

Is American Agriculture Near the End of Its “Life Cycle”?

by

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Think of all the American industries that once flourished and now are gone or virtually so. Copper mining in the southwest; gold mining in California, South Dakota and Alaska; the timber industries of the East Coast; the fishing industries along many parts of both coasts; and the steel industry of the Great Lakes region. Each of these industries once was the central force in some local or regional economy. Now each of them has vanished to some degree. All that is left of the copper mining that thrived in Arizona during the late-1800s are a scattering of ghost towns. Gold mining in California has left behind only a few hobbyists and numerous museums. The steel industry has mostly rusted into memory. In their heyday each of those industries caused inward migrations of workers to the regions, triggered large-scale investments in economic activities of many sorts, and fueled the economy of the surrounding region. Each of those industries was proud, productive and profitable ... in its prime.

Now, think of American agriculture. Farms and ranches once numbered over 6 million in this country. One quarter of the land in agriculture in 1954 has now left the industry (USDA 1998). Agriculture was the dominant industry in the nation for much of our history. It caused mass migrations and large-scale investments that created and supported entire regions. It remains proud and may be at its productive prime. But it is no longer very profitable, thus it is slowly disappearing (Blank 1998). Ghost towns are beginning to appear in parts of the Midwest where agriculture was the economic mainstay (Goetz and Debertin). Nationally, hobby farmers and agricultural museums are becoming more numerous. And with each generation our rural roots are becoming a smaller part of the nation's collective memory, thus making it easier to let agriculture go. Therefore, the question of whether the entire production agriculture industry is nearing the end of its economic life needs direct consideration.

To begin that process, two other questions come to mind: What have we learned from the disappearance of other industries? Are these lessons relevant to American agriculture's decline?

First, we have learned that entire industries can and do disappear. The pace of changes leading to an industry's disappearance is much slower than the pace of changes observed at the firm or individual product levels, but the pattern of changes seems to be similar. Also, some industries have disappeared faster than others. For example, for a couple centuries there was an American industry producing buggy whips – the whips used by drivers of wagons, carts, “buggies” and other animal-drawn vehicles. That industry has now all but disappeared because the demand for buggy whips fell dramatically with the spread of automobiles. Yet, the time span of the industry's decline lasted decades, far longer than it took for some other industries to fade. The length of time that individual firms survive is, on average, far shorter than the usual life span of industries. Shorter still is the usual life span of particular products. We can probably all name a branded product that went from top seller to insignificant very quickly. Thus, it appears that as the scale of aggregation increases, from product line to firm to industry, the average life span also increases. However, even industries have reached the end of their life spans and disappeared.

Second, many of the industries that have virtually disappeared from the American economy produce a commodity. This implies there is something about the structure of industries with outputs that are undifferentiated between firms which makes it possible for those industries

to disappear. This is somewhat surprising because it would seem that, in general, demand for a commodity would be stronger than demand for differentiated (branded) products, thus making commodity industry failures rare.

Finally, the changes over a life span seem to follow a similar pattern. That general pattern includes a series of time periods over which the total sales and profits of the economic unit first increase, peak, and then decline.

All of these points are relevant to American agriculture and its apparent decline. In total, they indicate that an analytical framework which evaluates economic performance over time, such as the “product life cycle” model (PLCM) developed originally to study the sales and profit patterns over time of branded products (Lilien and Kotler, pp. 608-613), can be modified for use in analyzing the American production agricultural industry.

Therefore, in this paper I use the PLCM to create a test of the general hypothesis that American production agriculture is nearing the end of its life cycle. First, I explain the PLCM and the underlining economic justification for its use with an industry. Next, I propose a methodology to test the general hypothesis and then I apply the methodology in an empirical analysis. After doing so, I offer an explanation for the results and, finally, I discuss the implications of the results for the American production agriculture sector.

The Product Life Cycle Model and Industry Analysis

The PLCM offers a plausible explanation of the relationship between an economic unit and its market over time. Although the model was developed originally to look at specific products or product lines, it can be extended to firms and to industries because those larger economic units also follow a growth and decline process that is based in the results of sequential decisions. The success of those decisions, relative to the decisions of competitors, in satisfying market demand influences the competitive position of the product, firm or industry at each point in time. However, each group of decision-makers has some constraints upon their ability to completely satisfy demand. Some of those constraints include the attributes of the product or service being sold, the selling price, the cost of production, the volume of output per time period, the storage and distribution system available, and many others. The net effects of those constrained decisions create a unique life cycle for the firm or industry. In essence, the PLCM shows the effects of the economic unit’s comparative and absolute advantages and how they change over time. In the four stages of the PLCM, described below, comparative advantage is the most relevant in the first two stages, with absolute advantage becoming the most important factor during the last two stages.

The standard PLCM is shown in Figure 1. The model is based on the idea that there are four distinct stages of the “life cycle” and these successive stages are each characterized by different patterns in sales and profit performance. The sales and profit patterns are considered to be economic signals indicating the degree of success the unit is having in both satisfying market demand and coping with market competitors.

As shown in Figure 1, the life cycle begins when the first sale is made. For a product, this occurs when it is introduced into the market, hence the name “Introduction” for the first stage of the life cycle. For an industry, the Introduction Stage begins when the first firm to sell a new type of product makes its first sale. Obviously, it is more difficult to pinpoint the beginning of a life cycle for an industry than for a single product, but the logic is the same. For the American production agriculture industry, the life cycle began shortly after people arrived on the

continent. The Introduction Stage is characterized by a slow increase in sales over time and profit levels that are negative initially, but less so over time. The Introduction Stage ends sometime soon after profits become positive.

The Growth Stage is characterized by sales increasing at an increasing rate over time and profit levels that increase in absolute amounts over time. While total profits increase during this stage, profit margins may increase at first but are expected to decrease later in the stage. For a product, the sales growth during this stage comes from both expanding into new geographic markets and developing stronger demand. For an industry, the sales growth comes from both new firms entering the industry and existing firms expanding their output, all in response to rapidly expanding total demand. The Growth Stage ends when both sales and profits slow in their rate of increase over time. For American agriculture, there was an obvious period of growth as settlers moved west from the Atlantic and expanded the number of farms and amount of land in production.

The Maturity Stage is characterized by turning points in both profits and sales volumes, with profits leading sales revenues. Sometime early in the stage, profit totals per unit of time peak and begin declining. Late in the stage, total sales volume per time period peaks and slowly begins to decrease. Between the two peaks, profit margins are clearly decreasing rapidly. For a product, total profits peak while sales continue to expand early in the stage because new geographic markets and/or market segments are being entered, but competition is raising expenses on all sales. Also, the declining rate of increase in sales can be the result of both market saturation and competition from other products. Late in the stage, sales of a product peak and begin decreasing due to increased competition. Profits decrease because costs of maintaining demand and competing with other products increase. For an industry, sales increase early in this stage because new firms are entering and/or existing firms are expanding their output. Profits peak when competition between firms within the industry and competition from other industries becomes significant. More firms may be exiting the industry than are entering. Sales peak later due to competition from other industries and market saturation, which occurs when changes in the industry's demand and supply curves cause marginal revenues to be zero. Industry profits continue decreasing late in the stage because of the costs of competition with other industries and competition between firms within the industry. These costs can be due simply to the industry's lagged response to falling market prices. American agriculture probably entered its Maturity Stage sometime during the last century as the country completed its westward expansion.

The Decline Stage is the final part of the life cycle. It begins sometime soon after total sales per time period begin decreasing. Total sales and profits both decrease during the stage although, on average, profits remain positive. The life cycle ends when the decision is made to discontinue all sales. That decision is triggered by the availability of better profit margins offered by alternative investments, thus the decision is usually made before profits fall to zero. For a product, the sales decrease over time is usually the result of a shift in demand brought on by the introduction of an alternative product that is considered "better" or by competitors' ability to provide a similar product at a lower price. It is easy for all sales of a product to be halted within a short period of time. For an industry, however, total sales are the aggregation of sales from all firms within the industry, therefore many individual decisions to exit must be made before the industry disappears. Thus, industries can decline over a lengthy period of time. For American agriculture, the question is whether or not it has entered its Decline Stage.

In summary, the PLCM, developed to explain the pattern of development and eventual

decline of an individual product over time, can be modified to explain the expected cycles in the life of an entire industry or economic sector. The underlying causes of the cycles are comparative and absolute advantage. The model shows that sales and profit totals increase during the “introduction” and “growth” stages of the life cycle. This is due to the firm or industry developing, and then exploiting, its comparative advantage in the production of the product. Early in the “maturity” stage, profits level off and sales continue to increase. This is due to the costs of increased competition in the product market as either new firms develop their comparative advantage in that product or existing firms experience changes in their absolute advantages. In the “decline” stage, firms exit the market in favor of more profitable alternatives created by changes in comparative and absolute advantages. At some point, absolute disadvantages cause all (or virtually all) firms to exit. Thus, relative profit margins influence total profit amounts. When total profits start to decline, it signals that total revenues are going to follow. For American agriculture, total sales revenue is an important indicator of the race between falling prices and rising yields. The final indicator of agriculture’s demise is signaled when profit and revenues turn down for good.

Methodology

A methodology designed to indicate which stage of the life cycle an industry is in at any point in time is proposed here. In general it is based on the idea that each stage of the PLCM presents testable hypotheses that, for an industry, are derived from changes in the comparative and absolute advantages of that industry and its competition. The hypotheses for each stage of the life cycle are tested by comparing the proposed patterns with data from the time period of interest. The industry is in the stage that offers hypotheses consistent with the data.

The hypotheses focus on the absolute size of the sector’s economic outputs: total sales revenues and total profits. Economic outputs, rather than tangible outputs, are relevant to managers and investors. The fact that the USDA’s index of aggregate output has risen most years does not help decision-makers in their tasks. Aggregate agricultural output is a productivity factor, not an economic factor. Productivity factors affect costs per unit of output, but economic outputs such as profits and sales revenues are decision factors. Sales revenues measure how the market values aggregate output, and profits measure how well the firm or industry is performing in increasing owners’ wealth. In commodity markets where demand can be inelastic, increasing aggregate output is not always a positive result and, thus, is not a strong indicator of economic performance.

For this simple analysis of the American production agriculture sector, total sales revenues (R) and profits (π) are defined below. Only revenues from farmers’ and ranchers’ sales of production output are considered; government transfers and other income sources are excluded. Therefore, the industry’s revenue from all crops ($i = 1, 2, \dots, n$) at time t is:

$$(1) \quad R_t = \sum_{i=1}^n P_{it}Q_{it}$$

and the industry’s profit from all crops at time t is:

$$(2) \quad \pi_t = R_t - C_t - K_t$$

where:

$$\begin{aligned} Q_{it} &= Y_i A_{it} \\ C_t &= \sum_i \sum_j c_j x_{ijt} \\ K_t &= \sum_i \sum_h k_h z_{iht} \end{aligned}$$

and $P_i, c_j, k_h > 0$; $Y_i, A_i, x_j, z_h \geq 0$. n is the number of crops produced by the industry. P_{it} is the average unit price of crop i at time t . Q_{it} is the quantity of crop i produced at time t . Y_i is the yield per acre of crop i . A_i is the total acreage of crop i . C_t is the total production costs of all crops at time t . c_j is a vector of unit costs of j variable inputs. x_{ij} is a vector of quantities of j variable inputs to be applied in the production of crop i . K_t is the total ownership costs of all crops at time t . k_h is a vector of unit costs of h capital inputs (land, improvements, equipment, etc.). z_{ih} is a vector of quantities of h capital inputs used in the production of crop i .

As summarized in Exhibit 1, the approach jointly tests groups of hypotheses to determine which group best fits the data for the time period of interest. Each hypothesis expresses a relationship between time and sales and/or profits, thus the data are time series. For each stage there are two hypotheses. For the Introduction Stage, accepting hypotheses H_{I1} and H_{I2} are each necessary and together they are sufficient conditions to determine that the industry is in the first stage of its life cycle. The same is true of hypotheses H_{D1} and H_{D2} for the Decline Stage. As noted in Exhibit 1, an industry can be identified as being in its Growth Stage in either of two ways. First, accepting both H_{G1} and H_{G2} is a sufficient condition. Second, accepting only substitute hypothesis H_{G1*} is a sufficient condition. A convex sales function is not necessary, but a sufficient condition to determine that an industry is in its Growth Stage because it is a rare situation that could only occur for a relatively new industry experiencing rapid sales growth. The Maturity Stage is characterized by two turning points, one for each of the data sets, so it is evaluated as if it were two different stages. H_{M1} identifies the “early” portion of the stage by testing sales and profit patterns jointly. Each of the two pieces of the hypothesis could be written as separate hypotheses, but for convenience sake they are written as one sufficient condition. H_{M2} is handled the same way for the “late” portion of the stage. This means H_{M1} and H_{M2} are mutually exclusive; an industry can be in only one portion of the stage or the other, so only one of these hypotheses can be accepted.

The time series data used should be in real terms if the period of analysis is very long. For products, the life cycle can be quite short (e.g., weeks or months), but when studying firms or industries the period will often cover decades. For American agriculture, the partial life cycle has already lasted centuries. (Bressler and King begin their history of American agriculture in the early 1600’s.) Therefore, some data aggregation and/or truncation may be appropriate. For example, in this case it is clear that agriculture in the U.S. has passed its Introduction and Growth stages long ago because Blank (2001b) shows that American agriculture is shrinking in size, therefore only tests of the Maturity and Decline stages need to be undertaken.

Empirical Results for American Agriculture

The objective of this study is to test whether American production agriculture is a “mature” or “declining” industry. In those life cycle stages the key to empirical analysis is to determine whether turning points have occurred, first in profits then in sales. The combined results of those tests enable the current life cycle stage to be identified.

Tests of Profit Hypotheses

Total annual (pre-tax) profits earned from American agricultural production over the last three decades are shown in nominal terms in the middle column of Table 1. The net farm income totals reported by the USDA are one of the most commonly used measures of absolute profitability. However, they are overstated. Among other things, those totals include direct government payments to agriculture, which have been at record levels the last couple years. Thus, in Table 1, direct government payments are subtracted from the net farm income totals to get “adjusted production income.” The result is that the recent decline in profits is much more significant than indicated in reported figures. Without government subsidies it is clear that the profits earned from agricultural markets have dropped, from \$47.6 billion in 1996 to \$22.3 billion in 2000.

On the surface it might appear that the local (and global) maximum of profits occurred in 1996. The first- and second-order conditions for a local maximum are met at that point in the time series for both Net Income and Adjusted Production Income. However, this raises two issues affecting empirical analyses of the life cycle for an industry. The first issue concerns how long the relevant time series needs to be. For example, if only the 1990-2000 period is used, 1996 would appear as a local maximum. If only the 1980-1990 period is used, 1983 would appear as a local minimum. And, finally, if only the 1970-1980 period is used, 1973 would be a local maximum. Therefore, the relatively short-run cycles in an industry’s life need to be placed into a long-run context. This brings up the second issue: difficulties arising in long-run analysis of nominal data. For example, using the entire 1970-2000 period shows 1996 and 1983 to be the global maximum and minimum, respectively. Yet, what about the local maximum at 1973? The nominal Adjusted Production Income of \$31.7 billion for that year was not exceeded until 1989 and is significantly larger than recent years’ results, so the year ought to be evaluated. To get a true comparison of the economic performance of the industry over such long time periods, the data need to be converted into real dollars. This was done for the 1949-2000 period (with 2000 being the base year) in an effort to deal with the two issues raised above.

The real profit data are shown in Figure 2. These data tell a very different story than the nominal data. Clearly, the peak in 1973 and the bottom in 1983 bracket an unusual decade of change in American agriculture. Nevertheless, real net farm income and adjusted production income are both slowly trending down in the long-term. The local maximum at 1951 is exceeded only in 1973 and trend lines from either of those two starting points have negative slopes through 2000.

The real profit data are consistent with the profit portions of both H_{M2} and H_{D2} , and inconsistent with the profit portion of H_{M1} . This is a clear signal that American agriculture is past the “early” Mature Stage of its life cycle. Whether it is in its “late” Mature Stage or its Decline Stage is yet to be determined.

Tests of Sales Hypotheses

As shown in Table 1, total sales (final crop output plus final animal output, as reported by the USDA 2001) of American agricultural producers have been mixed in recent years. In nominal terms it peaked at \$208.9 billion in 1997 and was \$20 billion lower two years later. No strong trend, up or down, can be detected in the recent data. This fact is obscured by the widespread reporting in the media of gross cash income and other aggregate “sales” figures that include items such as government payments, “other farm income” and “imputed rental value of

farm dwellings,” which distort true sales results and give the impression that sales are trending upward. Also adding to the confusion is the reporting of sales totals in nominal terms. Thus, total sales were converted into real dollars for the 1949-2000 period.

The results reported in Figure 2 give rise to two possible conclusions. First, one could conclude that real sales totals have a relatively flat trendline over the entire data period, with the 1972-1982 period being an anomaly. Second, one could interpret 1973 (or the 1973-1983 period) as a turning point when a slight uptrend reversed to create a downtrend. Regression analysis shows a positive trend in the real sales data prior to 1973 and a negative slope in the trend thereafter, thus 1973 would be the global maximum.

The hypotheses test results depend upon which conclusion above is used. If the first interpretation is used (i.e., 1972-1982 was an anomaly) the real sales data are consistent with the flat trendline described in the sales portion of H_{M2} . If the second interpretation is used (i.e., 1973-1983 was a turning point) the real sales data are decreasing as described in H_{D1} . In either case, the real data are not consistent with the sales portion of H_{M1} . I believe the first interpretation is arbitrary and invalid; an entire decade is *not* an anomaly. Therefore, the second conclusion is used here.

The nominal sales data tend to favor using the second interpretation: 1973-1983 was a turning point. As shown in Table 1, sales increased each year until 1980 (with 1973 having the single biggest increase of the 30-year period) and have increased in only 11 of the 20 years between 1980 and 2000. Clearly, markets for America’s agricultural output have been different since 1973-83.

Life Cycle Stage Determination

The determination of which life cycle stage American agriculture currently occupies depends on whether nominal or real data are used. In nominal terms it appears that total profits have fallen recently, but total sales revenues have not followed a clear trend in recent years. In terms of real dollars, total profits to American agriculture have clearly trended downward for half a century while total sales may have a flat or declining trend over recent decades.

If real data are used, the hypothesis tests indicate that American agriculture has unambiguously passed its early Mature Stage and is probably in the Decline Stage of its life cycle. The data do not support H_{M1} . The data support H_{M2} only if 1972-1982 is considered an anomaly and arbitrarily excluded from the analysis. Finally, it is argued here that 1973 was a turning point and, therefore, the data support H_{D1} and H_{D2} .

If nominal data are used, the results are inconclusive. The profits and sales peaks occurred in 1996 and 1997, respectively, so it is unclear whether the recent downturns are permanent or just short-term cyclical dips. Additional nominal data is needed to make conclusive inferences.

Real data are more appropriate for evaluating an industry’s economic performance over time. On the other hand, for an industry to disappear it must suffer nominal sales and profit declines. Thus, both types of data ought to be used when evaluating the end of an industry’s life cycle.

To do so it is proposed here that the Decline Stage of the PLCM be treated as having an “early” and “late” period, similar to the Mature Stage. When historical sales and profit data are converted into real terms with their purchasing power expressed in current dollars, trend turning points will be evident earlier in the real data than in the nominal data. That means hypotheses H_{D1} and H_{D2} will be supported earlier with real data. Therefore, the Early Decline Stage is

defined here to begin when H_{D1} and H_{D2} are supported by real data and the Late Decline Stage begins when H_{D1} and H_{D2} are supported by nominal data.

Using this methodology, the results of the hypotheses tests presented here are consistent with an American production agricultural sector that is in its Early Decline Stage. The sector's economic output is clearly shrinking in real terms. However, only when additional nominal data reveal that the recent decline in sales and profits is the permanent trend will we have enough "degrees of freedom" to know that American agriculture is near the end of its life cycle.

Why is American Agriculture Declining?

The answer to this question is first explained below using economic theory. Then the answer is illustrated with a case study.

The Underlying Economics

American production agriculture is declining because it is feeling the effects of two types of on-going changes: changes in its comparative advantage over the long run, and changes in its absolute advantage over recent decades. The general effects of these changes are illustrated in Figure 3.

Changes in comparative advantage occur as technological advances create new industries or substantially change existing industries within a region or country. When those advances result in changes in the relative profitability between industries, they can reduce the attractiveness of investments in existing industries, such as agriculture, causing resources to be shifted out of the sector. For example, Panel A of Figure 3 shows how changes in comparative advantage due to technological advances in the non-agricultural sector of the American economy make declines in the agricultural sector possible. In that figure, the production possibility frontier, FF, shifts upward to FF* when technical advances lower the marginal costs of production in the non-agricultural sector. In this two-sector model, the result is that the equilibrium output shifts from point E_1 to E_2 , which is on a higher indifference curve, thus America is better off. At that new equilibrium point, non-agricultural output clearly increases from Y_1 to Y_2 . Agricultural output is expected to decline from X_1 to X_2 because, as Johnson, Anderson and others have shown, even if a country retains a strong comparative advantage in agriculture, the sector's terms of trade relative to manufacturing and other non-agricultural industries will decline with economic growth. This will be true even if factor productivity growth is biased to agriculture because income inelastic demand for agricultural output ensures that agriculture's terms of trade will still decline over time (Anderson).

Changes in absolute advantage affect the degree of competition an industry faces. International competition and absolute advantage are now relevant to some industries in which comparative advantage exists, like American agriculture, because a regional comparative advantage in the production of some commodity is insufficient to overcome the industry's absolute disadvantage in a global market.

A global market now exists for a growing number of agricultural commodities due to technological advances in production, storage and transportation. Technology expanded production output, thus making it possible to saturate local markets (market saturation is discussed later in this section). That made it necessary for producers to look to more geographically distant consumers to purchase the surplus output. Technological improvements to storage methods enabled commodities, even the most perishable, to be kept in marketable

condition longer which, when combined with technological improvements to transportation systems, enabled firms to cover more distance and reach new markets. It is now routine for perishable agricultural commodities to be traded from one continent to another. That means every producer of a particular commodity is in direct or indirect competition with all other producers of that commodity, no matter where those producers might be located. This competitive market structure is a symptom of the undifferentiated nature of agricultural commodities.

Panel B of Figure 3 illustrates how being a part of a global market effects the terms of trade between America's agricultural sector and its non-agricultural sector. To begin, assume that no international trade of agricultural commodities occurs because it is not technically possible to deliver marketable products to foreign locations. Each country has available to it only the agricultural commodities it can produce. In that situation the American economy operates at point *A* on the production possibility frontier, *FF*. At that point, the domestic price ratio is $-P_x/P_y$, agricultural output is X_A , and non-agricultural output is Y_A . Then, assume a technological advance in product shipping (i.e., storage and/or transportation) makes it possible to deliver commodities to foreign markets. No trade will occur if agricultural prices in America, P_x , and the rest of the world, P_{xw} , differ by no more than per unit shipping (transport and storage) costs, s . However, if another technical advance in production, storage or transportation occurs outside of America such that $P_x - s > P_{xw}$, international trade will occur (if trade barriers do not prevent it) and the terms of trade between the American agricultural and non-agricultural sectors will change. In Panel B, the lower foreign price would shift the inverse price ratio in America to $-P_{x^*}/P_{y^*}$, which is the slope of the line *BC*. America would move to a new equilibrium in which it produced combination *B* and consumed combination *C*. Combination *B* involves America reducing its agricultural output from X_A to X_B and increasing its non-agricultural output from Y_A to Y_B . We would export $Y_B - Y_C$ to pay for our imports of $X_C - X_B$.

In summary, Panel B shows that technological advances in production that reduce commodity prices in other agricultural sectors, such as those of less-developed countries, reduce our absolute advantage in global commodity markets and reduces the terms of trade between our agricultural and non-agricultural sectors. The same result is also caused by technical advances that reduce shipping costs, s . Both of these results cause resources to be shifted out of American agriculture.

Technological advances in American agriculture counteract the effects of technical advances overseas by reducing our costs per unit, thus improving American agriculture's terms of trade and absolute advantage. Unfortunately, improvements in production have come with a downside for producers over the last several decades. "Agriculture in the twentieth century was characterized ... by technological innovation that ... made it possible for agricultural production to grow faster than the demand for food despite a rapidly growing world population. The result was a decline in real agricultural commodity prices throughout this era..." (Antle, p. 993). Thus, the "technological treadmill" of continual productivity improvement expands global supplies, which helps push commodity prices lower (Johnson and Quance).

It appears that the combined effects of globalization of agricultural markets and the (nearly) perfectly competitive structure of local markets facing individual producers have turned the "treadmill" to a critical point for American agriculture. The problem begins with the different demand curves facing producers versus the industry. For a producer in a perfectly competitive market for an undifferentiated commodity, the demand curve is flat. That creates a marginal revenue curve that is also flat. Marginal revenue (MR) is defined as

$$(3) \quad MR = \frac{dR}{dQ} = \frac{d(PQ)}{dQ} = P + Q \frac{dP}{dQ} .$$

As can be seen in equation 3, a flat demand curve has marginal revenues at all price levels of $MR = P$. For a producer, if MR exceeds marginal costs, the producer will expand output. Also, there is an incentive for each producer to adapt any technological advance that reduces marginal costs because it enables profits to be increased by expanding output. In other words, a flat demand curve encourages each producer to push his/her supply curve as far to the right as possible. Unfortunately, the demand curve facing the entire American production agriculture industry is normal, downward sloping to the right. That means both prices and marginal revenues will decrease with increased market supplies. As noted by Antle, industry supply has increased faster than demand, thus real prices have fallen for a century. Nominal prices have also fallen in recent decades, as indicated by the USDA's index of prices received by all U.S. farmers. These trends indicate the industry may have saturated its market. The saturation point is where $MR = 0$. As long as $MR > 0$, total sales will increase with expanded output. However, when $MR < 0$, sales revenues decrease with expanded output. Therefore, it appears that the addition of new foreign supplies to the global market, plus productivity improvements around the globe, have created a new equilibrium where the demand curve facing American producers offers negative marginal revenues at current market prices for many commodities. This partially explains the decreasing sales totals observed in this analysis.

The discussion above indicates that a key issue in a global competitive market is the *relative* rates of productivity increases between competitors because those rates affect marginal cost differences. In less-developed countries, agricultural productivity gains have been relatively higher than those in America over the last 40 years. Duffy (pp. 344-5) points out that "while the U.S. has out-paced the average of the other industrialized countries in increasing its production, the greatest gains have occurred in the developing nations." She reports Laspeyers indices for the 1961-2000 period of 2.0 for the U.S., 1.6 for other developed countries and 3.5 for less developed countries. That means costs per unit have dropped faster in newly competitive nations enabling them to remain profitable despite falling world prices. Therefore, America is losing the absolute advantage battle created by the advent of global commodity markets.

According to the Heckscher-Ohlin theory of international trade, when a country does not have an absolute advantage in the global market for a product in which it has a comparative advantage, it is forced to compete on the basis of lower factor prices (e.g., wages, land prices, etc.) or by adjusting its currency exchange rates. A country can make the price of its product in which it has a comparative advantage competitive in absolute terms by forcing down factor prices or lowering the value of their currency (Harrigan; Peterson and Valluru).

In America, however, falling agricultural factor prices create incentives to shift resources out of agriculture and into alternative investments. When land, capital and other factor prices are pushed down by declining agricultural profitability, as they have been in the northern and southern plains over the past two decades (USDA 2000a, 2000b), non-agricultural uses of those factors become more attractive. Thus, agricultural output will decline most quickly in regions where there are the most alternative uses of input factors. However, in regions with few alternatives, agricultural production will hang on as long as it offers any profits.

A Case Study

The same economic analysis used to explain international trade explains the patterns of production and trade between regions within America over time. For example, Iowa was the sixth largest apple and grape producing state in the 1920's, but it and the other Midwestern states are now dominated by the production of grain crops and grain-eating livestock. The change was brought about by technological changes that altered the absolute advantage of those Iowa apple and grape growers. To begin, perishable commodities like apples could not be transported very far during the 1920's because storage and transportation technology was far less effective and more expensive than it is now, so Iowa and other states in the region had to be self-sufficient in those markets. If apples were not grown in the area, consumers would have to go without apples because it was not possible to import them from other apple-producing regions, like Virginia, New York and Washington. Thus, farmers in Iowa who had a regional comparative advantage in growing apples were the sole source for the local market. However, as technology changes made it possible to ship apples, grapes and other perishable commodities to Iowa from the east and west coast regions, absolute cost became relevant, as illustrated in Figure 3. Quickly demand for apples in Iowa and the surrounding region could be met entirely by supplies from outside the region. Midwestern consumers chose to buy the cheaper apples imported from the coasts. Iowa farmers were forced to shift out of the high-value crops that were not well suited to the Midwestern climate and into production of the next-best commodities for which they had a comparative advantage: grains and grain-eating livestock.

“The ultimate expansion of cereal production into the semiarid lands of the Great Plains was dictated by least comparative disadvantage. These lands are far less productive in wheat than the fertile and well-watered areas to the east, but cereals are one of the few alternative uses for the dry lands and their production is made economical by an appropriate evaluation of the basic land resource.” (Bressler and King, p. 350)

For decades the Midwest region had an absolute advantage in the market for grains, so those were profitable industries. In recent decades, however, technology changes have enabled foreign competitors to expand output, pushing global market prices for those commodities down to levels that are often not profitable for Midwestern producers (Weimar and Hallam). One result is that farmland values in Iowa, Texas and other states in the Great Plains are lower now in nominal terms than they were two decades ago (USDA 2000a). However, this factor price decline is not enough to save much of the domestic industry in the long run.

As Thurow (pp. 44-45) explains, there are other places with both comparative and absolute advantages in grain production that will push global prices so low that American producers will be forced out of the market. “The Ukraine is potentially the best place on earth for growing grain.” It has not yet reached its current potential for contributing to global supplies because of capital and other constraints on its ability to fully implement modern production and distribution technologies. When it does get its industry up to western standards, their “sales will drive millions of less productive grain farmers out of business all around the world.”

“In the United States it is clear who goes out of business. Go to the 98th meridian, remembering that about one third of Kansas is east of the 98th meridian, and draw a line from the Canadian border to the Gulf of Mexico; then swing west to the

Rocky Mountains. Every grain farmer in that part of the United States goes out of business. The soil is worse, the rainfall is worse, and the transportation system is much, much worse than what is found in the Ukraine. It won't happen tomorrow, but it will happen." (Thurow, p. 45)

Implications and Conclusions

The "overproduction trap" described by Johnson and Quance three decades ago has become worse with market globalization. Economic incentives facing all producers encourage expanding output, and production and trade capacities have increased across the globe due to technological advances. The result is a trend of falling commodity prices that is expected to continue in the future (USDA 2000b). This leads to (at least) three conclusions.

First, production agriculture has been declining in relative terms across America for decades due to changes in comparative advantage. Other industries offer better returns on investments and, thus draw resources out of agriculture (Bjornson and Innes). This is occurring despite the effects of regional production specialization, falling factor prices, and government interventions in commodity markets (Harrigan; Peterson and Valluru). In sum, individual agricultural producers are making investment decisions to protect their personal wealth and, in the aggregate, these decisions are causing resources to leave America's agricultural sector (Blank 2001a).

Second, the scale of changes has reached the level where absolute declines in agriculture's economic output are now beginning to show. As prices fall due to expanding global supplies and international trade, marginal revenues fall. American agriculture may now face an aggregate demand curve where marginal revenues are negative.

Absolute reductions in agriculture's output are directly related to, but lagged behind, changes in prices and production costs. When price or cost changes make $MR < MC$, producers shift resources out of production as soon as they expect the change to continue in the long run. However, agricultural asset fixity slows the adjustment process (Johnson and Quance). Also, there are different rates of adjustment in various regions. The decline is fastest where non-agricultural alternatives exist. America's East and West coast regions have many alternatives, therefore no large factor price depressions will occur before resources are reallocated in those areas. The availability of alternative investments means that opportunity costs of not shifting resources are high. On the other hand, the decline of agriculture is slowest where non-agricultural alternatives are few. In the Midwest large factor price depressions occur before resources are reallocated because opportunity costs are low, especially for land.

The third conclusion is that the competitive structure of markets for undifferentiated products makes survival dependant upon local costs relative to global market price. This indicates that America's absolute disadvantage will continue to force our producers out of business. Our production inputs – land, labor, etc. – are higher priced than resources in less-developed countries (Antle). The resulting absolute cost advantage of less-developed countries makes them economically stronger over time and willing to continue expanding their output.

In summary, America appears to be in the Early Decline Stage of its production agriculture sector's life cycle. The industry's economic output is declining and faces an increasingly difficult future due to the competitive structure of the expanding global markets for commodities.

References

- Anderson, Kym, "On Why Agriculture Declines With Economic Growth," *Agricultural Economics* 1(1987): 195-207.
- Antle, John M., "The New Economics of Agriculture," *American Journal of Agricultural Economics* 81(1999): 993-1010.
- Bjornson, B. and R. Innes, "Another Look at Returns to Agricultural and Nonagricultural Assets," *American Journal of Agricultural Economics* 74(1992): 109-119.
- Blank, Steven C., *The End of Agriculture in the American Portfolio*, Westport, Connecticut: Quorum Books, 1998.
- _____, "Producers Get Squeezed Up the Farming Food Chain: A Theory of Crop Portfolio Composition and Land Use," *Review of Agricultural Economics* 23, 2 (2001a): 404-422.
- _____, "The Challenge to Think Big as American Agriculture Shrinks," *Journal of Agricultural and Resource Economics* 26, 2 (2001b): 309-325.
- Bressler, Jr., R. and R. King, *Markets, Prices, and Interregional Trade*, New York: John Wiley & Sons, 1970.
- Duffy, Patricia A., "Casting Bread Upon the Water: Comments on Technology, Globalization, and Agriculture," *Journal of Agricultural & Applied Economics* 33, 2 (2001): 341-347.
- Goetz, S. and D. Debertin, "Rural Population Decline in the 1980s: Impacts of Farm Structure and Federal Farm Programs," *American Journal of Agricultural Economics* 78(1996): 517-529.
- Harrigan, J., "Technology, Factor Supplies, and International Specialisation: Estimating the Neoclassical Model," *American Economic Review* 87, 4 (1997): 475-494.
- Johnson, D. Gale, *World Agriculture in Disarray*, Fontana: London, 1973.
- Johnson, Glenn L. and C. LeRoy Quance (eds.), *The Overproduction Trap in U.S. Agriculture*, Resources for the Future, The John Hopkins University Press: Baltimore, 1972.
- Lilien, G. and P. Kotler, *Marketing Decision Making, A Model-Building Approach*, New York: Harper & Row, Publishers, 1983.
- Peterson, W. and S. Valluru, "Agricultural Comparative Advantage and Government Policy Interventions," *Journal of Agricultural Economics* 51, 3 (2000): 371-387.
- Thurow, Lester C., *The Future of Capitalism: How Today's Economic Forces Shape Tomorrow's World*, New York: Penguin Books, 1996.
- U.S. Department of Agriculture, *1997 Census of Agriculture*, National Agricultural Statistics Service, 1998.
- _____, "Accumulated Farm Real Estate Value Will Help Farmers and Their Lenders Through Period of Declining Cash Receipts," *Agricultural Income and Finance: Situation and Outlook*, Economic Research Service AIS-74, February 2000a, pp. 30-3.
- _____, "With Low Commodity Prices, Government Payments Support Farm Income," *Agricultural Income and Finance: Situation and Outlook Report*, Resource Economics Division, Economic Research Service, AIS-75, September 2000b, pp. 4-13.
- _____, "Off-Farm Income Supports Many Farm Households," *Agricultural Income and Finance: Situation and Outlook Report*, Resource Economics Division, Economic Research Service, AIS-76, February 2001, pp. 32-34.
- Weimar, M. and A. Hallam, "Risk, Diversification, and Vegetables as an Alternative Crop for Midwestern Agriculture," *North Central Journal of Agricultural Economics* 10(January 1988): 75-89.

Exhibit 1. Methodology to Identify Life Cycle Stage.

Introduction Stage hypotheses:

H_{I1}: Total sales revenues are slowly increasing ($R_{t+1} > R_t$).

H_{I2}: Total profits are negative but improving ($0 > \pi_{t+1} > \pi_t$).

Growth Stage hypotheses:

H_{G1}: Total sales revenues are increasing ($R_{t+1} > R_t$).

H_{G2}: Total profits are positive and increasing ($\pi_{t+1} > \pi_t > 0$).

A convex sales function is not necessary, but a sufficient condition, thus:

H_{G1*}: Total sales revenues are increasing at an increasing rate.

$$(dR_{t+1}/dt+1) > (dR_t/dt) > 0$$

Maturity Stage hypotheses:

H_{M1}: Early in the stage, total sales are increasing and profits peak.

$$(R_{t+1} > R_t) \text{ and } [(d\pi_t/dt) = 0]$$

H_{M2}: Late in the stage, total profits are decreasing and sales peak.

$$(\pi_t > \pi_{t+1} > 0) \text{ and } [(dR_t/dt) = 0]$$

Decline Stage hypotheses:

H_{D1}: Total sales revenues are decreasing ($R_t > R_{t+1}$).

H_{D2}: Total profits are decreasing ($\pi_t > \pi_{t+1}$).

Figure 1. The Product Life Cycle

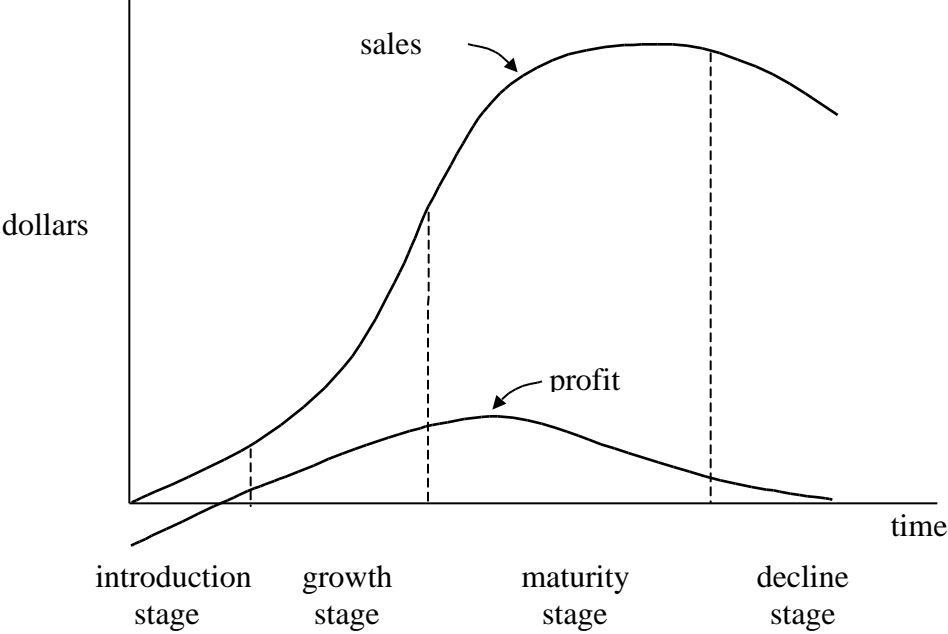


Figure 2. Real U.S. Agricultural Sales and Income, 1949-2000

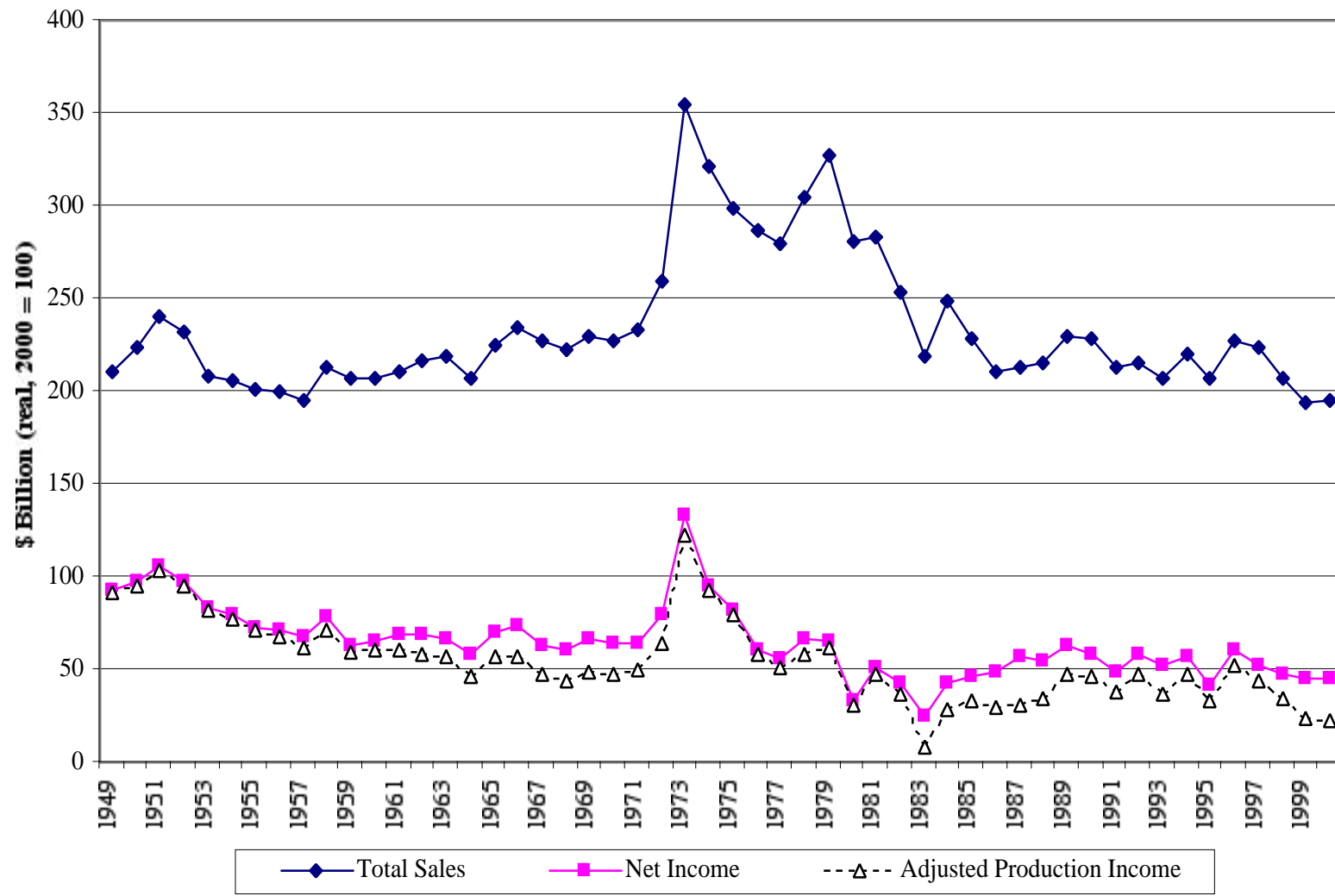
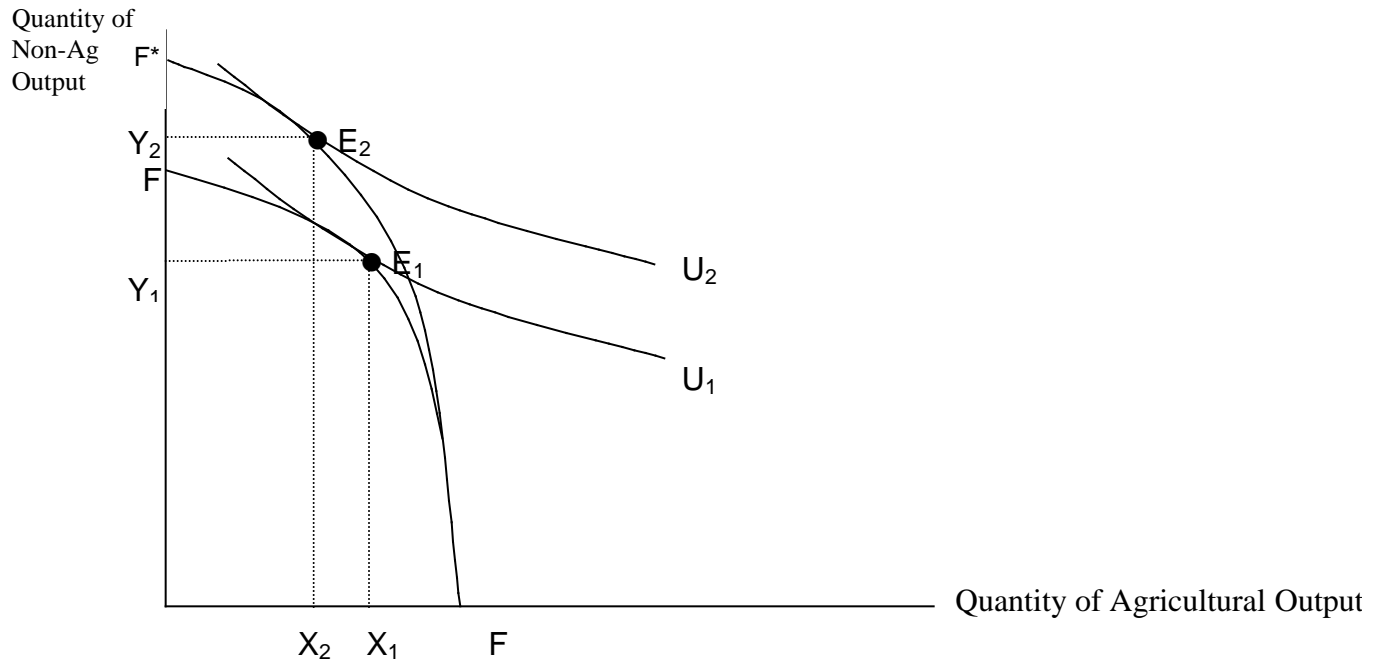


Table 1. U.S. Agricultural Sales and Income, 1970-2000 (Nominal)

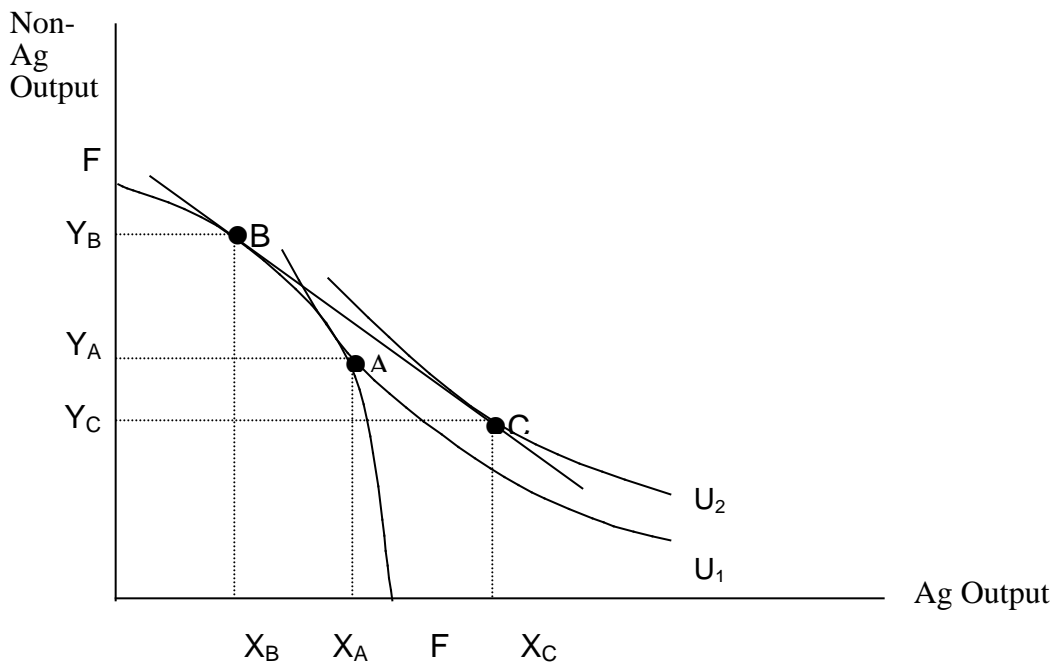
Year	Total crop and livestock Sales	Net Income	Direct Government Payments	Adjusted Production Income
\$ billion				
1970	51.3	14.4	3.7	10.6
1971	54.9	15.0	3.1	11.9
1972	62.9	19.5	4.0	15.5
1973	91.4	34.4	2.6	31.7
1974	92.0	27.3	0.5	26.7
1975	93.4	25.5	0.8	24.7
1976	95.0	20.2	0.7	19.4
1977	98.5	19.9	1.8	18.1
1978	115.5	25.2	3.0	22.2
1979	137.9	27.4	1.4	26.0
1980	134.7	16.1	1.3	14.9
1981	149.3	26.9	1.9	24.9
1982	142.3	23.8	3.5	20.4
1983	126.9	14.2	9.3	5.0
1984	149.8	26.0	8.4	17.5
1985	142.8	28.6	7.7	20.9
1986	134.1	30.9	11.8	19.1
1987	140.2	37.4	16.7	20.7
1988	147.9	38.0	14.5	23.5
1989	165.3	45.3	10.9	34.4
1990	173.5	44.6	9.3	35.3
1991	168.3	38.5	8.2	30.3
1992	176.0	47.7	9.2	38.5
1993	174.3	44.3	13.4	30.9
1994	190.0	48.8	7.9	40.9
1995	183.4	36.9	7.3	29.6
1996	207.6	54.9	7.3	47.6
1997	208.8	48.6	7.5	41.1
1998	196.3	44.6	12.2	32.4
1999	188.2	43.4	20.6	22.8
2000	195.3	45.6	23.3	22.3

Source: USDA (2001) and earlier.

Figure 3. Effects of Changes in Comparative and Absolute Advantages



Panel A. Technology changes comparative advantage



Panel B. Technology changes absolute advantage

The period of a business cycle after its lowest point and before its highest point. _____ Occurs after the trough and before the peak. It is a period during which aggregate economic activity is increasing. Trough. The lowest point of a business cycle, as the economy comes out of a recession towards an expansion. Peak. As the expansion slows down and the economy moves towards a recession _____ Occurs at the end of the expansion or boom, and signals the onset of a contraction (also known as downturn or slowdown). Contraction or (recession). The period of a business cycle after the peak and before the trough; often called a recession or, if exceptionally severe, called a depression. A period during which aggregate economic activity is declining. Recession. It was a time when the Cold War was also at its height, but great faith was being put on multilateral action to promote development and economic growth and to maintain peace. I decided to join FAO not only because the United Nations system was being called on as the major conduit of high-quality technical and material assistance to developing countries, but mainly. Primary product prices were relatively stable, official development assistance was increasing in real terms over time. and the presence of large stocks of cereals was taken for granted. This relatively stable era for most developing countries came to an end with the oil price increases of 1972-73 and the fall in grain production in the main producing areas in 1972. Import needs rose, and grain surpluses disappeared almost overnight. Agriculture is an important branch of economy. Economic growth of any country depends on the development of agriculture, which supplies people with food and clothing and industry with raw materials. The word "agriculture" is a Latin word. It means the cultivation of fields in order to grow crops. Now agriculture also includes the use of land to breed farm animals. We do not know when people began to grow crops. It was many thousands years ago. Now crop production and animal husbandry are highly developed branches of agriculture. Life is impossible without plants. They play a highly important r American Agriculture: Its Changing Significance. United States Economy. But farming has been particularly valued in the United States. Early in the nation's life, farmers were seen as exemplifying economic virtues such as hard work, initiative, and self-sufficiency. Moreover, many Americans -- particularly immigrants who may have never held any land and did not have ownership over their own labor or products -- found that owning a farm was a ticket into the American economic system. Changes in the weather give agriculture its own economic cycles, often unrelated to the general economy. And nearly 60 percent of the remaining farmers at the end of the century worked only part-time on farms; they held other, non-farm jobs to supplement their farm income.