Distribution of Domestic Policy Benefits and the Willingness to Support Trade Liberalization

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Abstract: Agricultural trade liberalization for developed countries may mean elimination of existing domestic support programmes. The difficulty of achieving freer trade is directly related to the distribution of the pain of adjustment in domestic agricultural economies. A cost function is estimated for post-World War II US agriculture to examine the functional distribution of agricultural income in a consistent way, disentangling the separate effects of technological and policy influences on factor shares. Insight is thereby gained into the probable effects of removal of government support for agriculture. The analysis implies that landowners have the most to lose from removal of domestic support programmes as a prelude to trade liberalization. Application of this framework to the experience of other nations would provide a basis for the comparison of the size of prospective domestic losses affecting a country's willingness to negotiate trade liberalizing measures.

Introduction

As general economic growth has proceeded, developed countries have allocated a smaller portion of their aggregate resources to agricultural production. Many observers, among them Schultz (1951), and, more recently, Anderson (1987) have remarked upon the decline in economic importance of the farm sector in developed countries. Both the low income elasticity of demand for food and the productivity impacts of technological advance in agriculture have relieved societies of the need to devote an increasing part of their resources to growing food.

Beyond a comparison of the status of agriculture relative to other sectors of the economy, the question arises as to how the decline in agriculture's share has been apportioned among the factors of production. The functional distribution of income within the sector is largely determined by changes in factor use, as production possibilities expand with technological advance. Technological change in developed country agriculture has generally been labour and land saving and capital and materials using (see, for example, Antle, 1984, on the USA; Lopez, 1980, on Canada; and Behrens and de Haen, 1980, on the EC). Consequently, the impact of the decline in sectoral income is felt more acutely by some factors than others.

In spite of the decline in farming, or perhaps because of it, developed country agriculture is characterized by pervasive government intervention in factor and commodity markets. Were it not that high-income countries tend to overprice agricultural products, Anderson (1987) suggests that the "measured rates of decline in agriculture's importance would be even faster" (p. 197). To what extent can the policies of developed countries to maintain returns to agriculture overcome the structural tendency towards decline? And, how does government intervention affect the distribution of income to factors of agricultural production?

These questions about the sectoral effects of government intervention have particular relevance when multilateral trade talks may, for the first time, consider agricultural trade liberalization. Success in obtaining freer trade will be conditioned by the willingness of nations to reduce or eliminate domestic support. The distribution of the pain of adjustment to removing support can be an important determinant of the kinds of concessions a nation will make in multilateral negotiations. Here, linkages among factor returns, technological advance, and government intervention in developed country agriculture are considered. An analytical framework for quantifying these relationships is described and implemented for post-World War II US agriculture. Finally, the implications of the findings for the formulation of multilateral trade negotiating positions are examined.

Technology, Policy, and Factor Shares

In discussing the consequences of the decline in the relative importance of farming, Schultz (1951) paid particular attention to the implications for the share of land in the value of production. Schultz noted that "because of technical advances, it has become economic to substitute to an increasing extent several classes of inputs for both land and labour, notably motor vehicles and fertilizer and lime" (p. 740). These technological improvements may result in a decrease in the share of land in the value of agricultural production, a reversal of the Malthusian prediction of ever increasing land rents. This possibility is known as Ricardo's paradox (Offer, 1980, p. 237). Whenever the relative importance of agriculture in the economy diminishes and other factors are substituted for land in farming, the fall of the importance of land in the aggregate and in agricultural production is accelerated.

This focus on land is appropriate, as it represents the major source of wealth in the farming community. In developed country agriculture, land and labour are supplied by the farming sector, while capital and intermediate inputs (materials such as fertilizers and pesticides) are supplied from outside its traditional boundaries. When farmers are also landowners, returns to both factors remain in production agriculture. However, to the extent that the bias in technological change is to save both land and labour, their shares in the value of production are diminished. As farming comes to rely more heavily on inputs supplied from the financial and manufacturing sectors, an increasing portion of returns flows out of agriculture.

To start, one may consider the effects of government policy intervention on factor shares, independently of the effects of technological advance. Floyd (1965) describes the implications of three stylized forms of intervention representative of developed country agricultural programmes. First, commodity prices may be supported without output controls, as in the EC. In that case, gross income will rise and so increase the demand for all factors. In the second form of intervention, prices are raised as a result of reducing production by restricting input use, usually land. This feature is characteristic of US support programmes for major grains. The third form of intervention involves controlling output directly through the issuance of marketing certificates that establish quotas. In that case, no specific directive is made as to how input use may be adjusted. The EC dairy programme most closely resembles this scheme, although it has not been widely applied in other developed country programmes. In all three cases, intervention raises the price of the factor in most inelastic supply by the greatest extent. This factor is land.

In considering the effects of alternative support policies on returns to land, recall the definition of share (i.e., input quantity multiplied by its own price divided by total costs or returns). Then, in Floyd's first case, comparable to EC policy, output price support causes the demand for land to shift outwards, increasing its price and use and so its share. To the extent that land supply is ultimately fixed, prices and the value of the share will rise even further. In the second case, more representative of US intervention, the acreage restriction shifts the supply curve for land inwards, thereby raising its price but reducing the quantity used. This sequence of events may or may not lead to an increase in land's share in the value of production. In either case, the price of land, as reflected in rents, will rise, but the direction of the change in its cost share is ambiguous in the US case.[2]

The net effect of technological advance and policy intervention on land share must be determined empirically. If Ricardo's paradox holds, then the share of land will be diminished by land-saving technological change. At the same time, if government intervention is successful in maintaining returns to resources in agriculture, then the effect of the programmes on land share would be positive. The question to be resolved is one of the relative strengths of the tendency of technological changed to diminish land share and the possibility that government support will increase or maintain it. These separate effects of technology and policy need to be disentangled to judge the impact on factor returns of removing domestic support programmes as part of trade liberalization. In the next section, a framework is proposed for evaluating these two effects simultaneously.

Empirical Analysis

The empirical analysis will focus on measurement of changes in land's share of the value of US agricultural production when support programmes restricting acreage as an input are in place. Acreage control programmes are hypothesized to have held the share of land in the value of production above the level that would prevail in their absence. In the case of the USA, total land in farms has remained fairly constant over the past three decades, implying that any change in the share is due to factor price movement. The portion of land in farms idled under government programmes varies, and these changes in programme participation affect the price of land remaining in production. As Floyd explains, the price of the factor in most inelastic supply (i.e., land) will rise when acreage restrictions are in place, and the right to receive government payments for acreage reduction may be capitalized into land values by raising expected income earnings capacity. Technological change is hypothesized to be land saving, thereby decreasing the share of land in the value of production.

These hypotheses are examined via the concept of duality that follows from a producer optimizing framework. A translog cost function and factor share equations, as suggested by Christensen and Greene (1976), are estimated using data on aggregate US agricultural production during 1948-84. The cost function is specified generally as $C = C(Y, W, T, D)$, where C represents total cost, W is a $n \times 1$ vector of input prices ($i=1, ..., n$), T represents the level of technology, and D represents a fixed factor, in this case total idled programme acres. The variable inputs are capital (K), labour (L), materials (M), and land remaining in production (A). All variables are expressed in logarithms except T and D. The system of factor demand equations were derived via the envelope theorem. Because the arguments are expressed in logarithms, the demands are expressed as cost shares, which makes the translog particularly appropriate due to the interest in how shares have changed with acreage control programmes.[3]

Land removed from the production of programme crops may be treated as a fixed factor because farmers must agree to participate in acreage control before any crops are planted. Once farmers have accepted programme requirements, decisions about input use on the remaining acreage can be made. In the aggregate, "slippage" may occur when acreage planted increases as nonparticipants attempt to take advantage of higher product markets prices that may result from output reduction as an effect of the acreage control programmes.

The variables are constructed as Divisia price indices. The capital service price is derived following Hall and Jorgenson (1967). Capital includes durable equipment, structures, and inventory. Labour includes hired and self-employed labour. Materials include all purchased inputs, such as feed, seed, breeding stock, fertilizer, agricultural services, energy, and other intermediate inputs. All data are found in US Departments of Agriculture and Commerce sources. The cost share of land is calculated as the product of the quantity of land in production net of idled acres and an implicit rental price divided by total cost. As in Hall and Jorgenson, the implicit rental price is defined to reflect the opportunity cost of capital. The quantity of output, including all crops and livestock, is represented by a Divisia quantity index. Because the value of D, the measure of acreage controlled by programmes, is zero in a few years, this variable is normalized to its 1972 value, which bounds its value between zero and slightly over one (Gollop and Karlson, 1978).

The full information maximum likelihood estimates of the model's coefficients in the system of input share equations were obtained using TROLL software. The cost share equations are expressed as:

$$(1)\quad S_i = a_i + \sum_j b_{ij} \ln w_j + b_{iy} \ln y + b_{it} T + b_{id} D.$$

The cost function is linearly homogeneous in prices, which requires:

$$(2)\ \sum_i a_i = 1, \text{ and } \sum_i \sum_j b_{ij} = \sum_i b_{iy} = \sum_i b_{id} = \sum_i b_{it} = 0.$$

Only those coefficient estimates of immediate interest are reported here.

The direct effect (factor bias) of acreage control is examined by partially differentiating each factor cost share, S_i, with respect to D; i.e., $b_{id} = \delta S_i/\delta D$. If this derivative is greater than zero, then (holding other shares, prices, and output constant) the implication is that acreage control programmes have resulted in increasing the share of input i. The effects of technological change can be evaluated by differentiating each cost share with respect to T, the linear trend term representing technological advance. When the derivative with respect to a particular input i's cost share is positive, technological change is considered ith factor using. When negative, the change has been relatively ith factor saving; if zero, change has been neutral with respect to input i. Here, $b_{it} = \delta S_i/\delta T$ denotes the factor bias associated with technological change.

Table 1—Direct Factor Biases Associated with Technological Change (b_{it}) and Acreage Control Programmes (b_{id})

	Capital	Labour	Materials	Land
b_{it}	0.045	-0.100	0.096	-0.042
	(0.002)	(0.005)	(0.014)	(0.013)
b_{id}	-0.011	-0.002	0.007	0.006
	(0.001)	(0.005)	(0.006)	(0.002)

Note: Standard errors are in parentheses.

The importance of agricultural land is expected to decrease with technological advance in farming. In Table 1, the top row shows that the sign on the change in the land cost share with respect to technological change is negative, implying a fall in the share of land, as would be expected from the notion of Ricardo's paradox. The null hypothesis, that the value of b_{At} is positive or zero at the 95-percent confidence level, is rejected. The empirical results indicate that technological change has also been labour saving and capital and material using, consistent with the findings of other researchers.

While technological change has depressed land's share, acreage control programmes might increase it. When acres are idled, the shift inwards of the supply curve of land in production will put upward pressure on the land price. In addition, the diversion of land from production has often been associated with a transfer (deficiency) payment which accrues to landowners and is capitalized into the value of land. The transfer payment could be thought of as the economic rent going to the fixed factor, the diverted acreage, thereby increasing the value of all agricultural land (Floyd, 1965).

The change in land share's with respect to these programmes has indeed been positive. The null hypothesis, that the value of b_{Ad} is negative or zero at the 95-percent confidence level, is rejected. At the same time, the programmes have apparently decreased the shares of capital and labour, while that of materials has risen. This outcome is consistent with the supposition that the use of some nonland inputs, most likely the fertilizer component of materials, may increase with acreage controls.

Comparing the technology and programme effects on land share in Table 1, the technology effect is seen to be seven times larger in absolute value than the programme effect. One can infer, therefore, that government intervention can only hope at best to slow the decline in the share of land. When policy aims include maintenance of returns to the factor as well, programme costs will only rise with time, since the deficit to be made up increases as technological advance continues to drive land's share downwards. Moreover, when the concept of parity between farm and nonfarm income is based on some notion of costs of production, programmes that increase land values only create a further need for compensation. Additional empirical evidence (not reported here) suggests that by acting to buoy the value of land, government programmes may actually enhance the land-saving bias of technological change, since factors in relatively short supply are used the most sparingly.

The cost function has been employed in a novel way to try to disentangle the separate effects of policy and technology on factor shares. The advantages of this approach are that the influences can be dealt with simultaneously and in a consistent way and that effects are traced to their ultimate implications for resource allocation. The perspective adopted is long run, so the transitory effects of limited income transfers are diminished. The disadvantages of this approach are similar to any application of duality relations to aggregate, nonmicrolevel data. At the sectoral level, the assumptions of exogenous factor and commodity prices and of fixed output level are tenuous. Furthermore, in introducing policy into the neoclassical framework, all its effect is summarized in one instrument, acreage diversion. While this approach is convenient, it may overestimate policy's effect. Nonetheless, this attempt is one of only a few to inject realism into agricultural production studies employing duality concepts.

Domestic and International Policy Implications

An important determinant of agricultural support and trade policy is not just the level of income going to the sector but its distribution among the factors of production. This distribution is particularly important in developed country agriculture where a large portion of the value of production is captured by the providers of capital and intermediate inputs who are not part of the traditional farming community. Land and labour are the factors that remain largely in the control of the farm population that is the target of much policy intervention. Because political decisions often turn on distributional issues, knowledge of the effects on factor shares may ultimately be of more interest to policy makers than gross measures of changes in producer welfare, such as producer subsidy equivalents.

Conclusion

The implications of technological change and government support on factor shares for one developed country, the USA, have been investigated. Were the data available, one could apply this approach to other developed countries' experience and thereby gain a basis for international comparison. Agricultural trade liberalization for developed countries may mean elimination of existing domestic support programmes. The difficulty of achieving freer trade is directly related to the distribution of the pain of adjustment in domestic agricultural economies. The present analysis implies that landowners have the most to lose from removal of domestic support programmes as a prelude to trade liberalization. Unless trade reform substantially increases real demand for their agricultural output, landowners of the developed countries will suffer a loss of wealth as the share of land in the value of production falls.

The cost function approach permits examination of the functional distribution of agricultural income in a consistent way, disentangling the separate effects of structural and policy influences on factor shares. Insight is thereby gained into the probable effects of removal of government support for agriculture. Application of this framework to other nations would provide similar information. Developed country policies could probably be shown to have slowed the decline in the value of the share of land, but to not have overcome the land-saving bias of technological advance. If support is removed, the farming community will experience a decline in wealth. Ultimately, the size of this prospective loss is what affects a country's willingness to negotiate trade liberalizing measures.

Notes

[1]US Office of Management and Budget; and Economic Research Service, US Department of Agriculture; respectively.

[2]A body of literature on the effects of US support programmes on land values has failed to incorporate the crucial characteristics of acreage restriction (e.g., Herdt and Cochrane, 1966; Boehlje and Griffin, 1979; and Harris, 1977). Research on the EC experience (e.g., Traill, 1979) with price supports is not susceptible to this error.

[3]The function was estimated assuming nonhomothetic and Hicksian nonneutral technologies to allow maximum flexibility in establishing the effects of the acreage control programmes. A nonhomothetic function implies nonconstant returns to scale due to the presence of a fixed factor; in this case, idled acres. Estimated bias due to these factors and compensated price elasticities are available from the authors.

References

Anderson, K. (1987) "On Why Agriculture Declines with Economic Growth," *Agricultural Economics*, Vol. 1, No. 3, pp. 195-207.

Antle, J. (1984) "Structure of U.S. Agricultural Technology, 1910-78," *American Journal of Agricultural Economics*, Vol. 66, No. 4, pp. 414-421.

Behrens, R., and de Haen, H. (1980) "Aggregate Factor Input and Productivity in Agriculture: Comparison for the EC-Member Countries, 1963-76," *European Review of Agricultural Economics*, Vol. 7, No. 2, pp. 109-146.

Boehlje, M., and Griffin, S. (1979) "Financial Impacts of Government Price Support Programs," *American Journal of Agricultural Economics*, Vol. 61, No. 2, pp. 285-296.

Christensen, L.R., and Greene, W.H. (1976) "Economies of Scale in U.S. Electric Power Generation," *Journal of Political Economy*, Vol. 84, No. 4, pp. 655-676.

Floyd, J. (1965) "Effects of Farm Price Supports on the Returns to Land and Labor in Agriculture," *Journal of Political Economy*, Vol. 73, No. 2, pp. 148-158.

Gollop, F.M., and Karlson, S.H. (1978) "Impact of Fuel Adjustment Mechanism on Economic Efficiency," *Review of Economics and Statistics*, Vol. 60, No. 4, pp. 574-584.

Hall, R.E., and Jorgenson, D. (1967) "Tax Policy and Investment Behavior," *American Economic Review*, Vol. 57, No. 3, pp. 391-414.

Harris, D.G. (1977) "Inflation-Indexed Price Supports and Land Values," *American Journal of Agricultural Economics*, Vol. 59, No. 3, pp. 489-495.

Herdt, R.W., and Cochrane, W.W. (1966) "Farmland Prices and Technological Advance," *Journal of Farm Economics*, Vol. 48, No. 2, pp. 243-264.

Lopez, R.E. (1980) "Structure of Production and the Derived Demand for Inputs in Canadian Agriculture," *American Journal of Agricultural Economics*, Vol. 62, No. 1, pp. 38-45.

Offer, A. (1980) "Ricardo's Paradox and the Movement of Rents in England, c. 1870-1910," *Economic History Review*, Vol. 33, No. 2, pp. 236-252.

Schultz, T.W. (1951) "Declining Economic Importance of Agricultural Land," *Economic Journal*, Vol. 61, No. 2, pp. 725-740.

Traill, B. (1979) "Empirical Model of the U.K. Land Market and the Impact of Price Policy on Land Values and Rents," *European Review of Agricultural Economics*, Vol. 6, No. 2, pp. 209-232.

DISCUSSION OPENING—*R.G.F. Spitze* (University of Illinois)

The authors are commended for a professional performance on an important area of economic supply analysis of agricultural production. Their study design, theoretical foundation, and demonstration of a useful technique leave little to quibble about. However, their policy efforts deserve more scrutiny.

In a developing economy, the implications for any sector with a highly inelastic demand against income, such as agriculture, are generally understood. That is, factors of production in such sectors continually face relatively slower gains in returns compared to sectors

producing less inelastic products and hence must continually adjust resources, usually involving an outmigration of human resources. Thus we have Ricardo's paradox and the dilemma of agricultural economies throughout a developing world.

This study gives us some additional corroboration, with the added bonus of an analytical technique for measuring the relative economic impacts among those agricultural factors using their comparative cost share in total production. The results generally bear out our theoretical expectations. A few, admittedly minor, questions trouble me about this part of the paper. First, we should be cautioned to speak of a decline in the *relative economic importance* of the farm sector, not just "decline in farming" or "decline in economic importance." Farming and agriculture surely remain economically important regardless of country.

Second, is it operationally logical to separate land capital from structures and durable equipment capital? Third, do we adequately understand that, in recent US policy, deficiency payments accrue to both landowners and most renters? Fourth, how useful is acreage control as a proxy for policy when programmes of both compulsory and voluntary controls over a 36-year period are lumped together, and this is only one of many varied provisions? Finally, how comfortable do we feel drawing inferences from technical results measured by differences between -0.002 and +0.007.

I am much more concerned about the authors' efforts to hook their empirical analysis to the policy area with such words as "multilateral trade talks" and distribution of domestic policy benefits." Their analysis has merit because we need reliable measurement of what happens to farm factor returns as an economy develops, not because it tells us much, if anything, about trade negotiations. Do they really ask the relevant policy question; i.e., Can policies to maintain returns overcome the structural tendency to decline? To imply that a major determinant of interventions, such as trade barriers, is the relative pain of owners of the farmland factor as contrasted to all other farm factors, much less nonfarm interests in food, is a formidable leap.

The owners of agricultural factors do suffer pain during development, and participatory governments intervene to ease that pain and smooth the necessary adjustments, as well as recognize the role of food in political and economic survival. Operators in most developed countries reap some returns from all the production factors of land, labour, management, and capital; their differentiation may be of more concern to economists than policy makers. Trade negotiation implies trade-offs among gainers and losers, among sectors, and among nations. Reliable knowledge helps negotiators. However, to recognize the limitations of economic analysis in policy is not to demean our product but to dignify it with creditability.

Additional knowledge exists about US agriculture: (1) the real total farm factor returns have generally declined for 40 years, but per-farm returns have increased slowly due to relentless outmigration of 1 to 4 percent per year, and to persistent evolving public policy; (2) these returns per operator are not significantly different between the participants and nonparticipants in our voluntary supply-demand balancing policies, and the benefits contribute to less inequality of incomes; (3) the productivity of the total farm labour factor has continuously outperformed that of the rest of the economy; (4) total federal government programme outlays as a proportion of all government costs has trended downwards; and (5) the adjustment of surplus farm labour is threatened by a slowing over three decades to a trickle of increases in off-farm incomes. This knowledge does not point directions of policy nor even of trade negotiations any more than that provided in this study, but we can respect both the value of our research to public policy, and its limitations.

[Refer to the general discussion following Krissoff and Ballenger's paper on page 72.]