Do Nonagricultural Distortions Justify the Protection of US Agriculture?

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Abstract: Optimal agricultural distortions are calculated, taking as given distortions in the nonagricultural sector. The calculations use a general equilibrium model and assume that the sole criterion is economic efficiency. For most agricultural commodities, existing distortions should be decreased; for cotton and oil-bearing crops, the existing tariff should be increased. Under these optimal distortions, the USA would become an importer of dairy products, poultry, and eggs. Imports of meat, fruit, and vegetables would increase, as would exports of feed grains. The USA would become a major exporter of food and beverage products.

Introduction

Empirical evidence is used to determine whether distortions in the nonagricultural sector of the US economy justify, on efficiency criteria, the current level of distortions in the agricultural sector. Estimates of optimal distortions for the US agricultural sector are provided under the assumption that distortions in other sectors of the economy are fixed. This is a standard problem of choosing second-best policies (the first best being to remove all distortions). In a simple two-good model, the distortion in one sector can be chosen to offset exactly the fixed distortion, so that the economy faces world relative prices. This makes it tempting to compare aggregate distortions in the US manufacturing and agricultural sectors and to argue that, if the former were fixed, economic efficiency would be improved by setting the aggregate agricultural distortions at the same level. This would maintain the domestic relative aggregate price of agricultural to industrial goods at the same level as the world relative aggregate price. This proposal ignores the general equilibrium linkages within and between sectors and can be expected to yield poor results.

A general equilibrium model, which disaggregates the agricultural and manufacturing sectors, is used to calculate optimal distortions within the former, taking as given the distortions within the latter.

The producer distortions (hereafter referred to as tariffs) are defined as the difference between the producer price (adjusted for transport costs and subsidies) and the shadow price of a commodity in *ad valorem* form. Although policy makers should clearly prefer altering both agricultural and nonagricultural tariffs simultaneously, this seldom occurs in practice. A notable example was the 1985 Farm Bill. The debate surrounding this Bill concerned how to modify agricultural policy independently of manufacturing policy. Many reasons exist as to why actual policy choices may not approximate optimal (i.e., economically efficient) decisions, but the extent and direction of the discrepancy are worth understanding. This understanding may provide surprising evidence for or against certain policies.

The current GATT discussions illustrate another potential use of the calculations performed here. The USA is especially interested in reducing international distortions in agricultural trade. Estimating the effects of particular compromises and measuring how changes in one sector make other compromises more or less palatable are, therefore, important. For example, the empirical results indicate that a reduction in the protection of the textile sector has a dramatic effect on the optimal distortion for raw cotton.

The use of computable general equilibrium models provides the most sophisticated method of determining these effects. An alternative developed by Dixit and Newbery (1985) is used in this paper. The advantages of this latter method are its simplicity and more modest demand on data. These features permit one to develop the empirical model quickly and perform relatively transparent sensitivity analysis. Dixit and Newbery (1985), Dixit and Norman (1980), and Dixit (1985) show that the optimum tariff on the sector in which the policy maker intervenes is a weighted average of the existing tariffs in the other sectors of the economy. In the present study, agriculture is disaggregated into seven sectors, and the methodology is extended to determine the vector of optimum tariffs.

Because most of the input-output and final demand data were available for 1982, it was used as a reference year. The existing market distortions have been estimated for the same year. The results suggest that lower tariffs should be applied to the dairy, cattle, pig, sugar, tobacco, and fruits and vegetables sectors. More protection (a higher tariff) should be given to oil-bearing crops and cotton. Optimum tariffs for the food and feed grains sectors are close to zero, exposing those two sectors to international competition.

Model

A Ricardo-Viner-Leontief model and duality theory constitute the core of the methodology. World prices are initially taken to be exogenous, but this assumption is relaxed later. No formal consideration is made of retaliation by US trading partners to changes in US policy. Costs of adjustment are ignored.

Demand is represented by a single consumer having a Cobb-Douglas utility function, u, with an associated expenditure function, e. This assumption is not restrictive since efficiency and not distributional questions is of concern here. Government revenues can be redistributed in a nondistortionary way through lump-sum transfers. Production is characterized by a revenue function, r. The production functions exhibit constant returns to scale, with labour being the only mobile factor, and capital sector specific. The model has m traded goods and l nontraded ones. Domestically produced and foreign-traded goods are assumed to be perfect substitutes. The accounting identity for this economy is given by:

$$(1)\ e(p+t+c,\ q+b,\ u) = r(p+t,\ q) + (t+c)e_p + be_q - tr_p - pg - qg^n,$$

where p is a vector of world prices; t is a vector of tariffs; q is a vector of producer prices for nontraded goods; c and b are vectors of consumer taxes applied on traded and nontraded goods, respectively; e_p and e_q are gradients of the expenditure function with respect to p and q; r_p is a gradient of the revenue function with respect to p; and g and g^n are vectors of government consumption of traded and nontraded goods. The vector of excess supply of nontraded goods must be equal to zero at equilibrium. Differentiating *(1)* and the equilibrium condition of the nontraded goods, holding b, g, g^n constant, yields:

$$(2)\ B\ du = [(t+c)E_{pp} + (b+h)E_{qp} - tR_{pp} - hR_{qp}]dt' + [(t+c)E_{pp} + (b+h)E_{qp}]dc',$$

where B is a positive scalar; h is a vector of the differences between the producer price and shadow price for nontraded goods; E_{pp} is a Hessian submatrix of the expenditure function corresponding to the traded goods ($d^2e/dpdp'$); and E_{qp} is a Hessian submatrix for the cross derivatives of e with respect to q and p. Similarly, R_{pp} and R_{qp} are Hessian submatrices of the revenue function ($d^2r/dpdp'$ and $d^2r/dqdp'$). Assume the policy maker can change taxes and tariffs in the first n traded sectors, holding taxes and tariffs constant in the other sectors. Define t^* and c^* as the vectors of optimum tariffs and taxes that will maximize utility; i.e., $t = [t^*: t(-n)]$ and $c = [c^*: c(-n)]$, where $t(-n)$ and $c(-n)$ give the last $m - n$ elements of t and c, respectively. The optimum t^* is:

$$(3)\ t^* = -[t(-n)R_{mn} + hR_{qn}]R_{nn}^{-1},$$

where R_{mn} is $d^2r/dp_w dp_j$ for, $w = n + 1, ..., m$ and $j = 1, ..., n$; R_{qn} is $d^2r/dq_k dp_j$, for $k = 1, ..., l$ and $j = 1, ..., n$; and R_{nn} is a square matrix $d^2r/dp_i dp_j$ for i and $j = 1, ..., n$. Equation *(3)* expresses the optimum tariffs as a weighted average of the existing distortions, $t(-m)$ and h, in the remaining sectors. The vector c^* is:

$$(4)\ c^* = -t^*\ \{[c(-n) + t(-n)]E_{mn} + (b+h)E_{qn}\}/E_{nn}^{-1},$$

where E_{mn}, E_{qn}, and E_{nn} are the counterparts of R_{mn}, R_{qn}, and R_{nn} for the expenditure function. According to *(4)*, the optimum consumer tax should be the negative of the optimum tariff minus a correction term accounting for the distortions in the other sectors. The values of t^* and c^* are computed after the Hessian matrices R and E have been estimated at a point using current data (1982). The underlying model implies that the Hessian R varies with prices. Therefore, the computed values of t^* and c^* are only approximations to the optimal level.

Data

The estimation of the Hessian matrix of the revenue function requires the knowledge of input-output and value-added data. The data set of Adelman and Robinson (1986) was used. It gives the input-output table and value-added matrix for 1982. Elasticities of substitution between labour and capital are also needed for the estimation of the Hessian R. The estimated elasticities come from Whalley *[reference not provided—eds.]*. The Hessian matrix of the expenditure function is calculated using expenditure shares and total expenditure. The 1982 final demand data of Adelman and Robinson were used. Total expenditure is the sum of private consumption and investment. The shares are the ratio of the expenditure for each sector divided by total expenditure.

The vector of consumption taxes is estimated by the vector of "total indirect business taxes" paid by each sector, which appears in the value-added data of Adelman and Robinson. Consumption taxes are expressed as percentages of the value of total output of each sector. These tax rates underestimate the true consumption tax rates because they do not include sales taxes. The effect of this underestimation is investigated in the sensitivity analysis. The tariffs for the agricultural sectors are computed using weighted averages of tariffs prevailing in the markets within each sector in *ad valorem* form. The tariff in a given market is the difference between the producer price, adjusted for transport costs and direct payments (deficiency, storage, and disaster payments), and the border price, c.i.f. for imports and f.o.b. for exports. The price data come from USDA (1983 and 1985), World Bank *[reference not provided—eds.]*, Commodity Research Bureau (1985), UN Conference on Trade and Development (1985), Duncan (1984), and Finger and Yeats (1976). The tariffs for the manufacturing sectors are based on Morici and Megna (1983); they estimated *ad valorem* equivalents of the different producer subsidies in manufacturing for 1976. Custom duties for 1982 are also available from the US International Trade Commission *[reference not provided—eds.]*. The duties and subsidies, in *ad valorem* form, are aggregated to approximate the tariffs for the manufacturing sectors.

The tariffs in the nontraded sectors are calculated following the Dixit-Norman methodology. The sector nomenclature, existing tariffs, and consumer tax rates are presented in Table 1.

Results

The computed optimum tariffs and consumer taxes for the seven agricultural sectors are shown in Table 1. The results suggest that the price support to the "dairy, poultry, and eggs" sector should be decreased from the existing level of 26.02 percent to the optimum tariff of 2.98 percent. Similarly, the tariff on the "meat and livestock" sector should be lowered to 2.77 percent.

The optimum producer price level of the food and feed grains sector is close to the prevailing level in 1982. The protection of the fifth sector (cotton and oil-bearing crops) should be increased significantly to 49 percent. The opposite conclusions are reached for the last two sectors. For the "fruits and vegetables" sector, the tariff should be reduced to 3.81 percent; the price support to the "tobacco, sugar, and other agriculture" sector should be lowered to 3.33 percent. The aggregation scheme in the Adelman and Robinson data

Table 1—Sector Nomenclature, Existing Tariffs, and Consumer Tax Rates

Sector Nomenclature	Existing Tariff	Distortions of Consumption Tax	Optimum Tariff	Distortions of Consumption Tax	Predicted Net Exports	Existing Net Exports
1. Dairy, poultry, and eggs	26.02	1.41	2.985	5.852	-13,884.46	5.755
2. Meat and livestock	35.26	2.04	2.777	6.060	-40,397.89	-471.406
3. Food grains	0.78	1.94	1.326	7.511	4,608.891	5,420.757
4. Feed grains and grass seeds	7.44	1.96	0.575	8.262	17,048.66	5,771.896
5. Cotton and oil-bearing crops	6.60	1.49	49.009	-40.173	4,520.979	6,142.924
6. Fruits, vegetables, and tree nuts	23.93	1.42	3.811	5.026	-4,563.377	-734.723
7. Tobacco, sugar, and other agriculture	54.04	2.55	3.333	5.504	-16,745.28	-2,082.531
8. Metal, coal, nonmetal, and mining	-17.27	4.88			3,413.338	3,621.865
9. Crude petroleum gas	-25.12	12.80			-48,978.60	-50,117.23
10. Construction*	4.54	1.06			0.016	0.0
11. Munitions	6.03	1.11			3,428.766	3,788.338
12. Food, beverage, and tobacco products	5.57	3.56			70,548.15	-1,631.046
13. Textiles	13.82	0.97			-6,863.791	-566.050
14. Apparel	32.60	0.44			-10,313.36	-10,123.76
15. Wood and wood products	2.54	1.01			13,511.29	-1,096.472
16. Paper, paper products, and publishing	2.33	1.27			-5,697.080	-501.500
17. Chemical and chemical products	6.47	1.52			6,765.098	6,064.629
18. Petroleum and petroleum products	0.45	2.65			-7,955.418	-6,623.216
19. Leather and leather products	9.77	0.49			-6,066.524	-5,938.161
20. Nonmetallic mineral products	9.13	2.00			-2,717.214	-1,348.169
21. Iron and steel	5.82	2.07			-9,785.712	-9,535.274
22. Nonferrous metals	1.20	1.71			-4,486.537	-4,494.346
23. Metal products	5.12	1.03			-1,743.050	1,943.725
24. Farm equipment and motor vehicles	3.46	1.90			-21,536.23	-19,925.71
25. Machinery	5.88	1.10			8,784.966	10,356.95
26. Computing, radio, and TV equipment	5.46	1.03			-2,616.547	-515.754
27. Electrical machinery	5.09	0.69			1,975.568	2,866.238
28. Aircraft and other transport	3.69	0.72			9,781.806	11,271.73
29. Transport and communication*	6.83	4.26			0.0	0.0
30. Electricity, gas, and water*	2.99	4.00			0.004	0.0
31. Wholesale and retail trade	0.00	15.73			16,834.97	2,680.16
32. Banking and insurance*	4.72	3.50			0.0	0.0
33. Real estate*	-10.32	19.06			0.0	0.0
34. Hotel, personal services, and eating	4.38	3.69			0.0	0.0
35. Business services	0.00	0.77			3,113.490	6,427.182
36. Health, education, and social services	4.66	0.24			0.0	0.0
37. Federal, state, and local enterprises	5.57	0.00			0.004	0.0
38. Other industry	6.80	1.52			-10,255.17	-8,341.947

*The distortions for the nontraded sectors are computed with the optimum tariffs and consumption taxes.

does not allow one to determine the optimum protection on a commodity base. No obvious rule exists to translate the optimum tariff of a subsector into a set of optimum tariffs for each commodity within that subsector. The only rigorous way to proceed would be to use a disaggregated data set commodity by commodity.

The findings are quite robust to sensitivity analysis. This analysis is centred on the elasticities of substitution, existing consumer tax rates, and small-country assumption.

The influence of the elasticity of substitution on the value of the Hessian R is analytically ambiguous. A series of scenarios is considered within two extreme cases, with all elasticities of substitution equal to 0.05 and 5, respectively. The magnitude of the optimum tariff does not vary substantially except for the fifth sector, for which the optimum tariff drops from 49 percent to 34 percent in the case of very low elasticities (0.05).

The second part of the sensitivity analysis concerns the underestimation of the consumer tax rates. The estimates do not include sales taxes and are biased downwards. The tax rates of Table 1 are scaled up by 20 and 50 percent to determine the impact of their probable underestimation. The optimum consumption taxes are increased by approximately one cent per dollar (20-percent case) and three cents per dollar (50-percent case). The optimum tariffs are almost invariant to the changes in the consumer tax rates.

The small-country assumption is relaxed for three of the agricultural sectors (food, feed grains, and cotton and oil-bearing crops). Dixit's methodology, modified to take into account the nontraded sectors, is used to endogenize prices for these commodities. Several cases are considered. For each scenario, cross-price elasticities are set to zero and all commodities have the same own-price elasticity. Tariffs decrease significantly and become negative as the world demands for the three sectors become less elastic; i.e., exercising market power by means of an export tax becomes optimal. In the extreme case of unit elasticity of world demand, the tariffs on food and feed grains and cotton and oil-bearing crops are -98 percent, -99 percent, and -51 percent, respectively. Gardiner and Dixit (1986) survey the existing estimates of world demand elasticities for US agricultural exports. According to that study, no consensus exists on the real magnitude of the elasticities. One can conclude that the optimum tariffs presented in Table 1 are an upper bound for the "true" optimum tariffs for sectors 3, 4, and 5 (unless cross-price effects dominate).

The persistence of a high optimal tariff for the cotton and oil-bearing crops suggests that the high degree of protection of the textile industry determines the optimum tariff on raw cotton via the input-output coefficients. Similarly, the existing tariff on food and beverages affects the optimal tariff on oil-bearing crops. When the tariff on textiles (sector 13) is decreased by 50 percent, the optimal tariff on cotton and oil-bearing crops drops to 17 percent; conversely, when it is increased by 50 percent, the optimum tariff on cotton rises to 80 percent. The same analysis is performed for sector 12 (food and beverages). When the existing tariff on sector 12 is decreased by 50 percent, the optimum tariff on cotton and oil-bearing crops falls to 41 percent and the optimum tariff on feed grains falls to -11 percent (an export tax); i.e., a fall in the effective rate of protection of sector 12 caused by a decrease in the tariff on that sector should be partially offset by a decrease in the price of inputs. The tariffs on each of the other agricultural sectors are also decreased but to a lesser extent.

An attempt was made to determine the effects on production and trade of changing the current distortions. The Hessian matrix of the revenue function, used to calculate the optimal distortions, was used to construct own- and cross-price elasticities of supply at 1982 prices. These elasticities were used to generate constant elasticity supply curves. The revenue function implied by the model does not lead to constant elasticity supply curves, so the estimates reported here are only tentative. The predicted levels and the existing (1982) levels of net exports are presented in Table 1. The predictions indicate that, under the optimal distortions, the USA would change from being a net exporter to being a net importer of dairy, poultry, and eggs. Meat and livestock imports would increase by a factor of almost 10; exports of feed grains would increase by a factor of 3. Relatively little change would occur in exports of cotton and oil-bearing crops (despite the increased tariff in that sector), but textile imports would increase by a factor of more than 10. This reflects the fact that an increase in the protection of raw cotton decreases the effective protection of the textile industry. A sixfold increase would occur in the imports of fruits and vegetables, and an eightfold increase in tobacco and sugar imports. This would change the USA from an importer to an exporter of food, beverage, and tobacco products (sector 12). These effects are intuitive, given the changes in the distortions.

Conclusion

This study was motivated by asking whether existing (1982) distortions in the nonagricultural sectors justify the current (1982) level of distortions in the agricultural sectors. Since no theoretical basis for answering this question exists, this paper attempted to provide empirical evidence. This evidence must be interpreted cautiously because the model involves several strong assumptions. However, the extensive sensitivity analysis suggests that the results provide at least a rough guide. For four subsectors—dairy, poultry, and eggs; meat and livestock; fruit and vegetables; and tobacco and sugar—the existing distortions cannot be justified on efficiency criteria. For two subsectors—food and feed grains—the existing distortion, which is quite low, is approximately optimal.

For one subsector—cotton and oil-bearing crops—the existing distortion should be greatly increased. Both consumers and producers of these commodities should be subsidized. This result is due to the existing protection of the textile and food and beverage industries. Decreases in the tariff on these industries should be translated into a decrease in the optimal level of protection of the raw cotton sector.

The analysis uses economic efficiency as the sole criteria. The estimates of changes in production and trade induced by changes in the distortions suggest that the distributional issues may be significant. This observation is reinforced by the fact that the analysis ignores adjustment costs that increase the burden and decrease the benefits of proposed changes. Despite these qualifications, an important conclusion remains: levels of protection of the most highly protected agricultural commodities are not justified by efficiency criteria.

Note

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DISCUSSION OPENING—*John Fogarty* (University of Melbourne)

An important question has been posed in a challenging fashion and appropriate methodology employed. However, as is often the case with a highly specified model, the tight specification and qualification of results leave little to argue about. On the other hand, the rigorous methodology means that some of the most interesting issues are assumed away.

The object of the paper is to measure the optimum levels of distortions for agricultural production in a second-best situation where the existing distortions in the manufacturing sector remain intact. The conclusions, that those primary products where existing distortions are greatest (i.e., dairy, poultry, and eggs; meat and livestock; sugar; tobacco; and fruits and vegetables) should be subjected to more vigorous competition are hardly surprising. What I find most interesting are the conclusions with respect to other agricultural products such as cereals and cotton.

Estimates of the producer distortions are adjusted for subsidies and, in the case of food grains, found to be neutral. How are programmes like target prices taken into account? How, for instance, would the $2,000 million export assistance programme announced in the 1985 Farm Bill be brought into the calculations? Are we in the Southern Hemisphere mistaken in thinking that our grain is competing against subsidized US wheat in international markets?

I confess to being a little confused by the results for the cotton and oil-bearing crops. The argument is that high tariffs in textile manufacturing should be offset by increased protection for raw cotton in order to reduce the protection afforded to textiles. The model calls for a considerable rise in imports of textiles accompanied by a fall in cotton exports. Presumably raw cotton production declines as both internal and external markets are reduced, which intuitively I find difficult to reconcile with the optimum situation for a crop that suffers from low levels of distortion.

I have no difficulty with the conclusion that "levels of protection of the most highly protected agricultural commodities are not justified by efficiency criteria." I am convinced that efficiency criteria justify protection for agricultural commodities because they happen to be inputs into protected manufacturing industries.

I realize that my comments could be dismissed as lying outside the assumptions of the model. But my final question still must be, "How adequate, for practical purposes, is the second-best assumption that levels of distortions in the manufacturing sector remain intact?"

GENERAL DISCUSSION—*Thomas C. Pinckney, Rapporteur* (International Food Policy Research Institute)

The author was asked to clarify the distinction between tariff and sector-specific subsidies in term of their effects on resource shifts. Karp replied that a tariff raises both the producer and the consumer price of the product, while a sector-specific subsidy is assumed to raise the producer price but not the consumer price. In the latter case, the consumer price is assumed to move to world market levels, with the world price unaffected by domestic production levels. This small-country assumption has been relaxed in some versions of the model not reported in the paper.

One participant pointed out that every policy recommendation assumes an implicit constrained optimization model, with some of the constraints being distortions in other markets. The authors were commended for making the other trade policy distortions explicit, but many other distortions could have been added, including any misalignment of the exchange rate. Although this approach is correct methodologically, one questions whether such second-, third-, or fourth-best results should be used for policy recommendations when we economists frequently cannot even explain and interpret the first-best results.

This paper points to the danger in using PSEs *[producer subsidy equivalents]* or any other scalar representation of subsidies, since, according to the paper, the effects of production from a tariff are quite different from the effects of an equal amount of protection from a subsidy.

Participants in the discussion included D. Colman, D. Kirschke, and D. Orden.