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# Terms of Trade and Factor Commitments in Agriculture

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**Abstract.** *US agricultural economic growth in this century has been characterized by a slow rise in the demand for food and faster growth in farm output as against nonfarm productivity. In such an environment, one expects the size of the farm sector to decline as a share of the rest of the economy. What is not so clear is the effectiveness of the price system in signaling the appropriate resource adjustments or of the resource market in responding to available signals. We examine four terms-of-trade measures conceptually and, since 1929, empirically. We find that even distortions from farm programs have not offset the long-term trend of declining terms of trade. Labor and capital markets respond, albeit imperfectly and slowly.*

**Keywords.** *Agricultural terms of trade, agriculture, economic growth*

Since the 1930's, Federal farm programs have sought to help farmers adjust to changing market forces. These programs, however, have ramifications outside the agricultural sector. They affect not only farm incomes but market prices, producer incentives, and the allocation of resources across sectors.

Agricultural economics has long used relative prices to measure the impact of agricultural programs. For example, parity prices have frequently been used to indicate farmer well-being relative to others in the economy. This notion has been criticized because, as a measure of well-being, it inadequately accounts for technological and structural changes in the economy. This paper presents a variety of relative prices or terms-of-trade indicators, each of which captures a specific market mechanism or income effect. Together, these indicators form a composite of the agricultural economy relative to other sectoral economies.

We define four indicators of the agricultural terms of trade. In contrast to the single "parity prices" index, two indicators separately measure "resource pull" effects, a third measures relative real incomes (or well-being), and a fourth measures relative prices from the point of view of demanders. We show the historical paths of these measures since 1929 and describe how various domestic and international shocks affected them. We discuss how the indices

reflect long-term changes in the agricultural economy and how the observed movements in the different terms-of-trade measures are linked to changes in the relative position of agriculture in the economy, including resource movements and relative productivity growth among sectors.

## Value-Added Terms of Trade

To calculate the value-added terms of trade, the ratio of the agricultural gross national product (GNP) deflator to the nonagricultural GNP deflator, we used data from (8, 9).<sup>1</sup> This ratio measures factor income per unit of real value added in agriculture relative to that in the nonagricultural sectors. A unit of real value added is a composite indicator of primary factor inputs—capital, labor, and land. If all factors are mobile and factor markets function perfectly, then each primary factor would earn the same return in all sectors. The value-added terms of trade would then be constant, on average, over time. We did not, however, observe such constancy. Land is a sector-specific primary factor, so one would expect to find some variation in the value-added terms of trade with changes in land values over time. Except for land, changes in the value-added terms of trade indicate continuing disequilibrium in the factor markets and denote resource-pull effects that should lead to further factor reallocation.

We define two versions of the value-added terms of trade, one using farm national income and one using sectoral real value added, or GNP originating in the sector. The GNP version includes the effects of price supports on the terms of trade. The farm national income version incorporates the impact of transfer payments as well.<sup>2</sup> Figure 1 plots the two variants over time. The two measures of the value-added terms of trade generally move together, with the national income version above the GNP version in all years. They dropped sharply during 1929-32, increased during 1932-37 to near-1929 levels, then declined

<sup>1</sup>Italicized numbers in parentheses cite sources listed in the References section at the end of this article.

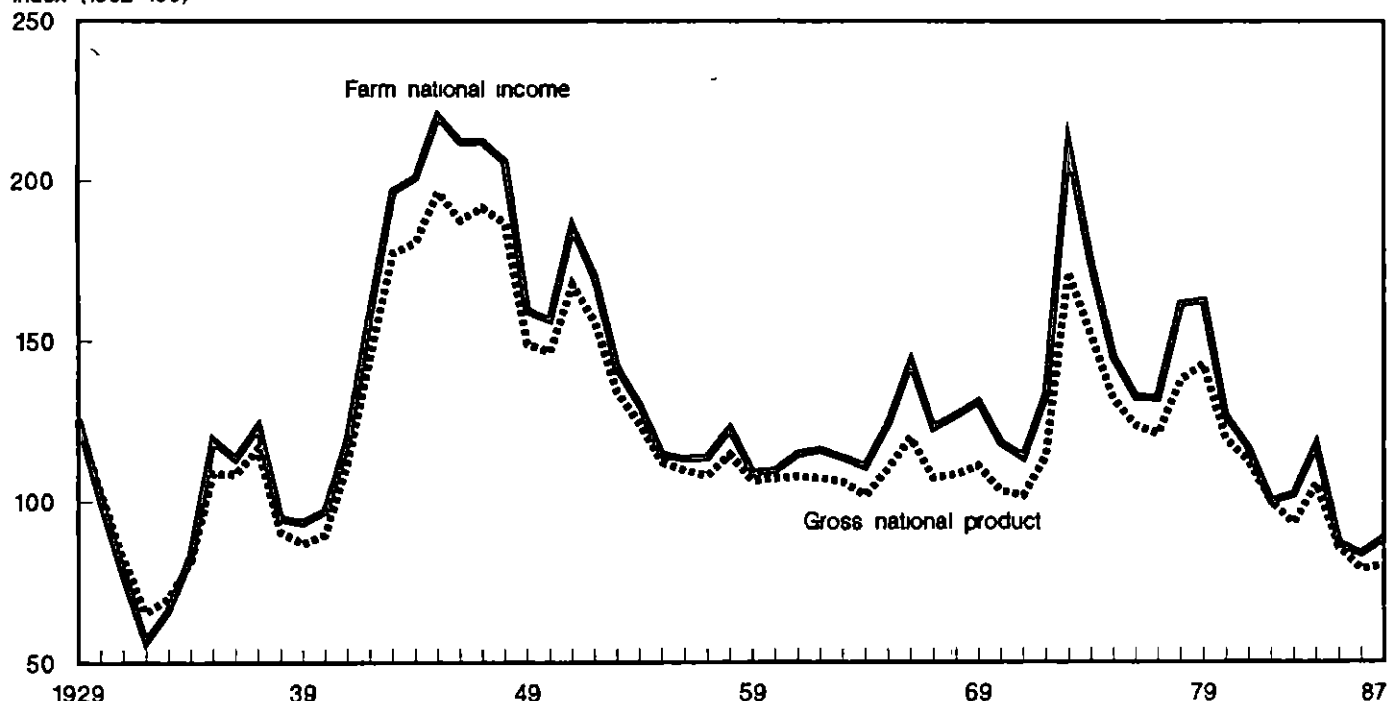
<sup>2</sup>In computing the national income version, we use the US Department of Commerce's Bureau of Economic Analysis (BEA) estimates of the real value of subsidies. As an alternative, we explored using the GNP deflator to deflate nominal subsidies. The resulting national income value-added terms of trade series is similar, with some significant differences in the 1959-72 period, when the BEA figures showed improvement, while the series computed with the GNP deflator showed a flat trend.

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Figure 1

**Two versions of the value-added terms of trade**

Index (1982=100)



until 1939. These movements mirrored the macroeconomic cycles of the Great Depression: the initial crash in 1929 accompanied by a sharp decline in relative agricultural prices, a strong recovery to 1937, and another major decline until the advent of the war economy.

World War II triggered a sharp upturn in the agricultural economy. Both measures of the value-added terms of trade peaked in 1945 and remained high through 1948. The postwar economic readjustment led to downward trends from 1948 to 1955, with a short, sharp improvement in 1951-52 due to the Korean War. The GNP value-added terms of trade remained nearly constant during the period of relative economic stability between 1955 and 1972, while the farm national income version improved slightly. Although there were some small variations in the GNP value-added terms of trade during this period, there were no large fluctuations until 1971 when the Smithsonian Agreement between major Western nations realigned their currencies and resulted in a devaluation of the dollar.

The 1970's were characterized by major swings in the macroeconomy and in the value-added terms of trade. The measures increased to above Korean War levels in 1973, but the trend has been strongly negative since

1974. In 1986, the GNP value-added terms-of-trade measure fell to its lowest point since 1934.

The post-Korean War movement of the national income value-added terms of trade meant that farm programs were successful in enhancing real incomes in agriculture. The national income value-added terms of trade increased on average between 1955 and 1972, while the GNP value-added terms of trade declined slightly. With the 1973 ascent, the national income value-added terms of trade reached World War II levels. When the GNP value-added terms of trade hit a 52-year low in 1986, the national income value-added terms of trade did not follow. However, the national income version also shows more volatility than does the GNP version. Throughout the 1970's and 1980's, when the GNP value-added terms of trade increased, the national income value-added terms of trade rose even more strongly. And, when the GNP terms of trade declined, the national income terms of trade dropped at least as much.

Comparing the two versions of the value-added terms of trade provides some insights into the effects of farm programs on the agricultural sector's ability to attract and hold a share of society's resources. The national income version of the value-added terms of trade differs from the GNP version by the dropping of taxes embodied in market prices (indirect business taxes).

and depreciation allowances and by adding Government transfer payments. Farm programs apparently influence the national income measure more than the GNP version. Most farm programs primarily affect market prices, however, and both measures use the same output and purchased input measures. The disparate influences of farm programs on these measures result directly from the effects of government transfer payments and indirectly from effects farm programs may have on indirect business taxes and on depreciation through the values of assets, both working and fixed. While transfer payments have successfully supplemented income levels for agricultural labor, land, capital, and management, they have not stabilized agricultural income over time. Income transfer programs have cushioned the drops, but they have padded the rises and have provided little consistent hindrance of wide price swings.

## Internal and Output Terms of Trade

To calculate the internal terms-of-trade index, the ratio of an index of the prices received for agricultural output to a combined index of the prices paid for agricultural inputs and of consumption by farm households, we used data from (7). This index is an indicator of the purchasing power of agricultural goods in terms of commodities bought by farmers. Of the indices we consider, this is the closest to the traditional definition of "parity" prices.<sup>3</sup>

The output terms of trade is the ratio of the agricultural prices received index (7) to the nonagricultural GNP deflator (8, 9) and indicates the purchasing power of agricultural goods in terms of all nonagricultural domestically produced goods. The ratio differs from the internal terms of trade only in the definition of the denominator. Figure 2 shows the output and internal terms-of-trade indexes over time. The movements in the output terms of trade closely paralleled those of the internal terms of trade, though the index dropped at a less dramatic rate from 1973 to 1987. Both indices reached a low in 1986. The swings in the output terms of trade generally have been more dramatic than those in the internal terms of trade, probably because the internal terms-of-trade index includes more of the same commodities in both numerator and denominator. The similarity in turning points, however, indicates that both measures have responded to the same economic shocks.

The output and internal terms of trade have followed a trend similar to that of the value-added terms of trade (fig. 1), with some notable differences. During

the Great Depression, the output and internal terms-of-trade indexes dropped at the same rate as the value-added terms of trade. However, the internal terms-of-trade measure surpassed its pre-Depression high during the recovery of the mid-1930's. The output and internal terms of trade rose together during the World War II boom and fell only slightly before climbing again during the Korean War.

After the post-Korean War readjustment, the output and internal terms-of-trade indexes continued to decline, but the two value-added indexes leveled off. The long-term decline in the output and internal terms of trade has continued since 1951, with a major but temporary upswing in 1973. During the Kennedy round of the GATT negotiations of the early 1960's, the European Economic Community refused to discuss issues affecting agriculture (3). The result was an agreement that favored an increase in world industrial trade at the expense of agriculture. In addition, with the overvalued dollar of the 1960's, U.S. agricultural exports were relatively expensive to the rest of the world.

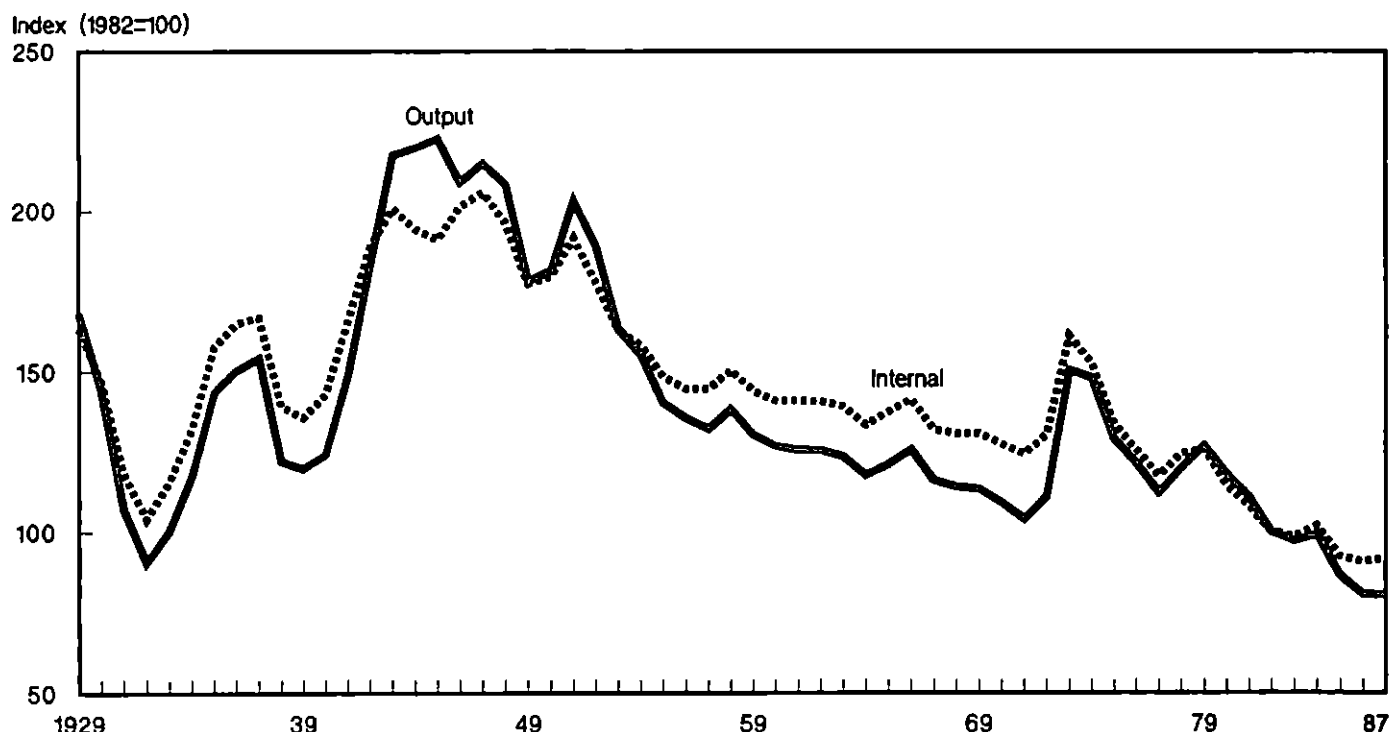
Agricultural prices peaked relative to other commodity prices in 1973, then dropped. The Smithsonian Agreement of 1971 specified an 8.57-percent devaluation of the U.S. dollar, thereby lowering the relative price of U.S. agricultural exports to the rest of the world. In 1973, the Smithsonian Agreement collapsed and the dollar floated down. Soon thereafter, developed countries, including Japan and some European nations, increased their purchases of the now cheaper American agricultural exports. Additionally, the Soviet Union agreed to a major grain purchase from the United States to support increased meat production. However, the formation of OPEC and the subsequent oil price shock in 1973-74 caused nonagricultural prices to jump.

The increase in worldwide demand in the mid-to-late 1970's, accompanied by a slower increase in supplies than was expected, caused agricultural prices to soar. Nonagricultural prices were also increasing, however, so the effect was only a slight increase in the output and internal terms of trade in 1978-79.

A second oil price rise in 1979 caused another sharp increase in commodity prices. In October of that year, the Federal Reserve tightened the money supply, causing higher interest rates and lower domestic aggregate demand. This action increased the value of the dollar, making American exports relatively more expensive to the rest of the world. There was continuing appreciation of the dollar through 1985. The January 1980 grain embargo on sales to the Soviets contributed to large surpluses and a subsequent price decline in agriculture. The output and internal terms

<sup>3</sup>This definition of parity is not quite equivalent to the legal definition of price parity. If we had used the 1910-14=100 indices, the internal terms-of-trade ratio would be the parity ratio. Teigen (6) discusses the evolution of the definition.

Figure 2  
Internal and output terms of trade



of trade dropped below the mid-Depression level in 1982 and hit their all-time low in 1986

## Analysis

Trends in each of the above terms-of-trade indexes suggest how the economic climate affected agriculture and how factors were committed in the sector

Table 1 gives the average yearly growth of each price index from 1955 to 1972 and from 1973 to 1987.<sup>4</sup> The average yearly increase of the agricultural GNP deflator dropped from 3.7 percent in the first period to 1 percent in the second period, and that of the index of prices received for agriculture only increased from an average of 1.4 percent per year to an average of 2.3 percent per year. Meanwhile, the average yearly increases in the prices paid index and the non-agricultural GNP deflator jumped from 2.3 percent and 2.9 percent, respectively, in the first period, to 6.4 percent and 6.7 percent in the second period.

Table 1 shows the long-term deterioration in all indexes of the agricultural terms of trade, with acceleration in the rate after 1973. Near stagnation in agricultural prices and strong growth in nonagricul-

tural prices combined to lead to this long-term deterioration. These trends have continued.

The value-added terms of trade is an indicator of relative real factor incomes. Declining relative factor income should signal factors, such as labor and capital, to move to other sectors. The two versions of the index, however, embody different assumptions about incentives. If income transfers do not affect producer incentives, then the GNP version better measures resource-pull effects. To the extent that farmers respond to income differentials, including transfers, then the national income version is more appropriate.

If all factors of production were perfectly mobile, one would expect each factor to receive the same rate of

Table 1—Average annual growth rates of price indexes

Index	Period 1, 1955-72	Period 2, 1973-87
	Percent	
Agricultural GNP deflator	3.67	0.97
Prices received index	1.41	2.33
Nonagricultural GNP deflator	2.94	6.72
Prices paid index	2.33	6.40

<sup>4</sup>The growth rates were estimated from log linear regressions of the variables against time for each subperiod.

remuneration in all sectors, and hence, little change in the value-added terms of trade over time.<sup>5</sup> Labor and capital, however, are not perfectly mobile. Changes in the terms of trade lead to disequilibria in the factor markets with only slow adjustment over time.

Figure 3 reproduces the farm national income version of the value-added terms of trade, along with the percentage of the work force employed in agriculture and the percentage of the real capital stock committed to agriculture from 1947 to 1987. The structure of employment did not follow the movements in the terms of trade. During the period of nearly constant value-added terms of trade (1955-72), the portion of the work force employed in agriculture dropped at an average yearly rate of 4.77 percent. However, during 1973-87, when the value-added terms of trade were declining rapidly, albeit from historically high levels, agriculture's share of employment fell at an average rate of only 2.58 percent per year. This trend seems to contradict the conventional wisdom that labor, the more mobile factor, should respond to the declining value-added terms of trade by leaving the sector. Clearly, workers lack the incentive, tangible or otherwise, to move out of agriculture as fast as the deterioration in the terms of trade would indicate. The addition of direct Government payments to agriculture, by increasing the value-added terms of trade, may have obscured the market forces that were present.

Although labor did not adjust fully to the changing terms of trade, capital stocks fluctuated as expected. From 1955 to 1972, agriculture's share of capital stocks remained fairly steady, dropping only 1.67 percent per year on average. Agriculture's share reacted slightly to the dramatic 1973 peak in the agricultural terms of trade, then began an accelerated decline during the post-1973 slide. The fact that agriculture's share of the capital stock fell faster than its share of employment could reflect the fact that part of the unexpectedly large drop (according to the terms-of-trade indexes) in agriculture's share of employment during 1955-72 came from a substitution of capital for labor. Thus, farm labor adjustment may have been more sensitive to relative agricultural labor and capital costs, while capital costs and agricultural capital allocation were more sensitive to the agricultural/nonagricultural terms of trade.

Though the output terms of trade are more volatile than the internal terms of trade, increasing faster in times of relative improvement and decreasing more

sharply in times of relative decline, both support the conclusions about labor and capital commitments in agriculture.

Agriculture's terms of trade are expected to decline as an economy develops. (1) The income elasticity of demand for agricultural products tends to be low, causing prices to fall if agricultural production grows faster than population. Meanwhile, higher incomes increase demand for nonagricultural goods, pushing up prices in those sectors. While automation in agriculture increased supply, demand did not keep pace, causing more downward pressure on farm prices. And because the decline in employment has been slower during the past 15 years, and capital stocks have only recently begun to decrease significantly, overproduction has persisted. Considering these effects with the historical factors described above, prices paid by farmers unsurprisingly grew twice as fast as prices received by them between 1955 and 1972 and almost three times as fast from 1973 to 1987.

The combination of declining relative prices and a constant value-added terms of trade that existed between 1955 and 1972 indicates that total factor productivity grew faster in agriculture than in other sectors. The farm sector adapted faster to innovations, thereby allowing for higher levels of production. At the same time, movements in the farm national income version of the value-added terms of trade during this period seem to indicate that the average yearly drop in employment of 4 percent was excessive.

The value-added terms of trade, however, during the past 15 years, has been declining with the internal and output terms of trade. This combined movement indicates that the market is signaling additional factors to leave the sector, assuming productivity is constant. Even when we consider the direct payments by the Government in the value-added terms of trade, the implication is the same: sector value added has been deteriorating along with the relative prices for agricultural products, signaling factors to move to other sectors.

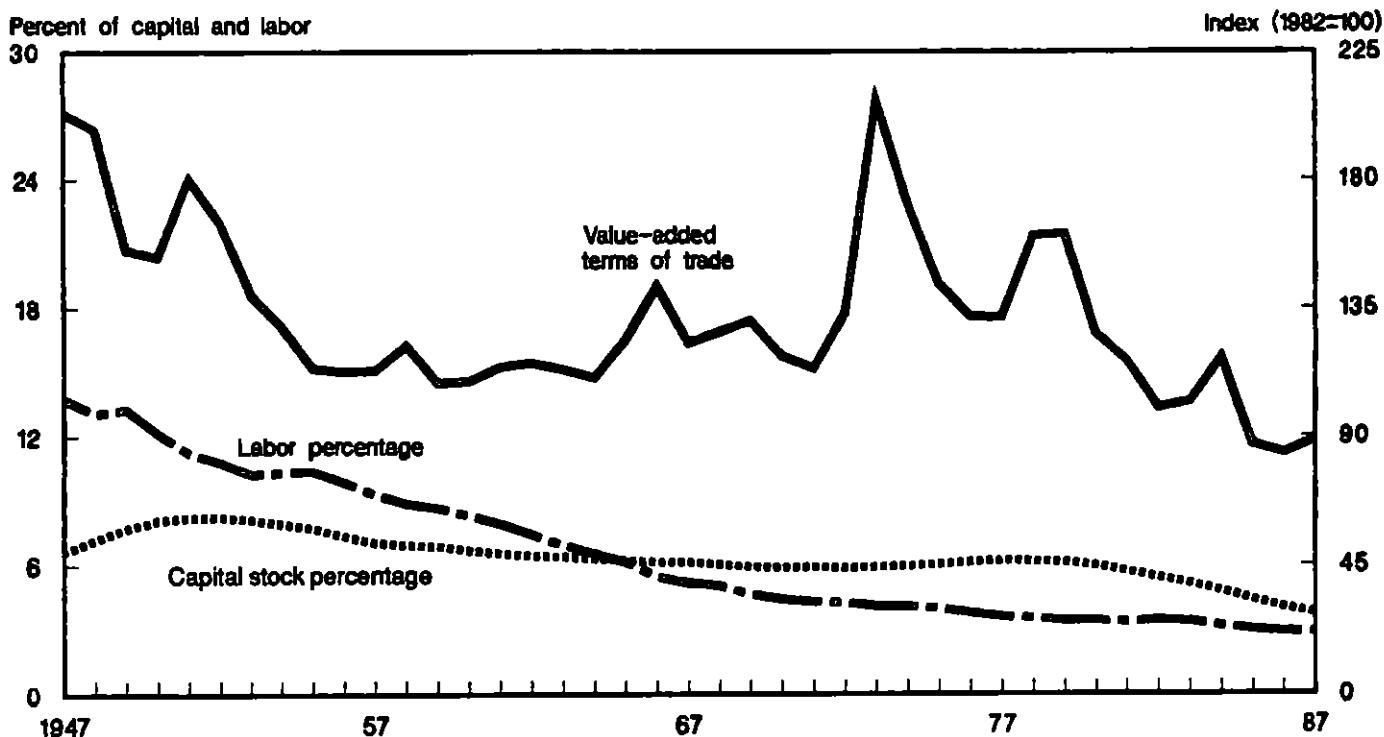
## Conclusions

The agricultural economy in the United States has suffered recently, and agricultural policy has attempted to slow that decline. But, one unstated goal of the policy, to allow farmers to shrink the sector on their own, has not been met. Price supports, which are intended to keep prices between average variable costs and average total costs, are not stemming the deterioration in relative prices in agriculture. The direct Government payments, which constitute much of the program, are either sending the wrong signals

<sup>5</sup>This result also assumes that the indices correctly account for changes in factor quality, technology, and firms' institutional environment.

Figure 3

# Labor and capital shares in agriculture and value-added terms of trade



or are obscuring the natural market forces that would tend to reallocate factors to other sectors.

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