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# Determinants of Farm Size and Structure

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*Robison/Introduction and Overview*

*Johnson/Farm Managerial Inquiry: Past and Present Status and Implications for the Future*

*Batte/Question and Answer Session Following Glenn Johnson's Presentation*

*Sonka/Factors We Observe on Successful Midwest Farms Today*

*Ruttan/Scale, Size, Technology and Structure: A Personal Perspective*

*Batte/Discussion Following Vernon Ruttan's Presentation*

*Hallam/Economies of Size: Theory, Measurement, and Related Issues*

*Henderson/Application of the Structure, Conduct, and Performance Paradigm to Research on the Structure of Agriculture*

*Young, May, and Shetewi/Farm Size Classifications and Economies of Size: Some Empirical Issues*

*DeFraín and Stinnett/Strong Families and Strong Farming Organizations: Is There A Connection?*

*Richardson, Smith, and Knutson/Who Benefits From Farm Programs: Size and Structure Issues?*

*Headley/The Effect of Government Policy on Farm Size and Structure*

*Tweeten/World Trade, Exchange Rates, and Comparative Advantage: Farm Size and Structure Implications*

*Carlin/Strong Communities - Strong Farms: What is the Connection?*

*Baker/Financial Stress in Agriculture: Likely Impact for Farm Structure*

# WORLD TRADE, EXCHANGE RATES, AND COMPARATIVE ADVANTAGE: FARM SIZE AND STRUCTURE IMPLICATIONS

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The topic assigned for this paper as indicated by the title is of interest in itself and as part of a broader mosaic of forces that influence farm structure. The topic must be placed in perspective because world trade, exchange rates, and comparative advantage are mainly intermediary variables through which other forces work to influence farm structure. We shall find that farm structure, defined by size, number, type, and organization of farms, is heavily if indirectly influenced by international linkages. A major objective of this paper is to lay out the conceptual framework relating changes in domestic and international agriculture to changes in farm structure.

The macroeconomics of agriculture has changed massively since T.W. Schultz published Agriculture in an Unstable Economy over four decades ago. Specifically, agriculture is much less sensitive to business cycles operating through domestic income and employment. Except for a few commodities sensitive to income, the low income elasticities of demand characterizing most farm products tend to insulate agriculture from fluctuations in domestic income. Agriculture now is much influenced through input markets and international linkages, however. Attempts to quantify linkages have frequently provided inadequate and conflicting results. In nearly all cases, we do a better job of estimating economic linkages between macroeconomic (commodity program, monetary, fiscal, and trade) policies that influence farm income and balance sheets than we do that influence farm structure. Hence, another objective of this paper will be to identify gaps in our understanding of the forces that determine farm structure.

Figure 1 shows the framework around which this entire paper is organized. It places world trade, exchange rate, and comparative advantage within an interdependent world system whereby changes in one country acting through international linkages affect changes in other countries which, in turn, reverberate back home to influence farm financial and structural conditions. Changes in U.S. farm structure then influence the preconditions for change, initiating a second round of effects. Although the presentation is treated as going in one causal direction, as indicated by the arrows in Figure 1, it must be recognized that sometimes the causal arrows could point in the opposite direction.

## Domestic Setting

The domestic setting in isolation can be conceptualized as preconditions and outcomes which in turn influence comparative and competitive advantage when exposed to world markets (Figure 1).

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Figure 1.

**Impact of Domestic Conditions in Countries Worldwide  
on U.S. Farm Structure Through International Linkages**

Domestic Setting	--->	Linkages: World Trade and Capital Flows	--->	Price, Income, Balance Sheet and Other Impacts on U.S. Agriculture	--->	U.S. Farm Structure	--->
<b>1. Preconditions</b> a. Human and natural resources b. Institutions including laws and government c. Culture and attitudes, e.g. determining propensity to save, work ethic, etc. d. Economic and other policies		<b>4. Markets and policies</b> a. Financial markets b. Product markets c. Resource markets, immigration d. Trade and other policies		<b>6. Main impacts on agriculture</b> a. Cost-price b. Cash-flow c. Real-wealth d. Instability		<b>8. Number and distribution of farms by size, type, legal organization, coordination</b>	
<b>2. Outcomes</b> a. Income and output, product prices b. Employment and factor prices c. Productivity, technology, and economies of size		<b>5. Linkage variables</b> a. Interest rates and capital flows b. Exchange rates and balance of payments c. Commodity prices and quantities d. Technology transfer		<b>7. Required to change structure</b> a. Economies of size b. Earnings of nonfarmers c. Off-farm earnings of farmers (rural development) d. Tax, credit, commodity programs, and other policies e. Agribusiness market conduct, structure, performance			
<b>3. Comparative and competitive advantage</b>							

## 1. Preconditions

Preconditions (see Tweeten, 1979; Tweeten and Brinkman, 1976) for economic progress are (1) human and natural resources, (2) institutions including laws and government, and (3) culture and attitudes including the work ethic and propensities to save and innovate. It may be argued that these preconditions determine economic and other policies listed as 1d in Figure 1. Interactions between institutions, attitudes, and policies are strong. For example, institutions determine culture and vice versa.

## 2. Outcomes

Preconditions influence economic outcomes including income, output, and product prices; and employment and factor prices. These in turn influence productivity, technology, and economies of size as noted in 2c of Figure 1. Economies of size strongly influence farm structure. Biological technology such as improved crop varieties and superior breeds of livestock along with chemical technology such as pesticides and pharmaceuticals have been somewhat scale neutral.<sup>1</sup> Exceptions are improved means of disease control which make large-scale livestock feeding operations feasible. Mechanical technologies such as the tractor and its complements have been scale biased, creating economies of size and moving agriculture towards larger and fewer farms.

Here it is important to recognize the distinction between commercial agriculture where families depend on farming for a living versus part-time farming where families derive most of their income from off-farm sources. Mechanical technologies have relentlessly driven commercial farms toward larger sizes and fewer numbers. At the same time, mechanical technologies such as the automobile and improved transportation and communications have made commuting and part-time farming more feasible. The number of part-time small farms may be expanding. Mechanical technologies have sharply skewed the distribution of farms and contributed to a dual agriculture. A few large farms account for a major part of farm output and part-time smaller operations account for most farms.

New biotechnologies could radically transform the way crops and livestock will be produced. Experts do not agree regarding the impact on farm structure. To be sure, bovine and porcine growth hormones are equally suited for small or large farms. But new technology tends to reward the early innovator and the early innovators are frequently the larger commercial farmers. The new biotechnologies and communications technologies such as the microcomputer entail substantial learning costs which are lower per unit if spread over larger size operations. It is more feasible for a large farmer than a small farmer to rent, hire, or otherwise obtain the know-how to experiment with a new technology on some part of the operation. Computers also expand the scope for controlling a large operation. Hence, emerging technologies are likely to favor larger commercial farms but are expected to have much less impact on farm structure than the tractor, milking machine, and other mechanical technologies of past decades.

### 3. Comparative and Competitive Advantage

Preconditions, including human and natural resources, institutions, culture, and policies, give rise to factor costs, technologies, and economies of size determining comparative and competitive advantage when exposed to world markets. I define comparative advantage in terms of relative profit per unit of fixed resources among enterprises in a well-functioning economy. The country is said to have a comparative advantage in those products it can export at greatest profit per unit of fixed resources in an open world economy. Comparative profit advantage is heavily influenced by basic elements such as soil, climate, and infrastructure including transportation, storage, processing, research, and education facilities and services.

In contrast, I define competitive advantage as ability to export a commodity at a profit when exposed to the real world of imperfect markets including trade barriers and subsidized exports by competitors. In a world of economic distortions, a country can possess a comparative advantage without possessing a competitive advantage. Temporary distortions arising from such elements as monetary policy and fiscal policy mask real comparative advantage. Unsustainable increases in credit, income, and trade in the 1970s associated with the erratic and generally excessive expansion of the money supply overstated U.S. comparative advantage by creating an artificially low value of the dollar in international exchange. In contrast, world recession, financial crisis, and the high value of the dollar in the mid-1980s understated U.S. comparative advantage.

Comparative and competitive advantage massively influence farm structure. The U.S. does not produce coffee, cocoa, tea, bananas, and sisal in which other countries have a comparative advantage. A growing number of studies indicate that the U.S. has a comparative advantage in production of grains and soybeans but not in sugar, "manufactured" dairy products, and fruits and vegetables having high labor requirements (see Agricultural Policy Working Group, 1987; CAST, forthcoming). Comparative advantage tilts structure of farms as measured by type toward soybean and grain operations. Other farm structure by type is determined by the nontraded goods aspect. That is, it does not pay to export or import certain commodities. Examples are pork and milk for fluid consumption purposes. Some studies indicate that in a more perfect market the U.S. would have a comparative advantage in production and export of beef. A challenge in this and other areas is to maintain open world markets so that comparative advantage is also competitive advantage.

Preconditions that give rise to efficient resource use, savings, investment, capital accumulation, and rapid improvement in productivity tend to speed the movement toward larger and fewer commercial farms. These same characteristics tend to result in the food and agriculture industry being a smaller part of the national economy and make for more small, part-time farms. But the structure of agriculture emerging therefrom in an isolated economy is far different than the structure which emerges when an economy is exposed to the world market through international linkages.

#### Linkages: World Trade and Capital Flows

As noted above, the structure of domestic agriculture would look very different around the world in the absence of foreign linkages. For example, Japan in the absence of international linkages would have a much lower standard of living and would not be the massive island "factory" processing raw materials from elsewhere into high-valued finished goods. In isolation, Japan would be much poorer but might have a similar structure of commodity production by size of farms, only because today's agriculture in Japan is highly protected. In the absence of this protection, Japanese agriculture would be a far smaller share of an open economy, more land would be converted from

agricultural to urban uses, and agricultural production would center on domestic commodities with high transportation costs per unit of value for the home market. Other foods and feed stocks would be imported.

In the absence of international linkages, the United States would have a lower standard of living, commercial farms would probably be smaller, more numerous, and less prosperous, and small part-time farms fewer in number. Less grain and soybeans would be produced but more tropical and semi-tropical products would be produced at high cost in the absence of imports. Because many of these products would be produced under "hot house" conditions, they would be expensive.

#### **4. Markets and Policies**

Principal institutions for transmitting international linkages are financial markets and commodity markets conditioned by trade and other policies (Figure 1). These markets are increasingly integrated on a worldwide basis. We are reminded that financial markets are highly interdependent by the domino effect obvious when the stock market crashed October 19, 1987. Improved communication and changing institutions have reduced the frictions that once isolated people and markets. Millions of dollars can be transferred in an instant to almost any financial center around the world. Financial capital markets have become highly liquid and elastic--even small changes in expected real returns can induce large capital flows. One implication is that markets provide essentially the same risk-adjusted expected real rates of return on capital worldwide in the absence of market interventions.

Commodity markets are much less liquid. To be sure, services flow more freely than merchandise. Entertainment sent by satellite moves in a quite frictionless environment but bulky agriculture commodities continue to require much time and expense to reach their destination. This means that supply-demand adjustments come somewhat slowly in agriculture even in the absence of policy distortions.

Most labor markets are isolated among countries, but legal and illegal movement sometimes are of sufficient magnitude to influence farm structure as in the case of the U.S. and Latin America. Restriction of labor movement to the U.S. coupled with open product movement tilts the structure of U.S. farms toward less seasonal hired labor, greater mechanization, and less labor-intensive enterprises.

#### **5. Linkage Variables**

How domestic monetary-fiscal policy affects the agricultural economy through international linkages is illustrated in Figure 2. Reaganomics, defined as a relatively restrained monetary policy coupled with a highly expansionary fiscal policy (large Federal deficits in a full employment economy) generated a strong demand for money to finance the debt and private investment in a growing economy (see Bradley et al., 1986; Tweeten, 1988; Barclay and Tweeten, 1988). Given monetary restraint and a domestic savings function that is only mildly responsive to real interest rates, the strong demand for savings relative to the supply drove up the price of money--the real interest rate. In the absence of international linkages, the large Federal deficits would have forced expansion of money supply and inflation to pay off the debt with "cheap" dollars or forced the real interest rate to a high level stalling the economy. Through international linkages, however, savings were attracted from abroad. Examining the right side of Figure 2, high real interest rates

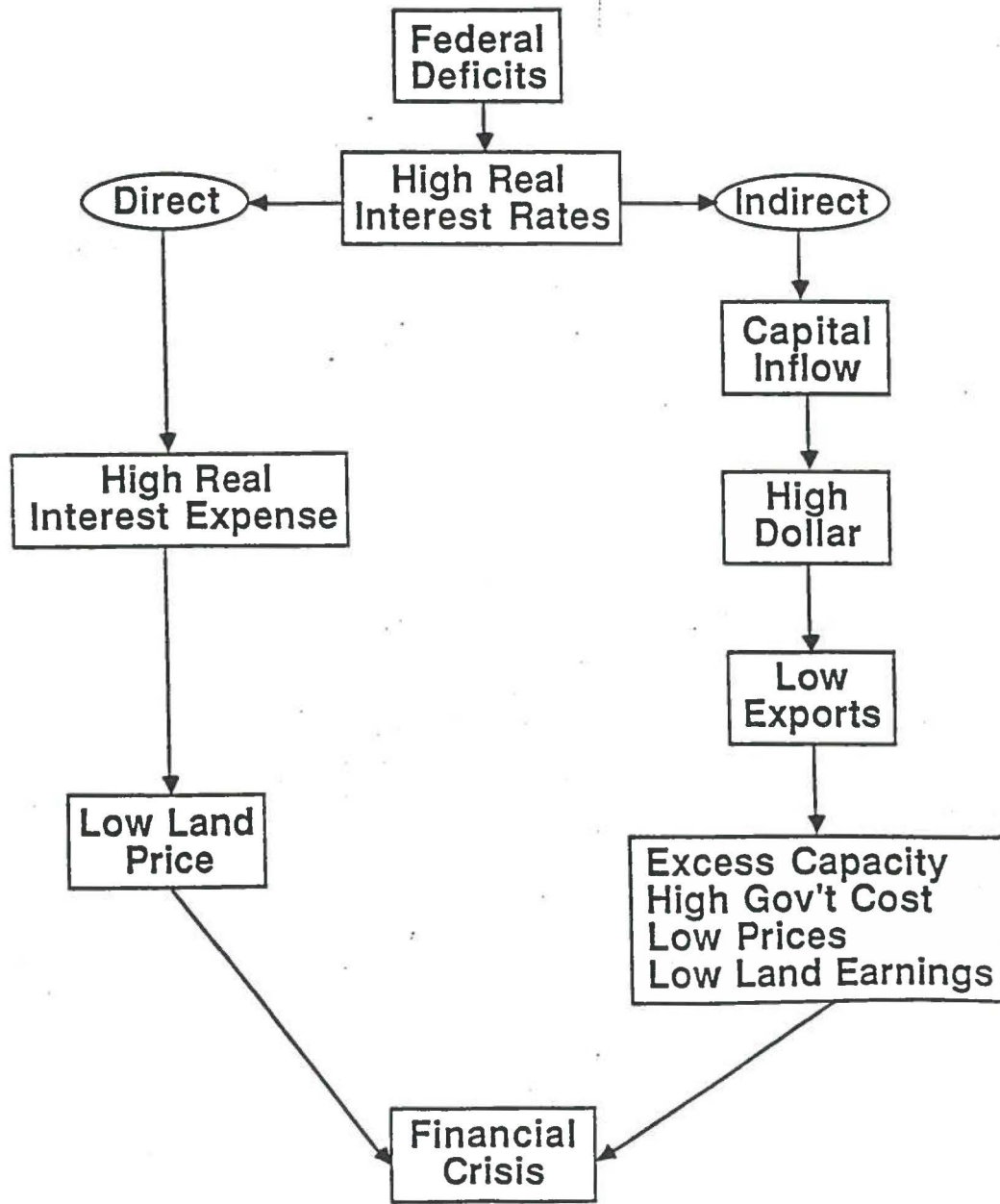


Figure 2.

Flow Chart Showing Impact of Reaganomics on the Farm Economy

Source: Tweeten (1988).



attracting capital from abroad created a strong demand for dollars relative to the supply of dollars to invest in the United States. This drove up the price of money in international markets--the foreign exchange value of the dollar. The high dollar in turn made it very difficult for Americans to export and easy to import, creating positive trade balances abroad which in turn provided the savings to invest in the United States. The unfortunate consequences for United States farmers were low exports, low demand, low prices, and excess production capacity--the latter removed from the market at high government cost.

Domestic linkages noted on the left-hand side of Figure 2 also contributed to farm financial stress. High real interest rates meant high real interest expenses which reduced net farm income. Lower farm prices and earnings changed expectations regarding the future of returns from land. Lower land earnings coupled with sharply higher discount rates reduced expectations of the discounted value of land. Discount rates for farmland were influenced by the 9 percent real interest rate, triple the "normal" rate (zero in the 1970s). The resulting lower present value of farmland caused massive capital losses, exacerbating the financial crisis.

The most highly leveraged commercial farmers lacking equity capital and substantial off-farm income were especially vulnerable to financial stress. Many forced to cut back or terminate their farming operations were young. The structure of agriculture was tilted toward older farmers and established commercial farmers with favorable debt-asset ratios.

Increasingly, the movements across international borders are neither conventional capital nor commodities. Instead, they might be characterized as technology transfer (see 5d, Figure 1) including research and development projects, or knowledge in other various forms including improved seed varieties, software programs, technology licenses, circuit board schematics, and managerial ideas. These are important to comparative advantage and farm structure at home and abroad but often go unrecognized in conventional trade and capital flows. A substantial literature has grown regarding the advisability of the U.S. fostering such technology transfers, recognizing the impact of feedbacks on U.S. exports and farm structure. That debate is likely to be resolved in favor of continuing technology transfer. In fact, environmental restrictions in developed countries on biotechnology may induce transnational firms to first test and then apply new biotechnologies in developing countries. Needless to say, resulting lags in technology used in the U.S. versus in developing countries could markedly realign comparative advantage and cause a major restructuring of agriculture and agribusiness.

### **Price, Income, Balance Sheet, and Other Impacts on U.S. Agriculture**

The impacts of international linkage variables on U.S. farm prices, income, and balance sheets have been examined in some detail. The relatively well-known cost-price, cash-flow, real-wealth, and instability effects will be discussed below but these only indirectly influence farm structure. We know very little about the impact of foreign linkages on variables such as economies of size, earnings of nonfarmers, and off-farm earnings of farmers that more directly influence farm size and numbers. Lack of significant results may be because the effects are small or because they have not been studied.

## 6. Main Impacts on Agricultural Income and Balance Sheet

The four main impacts on agriculture, as depicted in Figure 1, are discussed briefly.

**Cost-Price Impact.** International macroeconomic policies have real impacts on agricultural prices. A 1983 study (Tweeten) found that the initial impact of inflation was to raise prices paid by farmers more than prices received by farmers, worsening the domestic terms of trade. However, this negative impact in the first year was reversed in the second year. After the third year, the effects of inflation "washed out" to no real impact. Unstable monetary-fiscal policy appears to create instability but not less favorable long-run terms of trade for farmers.

**Cash-Flow Impact.** Unsound monetary-fiscal policy creating inflation generates cash-flow problems for farmers (Tweeten, 1981). Inflation raises costs and defers returns on assets because capital gains are not realized until land is sold. Highly leveraged commercial farmers without off-farm income are most disadvantaged by such policies. Exposure to international markets probably dampens inflation and cash-flow pressures induced by expansionary macroeconomic policies.

**Real-Wealth.** Low real interest rates induced by expansionary monetary policies in the 1970s and high real interest rates induced by large Federal deficits in the 1980s brought massive real wealth changes to landowners, as noted earlier. The value of farmland is closely tied to expected future rent divided by the expected real interest rate. The expected real interest rate or discount rate in turn is heavily influenced by the real interest rate on farm mortgages. It may be argued that farm real-wealth losses of the Reagan years simply offset the real-wealth gains of the Carter years. However, the expectations for future opportunities in farming that induced operators to enter or expand in the 1970s were rudely reversed in the 1980s. For many, the satisfaction of the 1970s could not compensate for the human cost of financial stress and changes in farm structure in the 1980s. Although farm size and numbers were changed much less by the financial stress of the 1980s than many had anticipated, some of the changes were irrevocable.

**Instability.** The cost-price, cash-flow, and real-wealth effects discussed above had cyclical properties, with expansionary and stabilization phases. Many of these effects resolve to issues of instability. Unsustainable monetary-fiscal, exchange rate, and commodity program policies make for highly unstable world food and agricultural economies. Other forces such as protectionism and unpredictable import policies of centrally planned countries add to this instability and tilt agriculture toward commodity programs, marketing orders, and other administered or negotiated pricing systems. The departure from a market orientation often means loss of economic efficiency. Measured by opportunity cost per unit of output, part-time small farms produce less efficiently than commercial farms (Tweeten, 1984, p. 22). An unstable economy tilts farm structure toward part-time small farms able to cope with risk but economically less efficient than larger farms. Large farms are more leveraged than small and medium-size farms, making them vulnerable to unfavorable cost-price, real-wealth, and instability impacts from world trade and exchange rates. However, large farms on average have more favorable rates of return than small and medium-size farms; many large farms are able to survive despite financial stress characterizing much of the agricultural economy. Grain and soybean farms especially dependent on exports were most disadvantaged by unstable world markets of the past decade.

In short, international linkages causing world trade and exchange rate adjustments in response to changes in macroeconomic and other policies most disadvantaged leveraged commercial cash grain and soybeans farms and least disadvantaged part-time small farms and livestock farms in the United States. Structure has tilted accordingly.

## **7. Variables Required to Change Agricultural Structure**

Quantitative data (Tweeten, 1984, p. 24) indicate that the most important variables determining farm size and numbers have been (1) technology (especially influencing economies of size), (2) earnings of non-farmers (opportunity cost), (3) access to off-farm earnings (for current or potential part-time farmers), and (4) public tax, credit, commodity program, and other policies.

We have very little information regarding precisely how world trade, exchange rates, and other international linkages impact farm structure through these variables. Although numbers are lacking, the conceptual basis is clear. For example, trade raises national income per worker. If farmers are to maintain income at a level comparable to that of workers elsewhere, farm size must expand and numbers decline if national acreage is stable. Economies of size, mechanization, and other technologies continually shift upward the farm size required to form an economic unit operating at lowest cost of production per unit. Availability of off-farm employment and earnings has maintained economic viability of many farms too small alone to provide livelihood for a family. Some of those off-farm jobs were opened by exposure to international markets. On the other hand, some off-farm jobs are lost to international competition.

The competition offered by exposure to international markets has encouraged reduction in unit cost through farm expansion to obtain economies of size. This has made for fewer, larger commercial farms. Lower farm prices arising from international competition forced some farmers to obtain off-farm employment, hence abetting the trend toward a dual agriculture of a few large farms accounting for most output and a great many small part-time farms. On the other hand, international linkages expanded farm markets, making for more commercial farms, other things equal. However, off-farm earnings opportunities of farm people depended more on communication and transportation technologies than on international linkages.

Much literature has centered on the role of public tax, credit, and commodity program policies in influencing farm structure. I give these public policies including public agricultural research and extension less credit or blame than have some other authors for changes in farm structure. Popular opinion notwithstanding, the most thorough studies (Sumner, 1985; Spitze et al., 1980) indicate that commodity programs have not had a major impact on farm size and numbers. While there is some evidence that farm commodity programs create stability allowing a given equity to be leveraged to form a large farm unit, data clearly indicate that medium-size farms receive substantially larger commodity program benefits per unit of output than do either large or small farms. This tilts structure toward mid-size farms.

Federal credit subsidies have been much larger per unit of output on small farms than on medium-size or large farms, hence also cannot be faulted for shifting structure towards large farms (Tweeten, 1984). Public agricultural research and technology have been primarily scale-neutral. However, these programs benefit early adopters, as noted earlier. The impact is to slightly tilt structure toward larger farms.

Tax policies have had a much larger impact but termination of investment tax credit and passive loss provision (requirements for "material participation" to be able to write off losses from other income), restrictions on capital gain write-offs for livestock, and limitations on tax write-offs to "at risk" investments have reduced public tax policies as a major determinant of farm structure. New tax rates are only mildly progressive but partly offset some of the tax advantages for large farms. Income taxes are low per unit of output for most farmers, especially if they work with able tax consultants. Low effective tax rates coupled with fewer incentives to substitute capital for labor make farm structure less influenced by income tax laws than by other forces.

Public provisions for electricity, roads, water, school bus, and other services and infrastructure probably had more impact than commodity or tax policies on farm structure by encouraging part-time small farms. At any rate, these issues are treated by other authors and are only peripherally related to world trade, exchange rates, and other international linkages--the central focus of this analysis.

### U.S. Farm Structure -- Summary

In Figure 1 and in the text, I have attempted to place the assigned topic--the impact of world trade, exchange rates, and comparative advantage on U.S. farm structure--in a broad context. In an internationalized, integrated global economy, domestic policies are filtered through international linkages to feed back to the U.S. in ways that cause a different farm structure than would be the case in isolation. The impact of international linkages on farm size and numbers is less than on income, balance sheets, or farm type. On the one hand, exposure to international markets has enhanced technology, productivity, the opportunity cost of farm labor, and economies of size, thereby generating fewer and larger commercial farms. On the other hand, the instability generated by exposure to international markets has motivated many farmers to turn to part-time farming, making for more and smaller farms--other things equal. Thus, the internationalization of agriculture probably is speeding the bifurcation of agriculture into a dual structure of a few large farms accounting for most output and many small part-time farms accounting for most farms.

Other international linkage impacts are more direct but of small magnitude. Small tractors sold in the United States are made abroad; availability of these tractors aids small farms. However, used machinery from commercial farms is such a close substitute for small foreign-made tractors that the effect of imported inputs on structure is small. Foreign sourcing has made computers cheaper and more accessible to farmers, but the impact on structure again has been small.

Little was said in the text regarding the impact of foreign linkages on the legal organization and type of coordination in agriculture. Uncertainties introduced by unstable foreign markets have induced many farmers to seek more secure market arrangements. Vertical integration, marketing orders, other forms of vertical coordination, and commodity programs, in part, may be the response.

Emphasis in this paper has been on the impact of international variables on U.S. farm structure. The causal structure may also work in reverse. Domestic policies to change the structure of agriculture could have a major impact on world trade, exchange rates, and comparative advantage. Domestic policies to restrict growth of farms and maintain a structure of small to medium-size farms could significantly raise cost of production and eliminate competitive advantage of the U.S. in international markets (see Tweeten, 1984). A system emphasizing small farms might provide more stimulus to rural communities but at a cost in terms of lost exports and higher food prices. In short, international linkages affect and are affected by farm structure.

**Endnotes**

<sup>1</sup>Large farmers are frequently early innovators and gain more total benefits from scale-neutral technologies; hence, the final incidence of benefits is scale-biased toward commercial farms.

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