.S. agriculture of interest and exchange rates have recently been formulated by Shei (1978), Hughes and Penson (1980), Chambers and Just (1982), Freebairn, Rausser, and de Gorter (1983), and by Stamoulis, Chalfant, and Rausser (1985).

The partial equilibrium analysis of U.S. agriculture stands in sharp contrast with traditional approaches to the formulation of agricultural policy in developing countries. Agricultural policy in LDCs is most frequently analyzed in a multisectoral framework which adopts an integrated treatment of agriculture and non-agriculture. Development economists have long been sensitive to the importance of leakages from policies aimed at the agricultural sector to the rest of the economy and vice versa. Indeed, the tensions arising from the

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[1]See, for example, the symposium volume published by the Federal Reserve Bank of Kansas City (1986).

often divergent economic interests of farmers and urban workers and capitalists have long been recognized as lying at the heart of the political economy of economic development.

The present study, which presents a multisectoral analysis of U.S. agriculture, represents a transfer of technology from economic development to the study of agricultural policy in developed countries. We shall demonstrate that, even though the agricultural sector in the U.S. is small, both in employment and value added, it has important linkages with the rest of the economy. Leakages from U.S. agriculture to the rest of the economy are quite large --larger by an order of magnitude than in a typical developing economy. But the relation between agriculture and the rest of the economy is asymmetric: changes in economywide activity have a very small leakage back into U.S. agriculture. Even agricultural exports have a greater multiplier on nonagricultural value added than on agricultural value added.

In this paper, we discuss how multisectoral, applied general equilibrium models can be used to analyze such issues. We start from the standard Leontief input-output model. We then discuss how that model can be expanded to capture income and expenditure flows among the major actors in the economy by using a Social Accounting Matrix (or SAM). We use a U.S. SAM for 1982 to analyze the impact of different exogenous shocks on agriculture, using a variety of multiplier models. Finally, we briefly outline how the SAM framework can be used as the basis for building a nonlinear, computable general equilibrium (CGE) model that captures price and incentive mechanisms, and so goes well beyond the simple input-output and SAM models.

2. Social Accounting Matrices

A standard input-output model includes the intersectoral flows of intermediate inputs, and so captures one major source of linkages in the economy. However, the input-output model ignores the flows from producing sectors to factors of production (value added), and then on to entities such as government and households, and finally back to demand for goods. A Social Accounting Matrix (SAM) expands the input-output accounts to include a complete specification of the circular flow in the economy. The development of SAMs was partly motivated by the need to reconcile the national income and product accounts (or NIPA) with the input-output accounts within a unified framework.[2] Figure 1 presents a schematic diagram of a SAM.

The SAM describes the full circular flow of money and goods in an economy. Production is carried out in column 1. Sectors pay for domestic intermediate inputs (the Leontief input-output table) in cell (1,1) and imported intermediates in cell (8,1). Sectors also pay for primary factors of production (value added) and indirect taxes.[3] The rest of the SAM traces the flow of value added from producing sectors to "institutions," which represent the various economic actors in the system. The circular flow is complete in the sense that every dollar that emanates from the activity accounts ends up being spent on goods sold by the activities (the entries in row 1). Account 2

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[2]This work was strongly influence by Sir Richard Stone, who was instrumental in the development both of SAMs and of the United Nations standard System of National Accounts (SNA). See Stone (1966), United Nations (1975), and Pyatt and Round (1985) for discussions of SAMs.

[3]The sum of cell (2,1) is total value added at factor cost. In the U.S. table discussed below, we include indirect taxes in cell (2,1), and so generate value added at market prices.

describes the factor distribution, while the later accounts describe the institutional distribution, which also includes the household distribution.

In the SAM, the rows and columns represent the receipt and expenditure accounts of economic actors. Thus, a defining characteristic of a SAM is that it is a square matrix whose row and column sums must balance. The conventions of double-entry bookkeeping guarantee that there will be no leakages or injections into the system, and there is no room for any "statistical discrepancy" --every flow must go from some actor to some other actor.

There are two different kinds of entries in a SAM. First, there are entries which reflect flows across markets, with payment moving in one direction (from column to row account) and some commodity moving in the opposite direction. Accounts 1 and 2 in Figure 1 are of this type, representing the flow of commodities across product markets and of factors across factor markets. Second, there are entries which represent nominal flows that have no real counterpart since they do not involve a transaction across a product or factor market. In terms of the national product accounts, such flows represent transfers, with no productive activity or real exchange occurring.

Tables 1 and 2 present a multisectoral SAM which has been constructed starting from the U.S. input-output matrix for 1982. Table 1 presents the full SAM, using a three-sector aggregation. Table 2 presents a more disaggregated view of the activities columns in the SAM, including the input-output table (see Figure 1). The particular aggregation used was chosen with a view to facilitating tracing through the linkages between agriculture and the rest of the economy.[4] Agriculture is disaggregated into seven sectors. The aggre-

[4]The full input-output table has 528 sectors and was produced by Engineering Economics Associates (of Berkeley, California) starting from the 1977 U.S. table produced by the U.S. Department of Commerce. The 1977 table is

Table 1: Aggregate SAM for the U.S., 1982
($ billions)

Account	Activities: Agric. 1	Activities: Agric. Related 2	Activities: Other 3	Value Added: Labor Income 4	Value Added: Capital Income 5	Value Added: Indirect Taxes 6	Institutions: Labor 7	Institutions: Proprietors 8	Institutions: Enterprises 9	Households: Low 40% 10	Households: Med 40% 11	Households: High 20% 12	Capital Accnt. 13	Govt. 14	Rest of World 15
Activities															
1 Agriculture	49.91	93.81	9.81							5.26	8.45	6.71	-0.22	8.28	19.41
2 Ag. Related Act.	70.63	1119.77	442.84							388.57	691.97	633.89	40.55	451.88	97.33
3 Other Activities	7.97	452.87	644.77							44.89	102.20	102.95	374.53	190.32	231.68
Sum	128.51	1666.45	1097.42							438.72	802.62	743.55	414.86	650.47	348.43
Value Added															
4 Labor Income	18.79	1314.26	531.18												
5 Capital Income	45.13	701.08	200.05												
6 Ind Bus Taxes	3.64	217.21	37.92												
Sum	67.56	2232.55	769.14												
Institutions															
7 Labor				1612.91											
8 Proprietors					111.50										
9 Enterprises					834.77									53.25	
Sum				1612.91	946.27									53.25	
Households:															
10 Low 40%							145.40	9.72	80.61					205.12	-0.18
11 Med 40%							742.07	33.92	133.37					107.09	-0.51
12 High 20%							725.44	67.87	225.32					49.71	-0.48
Sum							1612.91	111.50	439.30					361.92	-1.16
13 Capital Account									388.05	-18.76	56.86	97.40		-115.24	6.55
14 Government				251.31		258.76			60.66	20.71	156.47	226.90		179.51	-24.42
15 Rest of the World	5.35	38.42	285.63												
Totals	201.43	3937.42	2152.19	1864.22	946.27	258.76	1612.91	111.50	888.01	440.67	1015.95	1067.86	414.86	1129.91	329.40

Source: data provided by Engineering Economics Associates.

(5a)

Table 2: Sectoral Activity Accounts, U.S. SAM, 1982
($ billions)

	Input-Output Flows:																
	Dairy, Poultry 1	Meat Animals 2	Food Grains 3	Feed Grains 4	Cotton & Oil 5	Fruits Nuts 6	Tobacco Sugar 7	Sum	Prcssd Food 8	Chemi-cals 9	Utilities 10	Whlsale Retail 11	Banking Insrnce 12	Services 13	Sum	Other 14	Total intrmd
Agriculture:																	
1 Dairy, Poultry, Eggs	0.02	0.25	0.04	0.66	0.07	0.02	0.10	1.16	21.51	0.03	0.00	0.01	0.00	1.17	22.72	0.00	23.88
2 Meat Animals	0.11	12.57	0.23	0.88	0.26	0.11	0.34	14.50	31.57	0.03	0.00	0.05	0.00	0.39	32.04	0.35	46.89
3 Food Grains	0.09	0.07	0.48	0.02	0.02	0.02	0.02	0.73	2.72	0.00	0.00	0.02	0.00	0.00	2.75	0.01	3.49
4 Feed Grains, etc.	8.71	12.54	0.01	1.48	0.04	0.04	0.11	22.92	4.93	0.07	0.00	0.03	0.00	0.94	5.96	0.00	28.88
5 Cotton, Oil Crops	0.06	0.08	0.01	0.03	2.84	0.03	0.03	3.08	9.56	0.01	0.00	0.03	0.00	0.00	9.61	2.38	15.06
6 Fruits, Nuts, Veget.	0.04	0.04	0.01	0.02	0.02	0.20	0.02	0.34	4.95	0.00	0.00	0.02	0.00	1.47	6.45	0.00	6.79
7 Tob., Sugar, Other	1.60	0.73	0.31	0.86	0.95	1.09	1.63	7.19	8.02	0.45	0.03	0.81	3.17	1.81	14.29	7.07	28.55
Sum	10.62	26.28	1.10	3.94	4.20	1.51	2.25	49.91	83.26	0.60	0.04	0.96	3.17	5.79	93.81	9.81	153.54
Agriculture Related:																	
8 Food & Tob. Prod.	7.45	6.75	0.01	0.03	0.00	0.00	0.16	14.41	49.74	1.84	0.18	0.57	0.02	49.08	101.44	1.46	117.32
9 Chemicals	0.84	1.34	2.19	8.59	1.90	1.67	3.89	20.42	8.62	93.66	43.54	11.94	3.11	39.19	200.06	100.12	320.60
10 Utilities	1.06	1.27	0.40	1.86	0.39	0.52	1.02	6.51	14.17	36.38	83.36	34.06	17.01	61.20	246.18	82.38	335.08
11 Whlsale & Retail Trade	1.26	2.15	0.58	2.36	0.64	0.64	1.59	9.21	17.28	11.94	6.33	7.65	2.22	31.69	77.11	100.96	187.29
12 Bank, Ins. & Real Es.	1.17	2.30	1.75	4.68	2.26	0.74	1.51	14.40	3.11	5.86	10.80	30.15	105.63	56.80	212.34	44.62	271.37
13 Services	0.56	1.29	0.34	1.26	0.43	0.28	1.52	5.67	9.62	16.89	28.18	64.68	45.63	117.63	282.63	113.28	401.58
Sum	12.33	15.11	5.26	18.77	5.62	3.85	9.69	70.63	102.55	166.57	172.39	149.05	173.62	355.59	1119.77	442.84	1633.23
14 Other Activities	0.71	1.20	0.52	1.93	0.62	0.87	2.11	7.97	36.33	165.17	95.99	25.38	33.71	96.30	452.87	644.77	1105.61
Total Intermediate	23.67	42.59	6.88	24.65	10.45	6.24	14.05	128.51	222.14	332.34	268.41	175.38	210.50	457.68	1666.45	1097.42	2892.39
Value Added:																	
15 Ag Empl. Comp.	1.73	2.95	0.54	1.28	1.43	2.61	8.24	18.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.79
16 Ag Prop. Inc.	3.45	1.57	3.10	11.28	11.08	6.34	8.32	45.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.13
17 Ag Ind Bus Tax	0.41	0.96	0.20	0.73	0.34	0.22	0.78	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.64
18 Non-Ag Empl. Comp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.71	57.23	133.02	250.78	111.77	722.75	1314.26	531.18	1845.43
19 Non-Ag Prop. Inc.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.69	31.16	102.85	69.37	314.42	156.61	701.08	200.05	901.13
20 Non-Ag Ind Bus Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.12	9.07	21.63	77.89	83.00	15.49	217.21	37.92	255.12
Total Value Added	5.58	5.48	3.85	13.29	12.85	9.17	17.34	67.56	75.52	97.45	257.50	398.04	509.19	894.85	2232.55	769.14	3069.25
Total Gross Output	29.25	48.07	10.73	37.93	23.30	15.40	31.39	196.07	297.66	429.79	525.91	573.42	719.69	1352.53	3899.00	1866.56	5961.64
21 Rest of the World	0.01	0.66	0.01	0.09	0.02	1.96	2.60	5.35	12.38	34.72	-0.08	-9.15	0.43	0.12	38.42	285.63	329.40
Total Supply	29.25	48.73	10.73	38.02	23.33	17.37	33.99	201.43	310.03	464.51	525.83	564.27	720.12	1352.65	3937.42	2152.19	6291.04

Figure 1: A Schematic Social Accounting Matrix

Receipts:	Expentidures: (1) Activities	(2) Value added	(3) Labor	(4) Enterprises	(5) Households	(6) Capital acct	(7) Government	(8) Rest of wrld	(9) Totals
1. Activities	intermediate demand				household consumption	investment	government consumption	exports	Total sales
2. Value added	factor payments								Value added
Institutions:									
3. Labor		labor income							Labor income
4. Enterprises		capital income					transfers		Enterprise income
5. Households			labor income	distributed profits			transfers	foreign remittances	Household income
6. Capital accnt				retained earnings	household savings		government surplus	net capital inflow	Total saving
7. Government	indirect taxes	factor taxes		corporate taxes	direct taxes			reserve decumulation	Government receipts
8. Rest of world	intermediate imports				imports	imports	imports		Total imports
9. Totals	Total payments	Total income	Labor income	Enterprise expenditure	Household expenditure	Total investment	Government expenditure	Foreign exchange	

gation of the nonagricultural sectors has been chosen so that the sectors that have large linkages with agriculture (food processing, beverages, and tobacco (8); chemicals (9); utilities (10); wholesale and retail trade (11); banking, insurance, and real estate (12); and services (13)) are kept separate. All other sectors are aggregated into a single sector (14). The three-sector presentation in Table 1 aggregates the agricultural sectors, the agriculture-related sectors, and all others.

In Table 2, value added is separated into agricultural and nonagricultural accounts, in addition to distinguishing employee compensation, property income, and indirect business taxes. In the SAM, value added is distributed to three types of institutions: workers, proprietors, and incorporated enterprises.[5] The institutions, in turn distribute their incomes to three types of households: the poorest 40%, the next 40%, and the richest 20%. There is one capital account, which consolidates all financial markets, serving to collect savings and purchase investment goods.[6]

The SAM in Table 1 provides a framework for reconciling the input-output and national income and product accounts (NIPA) for the U.S. For example, the sum of value added, $3,069 billion, equals Gross National Product (GNP) in 1982.[7] Looking along the activity row, the sum of institutional demands de-

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described in U.S. Department of Commerce (1984).

[5]These definitions follow the conventions used in the U.S. National Income and Product Accounts.

[6]As defined, the SAM does not specify investment by sector of destination. To distinguish investment by sector of destination requires disaggregating the capital accounts.

[7]Total value added equals GNP rather than Gross Domestic Product (GDP) because the U.S. input-output table includes a sector called "rest of the world industry" which includes net factor income from abroad. In most other countries, value added from the input-output table equals GDP.

fines aggregate final demand (consumption, investment, government, and exports). This number, minus total imports, also equals GNP, since the row and column sums of the activity accounts must balance.[8] The various entries in the institutional accounts in the body of the SAM have all been reconciled with the published macro accounts.[9]

Note that in this SAM, the activity accounts purchase imports from the rest of the world. These are imports with the same sector definition, so that each activity account defines total supply of the sector, domestically produced and imported. Consistent with the treatment in the NIPA, demands for activities along the row (both intermediate and final) thus include imports. In other SAMs, two sets of sectoral "activity" and "commodity" accounts are often defined, which thus treat domestic production and imports in separate accounts. This latter treatment also permits using different sectoral definitions for activities and commodities, if desired, and can accommodate the fact that some sectors produce more than one commodity.[10]

An examination of Table 2 indicates that the linkages among the agricultural sectors are rather small, except for the large expenditure flows from dairy and poultry (1) and meat animals (2) to feed grains. The leakages from agriculture to the rest of the economy, however, are quite large. About 60

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[8]As noted above, indirect business taxes have been included as a value-added row. Total value added net of indirect taxes defines GNP at factor cost. Note also that in the U.S. accounts, by convention, tariffs are entered as an indirect business tax of the wholesale and retail trade sector. This treatment differs from that in many other countries.

[9]As published, for example, in the Survey of Current Business. A tabulation of the formal reconciliation between the NIPA and the SAM is available from the authors.

[10]In this case, the input-output table is divided into separate "use" and "make" tables.

percent of total gross agricultural expenditures are on purchases of nonagricultural inputs. By contrast, agriculture represents only 3.2 percent of aggregate gross production and accounts for only 2.2 percent of aggregate value added. In terms of final demand, agriculture represents only 1 percent of aggregate consumption (and 9.7 percent, adding in processed food, beverages, and tobacco). Agricultural exports are about 6 percent of total exports (10.2 percent, adding in processed food, beverages, and tobacco).[11]

In sum, agriculture is a relatively small sector in the U.S. economy. There are significant backward linkages from agriculture to the rest of the economy through intermediate inputs, and some forward linkages, especially in food processing. Property income constitutes about 70 percent of agricultural value added. Taxes, both personal and business, are about 9 percent of value added in agriculture and 16 percent outside of agriculture; the sector thus receives significant tax breaks.

3. SAM Multipliers

To go from a set of accounts to a model requires more assumptions.[12] In the static input-output model, the input-output coefficients are assumed fixed, defining a coefficient matrix A. The supply-demand balance equations are given by:

(1) $x = Ax + f$

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[11]As is common with input-output data, there are problems distinguishing between agriculture and processed food. Trade data reported by the Department of Agriculture use different definitions, including part of the processed food sector in the input-output table in agriculture.

[12]The discussion in this section draws on Robinson (1986), which provides a general survey of multisectoral models applied to developing countries.

where: x is a vector of sectoral gross production, A is the matrix of input-output coefficients, and f is a vector of sectoral final demand. The model is solved to yield multipliers through which changes in final demand are translated into changes in sectoral output:

$$(2) \quad x = (I - A)^{-1} f.$$

Within the SAM framework, the simplest way to create a model is to assume that the various column coefficients are all constant, as in the input-output model. One problem, however, is that the matrix is square and the coefficients in every column sum to one. The coefficient matrix is singular. There are no exogenous elements and hence no multipliers. The answer is to specify one or more accounts as being exogenous. A natural choice would be some combination of the capital, government, and rest-of-the-world accounts. The result is a partitioned SAM, with some columns specified as exogenous and some rows excluded. The structure of such a SAM coefficient matrix is shown below:

$$(3) \quad \begin{array}{l} \text{Activities} \\ \text{Value added} \\ \text{Endogenous institutions} \end{array} \quad A^* = \begin{bmatrix} A & 0 & F \\ V & 0 & 0 \\ 0 & Y & T \end{bmatrix}$$

where:

A^* = matrix of SAM coefficients $(n+m+k, n+m+k)$,
A = matrix of input-output coefficients (n,n),
V = matrix of value added coefficients (m,n),
Y = matrix of income distribution coefficients (k,n),
F = matrix of expenditure coefficients (n,k),
T = matrix of inter-institutional transfer coefficients (k,k),
n = number of sectors,
m = number of value added categories, and
k = number of endogenous institutions.

Given the choice of exogenous accounts, the balance equations can be written:

$$(4) \qquad A^* \begin{bmatrix} x \\ v \\ y \end{bmatrix} = \begin{bmatrix} e^x \\ e^v \\ e^y \end{bmatrix}$$

where:

x = vector of sectoral supply $(n,1)$,
v = vector of value added by categories $(m,1)$,
y = vector of institutional incomes $(k,1)$,
e^x = vector of exogenous sectoral demand $(n,1)$,
e^v = vector of exogenous value added $(m,1)$, and
e^y = vector of exogenous institutional incomes $(k,1)$.

Inverting A^*, we can write the multiplier matrix equation relating changes in sectoral supply, valued added, and institutional income to changes in the exogenous variables:

$$(5) \qquad \begin{bmatrix} x \\ v \\ y \end{bmatrix} = M \begin{bmatrix} e^x \\ e^v \\ e^y \end{bmatrix}$$

where $M = (I - A^*)^{-1}$.

Extending the input-output model to include more accounts in the SAM requires that we assume that various expenditure coefficients are fixed. It thus becomes important to define accounts so as to make this interpretation reasonable. For example, in the SAM in Table 1, the distribution of nominal income between wages and profits would be assumed fixed, as would the average tax and savings rates of enterprises and households. Also, the sectoral composition of nominal consumption, government, and investment expenditure would be assumed fixed. Such assumptions can be justified in a couple of ways. First, one can assume that the underlying aggregation functions are Cobb-Douglas. For example, optimizing behavior by consumers and producers with

underlying Cobb-Douglas utility and production functions yields fixed expenditure shares for final consumption and input demands. Second, one can assume fixed physical coefficients and fixed prices. Both types of assumptions are rather strong and represent a considerable extension of the usual input-output model which includes only demands for intermediate inputs. These assumptions are relaxed in a nonlinear CGE model, in which the underlying aggregation functions are restricted only by theoretical requirements such as homogeneity, diminishing marginal productivity, and so forth.

The choice of which accounts to specify as being exogenous is important. Standard practice is to pick one or more of the capital, government, and rest-of-the-world accounts, justifying the choice on the basis of macroeconomic theory, since these accounts are all financial in that they do not involve product or factor markets. The resulting multiplier model is completely demand driven, since no constraints on supply are specified, and is thus very Keynesian in spirit. Given the choice among three accounts, there are seven different combinations of exogenous accounts --each one singly, three pairwise combinations, plus all three together. Each of these choices defines a different macro "closure" of the SAM model. In each case, a shock is defined as a change in elements of the exogenous columns. The nature of the adjustment to these shocks will depend on the size and structure of the coefficients in the endogenous accounts and of those in the excluded rows (which define the leakages). Of course, the computed multipliers will be sensitive to the choice, and the realism of the macro closure must be judged on the basis of the particular question under study.

This issue of macro closure appears again in the context of CGE models

and has generated a considerable literature.[13] While the adjustment mechanisms in such nonlinear models are far more complex, involving both supply and demand adjustments, many of the important transmission links are captured in the SAM. The SAM multipliers thus can give a pretty good indication of the magnitude of the adjustments that will be captured in the CGE model, and of some of the major causal linkages.

In the empirical results presented below, we have chosen to make the government and rest-of-the-world accounts exogenous and keep the capital account endogenous. Given the swings in foreign trade and government expenditure during the early 1980s, it seems reasonable to make those accounts exogenous. It is also reasonable to make investment endogenous, adjusting to the changes in savings resulting from the swings in the balance of trade and government fiscal policy. The SAM model thus focuses on the adjustment of the economy to shocks arising from changes in government expenditures and exports.

4. Decomposition of SAM Multipliers

The SAMs presented in Figure 1 and Table 1 have a characteristic structure relating to the circular flow of income. From equation 3, it can be seen that one cycle from activities back to activities is achieved in three steps, First, the V coefficients map the flow of income from activities to factors of production. Second, the Y coefficients map the flow from factors to institutions. Finally, the F coefficients map from institutional income back to demand for activities. The elements on the main diagonal (the A and T coeffi-

[13]The development literature on this issue is surveyed in Robinson (1986).

cients in equation 3) capture interactions within these blocks of the SAM independently of links between blocks.

Given this structure, it has been shown that the multiplier matrix M can be decomposed into the sum of four terms involving three additive multiplier matrices:[14]

$$(6) \qquad M = I + (C1 - I) + C2 + C3$$

where:

$$C1 = \begin{bmatrix} (I-A)^{-1} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & (I-T)^{-1} \end{bmatrix}$$

$$C2 = \begin{bmatrix} 0 & C2_{12} & C2_{13} \\ C2_{21} & 0 & C2_{23} \\ C2_{31} & C2_{32} & 0 \end{bmatrix}$$

$$C3 = \begin{bmatrix} C3_{11} & 0 & 0 \\ 0 & C3_{22} & 0 \\ 0 & 0 & C3_{33} \end{bmatrix}$$

The elements of the C2 and C3 matrices are based on the partitioned inverse of

[14]See Pyatt and Round (1979) and Stone (1985). Pyatt and Round use a multiplicative decomposition, while the additive version we present below is from Stone.

A^* defined in equation 3.[15] Each element can thus be written as a function of the elements of A^*. The fact that the decomposed multiplier matrices have the structure shown follows from the structure of A^*.

The first term, I, represents the impact effect of the exogenous shock. The second term, C1-I, gives the net contribution of "transfer multiplier effects," or multiplier effects within the blocks of accounts.[16] The two together, C1, define the "own effects" multipliers. The upper left element of C1 is simply the Leontief inverse. If the other two blocks of accounts are treated as exogenous, the model collapses to the usual input-output multiplier model. The third term, C2, describes the net contribution of "open-loop" or "cross-multiplier" effects. These represent the impact of linkages between blocks of accounts. Finally, the fourth term, C3, describes the net contribution of "closed-loop" or "circular-multiplier effects." These are within-block effects that arise from the shock after passing from a block, through the open-loop effects, and back to the block.

In terms of the structure of the particular SAM used here, the first two terms of the multiplier decomposition describe the direct, within-block effects. For example, for a shock which consists only of an exogenous increase in some sectoral demands by government or exports, the only relevant part of the C1 matrix is the Leontief inverse, and the within-block effects consist only of the intersectoral or input-output multipliers. The third and fourth terms, taken together, capture the net effect of expanding the model to in-

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[15]After dividing A^* into the sum of two matrices, one consisting of its main diagonal and the other of the off-diagonal elements. Use is also made of the series expansion of the inverse.

[16]The term is due to Pyatt and Round (1979). Their terms for the other effects will also be used below.

clude the value added and institutional linkages. They thus might be described as the "net SAM-linkage effects," which supplement the input-output linkage effects.

5. Sam Multipliers for the U.S. Economy

The matrix of SAM multipliers, M, is given in Table 3. Table 4 gives the percentage shares of the net SAM-linkage effects, or the sum of the elements of the last two terms in the decomposition (C2 + C3, defined above) divided by the elements of the total induced multipliers, removing the initial injection; that is, (M - I). The decomposition matrices C1, C2, and C3 are given in the Appendix. Table A-1 provides the sum of the first two terms in the decomposition, C1, which includes all the within-block or own effects. Table A-2 gives the open-loop or cross-multiplier effects, and Table A-3 gives the closed-loop or circular-multiplier effects.

Consider, for example, the multipliers in column 1 of Table 3. An increase of one billion dollars of exogenous demand for dairy and poultry output induces an additional increase of $47 million (over and above the original billion demand injection). Significant increases in other sectoral demands include: $358 million for feed grains, $502 million for food processing, $420 million for chemicals, $407 million for utilities, $457 million for wholesale and retail services, $583 million for banking and insurance, $698 million for services, and $1.403 billion for all others. The original increase of a billion dollars of demand for dairy products thus generates an induced additional demand of $640 million for agricultural output and a $4.47 billion increment in demand for nonagricultural production.

Table 3: The Multiplier Matrix, M

Activities:

	Dairy, 1	Meat A 2	Food G 3	Feed G 4	Cotton 5	Fruits 6	Tob.,S 7	Food&T 8	Chemic 9	Utilit 10	Whlsal 11	Bank,I 12	Servic 13	Other 14
Activities:														
1 Dairy,Poultry,Eggs	1.047	0.047	0.022	0.037	0.022	0.018	0.020	0.105	0.015	0.017	0.017	0.016	0.022	0.015
2 Meat Animals	0.089	1.421	0.061	0.064	0.049	0.037	0.043	0.202	0.025	0.028	0.028	0.026	0.037	0.025
3 Food Grains	0.009	0.007	1.049	0.003	0.003	0.003	0.003	0.014	0.002	0.002	0.002	0.002	0.003	0.002
4 Feed Grains,etc.	0.358	0.403	0.029	1.073	0.027	0.022	0.026	0.112	0.015	0.017	0.017	0.016	0.023	0.015
5 Cotton,Oil Crops	0.022	0.019	0.009	0.009	1.147	0.009	0.009	0.052	0.007	0.008	0.007	0.007	0.010	0.008
6 Fruits,Nuts,Veget.	0.016	0.014	0.011	0.011	0.012	1.021	0.010	0.030	0.008	0.010	0.010	0.009	0.012	0.008
7 Tob.,Sugar,Other	0.099	0.060	0.055	0.048	0.071	0.086	1.071	0.067	0.020	0.020	0.020	0.024	0.024	0.021
Sum	1.640	1.971	1.236	1.245	1.332	1.196	1.182	0.581	0.094	0.101	0.100	0.100	0.131	0.094
8 Food&Tob. Prod.	0.502	0.412	0.189	0.194	0.199	0.173	0.184	1.413	0.160	0.177	0.176	0.168	0.239	0.155
9 Chemicals	0.420	0.427	0.538	0.569	0.390	0.368	0.394	0.343	1.509	0.377	0.262	0.241	0.300	0.293
10 Utilities	0.407	0.396	0.387	0.405	0.358	0.332	0.340	0.383	0.401	1.502	0.354	0.315	0.372	0.323
11 Whlsale & Retail	0.457	0.456	0.437	0.447	0.428	0.386	0.400	0.435	0.366	0.382	1.353	0.352	0.406	0.370
12 Bank,Ins.&Real Es.	0.583	0.596	0.685	0.636	0.642	0.502	0.511	0.492	0.432	0.491	0.507	1.610	0.547	0.431
13 Services	0.698	0.693	0.705	0.706	0.716	0.626	0.667	0.658	0.623	0.697	0.719	0.664	1.761	0.615
Sum	3.067	2.980	2.942	2.956	2.732	2.386	2.496	3.723	3.492	3.625	3.370	3.349	3.626	2.187
14 Other Activities	1.403	1.366	1.450	1.465	1.401	1.250	1.276	1.400	1.688	1.550	1.181	1.334	1.336	2.463
Value Added:														
15 Ag Empl. Comp.	0.107	0.121	0.074	0.056	0.095	0.179	0.267	0.047	0.010	0.010	0.010	0.011	0.013	0.010
16 Ag Prop. Inc.	0.275	0.202	0.338	0.346	0.580	0.409	0.282	0.108	0.019	0.020	0.020	0.020	0.026	0.020
17 Ag Ind Bus Tax	0.026	0.038	0.024	0.024	0.020	0.016	0.027	0.011	0.002	0.002	0.002	0.002	0.002	0.002
Sum	0.409	0.361	0.436	0.426	0.695	0.604	0.575	0.165	0.031	0.032	0.032	0.033	0.041	0.031
18 Non Ag Empl. Comp.	1.230	1.207	1.223	1.233	1.182	1.043	1.086	1.282	1.287	1.449	1.499	1.221	1.697	1.305
19 Non Ag Prop. Inc.	0.673	0.665	0.697	0.685	0.659	0.560	0.577	0.694	0.656	0.820	0.683	1.039	0.730	0.630
20 Non Ag Ind Bus Tax	0.204	0.202	0.205	0.203	0.195	0.167	0.172	0.217	0.188	0.219	0.300	0.288	0.192	0.175
Sum	2.108	2.074	2.126	2.120	2.036	1.769	1.835	2.193	2.132	2.489	2.482	2.548	2.620	2.110
Endogenous Institutions:														
21 Labor Force	1.157	1.149	1.123	1.115	1.104	1.058	1.170	1.150	1.122	1.263	1.306	1.065	1.480	1.138
22 Proprietors	0.244	0.194	0.288	0.292	0.445	0.323	0.240	0.134	0.072	0.088	0.075	0.108	0.084	0.070
23 Enterprises	0.704	0.673	0.747	0.738	0.794	0.646	0.619	0.667	0.603	0.753	0.628	0.952	0.673	0.580
Sum	2.106	2.016	2.158	2.145	2.343	2.026	2.029	1.951	1.797	2.103	2.009	2.125	2.236	1.787
24 Low 40% Households	0.190	0.182	0.194	0.193	0.210	0.182	0.183	0.176	0.162	0.190	0.181	0.192	0.202	0.161
25 Med 40% Households	0.713	0.689	0.716	0.713	0.763	0.682	0.704	0.670	0.629	0.721	0.718	0.666	0.807	0.632
26 High 20% Households	0.848	0.806	0.870	0.867	0.969	0.836	0.829	0.768	0.701	0.812	0.792	0.786	0.887	0.701
Sum	1.750	1.676	1.780	1.772	1.942	1.700	1.716	1.614	1.492	1.723	1.692	1.644	1.896	1.494
27 Capital Account	0.417	0.398	0.438	0.433	0.469	0.389	0.378	0.392	0.356	0.435	0.379	0.517	0.412	0.346

Table 3: The Multiplier Matrix, M (continued)

	Value Added:						Endogenous Institutions:						
	Ag Emp 15	Ag Pro 16	Ag Ind 17	Non Ag 18	Non Ag 19	Non Ag 20	Labor 21	Propri 22	Enterp 23	Low 40 24	Med 40 25	High 2 26	Capita 27
Activities:													
1 Dairy,Poultry,Eggs	0.019	0.020	0.000	0.019	0.018	0.000	0.022	0.022	0.018	0.030	0.024	0.019	0.015
2 Meat Animals	0.032	0.033	0.000	0.032	0.030	0.000	0.037	0.035	0.030	0.048	0.039	0.032	0.026
3 Food Grains	0.002	0.003	0.000	0.002	0.002	0.000	0.003	0.003	0.002	0.003	0.003	0.002	0.002
4 Feed Grains,etc.	0.019	0.020	0.000	0.019	0.018	0.000	0.022	0.021	0.018	0.029	0.023	0.019	0.015
5 Cotton,Oil Crops	0.008	0.009	0.000	0.008	0.008	0.000	0.010	0.009	0.007	0.012	0.010	0.008	0.006
6 Fruits,Nuts,Veget.	0.011	0.012	0.000	0.011	0.010	0.000	0.013	0.013	0.010	0.018	0.014	0.011	0.008
7 Tob.,Sugar,Other	0.020	0.022	0.000	0.020	0.021	0.000	0.024	0.023	0.021	0.028	0.024	0.022	0.021
Sum	0.112	0.119	0.000	0.112	0.108	0.000	0.130	0.126	0.106	0.168	0.136	0.115	0.093
8 Food&Tob. Prod.	0.204	0.214	0.000	0.204	0.190	0.000	0.236	0.229	0.186	0.311	0.250	0.206	0.155
9 Chemicals	0.245	0.274	0.000	0.245	0.267	0.000	0.284	0.278	0.266	0.337	0.294	0.262	0.285
10 Utilities	0.304	0.339	0.000	0.304	0.327	0.000	0.351	0.346	0.325	0.435	0.360	0.326	0.342
11 Whlsale & Retail	0.383	0.428	0.000	0.383	0.415	0.000	0.442	0.436	0.412	0.519	0.453	0.416	0.439
12 Bank,Ins.&Real Es.	0.516	0.560	0.000	0.516	0.507	0.000	0.596	0.591	0.499	0.694	0.602	0.571	0.459
13 Services	0.683	0.741	0.000	0.683	0.679	0.000	0.789	0.778	0.669	0.968	0.806	0.736	0.625
Sum	2.335	2.557	0.000	2.335	2.385	0.000	2.698	2.658	2.357	3.264	2.765	2.517	2.305
14 Other Activities	1.117	1.410	0.000	1.117	1.630	0.000	1.291	1.283	1.664	1.362	1.310	1.258	2.344
Value Added:													
15 Ag Empl. Comp.	1.011	0.012	0.000	0.011	0.011	0.000	0.013	0.012	0.011	0.016	0.013	0.011	0.010
16 Ag Prop. Inc.	0.023	1.024	0.000	0.023	0.022	0.000	0.026	0.025	0.021	0.034	0.027	0.023	0.019
17 Ag Ind Bus Tax	0.002	0.002	1.000	0.002	0.002	0.000	0.002	0.002	0.002	0.003	0.002	0.002	0.002
Sum	1.036	1.038	1.000	0.036	0.034	0.000	0.041	0.040	0.034	0.053	0.043	0.037	0.030
18 Non Ag Empl. Comp.	1.023	1.168	0.000	2.023	1.167	0.000	1.183	1.168	1.167	1.382	1.207	1.118	1.320
19 Non Ag Prop. Inc.	0.549	0.617	0.000	0.549	1.601	0.000	0.634	0.627	0.598	0.740	0.645	0.602	0.644
20 Non Ag Ind Bus Tax	0.164	0.183	0.000	0.164	0.177	1.000	0.189	0.187	0.176	0.221	0.193	0.179	0.187
Sum	1.736	1.968	0.000	2.736	2.945	1.000	2.006	1.982	1.941	2.343	2.045	1.898	2.150
Endogenous Institutions:													
21 Labor Force	1.760	1.020	0.000	1.760	1.019	0.000	2.034	1.021	1.019	1.209	1.056	0.977	1.150
22 Proprietors	0.065	0.737	0.000	0.065	0.159	0.000	0.075	1.074	0.068	0.089	0.077	0.070	0.071
23 Enterprises	0.507	0.904	0.000	0.507	1.463	0.000	0.586	0.579	1.551	0.684	0.596	0.555	0.592
Sum	2.331	2.662	0.000	2.331	2.642	0.000	2.694	2.673	2.638	1.983	1.728	1.602	1.813
24 Low 40% Households	0.210	0.238	0.000	0.210	0.239	0.000	0.243	0.238	0.239	1.179	0.156	0.145	0.164
25 Med 40% Households	0.905	0.830	0.000	0.905	0.737	0.000	1.047	0.883	0.723	0.686	1.599	0.554	0.640
26 High 20% Households	0.959	1.137	0.000	0.959	0.927	0.000	1.109	1.260	0.893	0.772	0.673	1.623	0.711
Sum	2.075	2.205	0.000	2.075	1.902	0.000	2.399	2.381	1.855	2.637	2.427	2.321	1.514
27 Capital Account	0.351	0.535	0.000	0.351	0.755	0.000	0.405	0.407	0.790	0.358	0.405	0.415	1.352

Of the $640 million induced indirect increase in agricultural demand arising from the increase in demand for dairy products, the decomposition calculation indicates that only 14.9 percent can be attributed to net SAM-linkage effects (see Table 4). Most of the indirect feedback to the agricultural sectors comes from input-output linkages. In particular, from Table 2, it can be seen that feed grains is the largest intermediate input into the dairy sector, followed by processed foods. Of the other agricultural sectors, meat animals is the only one which is a significant demander of intermediate inputs from other agricultural sectors (again, feed grains). All the other agricultural sectors have much higher levels of net SAM-linkage effects, compared to the within-block effects (see Table 4).

For all the agricultural sectors, however, there is an asymmetry between the leakages into and out of the sectors. Most of the income generated by an increase in agricultural demand leaks out of agriculture. From Table 3, the nonagricultural value-added multipliers for demand increases in the agricultural sectors range from 1.8 to 2.1, while the non-agricultural value-added multipliers range from 0.3 to 0.7. This "leakage across" phenomenon is a characteristic feature of the response in all the agricultural sectors. A one billion dollar increase in dairy demand, for example, induces an increase of $2.51 billion in total value added in the economy, which represents the Keynesian macro multiplier for the injection. Of this increase in aggregate value added, only 16 percent goes to agriculture.

There are two causes for this leakage-across effect. First, for most of the agricultural sectors, intermediate inputs come largely from the nonagricultural sectors. Thus, any increase in agricultural production generates a demand for nonagricultural production through the columns of the input-output

Table 4: Net SAM-Linkage Effects

(Percent)

	Dairy 1	Meat A 2	Food G 3	Feed G 4	Cotton 5	Fruits 6	Tob.,S 7	Food&T 8	Chemic 9	Utilit 10	Trade 11	Bank 12	Svcs 13	Other 14
Agriculture:														
1 Dairy,Poultry;Eggs	34.9	33.1	74.8	44.9	80.1	88.9	77.7	14.3	92.5	96.3	95.2	97.2	78.8	95.5
2 Meat Animals	30.0	6.1	45.0	42.7	60.4	70.0	61.1	12.3	91.0	95.8	94.6	96.9	78.6	93.7
3 Food Grains	22.9	28.6	4.2	70.9	64.8	61.4	69.7	13.3	91.9	95.9	94.0	97.4	80.6	95.1
4 Feed Grains,etc.	4.5	3.8	56.7	22.3	66.3	71.7	61.7	13.4	90.3	95.6	94.1	96.7	76.8	94.1
5 Cotton,Oil Crops	32.0	35.1	75.8	76.4	5.2	72.8	76.8	12.4	80.4	89.7	92.5	95.3	78.1	73.0
6 Fruits,Nuts,Veget.	57.5	62.5	89.7	90.4	88.8	43.3	90.0	29.6	95.7	97.5	96.4	98.0	83.0	97.0
7 Tob.,Sugar,Other	18.0	28.3	33.3	37.4	27.7	19.9	24.5	24.7	75.2	87.8	84.9	73.7	79.7	70.7
Sum	14.9	9.4	41.2	39.5	31.8	47.0	51.3	15.2	87.3	93.9	92.7	91.4	78.9	87.3
Agriculture Related:														
8 Food & Tob. Prod.	34.3	40.0	92.3	89.7	95.6	96.2	91.7	38.5	91.9	96.1	95.1	97.2	78.2	95.3
9 Chemicals	51.9	49.0	41.5	39.0	62.1	57.1	53.6	59.0	36.7	57.8	79.9	90.4	77.6	63.5
10 Utilities	66.1	65.2	71.1	67.7	83.6	78.2	76.6	65.1	57.3	53.5	72.9	85.0	77.4	71.0
11 Whlsale & Retail	74.4	71.4	79.6	77.4	88.2	84.9	82.1	72.5	79.3	88.8	92.2	96.2	89.4	78.3
12 Bank,Ins.,Real Es.	76.2	71.4	66.2	70.9	76.9	85.7	84.9	83.5	87.7	89.6	84.4	70.1	87.5	87.8
13 Services	84.4	81.4	85.2	84.7	91.4	91.1	86.1	82.9	80.8	83.9	79.0	85.8	83.4	81.7
Sum	66.3	65.3	70.5	69.8	82.6	82.3	79.2	69.1	69.7	76.9	82.5	84.5	83.2	79.3
14 Other Activities	79.1	77.7	79.2	77.8	88.5	84.5	82.0	73.9	56.2	72.8	88.1	91.4	85.9	63.9

Notes: Net SAM-linkage effects (C1) as a percent share of total induced multiplier (M-I).
See text for explanation.

table. Second, demand for agriculture is a small proportion of total final demand, even taking into account processed foods. Thus, any increase in income is largely spent on nonagricultural goods, even taking into account processed food, so the SAM-linkage effects benefit mostly the nonagricultural sectors. The size of the linkages with processed food on the output side and with wholesale and retail trade on the input side emphasize the importance of middlemen in U.S. agriculture.

Since the SAM distinguishes households by income quantiles, it is possible to trace the impact of a given shock on the size distribution. For example, consider again a billion dollar increase in demand for dairy products. The resulting overall increment in household incomes is distributed quite unequally: the poorest 40% of households receive an increase of $190 million; the next 40% an increase of $713 million; and the richest 20% an increase of $848 million. There is thus a trickle up of income. And the distribution of the marginal increment is more unequal than the original distribution of disposable income, so the relative distribution worsens as well. From the 1982 SAM, the share of aggregate disposable income of the poorest 40% of households was 17 percent, of the next poorest 40% was 40 percent, and of the richest 20% was 43 percent. The distribution of the marginal increment in household income generated by the multiplier process from an increase in dairy demand is 10 percent to the poorest, 41 percent to the next 40%, and 48 percent to the richest 20%. The net marginal effect of the multipliers is to transfer income from the poorest 40% to richest 20%. A similar story holds for the multipliers for the other agricultural sectors.

6. Trade and Transfer Experiments

In this section, we use the SAM to perform several experiments to analyze how different shocks would affect U.S. agriculture. Table 5 summarizes the results of four experiments, each of which involves a $10 billion increase in demand or injection into the SAM spread over different exogenous accounts. The experiments are: (1) an increase in agricultural exports; (2) an increase in manufacturing exports; (3) an increase in agricultural value added; and (4) an increase in household incomes. Each experiment is described in three columns: the first column describes the sectoral or institutional distribution of the injection (the distribution of the injection is spread across the affected accounts in proportion to the original flows); the second column gives the changes in the receipts of each endogenous account in the SAM; and the third column presents the results in terms of percentage changes.

The first two experiments are straightforward. The third experiment, an injection of value added to the agricultural sectors, can be seen as reflecting a mix of policies. For example, price supports, keeping quantities unchanged, result in direct increases in value added with no change in input demand. Alternatively, input subsidies combined with output controls also result in an effective subsidy to value added.[17] The third experiment can be seen as describing the result of such policies, although the SAM does not directly incorporate price effects. The fourth experiment, an exogenous injection of income to households, is intended to reflect a general increase in prosperity. Given the definition of the exogenous accounts in the SAM, it can

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[17]Such subsidies include, for example, the farm credit program. Another example is subsidized provision of irrigation water. In developing countries, there are often major subsidies to inputs such as fertilizers and pesticides.

be viewed as being brought about through an increase in government transfers to households or a general cut in individual taxes.

The results in Table 5 indicate that farmers benefit most from direct income transfers. A direct transfer of $10 billion to farmers yields an increase in their value added of $10.37 billion (15 percent). This transfer, however, generates large absolute leakages into nonagricultural incomes. Nonagricultural value added rises by $19 billion. The indirect multiplier on nonagricultural value added is thus 1.9, compared to 0.037 for agricultural value added. This large "leakage across" effect may help explain why agricultural support policies have such wide political support. However, since agriculture is a relatively small share of the aggregate economy, the trickle-across effects of the income transfer to agriculture, while large in absolute terms or as a share of agricultural value added, yield only small percentage changes outside of agriculture.

In terms of its impact on agricultural incomes, the next most potent experiment is an increase in agricultural exports. An increase of exports of $10 billion increases agricultural value added by $5.3 billion (7.83 percent) and gross farm sales by $12.7 billion. As before, however, its impact on nonagricultural incomes is larger. Nonagricultural value added rises by $20.6 billion, a multiplier of 2.06 compared to 0.53 for agriculture. An increase in agricultural exports thus generates more leakages than a direct transfer to farmers.

The reason for the increased leakages is that, in contrast to the transfer experiment, agricultural output also increases, leading to increased demand for intermediate inputs. Value added in the major sectors providing inputs to agriculture thus rises. The $12.7 billion increase in agricultural

Table 5: Results of the Experiments

	1982 Value	Experiment 1: $10b Increase of Agric. Exports			Experiment 2: $10b Increase of Mfg. Exports			Experiment 3: $10b Transfer to Agric. Value Added			Experiment 4: $10b Transfer to Households		
		Shock	Change	% Change	Shock	Change	% Change	Shock	Change	% Change	Shock	Change	% Change
Activities:													
1 Dairy,Poultry,Eggs	29.252	0.006	0.270	0.923		0.192	0.657		0.199	0.682		0.229	0.783
2 Meat Animals	48.732	0.098	0.693	1.421		0.337	0.691		0.329	0.676		0.375	0.769
3 Food Grains	10.734	2.797	2.958	27.559		0.025	0.228		0.025	0.230		0.027	0.254
4 Feed Grains,etc.	38.024	3.019	3.469	9.122		0.197	0.518		0.198	0.521		0.226	0.595
5 Cotton,Oil Crops	23.325	3.179	3.710	15.906		0.102	0.439		0.085	0.365		0.097	0.418
6 Fruits,Nuts,Veget.	17.366	0.634	0.750	4.321		0.094	0.544		0.116	0.669		0.134	0.770
7 Tob.,Sugar,Other	33.993	0.268	0.874	2.571		0.236	0.695		0.218	0.641		0.239	0.704
Sum	201.426	10.000	12.724	6.317		1.184	0.588		1.171	0.581		1.328	0.659
8 Food&Tob. Prod.	310.034		1.949	0.629	0.507	2.194	0.708		2.114	0.682		2.423	0.782
9 Chemicals	464.512		4.844	1.043	1.222	4.439	0.956		2.657	0.572		2.881	0.620
10 Utilities	525.829		3.785	0.720	0.000	3.355	0.638		3.285	0.625		3.584	0.682
11 Whlsale & Retail	564.274		4.331	0.767	0.000	3.726	0.660		4.149	0.735		4.489	0.796
12 Bank,Ins.&Real Es.	720.120		6.393	0.888	0.000	4.345	0.603		5.471	0.760		6.048	0.840
13 Services	1352.652		7.026	0.519	0.000	6.184	0.457		7.240	0.535		8.046	0.595
14 Other Activities	2152.191		14.209	0.660	8.271	23.146	1.075		13.242	0.615		12.970	0.603
Sum	6089.612		42.537	0.699	10.000	47.389	0.778		38.159	0.627		40.442	0.664
Value Added:													
15 Ag Empl. Comp.	18.787		0.876	4.663		0.117	0.623	2.939	3.054	16.258		0.129	0.689
16 Ag Prop. Inc.	45.133		4.189	9.280		0.240	0.532	7.061	7.297	16.168		0.268	0.593
17 Ag Ind Bus Tax	3.640		0.224	6.154		0.022	0.595	0.000	0.021	0.583		0.024	0.660
Sum	67.560		5.289	7.828		0.379	0.561	10.000	10.373	15.353		0.421	0.623
18 Non Ag Empl. Comp.	1845.434		11.976	0.649		13.017	0.705		11.252	0.610		11.998	0.650
19 Non Ag Prop. Inc.	901.134		6.691	0.743		6.366	0.706		5.971	0.663		6.433	0.714
20 Non Ag Ind Bus Tax	255.124		1.979	0.776		1.790	0.702		1.776	0.696		1.920	0.753
Sum	3001.692		20.646	0.688		21.172	0.705		18.999	0.633		20.351	0.678
Endogenous Institutions:													
21 Labor Force	1612.912		11.119	0.689		11.364	0.705		12.378	0.767		10.493	0.651
22 Proprietors	111.500		3.392	3.042		0.735	0.659		5.396	4.839		0.760	0.681
23 Enterprises	888.014		7.487	0.843		5.870	0.661		7.872	0.887		5.941	0.669
Sum	2612.425		21.999	0.842		17.969	0.688		25.646	0.982		17.193	0.658
24 Low 40% Households	440.671		1.978	0.449		1.621	0.368		2.301	0.522	1.746	3.297	0.748
25 Med 40% Households	1015.945		7.272	0.716		6.333	0.623		8.518	0.838	4.024	9.975	0.982
26 High 20% Households	1067.856		8.966	0.840		7.048	0.660		10.849	1.016	4.230	10.919	1.023
Sum	2524.472		18.215	0.722		15.003	0.594		21.668	0.858	10.000	24.191	0.958
27 Capital Account	414.857		4.412	1.064		3.494	0.842		4.808	1.159		4.010	0.967

sales generates the following increases in value added for sectors that are major suppliers of agricultural inputs: chemicals, $1.0 billion; utilities, $1.9 billion; wholesale and retail trade, $3.1 billion; banking, insurance, and real estate, $4.5 billion; and services, $4.6 billion.

Experiments 2 and 4 indicate that farmers do not benefit much from an increase in prosperity in the nonfarm sector. In experiment 2, an increase in nonmanufacturing exports has a multiplier of only 0.118 on agricultural production and of 0.038 on agricultural value added, compared to 2.12 for nonagricultural value added. Note that the increase in nonagricultural incomes generated by an increase in nonagricultural exports is only slightly higher than that generated by an increase in agricultural exports (a multiplier of 2.12 as compared to a multiplier of 2.06). The leakage from agricuture is dramatic, with most of the increase in both cases accruing to the nonagricultural sectors. In experiment 4, a general rise in household incomes has very little effect on the farm sector. The gross output multiplier for agriculture is only 0.13 and the value added multiplier is only 0.042, while the multiplier on nonagricultural value added is 2.03. The increase in food consumption is a small share of the increase in total consumption, and most of it is in the form of demand for processed foods. Middlemen and suppliers of agricultural inputs capture most of the induced effects of increases in food consumption.

It is interesting to examine the income distribution effects of the experiments. All of them make the relative size distribution of income substantially more unequal. The percentage changes they induce in the incomes of the poorest households are smaller than their average income share, and the percentage increases in the incomes of the richest households are larger than

their average share. The smaller marginal share of the poorest households in the induced multipliers is due largely to the fact that government transfers, which remain unaffected by the experiments, represent about half of their disposable income. The experiments all lead to increases in aggregate income. However, government transfer payments are fixed exogenously and do not increase, thus leaving the poorest households behind. This phenomenon arises from our choice of exogenous accounts, but also reflects a real structural feature of the U.S. economy. Much of government transfer income consists of pensions and social security, as well as welfare payments. These tend to be fixed in nominal terms and do not increase with economic expansion. Insofar as they also do not fall in a recession, any general contraction will lead to a decrease in relative inequality.

While all the experiments lead to a trickle up of income from the poor to the rich, those which transfer more income to agriculture have the most unequalizing effects. This result is due to the fact that the share of property income in agricultural value added is higher than in nonagricultural value added, and property income is distributed more unequally than wage income.

In summary, a number of lessons can be drawn from these experiments for the role of agriculture in the U.S. economy. First, given the small trickle across to agriculture of income-raising measures outside of agriculture, if one decides to formulate policies that benefit farmers, these policies must be targeted directly at them. This result is in strong contrast to the situation of the farm sector in developing economies, where farmers capture a large share of the benefit of urban income increases. Second, because of the large trickle across out of agriculture, partial equilibrium analysis of the impact of policy upon farmers is likely to be misleading. Third, the anti-middleman

attitude of farmers has a strong basis in fact; middlemen do capture the lion's share of benefits from farm production. Fourth, the widespread view of farmers that exports of agricultural products have a large impact on their incomes is correct. This means, inter alia, that general trade policy matters to the farm sector. Fifth, programs to raise farm incomes lead to a trickle up of income in the overall economy. This again contrasts with the situation in developing countries in which the overwhelming majority of the poor are farmers and agricultural laborers. In developing countries, policies that benefit farmers, even after leakages are taken into account, reduce economy-wide inequality.

7. Extension to a Computable General Equilibrium Model

While the behavioral specification used in the SAM-based multiplier analysis emphasizes important linkages in the economy, it is too simple for much policy analysis. The model is demand driven, and completely ignores issues of resource allocation, productivity, and factor utilization. With its fixed coefficients, the model ignores substitution possibilities in consumption, production, imports, and exports triggered by changes in relative prices. It also ignores possibilities for partial shifting of the incidence of taxes, tariffs, and subsidies through interactions between supply and demand. Finally, the model does not capture the behavior of economic agents interacting across markets in response to shifts in price signals, which constitute the major mechanism by which (non-transfer) government policies affect the economy.

All of these deficiencies can be remedied by embedding optimizing behavior in the description of the behavior of the various institutions in the SAM

and allowing the production functions to be more flexible. The next step in the analysis is to use the SAM accounting framework as a basis for constructing a computable general equilibrium (CGE) model.[18] The formulation of a CGE model involves specifying: (1) behavioral principles for the institutions in the system (e.g., utility maximization for consumers and profit maximization for producers); (2) the functional forms of the objective functions and constraints which shape the behavioral responses of the institutions in the system; (3) embedding the reduced-form solutions (if possible) in the accounting relationships of the SAM which must be satisfied ex post; (4) specifying the systemwide behavior rules for attaining ex post equalities in the accounting relations of the SAM (e.g., market clearing price adjustment, or rationing rules on the short or long side of any market with fixed prices, and macro closure rules for the financial flows); and, finally, (5) solving the excess demand equations for commodities and factors, which result from step (3), using the rules specified in step (4). A solution of the CGE model yields: relative prices for commodities and factors; sectoral output, demand, and employment; sectoral exports and imports, the balance of trade, and the equilibrium exchange rate; and finally, incomes and expenditures for all the institutions included in the model.

Using the CGE model as a laboratory for doing counterfactual experiments, we will be able to explore a number of policy questions relating to agriculture and compare the relative costs and benefits of alternative agricultural programs. We plan to focus on the role of international trade and explore further the impact on agriculture of policies aimed at achieving macro stabil-

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[18]CGE models applied to developing countries are surveyed in Robinson (1986) and in Dervis, de Melo, and Robinson (1982). CGE models of developed countries are surveyed in Shoven and Whalley (1984).

ization. In particular, we plan to explore the impact on agriculture of shifts in the real exchange over the past few years. Analysis of such issues requires a price responsive model.

8. Conclusion

The SAM-based analysis has enabled us to explore the important structural features of U.S. agriculture and has given upper bounds on the quantitative impact of various types of interventions intended to benefit U.S. farmers. Most of the policy interventions in a largely market-based economy work through the price system. Interest rates, exchange rates, energy prices, water prices, fertilizer and pesticide prices, and subsidy policies, all influence the international competitiveness of US agricultural production, change the value added ratio in agriculture, and elicit a quantity response in the supply of output and in the demands for inputs. These can only be captured in a price responsive model. Since both the forward and backward linkages of agriculture are substantial, a multisectoral analysis is desireable. The combination indicates the need to formulate a CGE model for the analysis of agricultural policy in the U.S, which is the next step in our research agenda.

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Appendix:

Multiplier Decomposition Tables

Table A-1: The Own Effects Matrix, C1

Table A-2: The Open Loop Effects Matrix, C2

Table A-3: The Closed Loop Effects Matrix, C3

Table A-1: The Own Effects Matrix, C1

		Dairy, 1	Meat A 2	Food G 3	Feed G 4	Cotton 5	Fruits 6	Tob.,S 7	Food&T 8	Chemic 9	Utilit 10	Whlsal 11	Bank,I 12	Servic 13	Other 14
1	Dairy,Poultry,Eggs	1.030	0.031	0.006	0.020	0.004	0.002	0.005	0.090	0.001	0.001	0.001	0.0	0.005	0.001
2	Meat Animals	0.063	1.395	0.033	0.036	0.019	0.011	0.017	0.178	0.002	0.001	0.001	0.001	0.008	0.002
3	Food Grains	0.007	0.005	1.047	0.001	0.001	0.001	0.001	0.012	0.0	0.0	0.0	0.0	0.001	0.0
4	Feed Grains,etc.	0.342	0.387	0.013	1.057	0.009	0.006	0.010	0.097	0.001	0.001	0.001	0.001	0.005	0.001
5	Cotton,Oil Crops	0.015	0.012	0.002	0.002	1.139	0.003	0.002	0.045	0.001	0.001	0.001	0.0	0.002	0.002
6	Fruits,Nuts,Veget.	0.007	0.005	0.001	0.001	0.001	1.012	0.001	0.021	0.0	0.0	0.0	0.0	0.002	0.0
7	Tob.,Suger,Other	0.081	0.043	0.036	0.030	0.052	0.069	1.053	0.050	0.005	0.002	0.003	0.006	0.005	0.006
	sum (1-7)	1.544	1.880	1.139	1.148	1.226	1.104	1.088	0.493	0.012	0.006	0.007	0.009	0.028	0.012
8	Food&Tob. Prod.	0.330	0.247	0.015	0.020	0.009	0.007	0.015	1.254	0.013	0.007	0.009	0.005	0.052	0.007
9	Chemicals	0.202	0.218	0.315	0.347	0.148	0.158	0.183	0.141	1.322	0.159	0.052	0.023	0.067	0.107
10	Utilities	0.138	0.138	0.112	0.131	0.059	0.072	0.080	0.134	0.171	1.233	0.096	0.047	0.084	0.094
11	Whlsale & Retail	0.117	0.130	0.089	0.101	0.050	0.058	0.072	0.120	0.076	0.043	1.028	0.013	0.043	0.080
12	Bank,Ins.&Real Es.	0.138	0.171	0.231	0.185	0.149	0.072	0.077	0.081	0.053	0.051	0.079	1.182	0.068	0.052
13	Services	0.109	0.129	0.104	0.108	0.062	0.056	0.093	0.112	0.119	0.112	0.151	0.095	1.126	0.112
	sum (8-13)	1.034	1.033	0.866	0.892	0.476	0.422	0.519	1.842	1.755	1.605	1.415	1.365	1.441	0.453
14	Other Activities	0.293	0.304	0.302	0.325	0.161	0.194	0.230	0.365	0.739	0.421	0.140	0.115	0.188	1.529
15	Ag Empl. Comp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	Ag Prop. Inc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Ag Ind Bus Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	sum (15-17)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	Non Ag Empl. Comp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Non Ag Prop. Inc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Non Ag Ind Bus Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	sum (18-20)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Labor Force	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Proprietors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	Enterprises	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Low 40% Hshlds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Med 40% Hshlds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	High 20% Hshlds	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	sum (24-26)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	Capital Account	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A-1: The Own Effects Matrix, C1 (continued)

		Ag Emp 15	Ag Pro 16	Ag Ind 17	Non Ag 18	Non Ag 19	Non Ag 20	Labor 21	Propri 22	Enterp 23	Low 40 24	Med 40 25	High 2 26	Capital 27
1	Dairy,Poultry,Eggs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Meat Animals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Food Grains	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	Feed Grains,etc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Cotton,Oil Crops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Fruits,Nuts,Veget.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	Tob.,Suger,Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Food&Tob. Prod.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Chemicals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Utilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Whlsale & Retail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Bank,Ins.&Real Es.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Other Activities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Ag Empl. Comp.	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	Ag Prop. Inc.	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Ag Ind Bus Tax	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	Non Ag Empl. Comp.	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Non Ag Prop. Inc.	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Non Ag Ind Bus Tax	0.0	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Labor Force	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	0.0
22	Proprietors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0
23	Enterprises	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	0.0
24	Low 40% Hshlds	0.0	0.0	0.0	0.0	0.0	0.0	0.090	0.087	0.091	1.000	0.0	0.0	0.0
25	Med 40% Hshlds	0.0	0.0	0.0	0.0	0.0	0.0	0.460	0.304	0.150	0.0	1.000	0.0	0.0
26	High 20% Hshlds	0.0	0.0	0.0	0.0	0.0	0.0	0.450	0.609	0.254	0.0	0.0	1.000	0.0
	sum (24-26)	0.0	0.0	0.0	0.0	0.0	0.0	1.000	1.000	0.495	1.000	1.000	1.000	0.0
27	Capital Account	0.0	0.0	0.0	0.0	0.0	0.0	0.063	0.069	0.465	-0.043	0.056	0.091	1.000

Table A-2: The Open Loop Effects Matrix, C2

		Dairy, 1	Meat A 2	Food G 3	Feed G 4	Cotton 5	Fruits 6	Tob.,S 7	Food&T 8	Chemic 9	Utilit 10	Whlsal 11	Bank,I 12	Servic 13	Other 14
1	Dairy,Poultry,Eggs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Meat Animals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Food Grains	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	Feed Grains,etc.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Cotton,Oil Crops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Fruits,Nuts,Veget.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	Tob.,Suger,Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	Food&Tob. Prod.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Chemicals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Utilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Whlsale & Retail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Bank,Ins.&Real Es.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Other Activities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Ag Empl. Comp.	0.098	0.112	0.065	0.047	0.084	0.170	0.257	0.038	0.002	0.001	0.001	0.002	0.003	0.002
16	Ag Prop. Inc.	0.256	0.183	0.319	0.326	0.559	0.390	0.263	0.090	0.003	0.001	0.002	0.002	0.006	0.003
17	Ag Ind Bus Tax	0.024	0.037	0.022	0.022	0.019	0.015	0.025	0.009	0.0	0.0	0.0	0.0	0.001	0.0
	sum (15-17)	0.379	0.332	0.405	0.395	0.661	0.575	0.546	0.137	0.005	0.002	0.003	0.004	0.009	0.005
18	Non Ag Empl. Comp.	0.305	0.321	0.275	0.290	0.152	0.153	0.195	0.424	0.496	0.523	0.616	0.284	0.714	0.519
19	Non Ag Prop. Inc.	0.184	0.197	0.196	0.187	0.115	0.088	0.104	0.241	0.238	0.332	0.214	0.551	0.209	0.214
20	Non Ag Ind Bus Tax	0.059	0.063	0.057	0.055	0.033	0.027	0.031	0.083	0.064	0.075	0.160	0.144	0.037	0.052
	sum (18-20)	0.547	0.580	0.528	0.532	0.301	0.268	0.330	0.747	0.799	0.930	0.991	0.978	0.959	0.784
21	Labor Force	0.349	0.374	0.294	0.291	0.205	0.280	0.391	0.400	0.431	0.454	0.534	0.247	0.620	0.451
22	Proprietors	0.187	0.140	0.230	0.234	0.382	0.268	0.185	0.082	0.023	0.031	0.020	0.051	0.023	0.021
23	Enterprises	0.253	0.240	0.285	0.279	0.292	0.211	0.182	0.249	0.218	0.303	0.195	0.502	0.192	0.196
	sum (21-23)	0.788	0.754	0.809	0.804	0.879	0.758	0.758	0.730	0.672	0.787	0.750	0.799	0.834	0.668
24	Low 40% Hshlds	0.071	0.068	0.072	0.072	0.078	0.068	0.068	0.066	0.061	0.071	0.068	0.072	0.075	0.060
25	Med 40% Hshlds	0.255	0.251	0.248	0.247	0.254	0.242	0.264	0.246	0.238	0.264	0.281	0.204	0.321	0.243
26	High 20% Hshlds	0.335	0.314	0.344	0.344	0.399	0.342	0.335	0.293	0.263	0.300	0.302	0.269	0.341	0.265
	sum (24-26)	0.661	0.633	0.665	0.663	0.731	0.652	0.666	0.604	0.562	0.634	0.651	0.546	0.737	0.569
27	Capital Account	0.152	0.145	0.167	0.164	0.175	0.134	0.122	0.146	0.130	0.171	0.126	0.252	0.130	0.121

Table A-2: The Open Loop Effects Matrix, C2 (continued)

		Ag Emp 15	Ag Pro 16	Ag Ind 17	Non Ag 18	Non Ag 19	Non Ag 20	Labor 21	Propri 22	Enterp 23	Low 40 24	Med 40 25	High 2 26	Capital 27
1	Dairy,Poultry,Eggs	0.008	0.007	0.0	0.008	0.005	0.0	0.009	0.009	0.005	0.015	0.010	0.007	0.0
2	Meat Animals	0.013	0.012	0.0	0.013	0.009	0.0	0.015	0.014	0.009	0.022	0.017	0.012	0.003
3	Food Grains	0.001	0.001	0.0	0.001	0.001	0.0	0.001	0.001	0.001	0.001	0.001	0.001	0.001
4	Feed Grains,etc.	0.008	0.007	0.0	0.008	0.005	0.0	0.009	0.009	0.005	0.014	0.010	0.007	0.001
5	Cotton,Oil Crops	0.003	0.003	0.0	0.003	0.002	0.0	0.004	0.004	0.002	0.006	0.004	0.003	0.0
6	Fruits,Nuts,Veget.	0.005	0.004	0.0	0.005	0.003	0.0	0.005	0.005	0.003	0.009	0.006	0.004	0.0
7	Tob.,Suger,Other	0.008	0.008	0.0	0.008	0.007	0.0	0.009	0.009	0.007	0.012	0.010	0.008	0.006
	sum (1-7)	0.046	0.044	0.0	0.046	0.033	0.0	0.053	0.050	0.031	0.079	0.058	0.042	0.011
8	Food&Tob. Prod.	0.085	0.079	0.0	0.085	0.055	0.0	0.098	0.092	0.051	0.149	0.109	0.076	0.005
9	Chemicals	0.093	0.102	0.0	0.093	0.097	0.0	0.108	0.105	0.096	0.132	0.115	0.096	0.097
10	Utilities	0.116	0.126	0.0	0.116	0.117	0.0	0.134	0.132	0.116	0.181	0.139	0.121	0.109
11	Whlsale & Retail	0.146	0.160	0.0	0.146	0.149	0.0	0.169	0.166	0.148	0.199	0.174	0.158	0.145
12	Bank,Ins.&Real Es.	0.208	0.211	0.0	0.208	0.161	0.0	0.240	0.239	0.153	0.277	0.239	0.234	0.075
13	Services	0.273	0.277	0.0	0.273	0.219	0.0	0.316	0.310	0.210	0.414	0.323	0.289	0.115
	sum (8-13)	0.922	0.954	0.0	0.922	0.798	0.0	1.065	1.045	0.774	1.352	1.099	0.974	0.547
14	Other Activities	0.338	0.529	0.0	0.338	0.762	0.0	0.390	0.393	0.799	0.307	0.392	0.406	1.394
15	Ag Empl. Comp.	0.0	0.0	0.0	0.0	0.0	0.0	0.005	0.005	0.003	0.007	0.006	0.004	0.002
16	Ag Prop. Inc.	0.0	0.0	0.0	0.0	0.0	0.0	0.011	0.010	0.006	0.016	0.012	0.009	0.002
17	Ag Ind Bus Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.001	0.001	0.001	0.001	0.001	0.001	0.0
	sum (15-17)	0.0	0.0	0.0	0.0	0.0	0.0	0.017	0.016	0.010	0.024	0.018	0.014	0.004
18	Non Ag Empl. Comp.	0.0	0.0	0.0	0.0	0.0	0.0	0.437	0.432	0.446	0.509	0.447	0.413	0.522
19	Non Ag Prop. Inc.	0.0	0.0	0.0	0.0	0.0	0.0	0.240	0.238	0.217	0.279	0.244	0.229	0.222
20	Non Ag Ind Bus Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.072	0.071	0.063	0.084	0.074	0.069	0.061
	sum (18-20)	0.0	0.0	0.0	0.0	0.0	0.0	0.750	0.741	0.726	0.873	0.764	0.711	0.805
21	Labor Force	0.865	0.0	0.0	0.865	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Proprietors	0.0	0.665	0.0	0.0	0.090	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	Enterprises	0.0	0.335	0.0	0.0	0.910	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Low 40% Hshlds	0.078	0.088	0.0	0.078	0.090	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	Med 40% Hshlds	0.398	0.253	0.0	0.398	0.164	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	High 20% Hshlds	0.389	0.490	0.0	0.389	0.286	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	sum (24-26)	0.865	0.831	0.0	0.865	0.540	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	Capital Account	0.054	0.201	0.0	0.054	0.429	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A-3: The Closed Loop Effects Matrix, C3

		Dairy, 1	Meat A 2	Food G 3	Feed G 4	Cotton 5	Fruits 6	Tob.,S 7	Food&T 8	Chemic 9	Utilit 10	Whlsal 11	Bank,I 12	Servic 13	Other 14
1	Dairy,Poultry,Eggs	0.016	0.016	0.016	0.016	0.018	0.016	0.016	0.015	0.014	0.016	0.016	0.015	0.018	0.014
2	Meat Animals	0.027	0.026	0.027	0.027	0.030	0.026	0.026	0.025	0.023	0.027	0.026	0.026	0.029	0.023
3	Food Grains	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
4	Feed Grains,etc.	0.016	0.015	0.016	0.016	0.018	0.016	0.016	0.015	0.014	0.016	0.016	0.015	0.018	0.014
5	Cotton,Oil Crops	0.007	0.007	0.007	0.007	0.008	0.007	0.007	0.006	0.006	0.007	0.007	0.007	0.008	0.006
6	Fruits,Nuts,Veget.	0.009	0.009	0.010	0.010	0.010	0.009	0.009	0.009	0.008	0.009	0.009	0.009	0.010	0.008
7	Tob.,Suger,Other	0.018	0.017	0.018	0.018	0.020	0.017	0.017	0.016	0.015	0.018	0.017	0.017	0.019	0.015
	sum (1-7)	0.095	0.091	0.097	0.097	0.106	0.092	0.093	0.088	0.082	0.095	0.092	0.091	0.103	0.082
8	Food&Tob. Prod.	0.172	0.165	0.175	0.174	0.190	0.166	0.168	0.159	0.147	0.170	0.167	0.163	0.187	0.148
9	Chemicals	0.218	0.209	0.223	0.222	0.242	0.210	0.211	0.202	0.187	0.218	0.209	0.218	0.233	0.186
10	Utilities	0.269	0.258	0.275	0.274	0.299	0.259	0.261	0.250	0.230	0.268	0.258	0.268	0.288	0.229
11	Whlsale & Retail	0.340	0.326	0.348	0.346	0.378	0.328	0.329	0.315	0.290	0.339	0.326	0.338	0.363	0.289
12	Bank,Ins.&Real Es.	0.444	0.426	0.453	0.451	0.494	0.430	0.433	0.411	0.379	0.440	0.428	0.428	0.479	0.379
13	Services	0.589	0.565	0.601	0.598	0.654	0.570	0.574	0.545	0.504	0.584	0.568	0.570	0.635	0.503
	sum (8-13)	2.033	1.948	2.075	2.064	2.256	1.964	1.976	1.882	1.737	2.020	1.956	1.984	2.185	1.734
14	Other Activities	1.110	1.062	1.149	1.140	1.240	1.056	1.046	1.035	0.948	1.129	1.041	1.219	1.148	0.935
15	Ag Empl. Comp.	0.009	0.009	0.010	0.010	0.010	0.009	0.009	0.009	0.008	0.009	0.009	0.009	0.010	0.008
16	Ag Prop. Inc.	0.019	0.018	0.020	0.019	0.021	0.019	0.019	0.018	0.016	0.019	0.019	0.018	0.021	0.016
17	Ag Ind Bus Tax	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.001
	sum (15-17)	0.030	0.029	0.031	0.031	0.034	0.029	0.030	0.028	0.026	0.030	0.029	0.029	0.033	0.026
18	Non Ag Empl. Comp.	0.926	0.886	0.949	0.943	1.029	0.890	0.891	0.858	0.791	0.926	0.883	0.937	0.983	0.786
19	Non Ag Prop. Inc.	0.489	0.469	0.501	0.498	0.544	0.471	0.473	0.453	0.418	0.488	0.468	0.489	0.522	0.416
20	Non Ag Ind Bus Tax	0.145	0.139	0.149	0.148	0.162	0.140	0.141	0.135	0.124	0.145	0.139	0.145	0.155	0.124
	sum (18-20)	1.560	1.494	1.598	1.589	1.735	1.501	1.505	1.446	1.333	1.559	1.491	1.570	1.660	1.326
21	Labor Force	0.809	0.775	0.829	0.824	0.899	0.778	0.779	0.750	0.691	0.809	0.772	0.818	0.859	0.687
22	Proprietors	0.057	0.055	0.058	0.058	0.063	0.055	0.055	0.053	0.049	0.057	0.055	0.056	0.061	0.049
23	Enterprises	0.452	0.432	0.462	0.459	0.502	0.435	0.436	0.418	0.386	0.450	0.432	0.451	0.482	0.384
24	Low 40% Hshlds	0.119	0.114	0.122	0.121	0.132	0.114	0.115	0.110	0.102	0.119	0.114	0.120	0.127	0.101
25	Med 40% Hshlds	0.457	0.438	0.469	0.466	0.508	0.440	0.441	0.424	0.391	0.457	0.437	0.461	0.486	0.389
26	High 20% Hshlds	0.513	0.491	0.526	0.522	0.570	0.494	0.495	0.476	0.438	0.513	0.490	0.517	0.546	0.436
	sum (24-26)	1.089	1.043	1.116	1.109	1.211	1.048	1.050	1.010	0.931	1.089	1.041	1.098	1.159	0.926
27	Capital Account	0.265	0.253	0.271	0.269	0.294	0.255	0.256	0.245	0.226	0.264	0.253	0.265	0.282	0.225

Table A-3: The Closed Loop Effects Matrix, C3 (continued)

		Ag Exp 15	Ag Pro 16	Ag Ind 17	Non Ag 18	Non Ag 19	Non Ag 20	Labor 21	Propri 22	Enterp 23	Low 40 24	Med 40 25	High 2 26	Capital 27
1	Dairy,Poultry,Eggs	0.011	0.013	0.0	0.011	0.013	0.0	0.013	0.013	0.013	0.015	0.013	0.012	0.014
2	Meat Animals	0.019	0.021	0.0	0.019	0.021	0.0	0.022	0.021	0.021	0.025	0.022	0.020	0.023
3	Food Grains	0.001	0.002	0.0	0.001	0.002	0.0	0.002	0.002	0.002	0.002	0.002	0.002	0.002
4	Feed Grains,etc.	0.011	0.013	0.0	0.011	0.013	0.0	0.013	0.013	0.013	0.015	0.013	0.012	0.014
5	Cotton,Oil Crops	0.005	0.005	0.0	0.005	0.005	0.0	0.006	0.005	0.005	0.007	0.006	0.005	0.006
6	Fruits,Nuts,Veget.	0.007	0.007	0.0	0.007	0.007	0.0	0.008	0.007	0.007	0.009	0.008	0.007	0.008
7	Tob.,Suger,Other	0.012	0.014	0.0	0.012	0.014	0.0	0.014	0.014	0.014	0.017	0.015	0.014	0.015
	sum (1-7)	0.066	0.075	0.0	0.066	0.075	0.0	0.077	0.076	0.074	0.090	0.078	0.072	0.083
8	Food&Tob. Prod.	0.120	0.136	0.0	0.120	0.135	0.0	0.138	0.136	0.134	0.162	0.141	0.131	0.150
9	Chemicals	0.152	0.172	0.0	0.152	0.170	0.0	0.176	0.174	0.170	0.206	0.179	0.166	0.188
10	Utilities	0.187	0.213	0.0	0.187	0.210	0.0	0.217	0.214	0.210	0.254	0.221	0.205	0.233
11	Whlsale & Retail	0.237	0.268	0.0	0.237	0.265	0.0	0.273	0.270	0.265	0.320	0.279	0.258	0.293
12	Bank,Ins.&Real Es.	0.308	0.350	0.0	0.308	0.346	0.0	0.356	0.352	0.346	0.417	0.363	0.336	0.384
13	Services	0.409	0.464	0.0	0.409	0.460	0.0	0.473	0.467	0.459	0.554	0.483	0.447	0.510
	sum (8-13)	1.413	1.603	0.0	1.413	1.586	0.0	1.633	1.613	1.583	1.912	1.666	1.543	1.758
14	Other Activities	0.779	0.882	0.0	0.779	0.867	0.0	0.901	0.890	0.865	1.054	0.918	0.852	0.950
15	Ag Empl. Comp.	0.011	0.012	0.0	0.011	0.011	0.0	0.008	0.007	0.007	0.009	0.008	0.007	0.008
16	Ag Prop. Inc.	0.023	0.024	0.0	0.023	0.022	0.0	0.015	0.015	0.015	0.018	0.016	0.015	0.017
17	Ag Ind Bus Tax	0.002	0.002	0.0	0.002	0.002	0.0	0.001	0.001	0.001	0.002	0.001	0.001	0.002
	sum (15-17)	0.036	0.038	0.0	0.036	0.034	0.0	0.024	0.024	0.024	0.029	0.025	0.023	0.026
18	Non Ag Empl. Comp.	1.023	1.168	0.0	1.023	1.167	0.0	0.746	0.736	0.721	0.873	0.761	0.705	0.798
19	Non Ag Prop. Inc.	0.549	0.617	0.0	0.549	0.601	0.0	0.394	0.389	0.381	0.461	0.402	0.372	0.422
20	Non Ag Ind Bus Tax	0.164	0.183	0.0	0.164	0.177	0.0	0.117	0.115	0.113	0.137	0.119	0.111	0.125
	sum (18-20)	1.736	1.968	0.0	1.736	1.945	0.0	1.256	1.241	1.215	1.470	1.281	1.187	1.345
21	Labor Force	0.895	1.020	0.0	0.895	1.019	0.0	1.034	1.021	1.019	1.209	1.056	0.977	1.150
22	Proprietors	0.065	0.072	0.0	0.065	0.069	0.0	0.075	0.074	0.068	0.089	0.077	0.070	0.071
23	Enterprises	0.507	0.569	0.0	0.507	0.554	0.0	0.586	0.579	0.551	0.684	0.596	0.555	0.592
24	Low 40% Hshlds	0.132	0.150	0.0	0.132	0.148	0.0	0.153	0.151	0.148	0.179	0.156	0.145	0.164
25	Med 40% Hshlds	0.507	0.577	0.0	0.507	0.573	0.0	0.586	0.579	0.572	0.686	0.599	0.554	0.640
26	High 20% Hshlds	0.570	0.647	0.0	0.570	0.641	0.0	0.659	0.651	0.640	0.772	0.673	0.623	0.711
	sum (24-26)	1.210	1.374	0.0	1.210	1.362	0.0	1.399	1.381	1.360	1.637	1.427	1.321	1.514
27	Capital Account	0.296	0.334	0.0	0.296	0.326	0.0	0.342	0.338	0.325	0.400	0.349	0.324	0.352