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CROPS AND LIVESTOCK

Alan L. Olmstead and Paul W. Rhode

The dynamics of American agricultural development have been closely intertwined with the political and social evolution of the country and dependent on changing technological and market forces. This is clearly reflected in the composition of crop and livestock output and the prices that farmers received. The data in this section offer insights into many of the fundamental structural changes that transformed rural America.[1] As examples, one can track the spread of new activities, such as the immense growth in soybean production (series Da677), the takeoff in fruit and vegetable output (Tables Da791–967), and the growing importance of the broiler chicken industry in the twentieth century (series Da1045). The mirror image of these changes has been a fundamental change in the diet of most Americans. The data on commodity prices in this section also help document the extent of the agricultural crises of the 1890s and the 1930s. For example, the data show that between 1890 and 1896, as Populist agitators urged farmers to "grow less corn and raise more hell," nominal corn prices plummeted from 50 cents to 21 cents a bushel (series Da697). In a similar fashion, it is possible to chart the disastrous fall in commodity prices in the Great Depression. For instance, the nominal price of cotton dropped from almost 17 cents per pound in 1929 to less than 6 cents per pound in 1931 (series Da757). The data also reveal the sharp increase in commodity prices – for example, the doubling of wheat prices over the 1972 and 1973 crop years (series Da719) – that led some to call the 1970s the "Era of Limits to Growth."

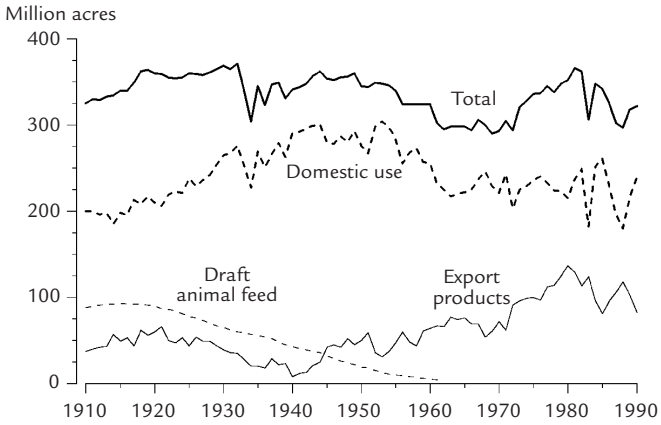

FIGURE Da-F Cropland harvested, by use: 1910–1990

Sources

Series Da661–664.

Documentation

Note that beginning in the early 1960s, as the importance of horses and mules declined, the U.S. Department of Agriculture ceased estimating the amount of cropland required to feed them.

Crops and Land Utilization

Figure Da-F offers an indication of the change in the market for agricultural output over most of the twentieth century. The figure shows the U.S. Department of Agriculture's (USDA) estimates of the acreage of harvested cropland devoted to three major categories – domestic consumption, feed for draft animals, and the export market – from 1910 to 1990. Over the twentieth century the total area harvested has fluctuated between about 290 and 370 million acres. The fluctuations in this indicator help trace the course of farm prosperity and farm policy. As an example, the sharp drop in acres harvested in the early 1930s was a result of the ravages of the Dust Bowl, the agricultural depression, and the acreage reduction programs discussed in the essay on farm policy in this chapter.[2] The total acreage harvested increased as a result of high demand during World War II and then inched downward with a slackening in demand and more aggressive federal land "conservation" policies.

[1] Atack and Passell (1994, pp. 274–98 and 402–26). These structural changes include factors discussed elsewhere in this chapter such as the change in the location of production, the introduction and spread of new crops, the changes in farming technologies and increases in farm productivity, and the relative (and after 1940, the absolute) decline in the farm population.

[2] As a result of prolonged periods of deficient rainfall coupled with farming technologies that made the soil more susceptible to high winds, vast areas of the Great Plains suffered prolonged dust storms beginning in 1933. These storms did terrible damage to Western agriculture, with the dust darkening the sky as far away as New York City. The worst-hit regions included the panhandles of Oklahoma and Texas, eastern Colorado and New Mexico, and western Kansas. This area became known as the Dust Bowl. American agriculture suffered a prolonged period of hard times beginning shortly after World War I and continuing to the early 1940s.

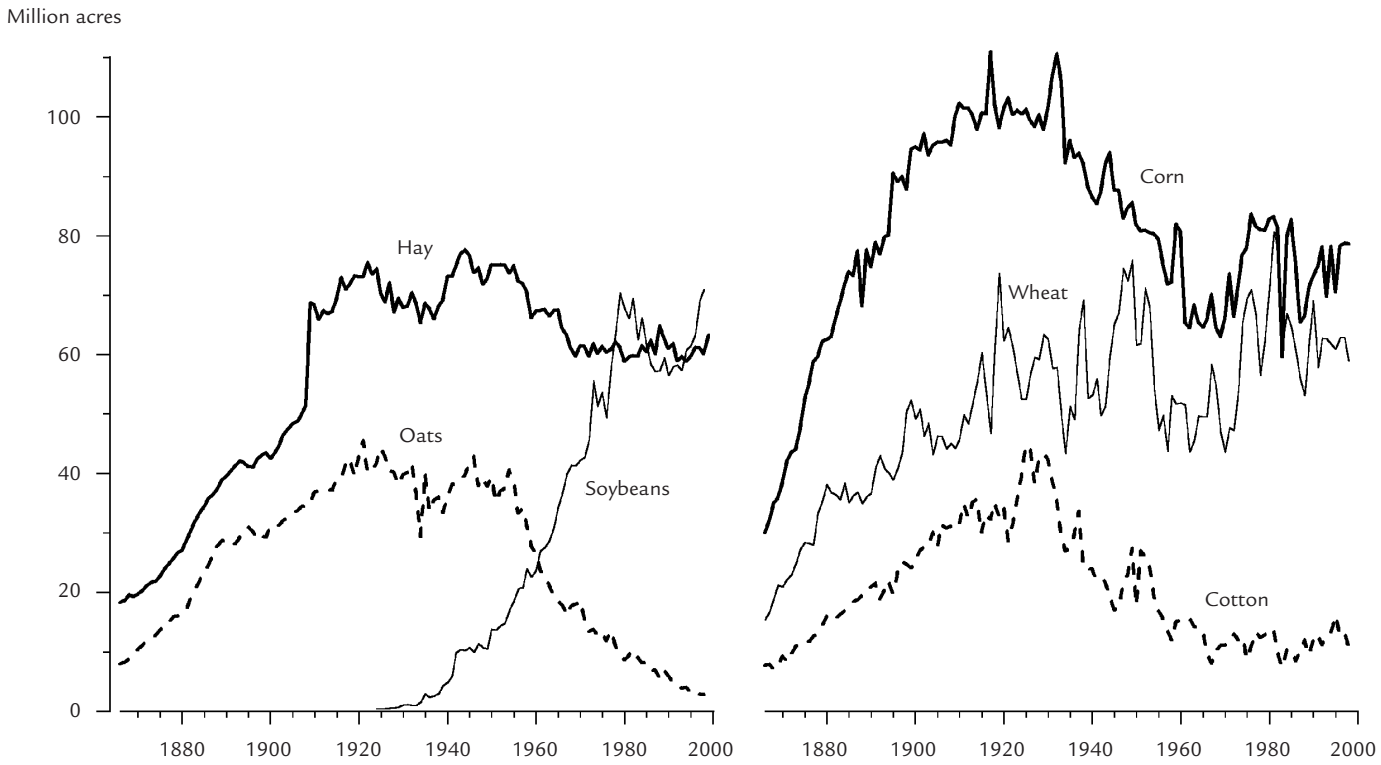

FIGURE Da-G Acreage of major crops: 1866–1999

Sources

Oats, series Da670; soybeans, series Da676; corn, series Da693; wheat, series Da717; hay, series Da733; and cotton, series Da755.

Documentation

Note that the series for hay represents tame hay (that is, cut from cultivated grasses) through 1908, and all hay thereafter – hence the jump in the series beginning in 1909.

Decomposing the total acreage harvested into its component uses also illustrates some of the most spectacular economic and social changes of the past 100 years. In 1910 about 27 percent of all American cropland harvested was devoted to feeding 24 million horses and mules. (Millions of acres of pastureland also were used to feed horses and mules.) These animals provided the power to make the country's farms and cities tick. The rapid decline after 1930 in the area devoted to grow food for horses and mules offers a graphic indicator of the wholesale adoption of automobiles, trucks, and tractors. The decline in draft animals was the flip side of the growth in the demand for petroleum products. This transformation reflected a significant change in the day-to-day nature of farm life (Olmstead and Rhode 1994).

The data on the acreage devoted to export markets also reflect broader changes in the economic and political landscape. The decline in the 1920s and 1930s signaled the breakdown of the international economy in the interwar years as most European countries raised their tariffs and imposed domestic content provisions requiring bakers and others to use locally grown commodities (Liepmann 1938).

The resurgence in acreage harvested for export crops beginning in 1941 reflects the impact of World War II, which disrupted agriculture in Europe and around the world and led to an increased international demand for U.S. farm products (see Tables Da1323–1336). It also reflects a movement away from the extreme tariff policies of the 1930s. By the 1990s about one third of America's cropland harvested was used to produce food and fiber for export.

The information in Figure Da-G allows us to take a longer-term view of American agricultural evolution by charting the acreage harvested for six leading crops since 1866. The growth in acreage until about 1920 reflects the continued westward expansion and filling in of the agricultural frontier. The settlement of new lands was one of the major features of American agriculture since the time of the first European settlements. As a result the locus of production for all crops inched westward. As an example, in colonial times New York, Pennsylvania, and Virginia were major wheat growing regions. By the time of the Civil War, the Wheat Belt had moved to the Midwest and included such states as Illinois, Michigan, Wisconsin, and Iowa. By the end of the nineteenth century, Kansas, North Dakota, and South Dakota had emerged as leading producers of wheat. With these shifts in the center of production came important shifts in the varieties of wheat grown. The soft wheat varieties that prospered in the East or Midwest were not suited for the harsh winters and relatively arid conditions found in the Great Plains. Thus settlement was dependent on a steady process of scientific inquiry and trial and error as new varieties from around the world were imported. As of 1929 more than 80 percent of the wheat acreage in the United States was planted with varieties (mostly hard winter and spring wheat) that had not existed in the country until the 1870s (Olmstead and Rhode 2002; Dalrymple 1980).

Similarly, the center of cotton cultivation shifted significantly over the nineteenth and twentieth centuries. On the eve of Eli Whitney's invention of the saw gin in 1793, U.S. cotton production

was limited chiefly to the coastal regions of South Carolina and Georgia. During the early nineteenth century, the crop spread over the black belt of Alabama and Mississippi and into the rich soils of the Mississippi–Yazoo Delta. Production in many areas of the "Old South" declined. After the Civil War, cotton acreage expanded throughout the South. Further, as the boll weevil began its campaign of destruction in the South after it appeared in 1892, cotton cultivation leapfrogged west to the irrigated valleys of Arizona and California, which were relatively insusceptible to the pest. Circa 1960, Texas, Mississippi, and California, respectively, were the three leading cotton-producing states. As in the case of wheat, the westward expansion of the crop was associated with significant changes in the varieties of cotton grown. As two examples, the expansion of the industry in the Mississippi Delta was largely based on Mexican cotton, introduced in 1806, whereas the growth in the production in California's Central Valley, roughly a century later, was founded on the cultivation of Acala varieties, also imported from Central America (Moore 1988).

For most years, corn has been the predominant crop in the United States in terms of acreage (series Da693). For example, between 1910 and 1925, an average of more than 100 million acres, or roughly three tenths of national cropland harvested, was devoted to raising this one crop. In the 1940s, the land area planted to corn began a prolonged decline. It is important to emphasize that because of productivity changes associated with the diffusion of hybrid seed beginning in the mid-1930s and the increased application of fertilizer, U.S. corn output continued to grow even though acreage fell. By the 1970s the acreage in corn was roughly equal to the acreage in wheat, hay, and soybeans. The meteoric rise in soybean acreage since the 1930s reflects the continued willingness of American farmers to adopt new crops from other parts of the world (series Da676).[3] For the most part, soybeans replaced cotton in the South and corn in the Midwest, providing increased diversification. This was particularly true in the South, where there was a decreased dependence on cotton and a significant increase in cattle and dairy operations.

The search for new products was not limited to introducing new crops such as soybeans, sorghum, and sugar beets. Even "old" crops such as cotton and corn could be put to new uses. For example, over the nineteenth century cotton farmers found a growing market for a previously little-used by-product, cottonseed. Before the Civil War, cottonseed, which is produced in roughly fixed proportions with cotton lint, was typically discarded and represented an environmental hazard. After the war, the seed was increasingly valued as a source of vegetable oil, as a lard substitute (Crisco®), and as an animal feed. By 1909, the dollar value of cottonseed output was more than 15 percent of that of cotton (series Da760). Over the twentieth century, one of America's oldest crops, corn, was consumed in such new forms as oleomargarine, ethanol, and corn sweeteners. In the latter case, scientific breakthroughs allowed for the manufacture of crystallized sugar from corn by 1922. The new product was an instant success and by 1928 150 million pounds of corn sugar were consumed (McMillen 1929, p. 177). Further scientific advances beginning in the 1950s led to the rapid growth of the high-fructose corn syrup industry in the 1970s. These examples illustrate how American farming became more efficient by finding higher-value uses for crops, animals, and their by-products.

The data on oats and hay acreage also tell an important story (Tables Da667–678 and Da733–745). The rise and fall in oat production roughly tracked the increase and decrease in the horse and mule population (Table Da983–987). The increase in hay acreage was in part a response to the increase in the number of draft animals. But the decrease in the demand for hay stemming from the decline in draft animals was largely offset by the increase in cattle feedlots (Olmstead and Rhode 1997).

Changes in the Livestock Industry

In recent decades the income generated from marketing livestock products has accounted for more than half of the gross value of all farm income (Schertz et al. 1979). Figure Da-H provides an overview of the changes in livestock on farms since 1867. Here one can clearly see the rise in the population of horses and mules on farms up until World War I and its subsequent decline as tractors, trucks, and automobiles became the predominant sources of power on farms. Perhaps somewhat surprising is that the population of dairy cows fell by more than 65 percent between the 1940s and the end of the twentieth century (series Da1020). This decline in the number of cows reflects the enormous improvement in productivity in the dairy industry: despite the radical reduction in the number of animals, the total volume of milk production increased by roughly 30 percent over this same period.

Among the most prominent features of American agricultural development in the twentieth century was the growth in the number of cattle (series Da968). Between 1940 and 1980 the number tripled, rising from about 40 million to about 120 million head. Just as there were important changes in the genetic makeup of the wheat and cotton crops grown in the United States, significant developments also occurred in the genetic composition of the

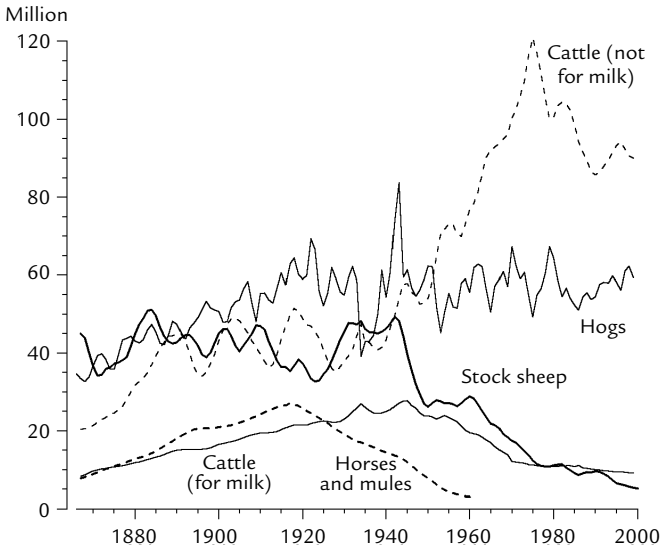

FIGURE Da-H Livestock on farms: 1866–2000

Source

Cattle (not for milk), series Da968 minus series Da1020; hogs, series Da970; stock sheep, series Da972; cows and heifers kept for milk, series Da1020; and horses and mules, series Da983 and Da985.

[3] Sugar beets (series Da783) and grain sorghum (series Da673), not shown in Figure Da-G, represent similar, if less dramatic, examples of the same phenomenon.

cattle population. In the colonial period most cattle (including those used for milking) were tough and sinewy, adapted for surviving in the wild, but not especially well suited for dairy or meat production. The same was true in the nineteenth century. The longhorns that participated in the famed cattle drives from Texas to the railheads in Kansas would be judged to be of very low quality by today's standards. Modern cattle, however, would not have endured the hardships of the wild Texas range and the long cattle drives (Leavitt 1933).

The nineteenth and twentieth centuries saw persistent efforts to improve cattle breeds, often involving the importation of purebred animals from Europe. As examples, statesman Henry Clay of Kentucky reportedly imported the first Hereford cattle into the United States in 1817. The first Guernsey cattle were imported in 1830, and the first Holstein–Friesians in 1857. The next step was for farmers to form registries and breeding associations. In 1846 the first herd book for Shorthorns was compiled and in 1863 an Ayrshire breed association was founded (Smith and Roth 1990). A slow process of transforming the bloodlines of American cattle followed over the next century. The spread of improved cattle breeds, along with better feed and care of dairy cows, led to a major increase in milk production per animal. In 1800 the average cow probably produced less than 1,000 pounds of milk a year. By the mid-1990s annual milk output per cow averaged more than 16,000 pounds (Pirtle 1926; Bateman 1968; Forste and Frick 1979). The improvements in meat quality, although more difficult to quantify, have also been enormous.

The broiler chicken industry also experienced rapid growth and profound technological change during the twentieth century. Between 1934 and 1998 production soared from about thirty-four million to almost eight billion birds a year (series Da1045). Over this same period the average weight of a live broiler increased by about 71 percent, from 2.8 to 4.9 pounds, and the inflation-adjusted price of broilers fell by 86 percent (series Da1047). These changes were made possible by revolutionary advances in the organization and scale of broiler production along with the application of scientific principles to the feeding and care of the birds. Whereas just a few decades ago it was the norm for every farm to raise its own chickens, perhaps marketing a few surplus birds, in the last decades of the twentieth century broiler production became a highly concentrated, capital-intensive industry, with much of the production moving to the Southern states (Rogers 1979). The effect on consumers was enormous. Chicken used to be a luxury item that was more expensive than beef. But the rapid growth in productivity in the poultry industry and the associated increase in output and fall in prices made chickens available to most Americans, more than making good Herbert Hoover's bold 1928 presidential campaign promise of a "chicken in every pot."

Demand and Prices of Farm Products

In addition to supply-side changes that increased productivity in the farm sector, changes in demand have played an important role in determining the mix of farm output. As the real incomes of Americans increased, consumers demanded a different and more varied market basket, in line with the predictions of Engel's Law. Consumption of starches has generally declined while that of more flavorful foods has increased. This has led to relatively more rapid growth in demand for livestock, dairy, and poultry products and for fresh fruits, nuts, and vegetables.[4] In addition to the growth in population and per capita incomes, a number of other changes affected the composition of demand for agricultural goods. Smaller families, the increase in the number and percentage of women working outside the home, and changes in household technologies, such as the change from iceboxes to electric refrigerators, all influenced consumption patterns. Exogenous supply-side changes outside the agricultural sector have also shaped the composition of agricultural output. For example, the development of artificial fibers such as rayon, nylon, and polyester fleece has reduced the demand for natural fibers such as wool, silk, and cotton.

As a final note, this section includes extensive information on commodity prices, typically measured at the farm gate. Movements in these series have attracted much attention over the past 130 years because commodity prices have played a central role affecting the well-being of rural America. These data have many uses, but one must be careful to note that they are in nominal or current value terms and therefore do not adjust for changes in the overall price level. It is important to recall that gross farm income is calculated by multiplying price and quantity. A farmer who increased production might well expect a higher income, but if all farmers increased production, the net effect might be a more than proportional decline in prices and, as a result, a fall in income.[5] In addition, prices often fluctuated significantly as a result of conditions in faraway lands. A comparison of the movement in farm prices with those in other sectors (for example, industrial prices) indicates that farm prices tended to be more volatile, especially before the New Deal. The reason is that the consumption and production of farm goods tended to be relatively unresponsive to price changes in the short run and because agriculture was more susceptible to exogenous shocks such as bad weather that could have significant effects on output. These factors help explain the periodic outbreaks of unrest in the farm sector, even when output was increasing. But it is also important to note that declining prices do not necessarily imply declining well-being of farmers, as the falling prices may be due to declining costs resulting from productivity advances, which are discussed in the essay on agricultural productivity in this chapter. Finally, the price movements after the 1930s reflect more than simply the working of the private market. The essay on farm policy in this chapter offers a more detailed analysis of the operations of federal agricultural policies.

By focusing on how price trends affected suppliers (that is, farmers), perhaps the most important implication of the development of American agriculture is often overlooked. That is the enormous benefits consumers have received. As a result of improved technology and more efficient production and distribution systems, the long-term trend has been to afford consumers a better and more varied bundle of goods at dramatically lower real prices. This is one of the most remarkable achievements of the last two centuries.

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[4] The growing importance of myriad products in the category of fruits, nuts, and vegetables accounts for the greatly expanded coverage in this edition of *Historical Statistics of the United States*.

[5] In more technical terms, this condition would hold if demand were price inelastic.

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AGRICULTURAL PRODUCTIVITY

Julian M. Alston and Philip G. Pardey

One of the most striking and central features of the development of U.S. agriculture has been the increased output per acre, per head of livestock, per farm, and per farm worker, especially during the twentieth century (Bonnen 1986). These are some of the more visible and tangible signs of productivity growth in agriculture arising from investments in the development and adoption of new methods, machines, plant varieties, livestock breeds, and agricultural production know-how.

In the earlier period of expansion of the agricultural land base, production growth came partly from increases in land and labor inputs, as well as from improved technology (Cochrane 1993). During the past 100 years, improved technology has allowed continuing growth in agricultural output from a given or shrinking area of agricultural land, while at the same time using many fewer hours of labor. Labor-saving technology has been critical. Much of the reduction of the agricultural labor force has come about through the consolidation of farms into fewer, more specialized, and larger units. In some instances, especially in intensive livestock and some specialty crops, vertical integration of farming with pre- and post-farm production has been an important element of structural change, facilitated by changes in technologies.

Through these means, U.S. agriculture has been able to supply such an abundance of food and fiber that real, that is, inflation-adjusted, farm-gate prices of food and fiber are much lower than they were 100 years ago, in spite of the growth in demand for most agricultural products that has accompanied the growth in population, per capita income, and trade (Schultz 1956). Productivity growth is the reason why the Malthusian nightmare, in which subsistence defines the entire economy, has not materialized.

Much of the dramatic transformation of U.S. agriculture over the past 100 years, as well as before that time, can be traced to the adoption of new technologies that allowed more to be produced with less (Griliches 1957; Smith and Roth 1990). To understand fully the implications of technological change requires considering and understanding all of the causes and impacts. Such understanding is elusive because the relationships are complex and ever-changing. A first step is to document those aspects that can be measured and more readily understood.

The Measurement of Agricultural Input, Output, and Productivity

The data in this section provide a comprehensive picture of U.S. agricultural productivity during the twentieth century, and some partial but useful measures of productivity extending back into the earlier periods. Economists use the word "productivity" in a technical sense with a meaning similar to that found in common usage, only more specific. The general notion is to measure the *quantity* produced, compared with the *quantity* or the *cost* of the inputs used to produce it.

Some *partial* productivity measures express the quantity of a particular output relative to the quantity of a particular input or resource – output or yield per acre, or output per worker (usually per year). Other measures account for more of the inputs. A *total* productivity measure would express total output relative to the total quantity of all of the inputs used in production, but we rarely have all the data needed to measure the totality of inputs and outputs. More often, what is practical to achieve is a *multifactor* productivity (MFP) measure that expresses aggregate output relative to aggregate input – perhaps omitting certain outputs and inputs that are either difficult to measure or not sufficiently covered by available data. For example, the accumulation of highly localized, within-farm information on soil conditions or improved planting, weeding, and harvesting operations has important productivity consequences. Management skill is another type of unmeasured input that accounts for some productivity growth.

These measures or *indexes* of input, output, and productivity necessarily involve aggregating across different commodities, or different qualities of the same commodity, at a given place and point in time; they usually also involve aggregating to some extent over space and time as well. The measures themselves will depend on the decisions made about how to go about this aggregation, which depend to some degree on the availability of data (Griliches 1960, 1963).

As a related matter, the choice of indexing procedure may be important. The so-called *index number problem* arises when distortions in the aggregate quantity (or price) index result from the use of inappropriate price (or quantity) weights in aggregating the quantities (or prices) of individual goods. For instance, the aggregate price index for agricultural output was computed as a Laspeyres index, in which the series of prices of each of the individual commodities making up the index was multiplied by a