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Agricultural Liberalization in Segmented or Integrated Markets, with Scale Economies

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Abstract

A rural-urban interregional computable general equilibrium (CGE) model of United States is constructed to simulate the effects of agricultural liberalization on household incomes, employment rates, farm and non-farm sectoral activity, regional costs of living, and other economic indicator. Rural areas generally lose, and urban areas gain. The overall gains are highest when regional factor and goods markets are fully integrated and economies of scale can be captured.

I. Introduction

The gains from free trade arise from three types of increased efficiencies: specialization according to factor endowments (Heckscher-Ohlin-Samuelson), specialization according to technological differences (Ricardo), or, by achieving economies of scale ⟨Krugman [1980, 1991]⟩. A further gain from liberalizing agricultural trade is the reduction of the excess burden of government spending on farm subsidies, spending which may be more productively allocated. Gains are not enjoyed equally by everyone everywhere,

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there will be some localized losses.

This paper focuses on how geographical market segmentation and scale economies interact to qualify our estimates of the gains from agricultural liberalization. Previous estimates of the gains from liberalization have assumed single, economywide markets for both goods and factors ⟨Hertel [1989], Kilkenny and Robinson [1990]⟩. Under these assumption labor is modeled as being able to move costlessly from job to job, regardless of where one lives relative to the location of employment; and, demand for household services rises in every region due to the rise in income. However, perfect factor mobility and totally integrated markets are unrealistic assumptions. This paper shows that in the presence of regional factor specificity the gains from liberalization increase with integration.

Goods markets may be segmented if goods are prohibitively difficult to transport such as across the United States, or it there are policies that restrict interregional trade as in Europe before *1992*. Goods market segmentation insulates regional prices from extra-regional changes, and, reduces the scope for achieving economies of scale. If rural and urban markets are segmented, a reduction in farm income due to liberalization will most likely lower the prices of *nontraded* goods like housing and services. Offsetting that negative effect, the reduction in rural factor costs and service sector prices could stimulate other non-farm rural activity such as manufacturing. Rural manufacturing industries could supply urban markets if there were no transportation or policy barriers causing strict market segmentation.

This paper will also show how the gains from liberalization increase with economies of scale, as long as markets are competitive.[1] A salient distinction between comparable industries located in rural and urban areas (with ostensibly equivalent technologies) is that the urban firms appear to display increasing returns to scale ⟨Blackley [1986]⟩. These may be internal (technological) or external (agglomeration) economies. An agglomeration economy for a manufacturing firm arises when the intermediate good market is

1 Welfare gains from liberalization may be lost when there are sunk costs and if firms behave as Cournot competitors or if they collude, as shown by Mercenier and Schmitt [1992].

large enough so that input suppliers and affiliated industries can achieve internal economies of scale, thus providing services at lower costs to the firm ⟨Duffy [1988]⟩.

To partial equilibrium analysts who treat factor prices as parameters, the optimal output level under either form of increasing returns to scale is indeterminant. In contrast, the general equilibrium analyst incorporates factor markets endogenously. Factor costs will rise if industries attempt to expand, particularly when factor markets are geographically segmented and the pool of labor is limited. Thus there is always a point of increasing marginal costs, and the optimal output level can be determined at which marginal revenue just exceeds marginal cost.

To show how these features of an economy interact under liberalization I developed a rural-urban interregional computable general equilibrium (CGE) model of the United States. The technology of production is modeled as displaying constant or increasing returns to scale. Factor market segmentation is explicit. Labor, land, and capital is employed (or left idle) in the region in which the household who supplies it resides. Goods market segmentation is also explicit. Goods produced in different regions are supplied (to the extent they are tradeable) to satisfy local demands. Although the model is of two regions of the United States, the implications are relevant to the European situation. Europe is simultaneously integrating its markets and liberalizing agriculture. Since technologies and factor endowments are similar across Europe, economies of scale are the most likely sources of gains.

II. An Interregional Rural-Urban CGE Model

This rural-urban computable general equilibrium model is a system of about 600 nonlinear and linear simultaneous equations representing the behavior of producers in all sectors consumers in rural and urban households, the government, and an aggregate rest of the world; as participants in regional factor and goods markets ⟨Kilkenny [1993]⟩. The model is written using the General Algebraic Modeling System (GAMS) and solved using the MINOS nonlinear mathematical programming algorithm on a 486 computer having 8 megabytes of RAM and a math co-processor. A solution of the model determines prices and quantities of goods, services, factor employment; income, expenditures, tax revenues, interregional and international trade flows, and interregional and international savings flows that clear all markets and satisfy all the agents' objectives subject to the constraints.

USA counties are aggregated into two regions: nonmetropolitan (*rural*) and metropolitan (*urban*). Almost thirty percent of the nonmetropolitan counties are farming-dependent; *i.e.*, derive 20% or more income from farming. No metropolitan counties are farming-dependent. The two household types are distinguished according to where they live as ***rural*** or ***urban***.

A minimum level of industry disaggregation is chosen to avoid proliferating data needs while still highlighting the key relationships between fundamentally different sectors. There are six types of industries in each region: agriculture, primary/extractives, ag-linked, manufacturing, business services, and household services (Appendix 1). This aggregation highlights the off-farm, rural community interindustry linkages with agriculture. Farming, ag-linked, and extractive industries account for proportionately more value-added in rural areas than urban; business services are more important to the urban economy. Manufacturing and household service industries are important in both regions ⟨Bluestone and Miller[1988]⟩.

The aggregation also highlights the pattern of regional specialization. The majority of the wage, salary, and imputed proprietor/labor income from farming is generated in nonmetropolitan (*rural*) counties. The rural share of economywide labor income generated in primary and extractive industries also exceeds the rural proportion of the national labor supply and of the average wage bill share. Urban areas provide proportionately more of the manufacturing, business and household services. Given these variations in industry mix, a change in the industry composition of aggregate demand will affect rural and urban areas differently. For example, decreased public stocking of grains and dairy products matched by increased private spending on investment goods will be met by reduced real output and increased urban real output.

Production and factor employment are determined simultaneously to maximize profit given the technology. Farm program deficiency payments and loan rate subsidies are modeled as coupled subsidies which augment nomi-

Table 1
Selected Rural-Urban CGE Model Equations

(1A)	$XD_{i,r} = A_{i,r} \cdot L^{\alpha L_{ir}} \cdot K^{\alpha K_{ir}} \cdot T^{\alpha T_{ir}}$	$\sum_f \alpha^{fir} = 1;\ \alpha^{T_{ir}} = 0$ for $i =$ nonfarm
(1B)	$XD_{i,r} = A_{i,r}\left[\alpha_{i,r} K^{\rho ir} + (1-\alpha_{i,r}) L^{\rho ir}\right]^{\epsilon ir/\rho ir}$	
(2)	$INT_{i,r} = \sum_j IO_{i,j} \cdot XD_{j,r}$	
(3A)	$L_{i,r} = \left[XD_{i,r} \cdot PVA_{i,r} \cdot \alpha^{L_{ir}}\right] / \left[W_{L,} \cdot \omega^{L_{i,r}}\right]$	(similarly for K, T)
(3B)	$K_{i,r} / L_{i,r} = \left[(W_{L_r} \cdot \omega^{L_{ir}} / W_{K_r} \cdot \omega^{K_{ir}}) \cdot ((1-\alpha_{ir}) / \alpha_{ir})\right]^{\sigma_{ir}}$	
(4)	$PVA_{i,r} = PX_{i,r} \cdot (1 - ITAX_{i,r}) - \sum_j IO_{j,i} \cdot P_{j,r} + PIE_{i,r}$	
(5)	$\sum_R HHFS_{R,f,r} = FS_{f,r}$	$R =$ region of Household residence, $r =$ factor market
(6)	$FYS_{i,f,r} = W_{f,r} \cdot \omega^{f_{ir}} \cdot FD_{i,f,r}$	
(7)	$NFY_{f,r} = ((1 - FTR_{i,f,r}) \cdot (1 - ESR_{i,f}) \cdot (\sum_i FYS_{i,f,r} + GENT_{i,f,r} - DEP_{i,f,r}))) / (\sum_i FD_{i,f,r})$	
(8)	$YH_R = \sum_{f,r} HHFS_{R,f,r} \cdot NFY_{f,r} + HHT_R$	
(9)	$CD_{i,r} \cdot P_{i,r} = CLES_{R=r,i,r} \cdot (RSAV_R + ((1 - MPS_R) \cdot (1 - HTAX_R) \cdot YH_R))$	
(10)	$P_{i,r} \cdot X_{i,r} = PD_{i,r} \cdot XXD_{i,r} + PXM_{i,r} \cdot XM_{i,r}$	
(11)	$PXM_{i,r} \cdot XM_{i,r} = PM_{i,r} \cdot M_{i,r} + PXHM_{i,r} \cdot XHM_{i,r}$	
(12)	$PX_{i,r} \cdot XD_{i,r} = PD_{i,r} \cdot XXD_{i,r} + PXE_{i,r} \cdot XE_{i,r}$	
(13)	$PXE_{i,r} \cdot XE_{i,r} = PE_{i,r} \cdot E_{i,r} + PXHE_{i,r} \cdot XHE_{i,r}$	
(14)	$XM / XXD = \left[PD / PXM \cdot \delta 1 / (1 - \delta 1)\right]^{\sigma 1}$	sector, region subscript dropped
(15)	$M / XHM = \left[PXHM / PM \cdot \delta 2 / (1 - \delta 2)\right]^{\sigma 2}$	from all variables and parameters
(16)	$X = AC1 \cdot \left[\delta 1 \cdot XM^{-\rho 1} + (1 - \delta 1) \cdot XXD^{-\rho 1}\right]^{-1/\rho 1}$	for readability
(17)	$XM = AC2 \cdot \left[\delta 2 \cdot XM^{-\rho 2} + (1 - \delta 2) \cdot XXD^{-\rho 2}\right]^{-1/\rho 2}$	for readability
(18)	$XE / XXD = (PXE / PD \cdot (1 - \gamma 1) / \gamma 1)^{\gamma 1}$	for readability
(19)	$E / XHE = (PE / PXHE \cdot (1 - \gamma 2) / \gamma 2)^{\gamma 2}$	for readability
(20)	$X_{i,r} = INT_{i,r} + CD_{i,r} + GD_{i,r} + I_{i,r} + DST_{i,r}$	
(21)	$RSAV_{R=r} = \sum_i PXHE_{i,r} \cdot XHE_{i,r} - \sum_i PXHM_{i,r} \cdot XHM_{i,r}$	
(22)	$SAVINGS = HHSAV + DEPRECIA + ENTSAV + GOVSAV + FSAV \cdot EXR$	
(23)	$INVEST = SAVINGS$	
(24)	$GOVSAV = GOVREV - GDTOT - \sum_R HHT_R - (\sum_{i,r} PIE_{i,r} \cdot XD_{i,r} + GENT_{i,r}) - FBOR \cdot EXR$	
(25)	$GD_{i,r} \cdot P_{i,r} = GLES_{i,r} \cdot GDTOT$	

nal value-added and induce increased production. Production technology in each sector and each region is specified in two parts, one for the value added by primary factors and the other for intermediate inputs. A simple Cobb-

Douglas form chosen for primary factors labor, capital, and land in agriculture and primary/extractives (Equation 1A, Table 1). A Constant Elasticity of Substitution (CES) form is used for all other sectors (Equation 1B). The scale parameter is greater than 1 in agricultural processing, manufacturing, and business service sectors. The notation key is in Appendix 2. Intermediate goods are required in fixed proportions per unit output, Equation (2).

The levels of primary factor employment are determined according to the first-order conditions for a profit maximum in each sector and region, (Equations 3A, 3B). The condition of zero economic profits prevails in the presence of increasing returns to scale as long as there is free entry, which is assumed here. Value-added per unit is given by the (wholesale) market price net of indirect business taxes, the cost of intermediates, and gross of any subsidies; Equation (4).

An output subsidy will raise value-added and induce increased employment of primary factors, intermediate good use, and increase that sector's output and factor income from production. If the subsidy is removed, factors will either relocate to sectors stimulated by the change in the spending pattern, or, if no sectors are stimulated – lie idle (unemployed).

Factor market segmentation and regional income determination is modeled as follows. First, each regional factor market includes labor, land, and capital supplied by local and other region households, Equation (5). The short run assumption is that commuting patterns are given. Local and commuter labor is mobile among sectors within a region, but not mobile between regions. In this way, regional labor markets are insulated from each other; which means average wages may differ between regions. Following recently popular macroeconomic model assumptions, wages are assumed set by contracts (sticky on the downside) in the short run. Employment is demand-determined. Local labor supply is perfectly elastic at the wage, up to 108% of the benchmark level of employment. After that it is perfectly inelastic. If labor demand exceeds 108%, wages rise to clear the labor market. If it falls short of 100% of the benchmark level, *additional* unemployment occurs at prevailing wage rates. The model estimates the extent of unemployment relative to the benchmark that may arise regionally from a given policy change.

Capital and crop land are modeled as sector and region-specific. The cost of sector-and region-specific capital is determined according to the regional/ sectoral composition of capital. In the short run, the capital purchased through investment is not productive within the period. Land supply is fixed in the short run and specific to the agricultural sector. A concomitant of farm subsidies are the land set-aside requirements. They are modeled as shifting land supply back by the percentage actually out of program crop production, and when subsidies are terminated the set-aside land is brought back into production.

Factor income by sector and region can vary from the economy-wide average because of efficiency wage practices[2], sectoral or regional constraints to factor mobility, and other reasons that are exogenous to the policy regime, Equation (6). Net factor income is distributed to households per unit factor supplied, after deducting enterprise saving and depreciation, paying land, labor, and capital factor taxes, Equation (7).

Household income is the sum of net factor income to each factor supplied in each region they are employed, plus any transfers from the government, Equation (8). The government can directly raise a household's income by either subsidizing the sector/region in which the household's labor, capital or land is employed; or by increasing transfers. The initial regional distribution of gains from farm subsidies will depend both on which method is used and on the regional pattern of factor ownership. Output subsidies provided to agriculture will accrue to owners of land and farm capital. Given the sticky wages, farm labor will continue to earn labor's opportunity cost in other sectors in the rural region. To the extent that farm land and capital is not owned exclusively by rural residents, coupled farm subsidies will immediately *leak out* of the rural region. A secondary drain of farm subsidy income out of the rural economy is through urban household ownership of claims on rural non-farm capital-related income steams; for example, dividend income from Wal-Mart that flows to metropolitan residents.

Households pay taxes, save, and provide (or receive) trade credit to households in other regions. With the remaining disposable income they

2 The *efficiency wage hypothesis* is that industries may find it optimal to pay higher wages (with threat of firing) to elicit productivity rather than to pay monitoring costs; ⟨Krueger and Summers [1988]⟩.

purchase commodities according to the observed budget shares. Individual household demands in each region are summed to give the demand for consumer goods in each regions's commodity market, Equation (9). Since consumer demand is a linear function of disposable income, one effect of a reduction in farm subsidies will be lower rural household income and lower rural final demand. This is potentially one of the most important links between farm support programs and the non-farm rural economy.

Supplies in each regions's market are locally produced or imported from nonlocal sources, Equation (10); where nonlocal goods are crosshauled in from the other domestic regions or the rest of the world, Equation (11). By the same token, local output is either sold within the region or to nonlocal markets, Equation (12); where nonlocal sales are crosshauled out, or exported to the rest of the world, Equation (13).

Preferences over the goods from different regions are given by Constant Elasticity of Substitution (CES) functions at each level. The composition of each mix is determined to satisfy the first-order conditions for expenditure minimization. The mix of local and nonlocal goods will vary with relative prices, Equation (14).[3] Likewise, the mix of imports and other domestic goods will vary with relative prices, Equation (15). The total quantity of final demand at each level is thus a CES aggregate, Equations (16) and (17).

Similarly, Constant Elasticity of Transformation (CET) functions represent the production possibility frontier between outputs destined for different markets and the optimal mix is determined at each level with respect to relative prices. At the regional level the choice is between production for local or nonlocal markets, Equation (18); and then they choose between other domestic markets and foreign exports, Equation (19).

Aggregated demand in each regional market is the sum of intermediate demand, consumer demand, investment demand, government demand, and inventory/stocks, Equation (20). The regional market prices are determined to clear each regional market.

Unlike for trading countries, there is no nominal exchange rate which

3 The portion of local demand met by locally produced supply is known as the *regional* or *local purchases coefficient*. No primary data on regional purchase coefficients is available at the country level.

adjusts relative nominal prices to balance payments between *subnational* trading regions. If there is a current account imbalance in a region there must also be an offsetting capital account imbalance. An inflow of savings from another region allows a region to consume in excess of local production. In the rural-urban CGE model this flow is determined endogenously to balance interregional payments, Equation (21). It is called *trade credit* because it finances current consumption (not investment) and is not modeled as flowing through the loanable funds markets.

All other nominal flows are modeled in three accounts. One pools household, enterprise, government, and foreign savings to finance investment, Equation (22). The savings-investment identity, Equation (23) is chosen to be the *n*th market in the simultaneous equation system and it remains implicit. When it clears in the solution of the rural-urban CGE model, we are assured that all transactions in the $4 trillion dollar economy have been correctly and completely accounted for and there are no leakages. This is not a trivial issue: the subsidy experiment changes nominal flows by 0.2% of GDP. Results could be completely spurious if the model did not satisfy Walras' Law.

The second nominal flow account is the combined state and federal government account. Farm program expenditures reduce the level of government savings (or raise the deficit), Equation (24). If program expenditures were terminated, the deficit would fall, and more savings would be available for investment. Government demand for commodities is expressed as fixed budget shares, Equation (25). An exception is program crop and dairy commodity demand. Only the portion required for food programs is considered exogenous. When farm programs are terminated, the government *demand* for stocks under the farm programs drops to zero, and further budgetary savings are achieved.

The third nominal flow account balances international payments by requiring the current and capital accounts to equate at the exchange rate. In the short run, the nominal exchange rate adjusts. In the longer run, the trade balance adjusts. Foreign savings are the net inflow of capital required to balance payments for our net excess demand for traded goods. Since our problem concerns the short-run, in the experiments the exchange rate adjusts with respect to changes in USA/rest-of-the-world prices; while the trade balance does not change.

III. The Simulation Results

This section presents the results of using the rural-urban CGE model to simulate the regional adjustment to unilateral agricultural liberalization. USA's farm program subsidies are modeled as specific ($ per unit) output subsidies equal to the 1986 average deficiency payment plus loan forfeit benefit per unit rural program crop output. Stocking under the loan program adds to overall demand facing producers. Acreage set-asides required of participants are modeled as a reduction in program crop land supply equal to the observed 12% taken out of production in 1986. Liberalization entails relaxing the set-aside constraints on land supply, terminating nonrecourse loan and dairy stocking, and reducing the specific subsidy payments to zero.

The interregional CGE model and the implications discussed here are relevant for the analysis of the short run effects of any policy targeting a region or a region-specific sector. The short run is defined as the time within which intermediate good use and labor are variable costs of production, labor defined as the time within intermediate good use and labor are variable costs of production, labor is only mobile between sectors, not regions (given preexisting commuting patterns). Wages are set by contract, capital and land are fixed, government expenditures forgone are saved and used for investment, and the exchange rate adjusts but the balance of trade does not.

Two sets of assumptions are varied to show the sensitivity of the results to segmentation versus integration and economies of scale. The more segmented are goods markets, the lower the substitutability in demand and in supply; *i.e.*, the higher the price differential would have to be to increase crosshauling. To simulate this, substitution parameters between local and nonlocal versions of the *same* goods in demand are ranged from *low* ($\sigma = 0.25$) to *high* ($\sigma = 4.0$); Appendix 2. Economies of scale are varied from constant to increasing returns to scale by varying the elasticity of scale parameter (ε) from 1 to 1.05 (See Blackley).

These two sets of polar cases give rise to four models called *Segmented/CRS*, *Integrated/CRS*, and *Integrated/IRS*. Each variant gives an identical benchmark solution, but the economies they represent will adjust differently to any given policy change. Each model is used to simulate the adjustment to terminating coupled and decoupled subsidies equal to less than one third of 1986 rural farm value-added, about $10 billion. The results from the Segmented/IRS version are not reported to conserve space: the effect of scale economies is qualitatively the same under integrated market assumptions.

The main results are shown in Table 2. The overall gains from liberalization increase with integration as well as with economies of scale. Metro areas always gain, and nonmetro areas lose, but the nonmetro losses are mitigated by integration. Liberalization reduces nominal rural value-added by $8-10 billion. Real rural product falls by as much as $2 billion, or not at

Table 2
Effects of Agricultural Liberalization

Model Variant	Metro	Non-Metro	National
Change in Real Product ($82 Bil.)			
Segmented	9.11	–2.10	7.01
Integrated CRS	11.14	–0.31	10.83
IRS	12.28	–0.14	12.14
Change in Nominal Value Added (Bil. $)			
Segmented	15.72	–8.60	7.01
Integrated CRS	21.07	–10.24	10.83
IRS	22.14	–10.00	12.14
Change in Employment (10,000 FTE's)			
Segmented	40.07	–24.27	15.80
Integrated CRS	53.73	–24.92	28.81
IRS	56.25	–24.05	32.20
Change in Household Income (%)			
Segmented	0.47	–0.89	
Integrated CRS	0.36	–0.05	
IRS	0.39	0.03	
Change in Consumer Surplus (Bil $)			
Segmented	–14.51	7.54	
Integrated CRS	–6.12	0.44	
IRS	–6.11	–0.50	

all. The difference between real and nominal is due entirely to the fall in prices in rural areas. Liberalization reduces the rural price level about 3.67% (not shown). Rural employment falls by about 240,000 full-time equivalents. Urban employment rises by 400-560,000 FTE's. Overall (nationwide) the gains range from $7-12 billion. The gains arise from a more efficient reallocation of labor out of farming and into investment-goods producing industries, and, higher employment rates.

Metro households experience income increases of less than 1% under all assumptions with liberalization. And nonmetro households lose from liberalization if markets are segmented. Integration appears to mitigate the negative impacts of agricultural liberalization on rural household income. Consumer surplus, however, falls for metro households because food costs rise. It rises for nonmetro households because service costs fall.

Under the *Integrated/IRS* assumptions, rural real output hardly changes even though employment declines. This is an outward sign of the *composition effect* on real GDP as labor moves from sectors where real value-added per worker is relatively low to where it is relatively high. Real value-added per worker is measured in 1982 prices *net* of production subsidies. Real value-added per FTE in agriculture is relatively low. Returns per worker are nominal and include subsidies. Labor moves to equate nominal returns, given distortions. The termination of farm subsidies stimulates labor movements out of farming. Real gains are achieved, however, if the displaced farm labor moves to sectors where real value-added per worker is higher. This is what happens in this scenario. When rural goods can be sold in urban markets, rural non-farm employment opportunities provide gains to offset the losses.

The man on the street in your quintessential rural town will tell you that the whole town could go under if farm subsidies were terminated. He's thinking about the layoffs at the gas stations or grocery stores following the reduction in disposable income. His fears would be justified if markets were segmented. Agricultural liberalization leads to almost as many layoffs from non-farm sectors than farming. Table 3 lists changes in employment by sector under segmented versus integrated markets. Over 104,500 are laid off from the service sectors, compared to 126,600 released from agriculture. If markets were integrated, however, almost all of the rural layoffs are confined to agriculture (–234,200 FTE's) and industries linked to agriculture

Table 3

Sector Results of Liberalization: Employment and Output Changes

Sector	Metro		Nonmetro	
	Segmented	Integrated	Segmented	Integrated
	Employment Change (10,000 FTE's)			
Agriculture	-0.19	1.26	-12.66	-23.42
Primary	0.95	1.23	0.55	0.62
Ag-Linked	-0.27	0.41	-3.00	-3.33
Manufactures	8.62	13.56	1.26	1.66
HH Services	7.99	6.66	-7.26	-2.12
Business Service	22.98	33.12	-3.19	2.55
	Output change (%)			
Agriculture	-0.13	1.26	-3.18	-5.61
Primary	0.36	0.44	0.46	0.49
Ag-Linked	-0.27	0.41	-1.20	-1.33
Manufactures	0.54	0.64	0.64	0.83
HH Services	0.27	0.23	-1.15	-0.34
Business Service	0.36	0.51	-0.20	0.16

(-30,000). Rural business service sector employment could actually expand. This is a consequence of both the demand-pull for investment goods and the scale economies that can be achieved in that sector.

IV. Conclusions

This paper applies a computable general equilibrium model to demonstrate that the gains from agricultural liberalization increase with integration and economies of scale. More than half (60%) of the gains from liberalization can be attributed to increased efficiency in resource allocation and spending. The subsidies raised the value of agricultural production over the market value, when saved these funds are modeled as reducing the government deficit, and thus reduce crowding-out of domestic investment. Resources drawn into investment goods-producing sectors produce a higher real value of goods, but at the expense of higher costs of food, which slightly reduces consumer surplus. An additional 40% of the overall gains from liberalization and can be achieved if goods markets can be integrated (30%) and scale economies can be captured (10%).

We have also shown that the gains will not be enjoyed equally by both metropolitan regions and nonmetropolitan regions. Since agricultural production is more significant in the economic base of nonmetropolitan (rural) areas, in the worst case of segmented markets, rural areas will lose in the short run. In the short run when markets are segmented, the liberalization of agriculture causes farm layoffs and hurts rural ag-linked industries, household services, and business services. The interregional model simulations indicate that rural real gross product *declines* as much as 2.10 billion; while urban real gross product increases $9.11 billion. The ag-linked sectors suffer from increasing costs, falling prices, and declining demand. The service sectors suffer because of reduced regional income and spending. The other traditional rural sectors: primary-extractives and manufacturing expand when farm subsidies are terminated. The implication is that it is possible for all regions to gain from agricultural liberalization if rural areas are compensated. The compensation required, however, may be significantly lower than the billions spent on farm subsidies. If markets are not segmented, liberalization imposes little hardship on the rural economy, and allows for significant urban gains of up to $12.28 (Bil. 82$).

Appendix 1
Industry Composition of Sectors

Sector Rural/Urban Model	BEA Commodity Number (85 Table)	Includes:
Agriculture	1-2	Livestock, Dairy, Field and Orchard Crops
Primary	3-10, 31 37-38	Forestry, Fisheries, Mining, Quarrying, Refining, Primary Metal and Steel
Linkag	14-15, 33 27, 44	Food and Feed Processing, Fertilizer, Pesticides, Farm and Garden Machinery
Manufacturing	16-64 nec, 80, 81, 13	Nondurable and Durable Goods

(Continued)

Business Services	11-12, 65-67, 69-73, 78	Non-farm Construction, Trade, Finance, Insurance, Transport, Federal Gov't
Household Service	68, 74-77 79	Utilities, Eating & Drinking Places, Health, Education, Amusements, Gov't

Note: The six sector aggregation was made relative to the 537 industry/commodity level BEA data. The input-output data was provided by IMPLAN, U.S. Forest Service; and aggregated by Kenneth Hanson at the USDA/ERS.

Appendix 2
Rural-Urban CGE Model Notation Key

Indices:

i or j = sectors:	*AG* agriculture
	PRIMARY primary/extractives
	LINKAG up and downstream linked to agriculture
	MNFCTR manufacturing
	HHSERV household services
	BUSERV business services
f = factors:	L labor (full-time equivalents)
	K capital (1982 bil. $ units)
	T cropland (mil. acres)
r or R = regions;	urban (metropolitan USA)
	rural (non-metropolitan USA)

Major Variables:

Market-clearing quantity		*Market-clearing price*
$FD_{i,f,r}$	Factor employment	$W_{f,r} \cdot \omega^{fir}$
$X_{i,r}$	Composite good supply	$P_{i,r}$
$XHE_{i,r}$	Regional exports	$PXHE_{i,r}$
$XHM_{i,r}$	Regional imports	$PXHM_{i,r}$
$E_{i,r}$	Exports to ROW	$PE_{i,r}$ domestic; PWE_i world
$M_{i,r}$	Imports from ROW	$PM_{i,r}$ regional; PWM_i world
Supplies		*Supply Price*
$XD_{i,r}$	Output supply by region	$PX_{i,r}$
$XXD_{i,r}$	Within-region supply used locally	$PD_{i,r}$
$XE_{i,r}$	Supply to nonlocal markets	$PXE_{i,r}$

Demands		*Demand Price*
$XM_{i,r}$	Demand from nonlocal marktes	$PXM_{i,r}$
$CD_{i,r}$	Final demand by private consumers	$(P_{i,r})$
$DK_{i,r}$	Fixed investment final demand	$PK_{i,r}$
$DST_{i,r}$	Inventory investment by sector	$(P_{i,r})$
$GD_{i,r}$	Government consumption	$(P_{i,r})$
$ID_{i,r}$	Final demand for investment goods	$(P_{i,r})$
$INT_{i,r}$	Intermediate input demands	$(P_{i,r})$

Income/Revenue & Current Expenditure

$FYS_{i,f,r}$	Gross factor income by sector and region of employment
GDTOT	Aggregate real government consumption total
GOVREV	Total government revenue
INDTAX	Indirect tax revenue
REMIT	Net remittances in
SSTAX	Social security revenue
TARIFF	Tariff revenue
TOTHHTAX	Household tax revenue
YH_R	Household income

Savings/Investment		*Rates (exogenous)*
DEPRECIA	Total depreciation charges	$DEPR_{i,r}$
ENTSAV	Enterprise savings	$ESR_{i,r}$
ENTTAX	Enterprise tax revenue	$ETR_{i,r}$
FBOR	Net foreign borrowing	exogenous level
FXDINV	Fixed capital investment	*ENDOGENOUS* sum
FSAV	Foreign saving	exogenous (*EXR* floats)
GOVSAV	Total government savings	*ENDOGENOUS* sum
HHSAV	Total household savings	MPS_R
INVEST	Aggregate investment	*ENDOGENOUS* sum
SAVINGS	Aggregate savings	*ENDOGENOUS* sum

Policy instruments		*Status in Experiments*
HHT_R	Government transfers to households	*ENDOGENOUS* for *Decoupled* only
$HTAX_R$	Household income tax rate	exogenous
$ITAX_{i,r}$	Indirect business tax rate	exogenous
$GENT_{i,r}$	Transfers to enterprises	exogenous
$PIE_{i,r}$	Farm program specific subsidy	exogenous
TE_i	*Ad valorem* export subsidy rate	exogenous
TM_i	*Ad valorem* tariff rate	exogenous

Miscellaneous variables		*Status in Experiments*
EXR	Exchange rate	*ENDOGENOUS* given *FSAV*
$HHFS_{R,f,r}$	Factor supplies	exogenous
$PINDEX$	Price index	exogenous
$PVA_{i,r}$	Value added per unit output	*ENDOGENOUS*
$RGNP$	Real gross national product	*ENDOGENOUS*
ω^{fir}	Sector/region to average factor return	exogenous

Behavioral Parameters

α^{fir}	Factor share parameter
$A_{i,r}$	Production function shift term
$AT1, AT2_{i,r}$	CET supply shift terms; levels 1, 2
$AC1, AC2_{i,r}$	CES demand shift terms; levels 1, 2
$CLES_{R,i,r}$	Expenditure share of household disposable income
$GLES_{i,r}$	Expenditure share of total nominal government spending
$\delta 1, \delta 2_{i,r}$	Nonlocal shares in CES demand
$\varepsilon_{i,r}$	Elasticity of scale parameter in CES production function
$\gamma 1, \gamma 2_{i,r}$	Export shares in CET supply
$IO_{i,j}$	Input-output coefficients
$\tau 1, \tau 2_{i,r}$	Export-local transformation substitutability
$\eta 1, \eta 2_{i,r}$	CET exponents = $1/\tau + 1$
$\sigma_{i,r}$	CES production function substitution parameter
$\sigma 1, \sigma 2_{i,r}$	Import-local substitutability
$\rho 1, \rho 2_{i,r}$	CES exponents = $1/\sigma - 1$
$IMAT_{i,j}$	Capital composition coefficients

	Substitutability in demand/supply		Elasticity of Scale				
	segmented	integrated	Constant	Increasing			
sector	σ		ε		*CLES*	$GLES_U$	$GLES_R$
AG	0.25	4.0	1.0	1.0	0.79	**	1.2
PRIMARY	0.25	4.0	1.0	1.0	2.33	1.5	0.5
LINKAG	0.25	4.0	1.0	1.05	6.24	0.8	0.3
MNFCTR	0.25	4.0	1.0	1.05	15.36	13.4	4.1
HHSERV	0.25	4.0	1.0	1.0	35.01	4.6	1.4
BUSERV	0.25	4.0	1.0	1.05	40.27	55.3	17.2

Note: (**) means very close to zero. $CLES_i$ is same for both region households, and sums to 100%. $\sum_i \sum_r GLES_{i,r} = 100\%$.

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