

EVALUATION OF THE U.S. ARMY CORPS OF ENGINEERS  
FORECASTS OF U.S. GRAIN EXPORTS

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In April 1997, Jack Faucett Associates, in cooperation with Sparks Commodities, Inc. (FS), submitted a report to the U.S. Army Corps of Engineers (COE) entitled "Waterway Traffic Forecasts for the Upper Mississippi River Basin, Volume II - Grain" (4). The forecasts in this report are used by the COE to estimate the benefits of extending several 600-foot locks to 1,200 feet on the Upper Mississippi and Illinois rivers. While the Faucett report was published in 1997, it forecasts U.S. grain exports from 1995-2050. Thus, there is a five-year period -- 1995-1999 -- in which the FS forecasted grain exports can be compared with actual 1995-1999 exports.

The FS forecast model, which assumes stocks to be a constant percent of supply, is:

$$X = S - C$$

where

X = U.S. grain exports

S = U.S. grain supplies

C = U.S. domestic consumption of grain

The FC model assumes that the United States will export all the residual supply that is not consumed domestically. The model simply assumes that importing countries will buy all of the U.S. grain remaining after domestic consumption and the constant percentage stocks are satisfied. These exports are allocated to importing countries based on historical export shares.

The model was estimated separately for corn, wheat, soybeans, sorghum, barley, and oats. This review will focus on corn, wheat and soybeans because these three grains are the dominate generators of Upper Mississippi River barge traffic.

The FC model does not include any variables relating to world grain import demand or world grain supply. Figures 1, 2 and 3 in the Appendix <sup>1/</sup> show world and U.S. corn and wheat production from 1960-1999 and soybean production from 1964-1999. In 1960, the U.S. produced about 50 percent of world corn production. By 1999, the U.S. share of world corn production had declined to about 40 percent. In 1960, the U.S. produced about 16 percent of world wheat production. By 1999, the U.S share had declined to about 11 percent of world production. In 1964, U.S. soybean production was about 65 percent of world soybean production. By 1999, U.S. soybean production had declined to 47 percent of world soybean production. From 1960-1980, the U.S. was the dominant producer of corn and soybeans. Now, the rest-of-the-world is the dominant producer of corn and soybeans. The U.S. has not been a dominant wheat producer.

Figure 4 shows the trends in world population and grain production and exports. World population grew from 3.3 billion people in 1965 to 6.1 billion in 1999, an increase of 85 percent. Grain production grew from 0.9 billion tons in 1965 to 1.86 billion tons in

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<sup>1/</sup> The Appendix contains all of the figures in this review.

1999, an increase of 107 percent. Thus, world grain production grew at a faster rate than world population. Moreover, most of this growth in grain production was in the countries where it was consumed. World grain exports were essentially flat from 1980-1999. Thus, it is clear that the world population is becoming less reliant on imports to satisfy its demand for feed and food grains.

#### U.S. SHARE OF WORLD EXPORTS

Figures 5, 6 and 7 show world and U.S. exports of corn, wheat, and soybeans.<sup>2/</sup> From 1960 to 1980, world and U.S. corn exports followed almost parallel upward trends. The upward trend in corn exports was slightly exponential; that is, exports increased at an increasing rate. However, that exponential rate of growth came to a dramatic halt in 1980. World corn exports declined sharply in the early-to-mid 1980s -- falling almost a billion bushels per year in the mid-1980s. World exports recovered in the late 1990s but have never again reached the 1980 level of 3.34 billion bushels.

U.S. corn exports declined even more than world corn exports. By 1986, U.S. corn exports had declined 38 percent from the 1980 level of 2.4 billion bushels. While U.S. corn exports rebounded sharply from 1986 to 1989, they have never reached the 1980 level of 2.4 billion bushels. Overall, the trend in world corn exports has been slightly upward since 1980 while the trend in U.S. corn exports has been downward. Thus, the U.S. has lost corn export market share since 1980.

World wheat exports also increased exponentially from 1970-1980. Since 1980, world wheat exports have increased but at a much slower rate of growth. U.S. wheat

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<sup>2/</sup> All export and consumption annual data are for crop years rather than calendar years. The reported year is the second year of the crop year.

exports increased rapidly from 1970 to 1980 but at a slower rate than world wheat exports. However, since 1980, U.S. wheat exports have declined sharply. The gap between the world export trend line and U.S. export trend line has grown dramatically, indicating that the U.S. has lost a substantial share of world wheat exports.

The U.S. was the dominate exporter of soybeans from 1964-1970. World soybean exports increased dramatically from 1970-1980. During the same period, U.S. soybean exports increased but at a much slower rate than world exports. From 1980-1987, U.S. soybean exports declined sharply. Beginning in 1988, soybean exports started trending upward but have never reached the 1980 export level.

#### FORECASTS OF U.S. GRAIN EXPORTS

Figures 8, 9 and 10 show the trends in U.S. corn, wheat and soybean exports for 1960-80 and 1980-99 extrapolated to 2025. These figures also show the COE export projections from 1995-2025.<sup>3/</sup>

#### CORN

The historical peak in U.S. corn exports was in 1980. The major drivers of the 1972-1980 surge in corn exports were:

1. In 1972, the U.S. dollar was released from the \$35 per ounce international gold standard and there was an abrupt global shift away from the Bretton Woods international agreement on fixed exchange rates. These two events resulted in a drastic decline in the value of the U.S. dollar and therefore a dramatic reduction in the cost of U.S. grains to importing countries.

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<sup>3/</sup> All COE export projections were taken from Appendix D of the FS report.

2. The Soviet Union began to develop its oil reserves to become a major oil exporter. These oil exports provided the revenues for massive purchases of U.S. grains.
3. Rapid global economic growth and inflation, stimulated by sharp increases in global money supplies to offset the quadrupling of petroleum prices, provided the revenues for importing countries to purchase U.S. grains.

This 1980 peak, which has never been reached again, was the end of the exponential growth in corn exports. Since 1980, U.S. corn exports have trended downward.

U.S. corn exports have declined sharply since 1995, while the COE erroneously forecasted U.S. 1995-1999 corn exports to increase sharply. The COE projection is based on a trend line from 1960-1993. Thus, the COE projection assumes that the rapid growth in 1972-80 corn exports will fuel exports in the future. Twenty years of export data since 1980 have shown this to be a false assumption. Even the reviewer hired by the COE to evaluate the FS projections stated "The odds of being correct are much higher by staying with the trend, but also having a system to recognize the turning points and adjusting to the changed direction" (3). Given the growth trend in world corn production shown in figure 1, there is nothing on the horizon to suggest that the world will, over the long term, buy all of the residual of U.S. corn supplies minus domestic consumption as assumed by the COE forecasts. Thus, the COE failed to follow the advice of its own reviewer to recognize the 1980 turning point and adjust to the change of direction in corn exports. As a result, the COE grossly overestimated future corn exports. This overestimation of corn exports directly leads to a gross overestimation of the benefits from lock extensions.

## WHEAT

U.S. wheat exports increased rapidly from 1960 to 1980. The rapid growth started with the famous "Russian wheat sale" in 1972-74 and was fueled by the same global forces which stimulated corn export sales from 1972-1980. Since 1980, U.S. wheat exports have trended sharply downward with a huge 49 percent drop from 1981 to 1985. There was a temporary recovery in 1985-86 but the downward trend resumed in the late 1980s. Despite a 14-year downward trend in wheat exports from 1980-1994, the COE analysis assumed a suddenly sharp upward trend in wheat exports beginning in 1995. As shown in figure 2, the strong upward growth in world wheat production means that there is little or no likelihood that the COE forecast of sharply escalating U.S. wheat exports will be realized.

## SOYBEANS

U.S. soybean exports increased sharply from 1965-1980 and declined from 1980-1993 before rising again. U.S. soybean exports have yet to reach the 1980 level. The trend of actual exports since 1980 has been slightly upward. However, the COE forecast for 2003 rises rapidly above the actual trend. The gap between the upward COE forecast and the actual trend line widens sharply to 2025 and beyond. Figure 3 shows that world soybean production is increasing at a much faster rate than U.S. production. Moreover, world production is likely to continue to increase even more rapidly as Brazil, Argentina, Bolivia, India, Uruguay, Paraguay and other developing countries continue to increase their soybean production. The Cerrados region in central Brazil alone has 160 million

acres of undeveloped land that is suitable for grain production (7). This is more arable land than the United States had in corn and soybean production in 1998.

Moreover, several other oilseeds and competing products, including palm oil, palm kernel products, rapeseed, field peas, grain milling by-products and synthetic amino acids, compete with soybeans. The production of these competing oilseeds and products has also been increasing rapidly. This growing competition facing U.S. soybeans means that the United States is already adding value to corn and soybeans through increased processing, and the conversion of corn and soybeans to meat and food products. Moreover, production of corn and soybeans for pharmaceutical and nutraceutical products and new industrial products is likely to grow. Many Iowa and Minnesota farmers are forming "closed cooperatives" which buy corn and soybeans from their members to be fed to swine or poultry rather than to sell their grain in the export market. This shift to value added production, encouraged by USDA and almost all Midwest state governors, will slow or decrease the growth in raw soybean exports. This slower growth in raw soybean exports will likely be accompanied by increased exports of value-added products.

Figure 11 shows the aggregated 1980-1999 actual trend in U.S. corn, wheat and soybean exports extrapolated to 2025. The chart also shows the aggregated COE forecasts for these exports. The trend of the actual exports, based on the 20-years from 1980-1999, is clearly downward. The COE, on the other hand, forecasts rapidly rising grain exports. This optimistic and unrealistic COE forecast is based on the U.S. dominance in the export market during the period from 1960-1980. However, that world no longer exists! The U.S. has been losing market share and the increasing world corn,

wheat and soybean production suggests that the U.S. will continue to lose market share with or without Upper Mississippi and Illinois river lock extensions.

## SHIFTS IN THE DEMAND FOR GRAIN IMPORTS

In addition to the growing world supply of corn, wheat and soybeans, there are fundamental shifts in the worldwide demand for imported grains. A country-by-country or group of countries analysis will help identify some of these shifts:

### TAIWAN, SOUTH KOREA AND JAPAN

These three countries are normally the largest customers of U.S. corn, importing about 1.17 billion bushels in 1998 or approximately 59 percent of all U.S. corn exports. Figures 12, 13 and 14 show actual corn exports to these three countries from 1987-1998. They also show 1995-2025 COE projections of exports to those three countries and a "most likely" projection based on basic changes in import demand. The "most likely" forecasts are based on the most recent 19-year export trends. These trend forecasts are modified based on one or more of the following:

- environmental restraints on livestock production in major east Asia markets
  - economic and political pressures on China to adopt modern corn production technology, and to shift livestock production from swine to more feed-efficient poultry and fish production
- and
- recognition of fundamental changes that have occurred in the FSU-15.

Corn imports to Taiwan have declined sharply since 1995, largely a result of an outbreak of foot-and-mouth disease in the Taiwan swine herd. A large portion of the hog population had to be destroyed thereby reducing the demand for U.S. corn imports. The so-called "Asian Flu" -- economic recession -- was a minor factor in this decline in imports. The Asian Flu affected other Asian markets more severely. Thus, the recent level of corn imports to Taiwan are sharply below COE projections for that country.

Exports of U.S. corn to Japan have also been below COE forecasts since 1994. The main reason for this failure to meet COE projections is concern about the ability of Japan to safely manage the waste from the large numbers of animals fed in Japan. Approximately 80 percent of all corn imported in Japan is fed to livestock.

U.S. corn exports to South Korea also slowed considerably following a huge jump in 1994. The COE forecasts very rapid increases in U.S. corn exports to Taiwan and South Korea and a moderate increase in corn exports to Japan. Presumably these forecasts are based on accelerated economic growth, with no environmental constraints to their domestic livestock and poultry production.

The "most likely" forecasts show no growth in U.S. corn exports to Taiwan and very slow increases in exports to South Korea and Japan. The reasons for the much less optimistic forecasts are contained in figures 15, 16, 17 and 18.

Figure 15 compares the population per square mile of Japan, South Korea and Taiwan with Iowa and Indiana. Taiwan's geographic area is one-fourth as large as Iowa; yet, Taiwan has almost 7.7 times more people than Iowa. Indiana is almost the same size as South Korea; yet, South Korea has 8 times more people than Indiana. Japan is 2.6 times larger than Iowa; yet, has 44 times more people than Iowa. All three countries have

mountainous interiors that have major limitations for human habitation and intensive grain-fed livestock production.

Figure 15 shows the population per square mile of these two states and three countries. Iowa has 51 people per square mile compared to 872 for Japan, 1,237 for South Korea and 1,603 for Taiwan.

Figure 16 shows the number of hogs per square mile for these two states and three countries. Taiwan has 471 hogs and 1,603 people per square mile. These numbers substantially understate the hog and people densities because the center of Taiwan is largely mountainous that holds few people or hogs. The inability of Taiwan to safely manage animal and human waste was likely a major contributor to the outbreak of foot-and-mouth disease. South Korea also has a large hog density.

Figure 17 shows the number of poultry birds for the two states and three countries. Japan has 24 times more poultry birds than Iowa. Taiwan has 12 times more broilers alone -- not including layers and ducks -- than Iowa.

Figure 18 shows the poultry birds per square mile. Taiwan has 31,650 birds per square mile - not including layers and ducks -- compared to 670 poultry birds per square mile in Iowa. South Korea has 7,050 broilers -- not including layers and ducks -- per square mile while Japan has 6,200 birds per square mile. All three countries have mountainous interiors which increases the population and animal density on level land. These mountain interiors are unable to absorb much of the animal and human waste produced by the large human and animal populations. Concerns about the safety of human and animal health will likely restrict animal numbers to about current levels and, thereby, restrict imports of U.S. corn to about current import levels even in the face of

economic recovery. Furthermore, economic recovery will provide the additional income to increase and pay for meat and poultry imports by these three countries rather than increasing corn imports for local livestock feeding.

Most Midwest states have low population and animal densities per square mile. Moreover, the large amount of corn produced in these Midwest states means that animal waste, properly handled as a substitute for chemical fertilizers, becomes an asset in the Midwest rather than a liability as it is in Taiwan, South Korea and Japan. Much of the imported meat and poultry products into these three countries, particularly pork and beef and frozen eggs will likely come from Upper Midwest states including Iowa, Minnesota, Missouri, Nebraska and Illinois as well as Canada. This substitution of meat and eggs for corn and soybeans will reduce the demand for barge traffic on the Upper Mississippi and Illinois rivers.

Figures 19, 20 and 21 show historical U.S. soybean exports to Taiwan, South Korea and Japan. The figures also contain COE export forecasts to 2025 along with a "most likely" export projection based on relatively stable livestock numbers. The COE forecasts increasing soybean exports to Taiwan and Japan while the "most likely" projections show imports continuing at approximately current levels to provide protein to relatively stable numbers of livestock.

## CHINA

Figures 22, 23 and 24 show historical U.S. exports of corn, wheat and soybeans to China. They also show the COE forecasts and "most likely" exports to China to 2025. China imported small amounts of U.S. corn in 1987 and 1989. In 1994 and 1995, China

imported 129 million and 88 million bushels respectively. These large corn exports to China in 1994 and 1995, along with Lester Brown's book "Who will feed China?" (1), created a euphoria that the United States must gear up to produce and transport huge amounts of corn to feed China. Therefore, the COE forecasts for China are not based on a trend of exports to China; rather they start at the 1994 peak exports to China which is extrapolated to almost 300 million bushels in 2025. This export peak was partially in response to weather problems which affected China's non-irrigated production. However, net U.S. corn exports to China collapsed to zero in 1996 and the following years as China resumed exporting its own corn. Lester Brown's book motivated the Chinese government to re-examine its agricultural policy and to intensify its longer-term agricultural planning. Thus, the question remains "Who will feed China?".

Figure 23 presents a comparison of U.S. and China corn yields from 1960-1999. The gap between U.S. and China corn yields has remained fairly constant at roughly 40 bushels per acre. However, U.S. corn yields are much more variable than China's. The principal reason for this higher variability is that a major part of China's corn crop is irrigated while U.S. yields are more dependent on the level of rainfall. Moreover, China continues to build dams on its large rivers which will provide water for additional irrigated crop acres. The principle reason for the difference in level of yields is the superior U.S. technology.

Figure 24 shows the trend in China corn production along with an estimate of potential corn production in China assuming that China adopts U.S. technology and applies this technology to all of its corn production. Under this assumption, China is capable of increasing its corn production from about 5 billion bushels to about 8 billion

bushels per year. In fact, combining China's vast irrigation system with the superior U.S. technology means that China's corn yields could even exceed those of the United States. Many U.S. seed and chemical companies are initiating sales programs in China which should speed up the adoption of U.S. technology. Therefore, the "most likely" corn exports to China are expected to be very low. While China may sporadically import larger quantities of corn, adoption of U.S. seed and chemical technologies, will over the long run, allow "China to feed China." This means that the COE has grossly overestimated potential U.S. corn exports to China.

Some observers place hope on a WTO agreement that would turn China into a consistently large corn importer. However, a number of other variables including closing the technology gap, political implications of heavy dependence on imported corn and the value of China's currency will be key factors affecting the supply, demand and trade position of corn in China in future years. The technological gap, alone, casts major doubt on the COE projections for China.

Figure 25 shows the historical level of wheat exports to China, along with the COE forecast and a "most likely" forecast of wheat exports to China. U.S. wheat exports to China have declined sharply since reaching 295 million bushels in 1988. By 1993, wheat exports had fallen to about 71 million bushels, recovered slightly in 1994 and 1995 and then continued a near free-fall in 1996, 1997 and 1998. Nevertheless, the COE forecasted a huge increase in wheat exports to China in 1997. Note that the huge forecast is not based on a trend but rather on what appears to be a "hope" that these exports will take place. The COE forecasted about 285 million bushels of wheat exports in 1998;

actual 1998 wheat exports to China were seven million bushels. Thus, the COE 1998 wheat export forecast to China was 41 times greater than actual 1998 exports.

Figure 26 shows why China is likely to import only small quantities of U.S. wheat. Wheat yields in China reached the same level as U.S. yields in the early-1980s and have continued to grow at a faster rate than U.S. yields. China's wheat yields now exceed U.S. wheat yields by 38 percent. This is further evidence that, with the adoption of modern technology, "China will feed China."

The one bright prospect for U.S. grain exports to China is soybeans. Unlike corn and wheat, China has not been successful in substantially increasing its soybean production. Figure 27 shows recent soybean export trends to China as well as COE and "most likely" forecasts. U.S. soybean exports to China began growing rapidly in 1995 and reached 80 million bushels in 1998. China will likely need additional protein for human and animal nutrition and U.S. soybeans will help fill this need. The COE, on the other hand, forecasts essentially no U.S. soybean exports to China in the late 1990s and only modest quantities for 2000 and beyond.

#### EU-15 (EUROPEAN UNION)

Figure 28, 29 and 30 show corn, wheat and soybean exports the EU-15. U.S. corn exports to the EU-15 have been declining since 1987 and essentially reached zero in 1997. The COE forecasts future corn exports to decline from about 111 million bushels in 1994 to around 70 million bushels around 2000 and then to rise gradually to 97 million bushels in 2025. In reality, the United States has already lost the EU-15 corn market

because of consumer dissatisfaction with genetically modified corn. Furthermore, the U.S. is unlikely to recover this market.

U.S. wheat exports to the EU-15 have been in the range of 25-50 million bushels per year. The COE forecasts little growth in U.S. wheat exports while the "most likely" forecast suggests that wheat exports will reach about 58 million bushels by 2025.

U.S. soybean exports to the EU-15 have been highly variable, falling from 328 bushels in 1995 to 230 million bushels 1998. The COE forecasts a sharp increase in soybean exports, gradually increasing to 390 million bushels in 2025. The most likely scenario, reflecting concern over genetically modified soybeans, forecasts more modest growth reaching about 345 million bushels in 2025. Much of the growth in EU-15 demand for oil and protein will likely be filled by Brazilian soybeans and other oilseeds and competing products.

#### FSU-15 (FORMER SOVIET UNION)

Figures 31, 32 and 33 show U.S. corn, wheat and soybean exports to the FSU-15 and projections to 2025. During the 1970s, the former Soviet Union was the major importer of U.S. corn and wheat. Since the breakup of the Soviet Union, U.S. corn, wheat and soybean exports have declined dramatically to very small quantities. Since the total COE grain export forecast is based largely on the dramatic growth in exports to the Soviet Union during the 1970s, the COE analysis is based on a world that no longer exists. While the COE forecasts only modest amounts of corn, wheat and soybean exports to the FSU-15, once these countries develop the correct economic incentives for increased domestic food production, the FSU-15 countries as a group will likely become

net exporters of corn and wheat. The Ukraine and Kazakstan have already shifted into that position. Thus, U.S. corn and wheat exports to the FSU-15 will likely fall to zero. On the other hand, once the FSU-15 develops the correct incentives for increased livestock production, they will likely increase their imports of U.S. soybeans to provide protein to livestock slightly above the COE forecasts. Climatic limitations in the FSU-15 restrain their ability to produce large amounts of soybeans.

## MEXICO

Figures 34, 35 and 36 show corn, wheat and soybean exports to Mexico. Corn exports to Mexico were higher than COE forecasts in 1994, 1995, 1997 and 1998. Therefore, the "most likely" forecast shows slightly higher U.S. corn exports to Mexico than the COE. However, increased corn exports for livestock feeding in northern Mexico will likely be transported from the U.S. by rail.

U.S. wheat exports to Mexico were also higher than COE forecasts each year since 1994. Therefore, the "most likely" forecast suggests higher levels of U.S. wheat exports to Mexico than the COE forecasts. Again, much of this wheat will be transported from the U.S. wheat belt to Mexico by railroad.

U.S. soybean exports to Mexico were also higher than COE forecasts for 1994-1999. Therefore, the most likely forecast estimates higher levels of soybean exports to Mexico than the COE. Again, soybean exports for use in animal feeds in northern Mexico are likely to be transported by railroads.

## SUMMARY

Figure 37 shows a comparison of actual 1999 total corn, wheat and soybean with COE 1999 export forecasts. Total U.S. corn, wheat and soybean exports were 3.9 billion bushels. The COE forecasted 4.9 billion bushels; i.e., one billion bushels -- 25 percent -- more than actual exports.

Figure 38 shows the 1995 and 1998 actual exports to the seven largest U.S. grain customers along with the "most likely" and COE forecasts to 2010. The most "likely forecasts" show 2010 exports to be higher than 1998 exports but lower than 1995 exports. The COE forecasts exports to be about 742 million bushels greater than 1995 actual. The largest differences between the "most likely" and COE forecasts are for Taiwan, South Korea and China.

Figure 39 shows a comparison of 1995 and 1998 actual exports with the "most likely" and COE forecasts for 2025. The "most likely" forecast is about the same as 1995 actual exports. The COE forecasts about 4.1 billion bushels of corn, wheat and soybean exports to these seven countries. The largest difference in the two sets of forecast are those to Taiwan, South Korea, China and Mexico. To put the very optimistic COE forecast in perspective, the U.S. has never exceeded the level of 1980 grain exports.

## CONCLUSIONS

The grain export forecasts used in the COE analysis to estimate the benefits from extending locks on the Upper Mississippi and Illinois rivers are taken from the results of a model developed by Faucett Associates and Sparks Commodities, Inc. (FS). The FS model assumes that importing countries will buy all surplus U.S. grain, i.e., U.S. supplies

minus U.S. domestic usage. Furthermore, the FS model uses a trend analysis of the period from 1960-1994 to forecast future U.S. grain exports. This model grossly overestimates actual U.S. grain exports from 1994-1999 and will likely overestimate future exports to the year 2050 for the following reasons:

1. The assumption that importing countries will buy all surplus U.S. grains has proven to be false for the first five-years of the COE projections. The COE forecast large increases in U.S. corn and wheat exports for the period 1995-1999 when, in fact, U.S. corn and wheat exports declined sharply during this period. Corn exports declined because of sharply lower exports to Taiwan -- which suffered an outbreak of swine foot-and-mouth disease, to South Korea, because of the economic recession and concern over animal waste management problems, and to China, which reduced its imports of U.S. corn to near zero. U.S. soybean exports increased from low levels in the late 1980s but have never reached the record levels of 1980. U.S. wheat exports declined sharply because of a huge reduction in wheat exports to China and reductions in exports to other countries. Historically, the U.S. has suffered through large carryover inventories and these inventories are accumulating again. There are recent calls for the U.S. government to re-impose controls on grain production via an expanded 10-year Conservation Reserve Program.
2. The FS model failed to account for dramatic increases in world production of corn, other feed grains, wheat and soybeans. This increased world production enables the rest-of-the-world to be less reliant on imports of U.S. grains.

3. The model failed to account for fundamental shifts in demand for corn in Taiwan, South Korea and Japan. These shifts in demand stem largely from concerns over the effect of large amounts of animal wastes on human and animal health in densely populated countries.
4. The model relied heavily on trends in U.S. exports from 1960-1980. During this period, the world did indeed rely heavily on U.S. grains. That reliance abruptly stopped in 1980. The trend in U.S. grain exports since 1980 has been steadily downward. There is no evidence on the horizon that suggests this trend in world grain production and U.S. grain exports will be reversed.
5. The COE ignored the advice of its own reviewer who suggested that "The odds of being correct are much higher by staying with the trend but also having a system to help recognize the turning points and adjusting to the changed direction." The COE failed to recognize -- or chose to ignore -- the changed direction in U.S. grain exports beginning in 1980 and trends since that time. As a result, its projections are based largely on the huge increases in U.S. exports in the 1970s, which were fueled by the shift from fixed to floating exchange rates, freeing the dollar from the \$35 per ounce international gold standard, drastic devaluation of the U.S. dollar and major grain sales to the Soviet Union. That world no longer exists!
6. Assuming the COE discounts future savings from lock extensions back to 1994 dollars, and recognizing that the early years, 1995-1999, will be discounted the least and therefore have the greatest impact on total benefits from lock extensions, the gross overestimation of actual 1995-1999 U.S.

exports guarantees that the estimated benefits of lock extensions are greatly overestimated. Given the extreme deviation of COE export projections from the recent 20-year downward trend in U.S. grain exports, the COE export projections and the resulting benefits from lock extensions are highly suspect and highly overestimated.

## Bibliography

- (1) Brown, Lester R. "Who will to feed China? Wake-up call for a small planet." W.W. Norton and Company. New York, NY: 1995.
- (2) Gudmunds, Karl and Alan Webb, PS&D View software. ERS, US Department of Agriculture. Washington, DC: April 1993.
- (3) Hurt, Chris, "Review of Grain and Oilseed Export Forecast for the Upper Mississippi River by Jack Faucett Associates." Purdue University: April 14, 1998.
- (4) Jack Faucett Associates. "Waterway Traffic Forecasts for the Upper Mississippi River Basin, Volume II: Grain." Appendix D. Bethesda, Maryland: April 18, 1997.
- (5) Komai, Toru. "Fewer Birds and Growers In Japan." Poultry International. March 1999, p.34-36.
- (6) Lawrence, John. Professor of Economics, Iowa State University, personal communication, January 2000.
- (7) Portugal, Alberto Dueque. "State of the Soybean Agribusiness in Brazil." Proceedings, World Soybean Research Conference VI. Chicago, IL: August 4-7, 1999.
- (8) Sell, Jerry. Professor of Animal Science, Iowa State University, personal communication, January 2000.
- (9) U.S. Department of Agriculture. *Foreign Agricultural Service-Grains: World Markets and Trade*. 5 Jan. 2000  
<<http://ffas.usda.gov/grain/circular/2000/00-01/graintoc.htm>>.
- (10) U.S. Department of Agriculture. *Foreign Agricultural Service-Livestock Tables*.. 1 Dec. 1999 <<http://ffas.usda.gov/dlp/circular/1999/99-10LP/livestock.html>>.
- (11) U.S. Department of Agriculture. *Foreign Agricultural Service-Poultry/Egg Tables*. 1 Dec. 1999 <<http://ffas.usda.gov/dlp/circular/1999/99-10LP/poultry.html>>.
- (12) U.S. Department of Agriculture. *Foreign Agricultural Service-U.S. Export Sales Reports*. 1 Dec. 1999 <<http://151.121.3.140/export-sales/>>.
- (13) U.S. Department of Agriculture. "Livestock, Dairy and Poultry Situation and Outlook." Economic Research Service. Washington, DC: November 23, 1999.
- (14) U.S. Department of Agriculture. *USDA Economics and Statistics System-NASS: Chickens and Eggs*. 1 Dec. 1999 <<http://usda.mannlib.cornell.edu>>.

- (15) U.S. Department of Agriculture. *USDA Economics and Statistics System-NASS: Hogs and Pigs*. 1 Dec. 1999 <<http://usda.mannlib.cornell.edu>>.
- (16) U.S. Department of Agriculture. *USDA Economics and Statistics System-State Facts by FAX*. 1 Dec. 1999 <<http://usda.mannlib.cornell.edu>>.
- (17) U.S. Department of Agriculture. *USDA Economics and Statistics System-World Agricultural Supply and Demand Estimates*. 1 Dec. 1999 <<http://usda.mannlib.cornell.edu>>.
- (18) U.S. Department of Agriculture. *USDA Economics and Statistics System-World Population and Projections to 2050*. 1 Dec. 1999 <<http://usda.mannlib.cornell.edu>>.
- (19) WorldWatch Institute. *State of the World*. Washington, D.C.: 1998.
- (20) World Book Encyclopedia, Chicago : World Book, c1997.

**APPENDIX**  
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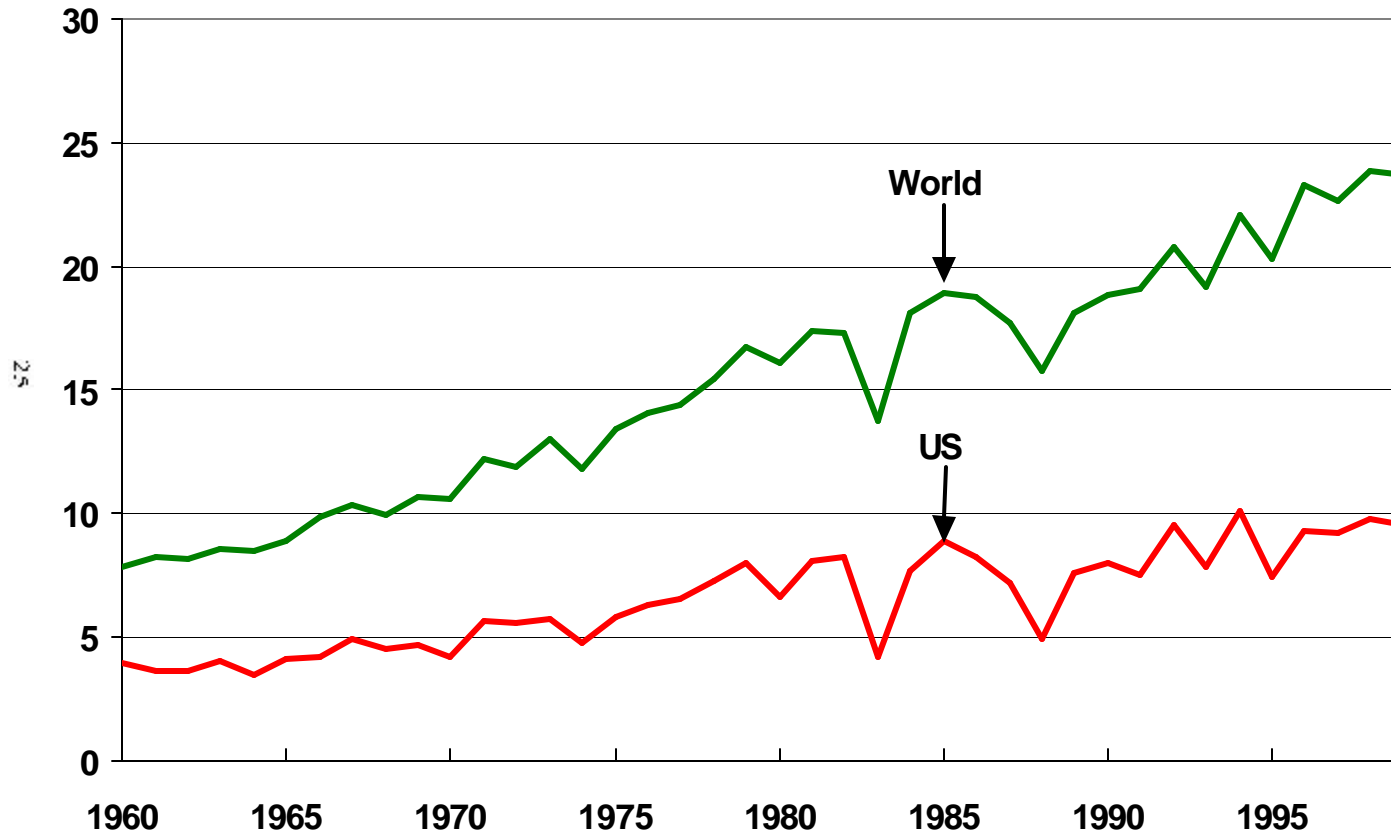
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Billion bushels

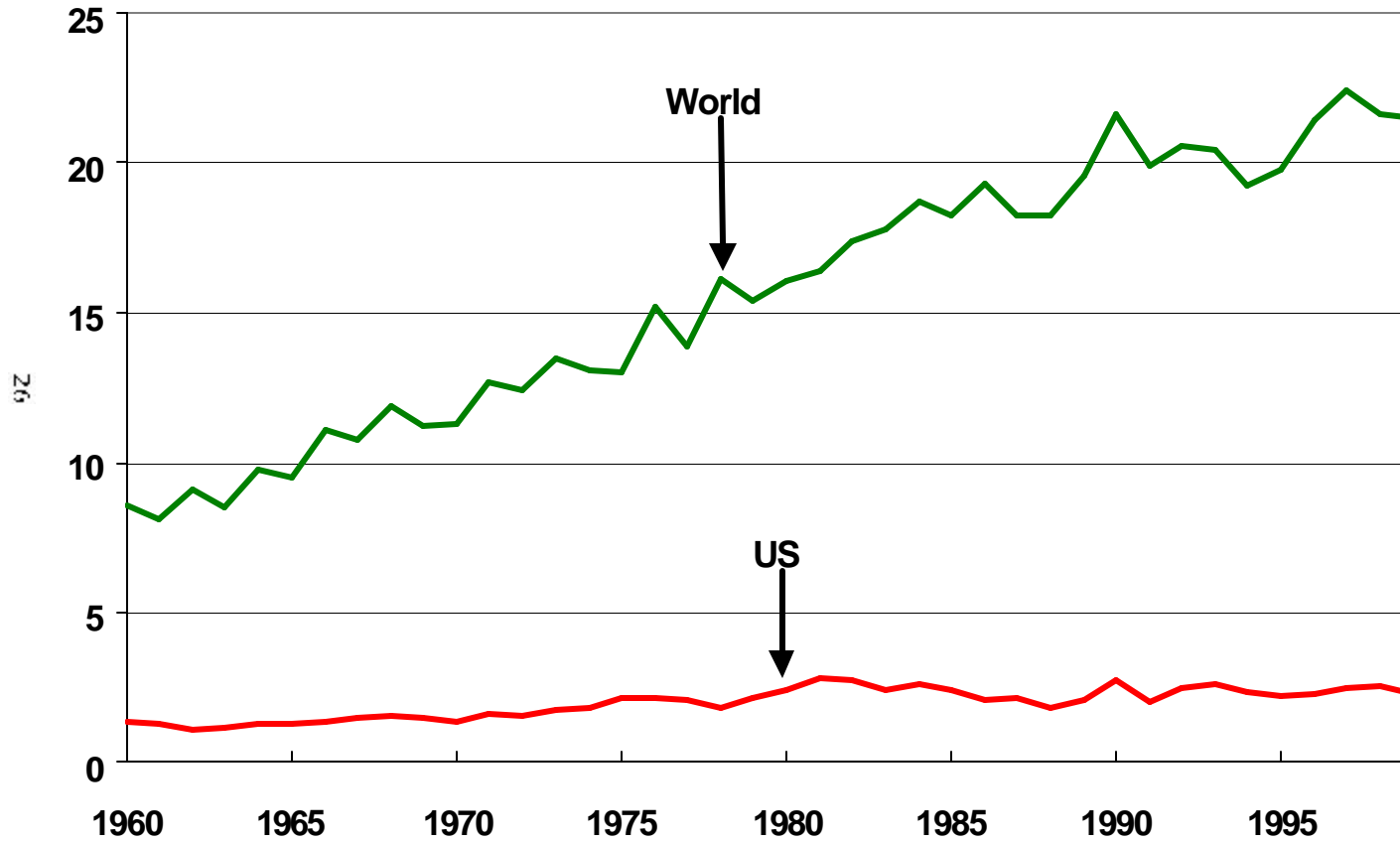
Figure 1. World Corn Production: 1960-1999



Sources: (2), (17)

Billion  
bushels

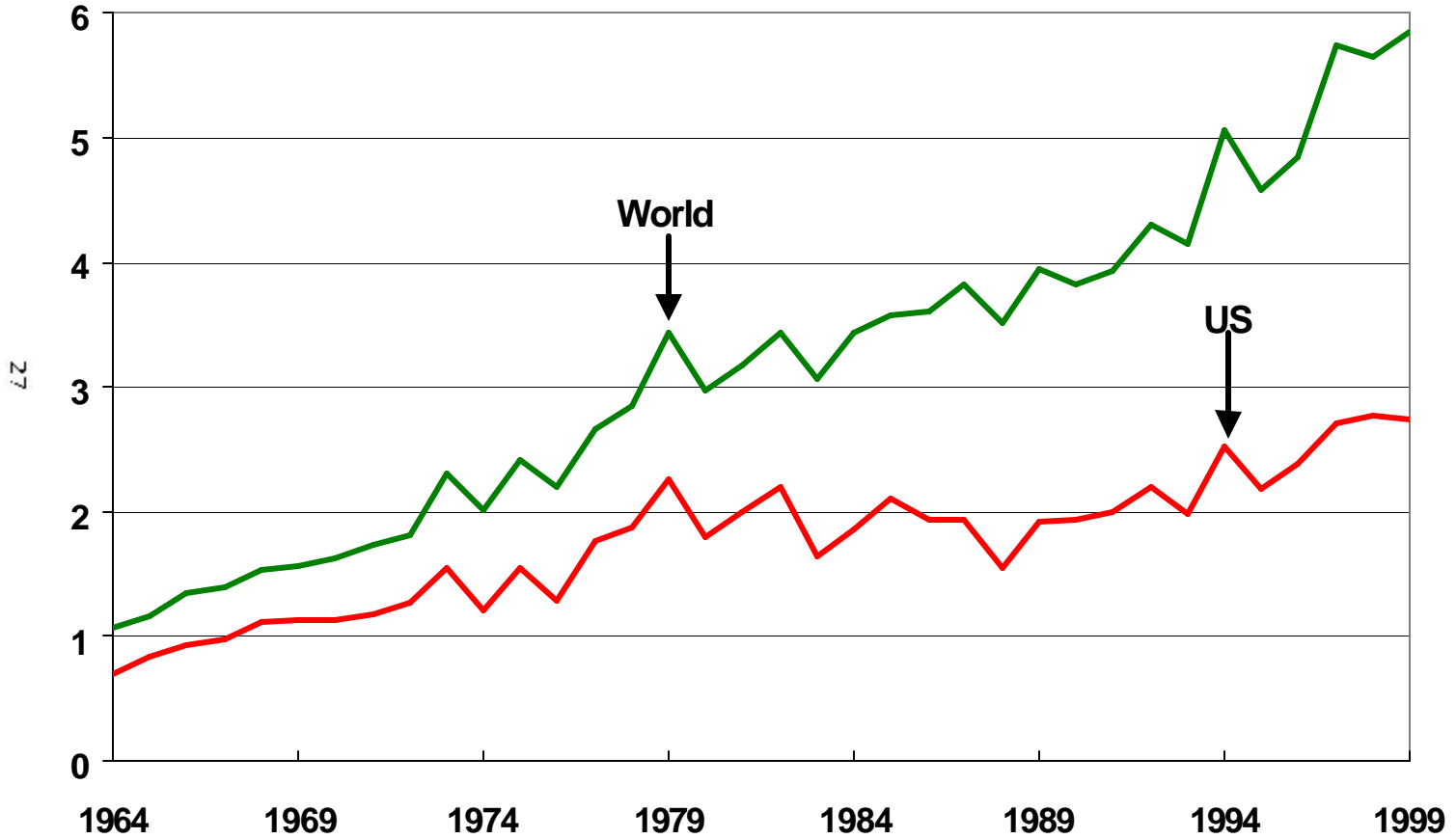
Figure 2. World Wheat Production: 1960-1999



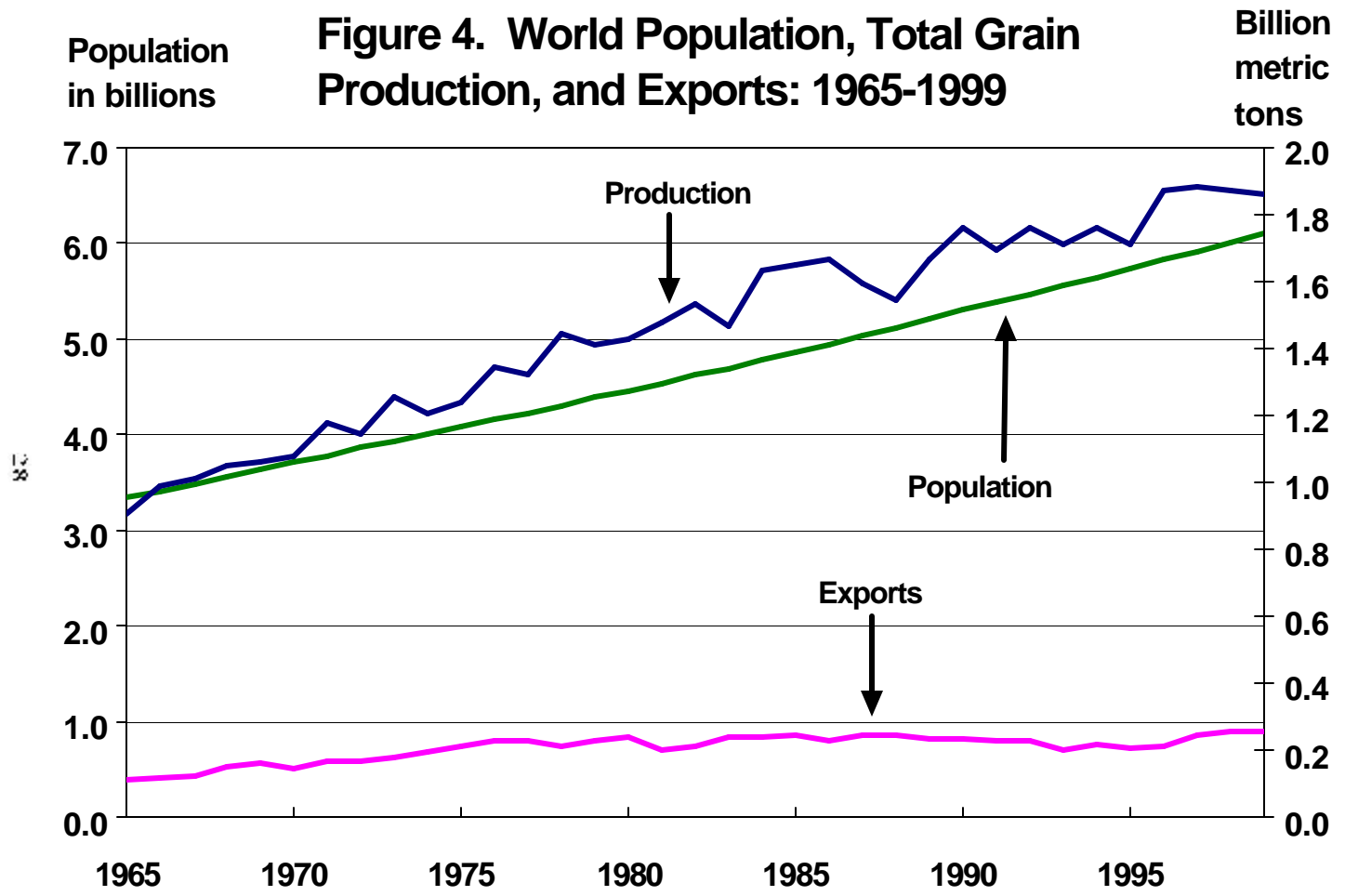
Sources: (2), (17)

Billion bushels

Figure 3. World Soybean Production: 1964-1999

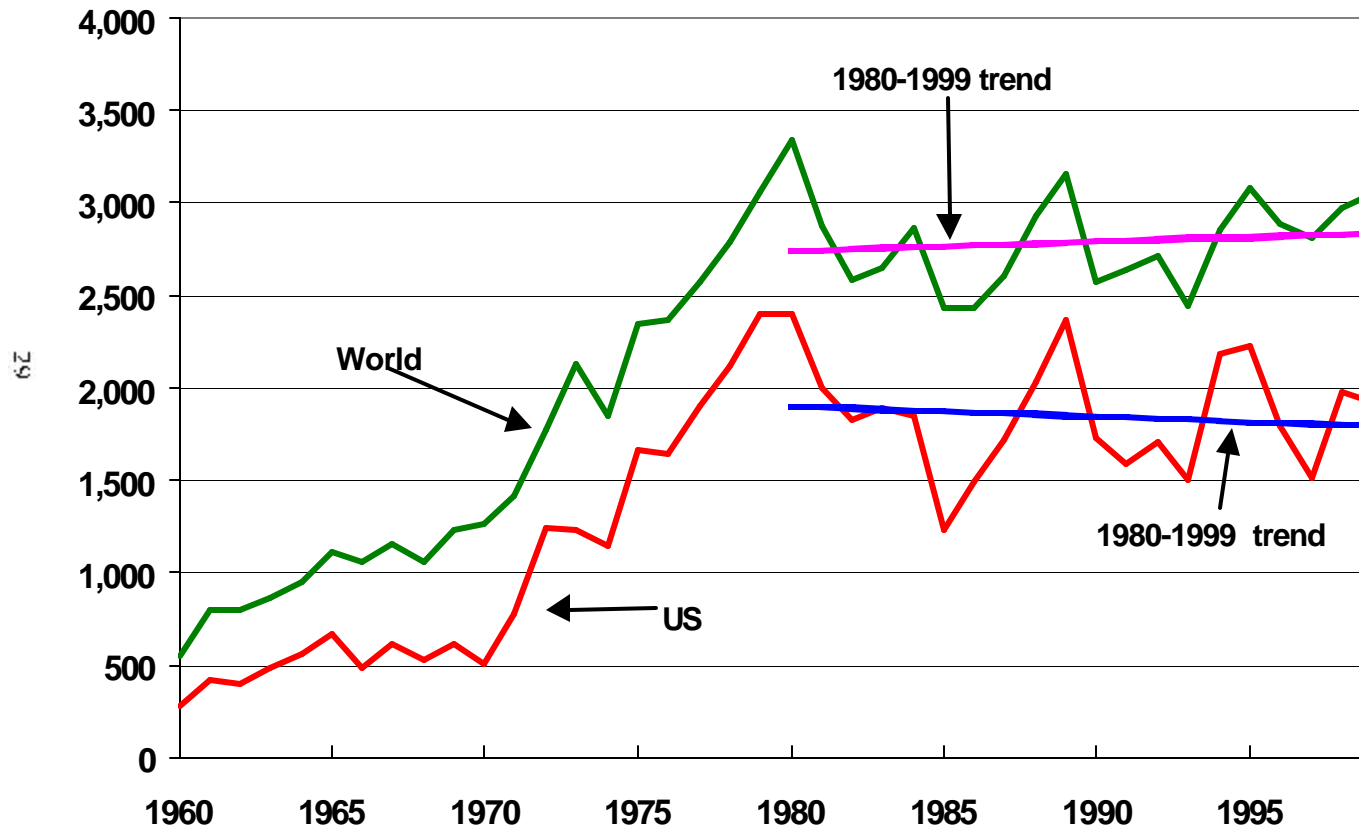


Sources: (2), (17)



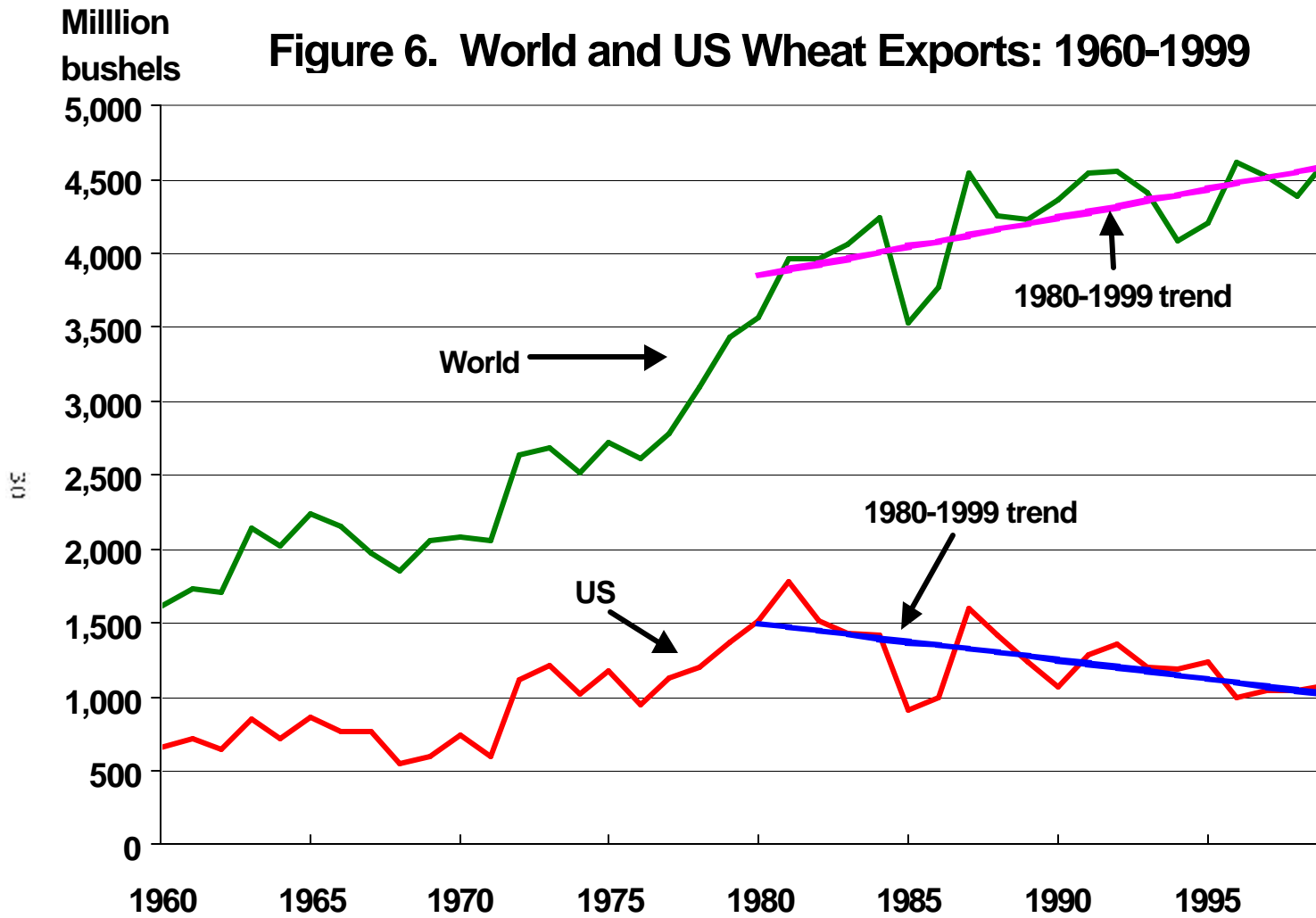
Sources: (2), (17), (19)

**Figure 5. World and US Corn Exports: 1960-1999**



Sources: (2), (17)

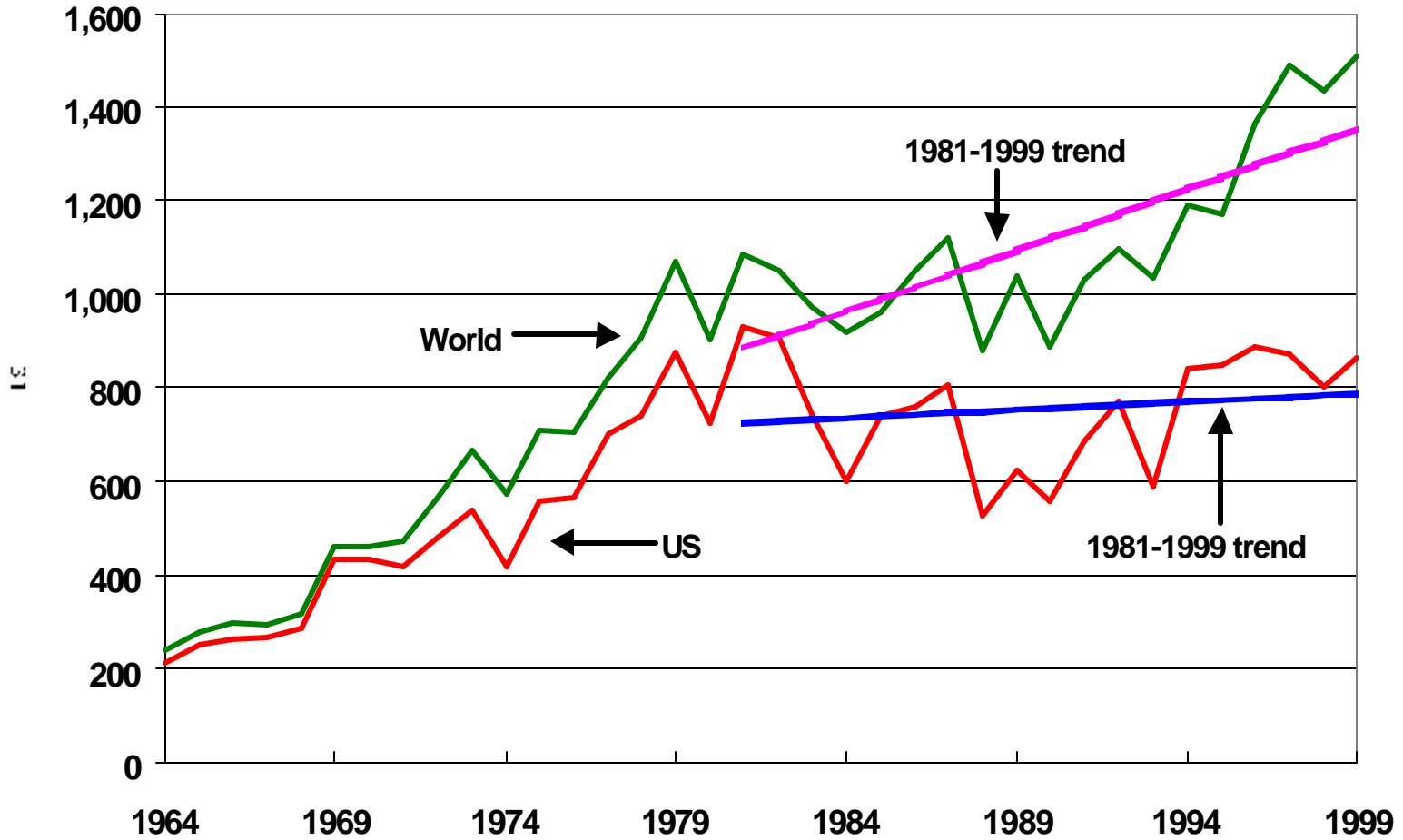
**Figure 6. World and US Wheat Exports: 1960-1999**



Sources: (2), (17)

Million bushels

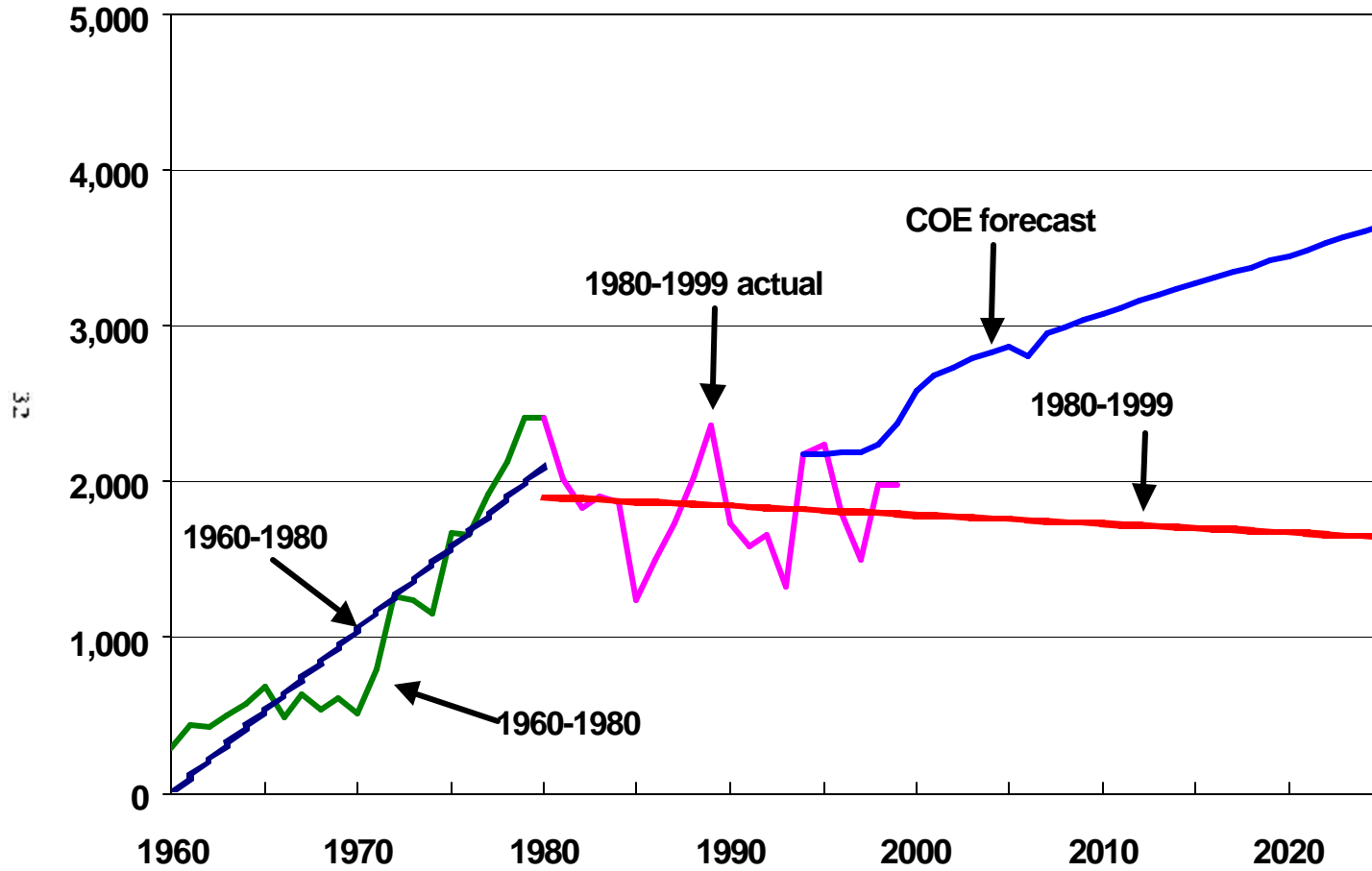
Figure 7. World and US Soybean Exports: 1964-1999



Sources: (2), (17)

Million bushels

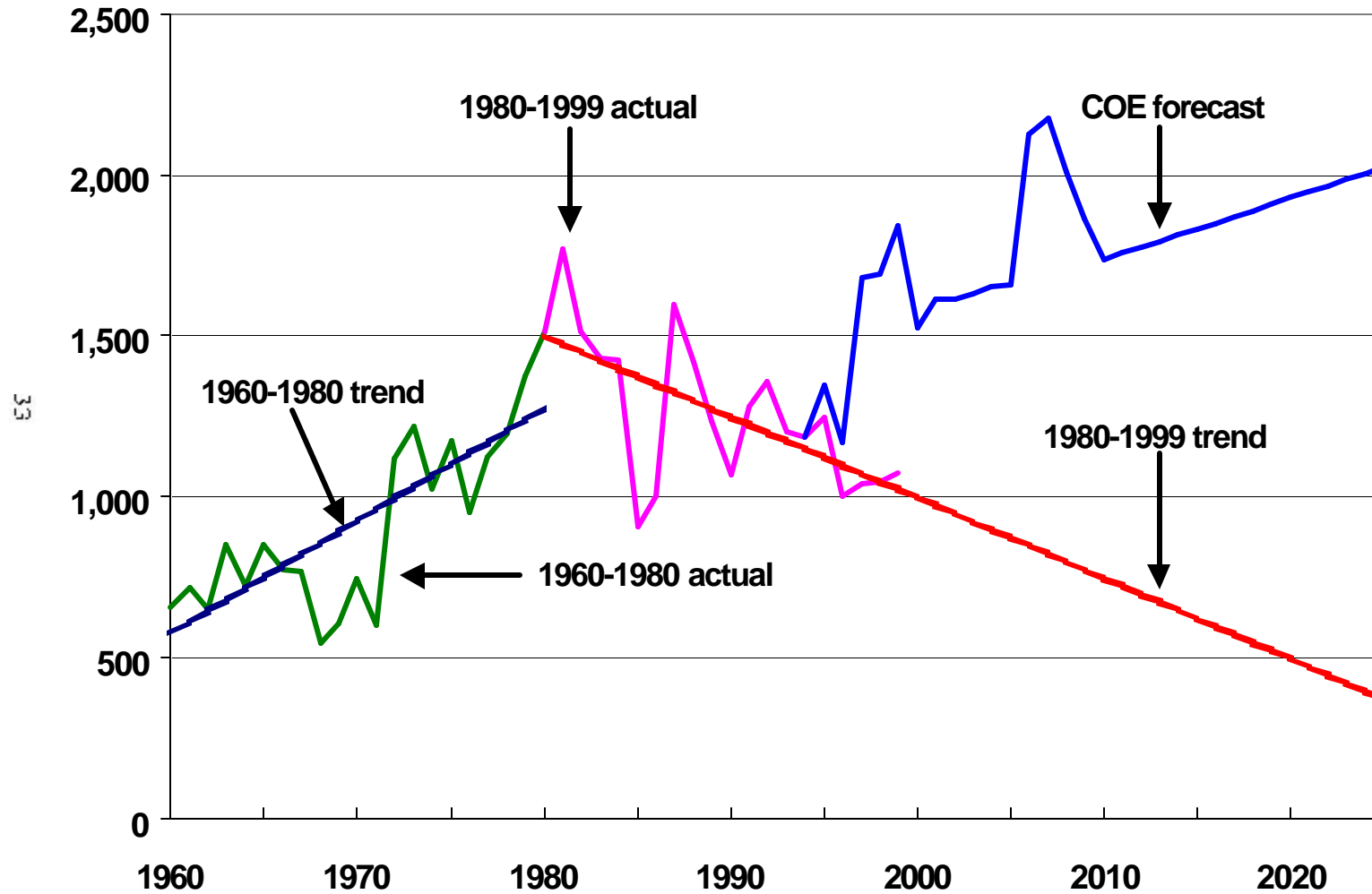
Figure 8. US Corn Exports: 1960-2025



Sources: (2), (4), (17)

Million  
bushels

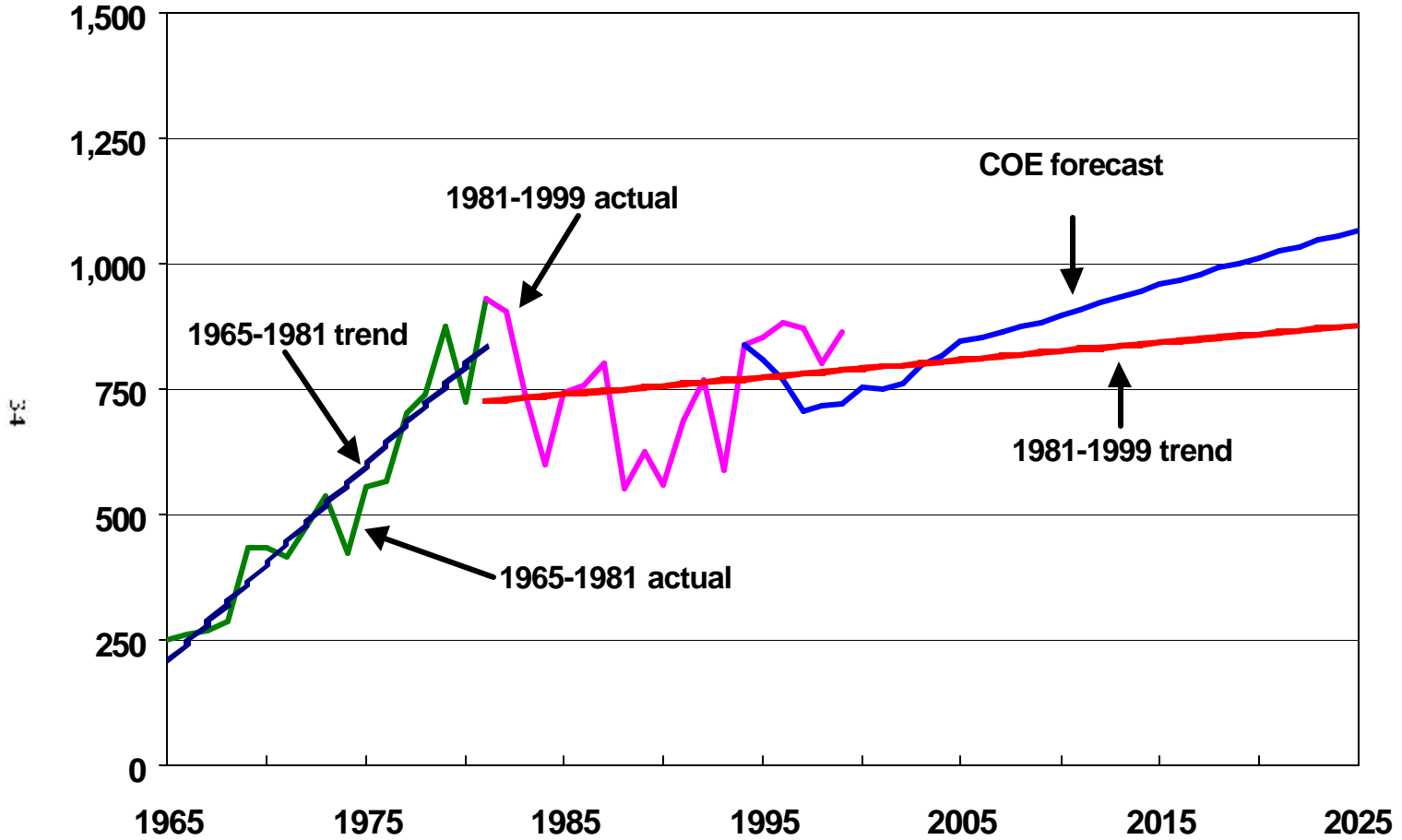
### Figure 9. US Wheat Exports: 1960-2025



Sources: (2), (4), (17)

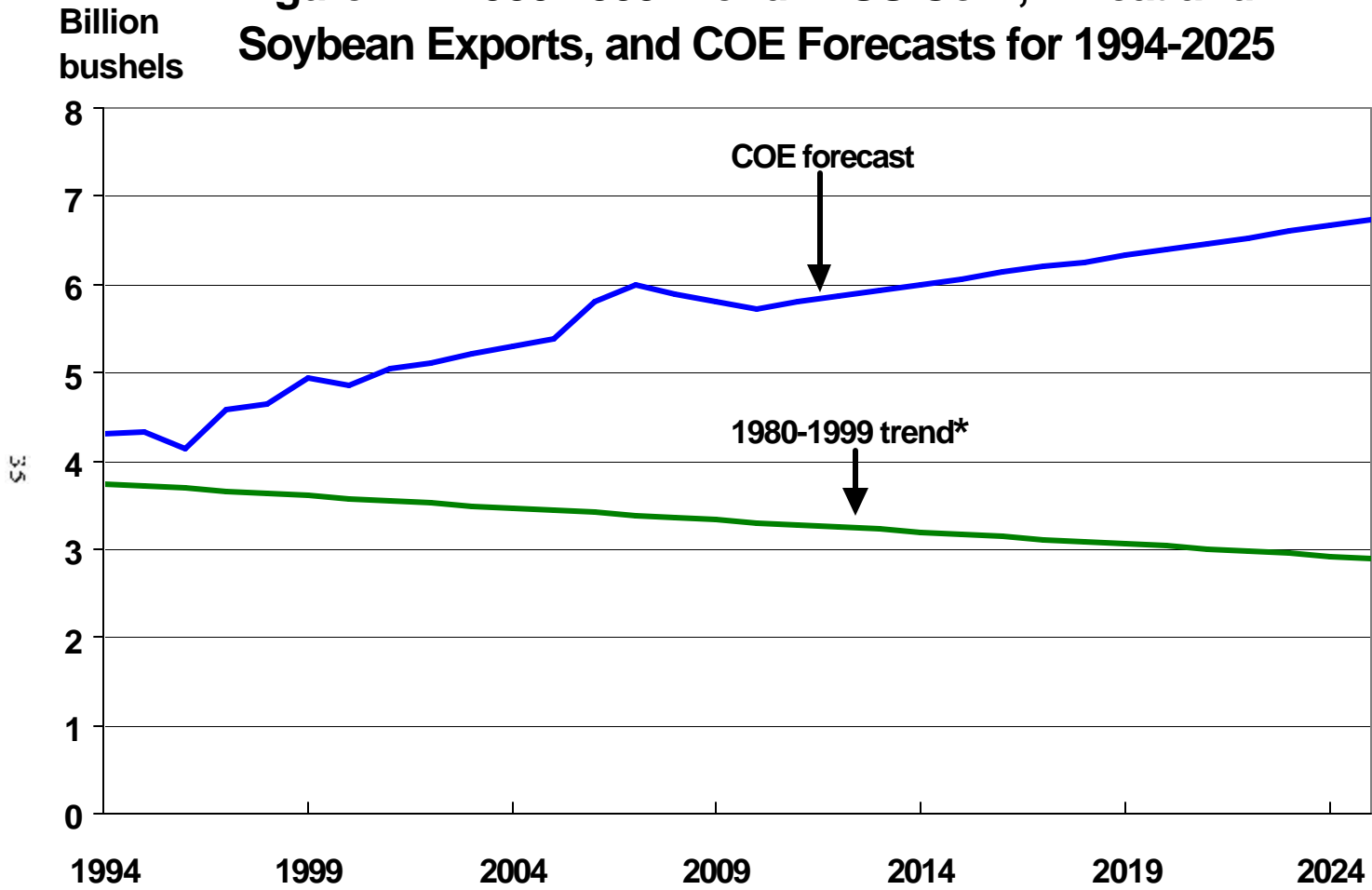
Million  
bushels

Figure 10. US Soybean Exports: 1965-2025



Sources: (2), (4), (17)

**Figure 11. 1980-1999 Trend in US Corn, Wheat and Soybean Exports, and COE Forecasts for 1994-2025**

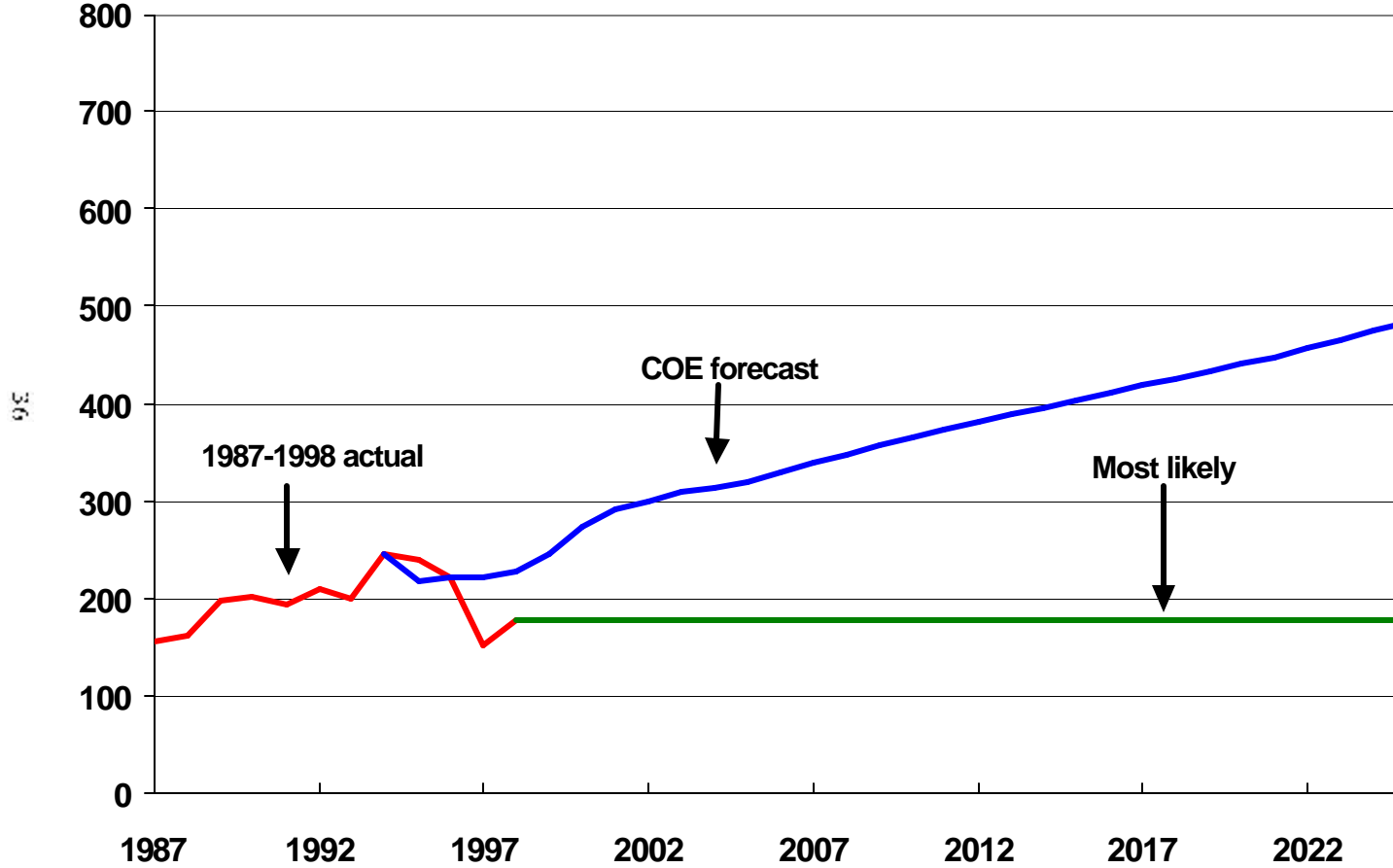


\* Soybean trend is for 1981-1999

Sources: (2), (4), (17)

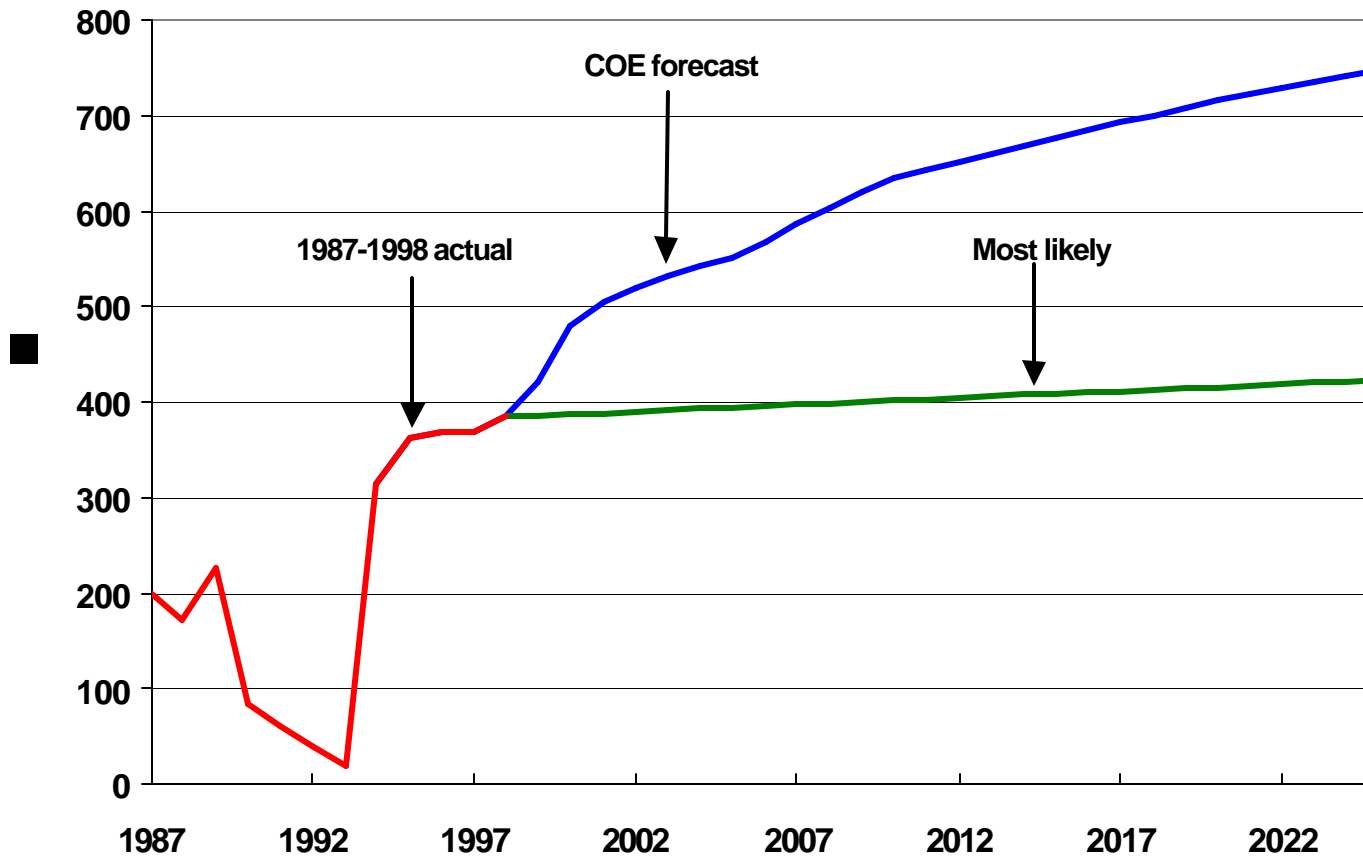
Million  
bushels

### Figure 12. US Corn Exports to Taiwan: 1987-2025



Sources: (4), (12)

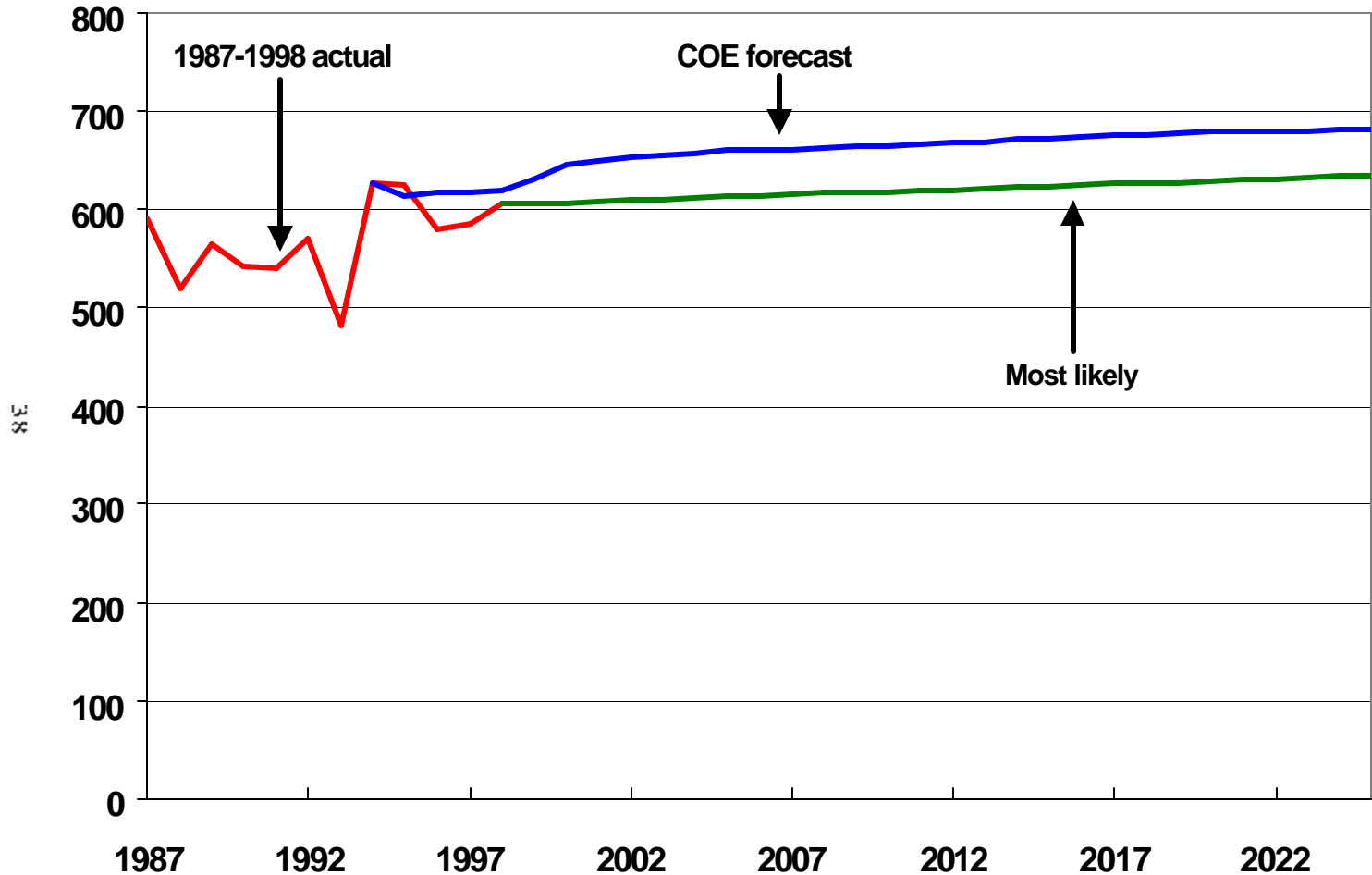
Million bushels **Figure 13. US Corn Exports to South Korea: 1987-2025**



Sources: (4), (12)

Million bushels

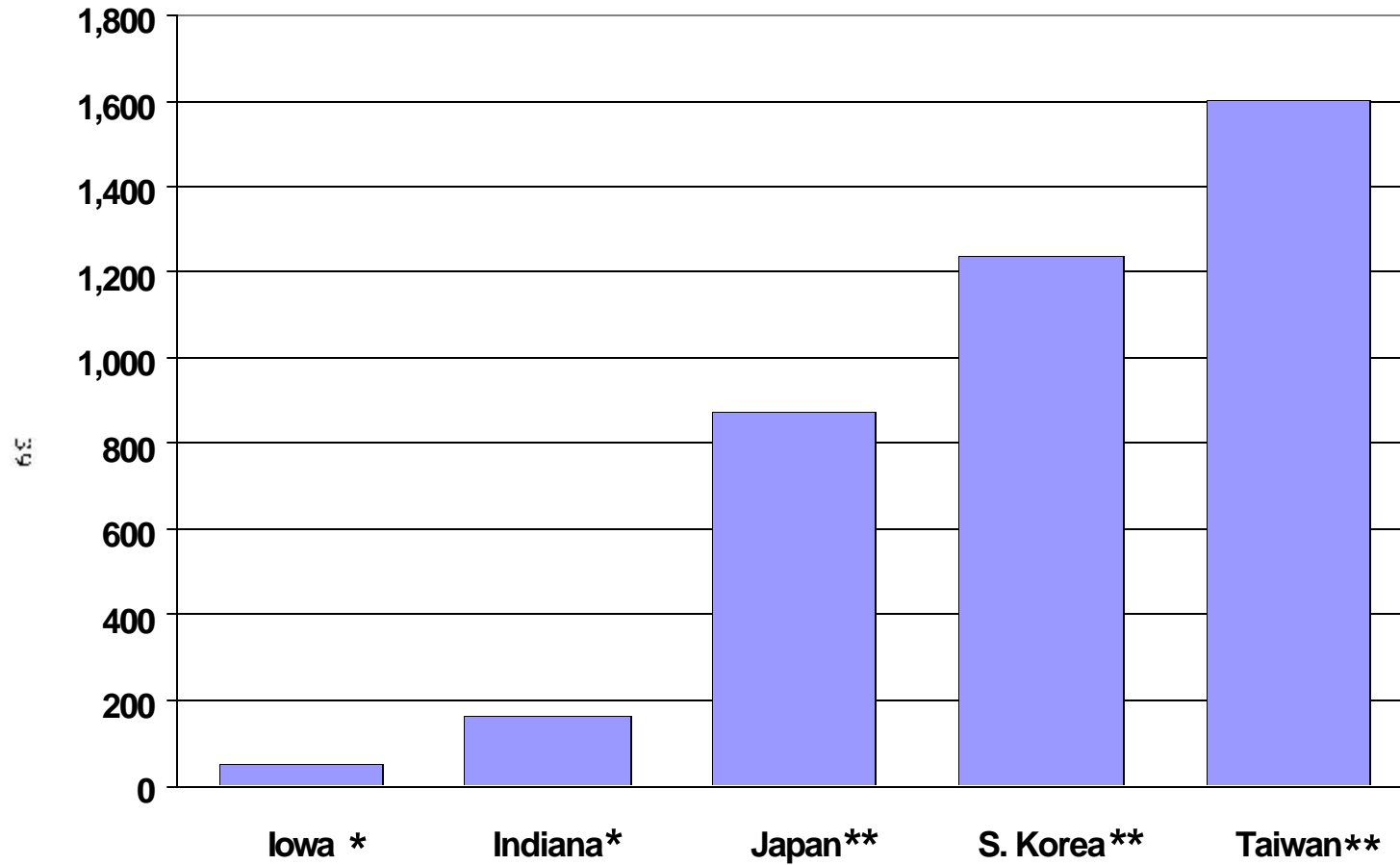
Figure 14. US Corn Exports to Japan: 1987-2025



Sources: (4), (12)

Population

Figure 15. Population per Square Mile



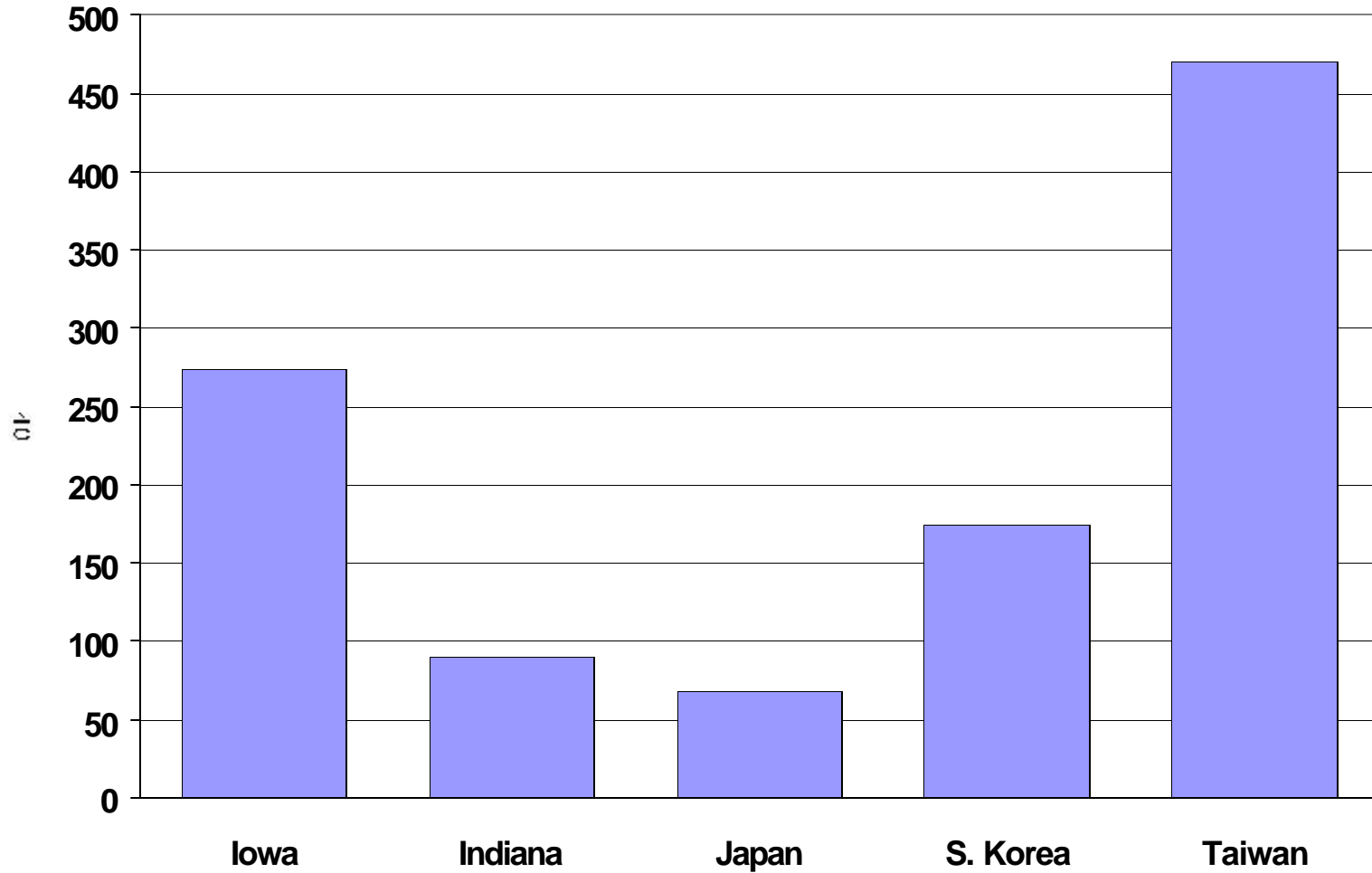
\* 1998

\*\* 1999

Sources: (18), (20)

Hogs

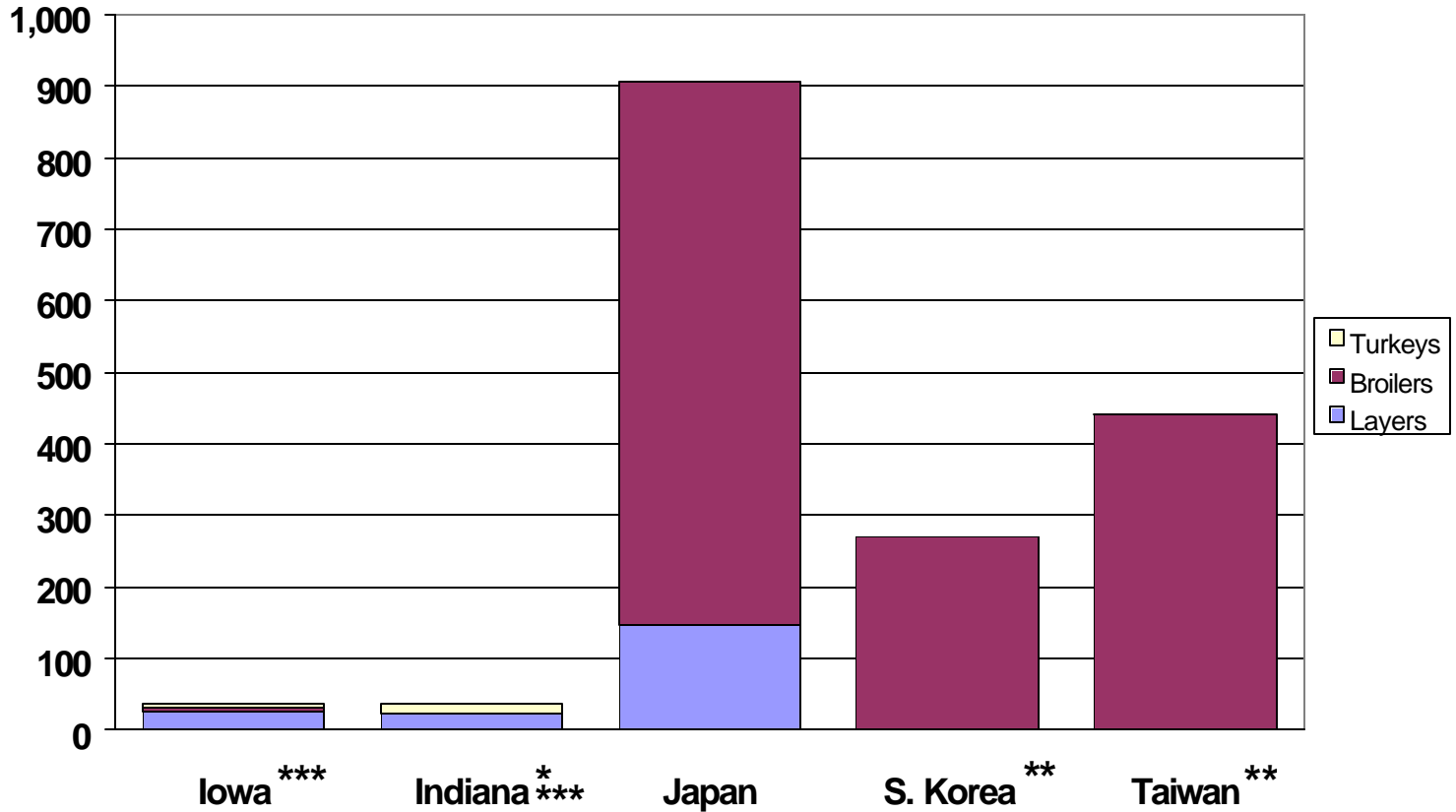
**Figure 16. Hogs per Square Mile, 1999**



Sources: (10), (16), (20)

Million  
birds

Figure 17. Total Number of Poultry Birds, 1999



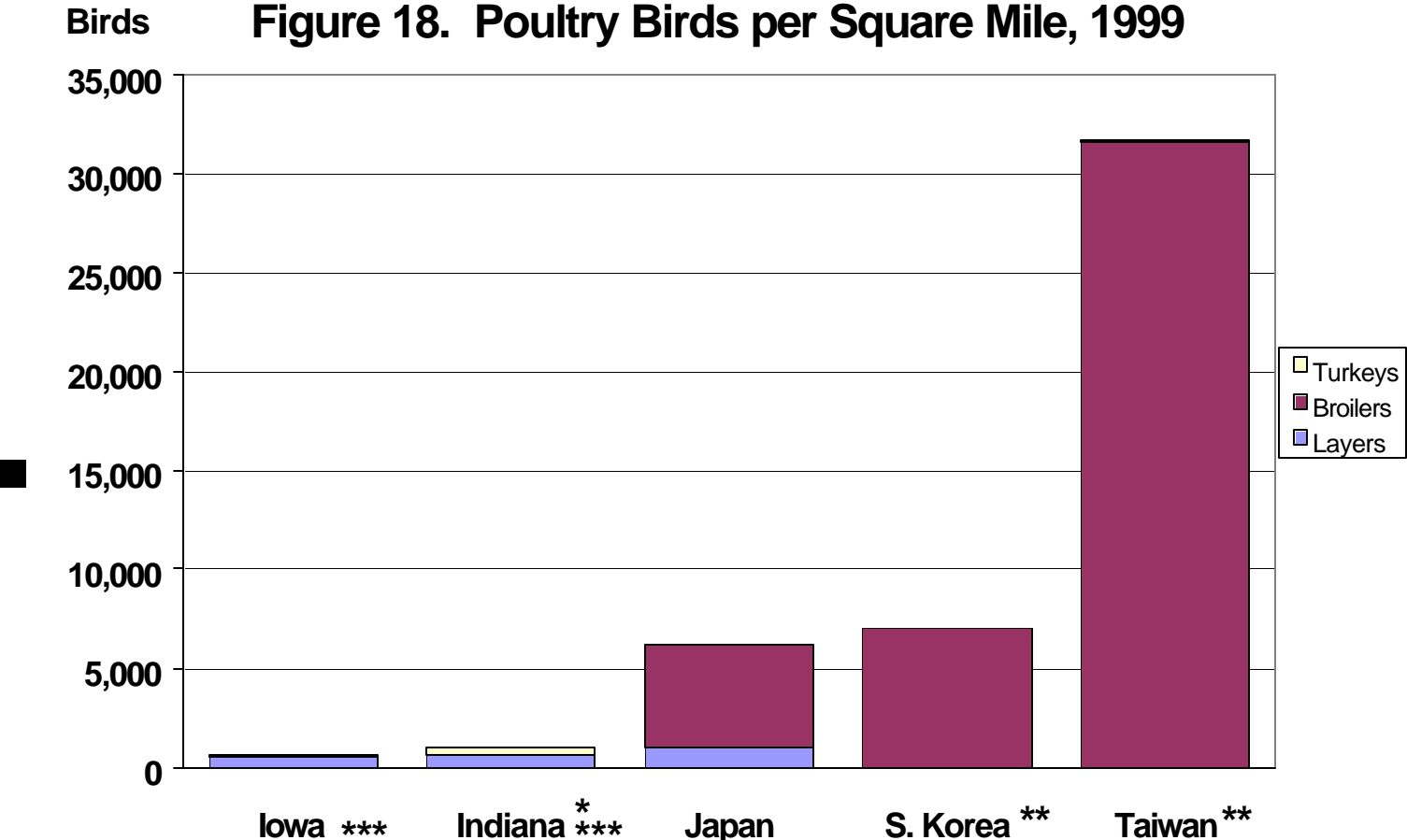
\* Missing broiler numbers

\*\* Missing layer and duck

\*\*\* 1998 turkey numbers

Sources: (5), (6), (8), (11), (13), (14)

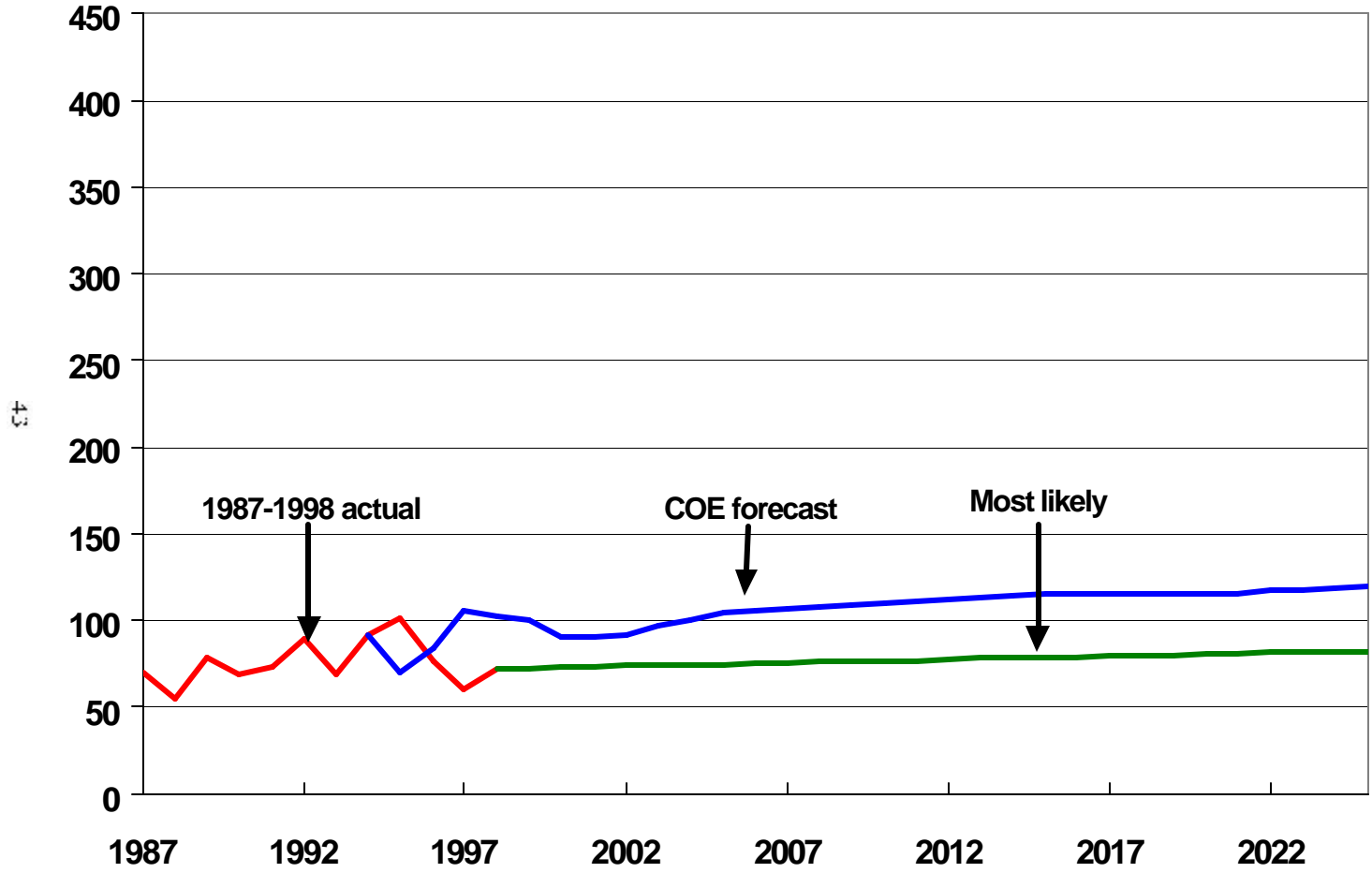
**Figure 18. Poultry Birds per Square Mile, 1999**



\* Missing broiler numbers  
 \*\* Missing layer and duck  
 \*\*\* 1998 turkey numbers  
 Sources: (5), (6), (8), (11), (13), (14), (20)

Million  
bushels

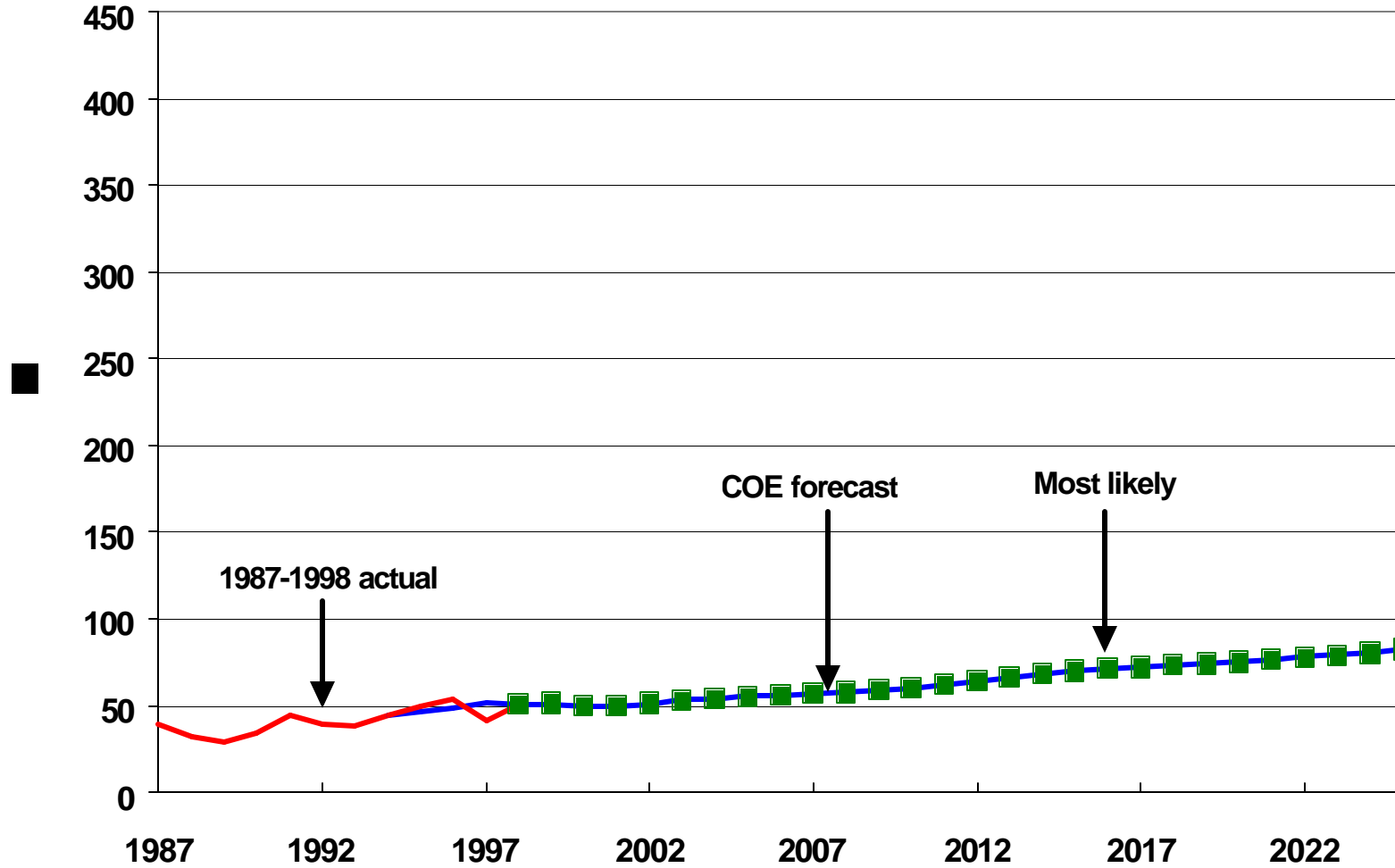
**Figure 19. US Soybean Exports to Taiwan: 1987-2025**



Sources: (4), (12)

Million bushels

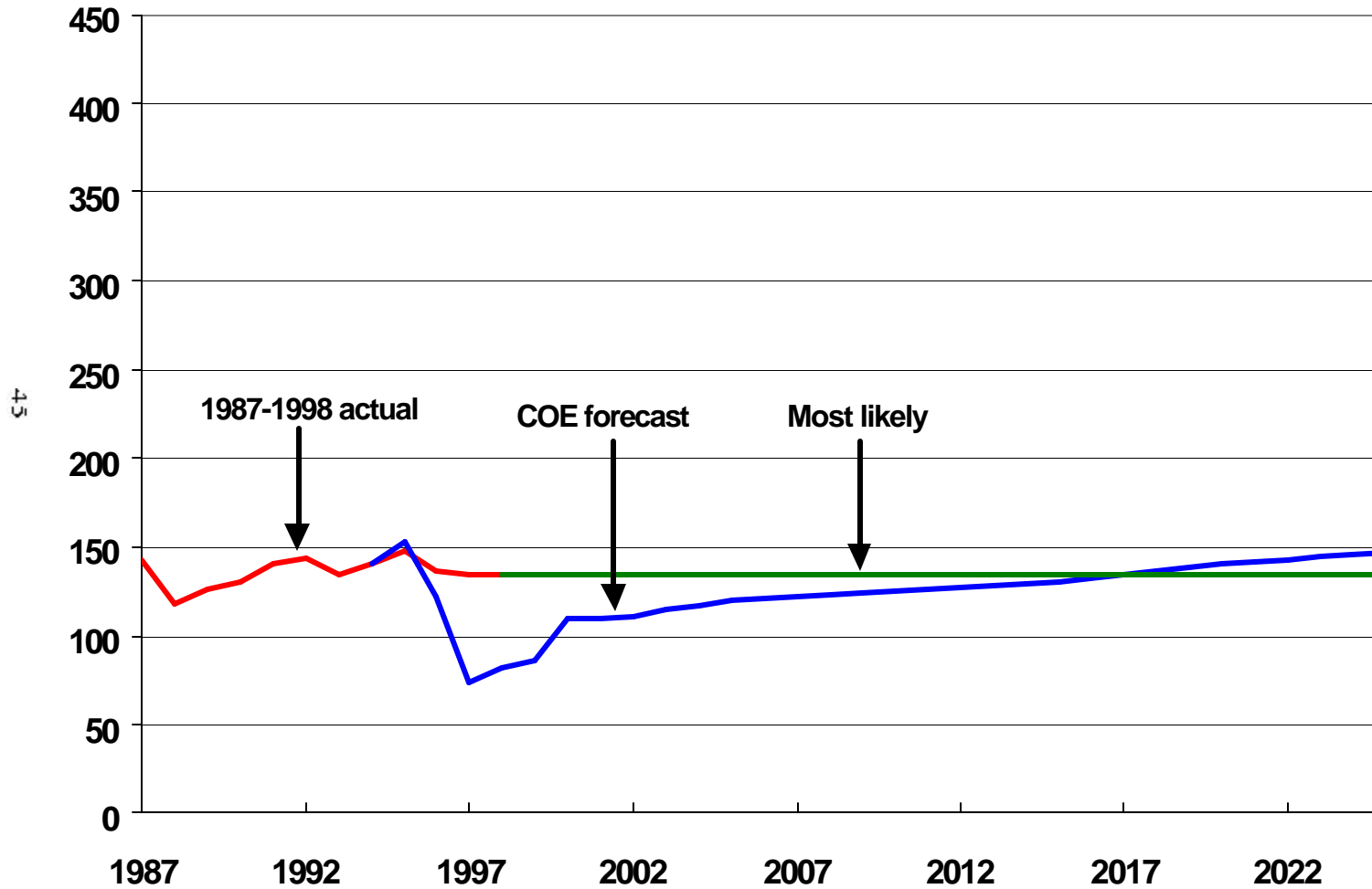
Figure 20. US Soybean Exports to S. Korea: 1987-2025



Sources: (4), (12)

Million  
bushels

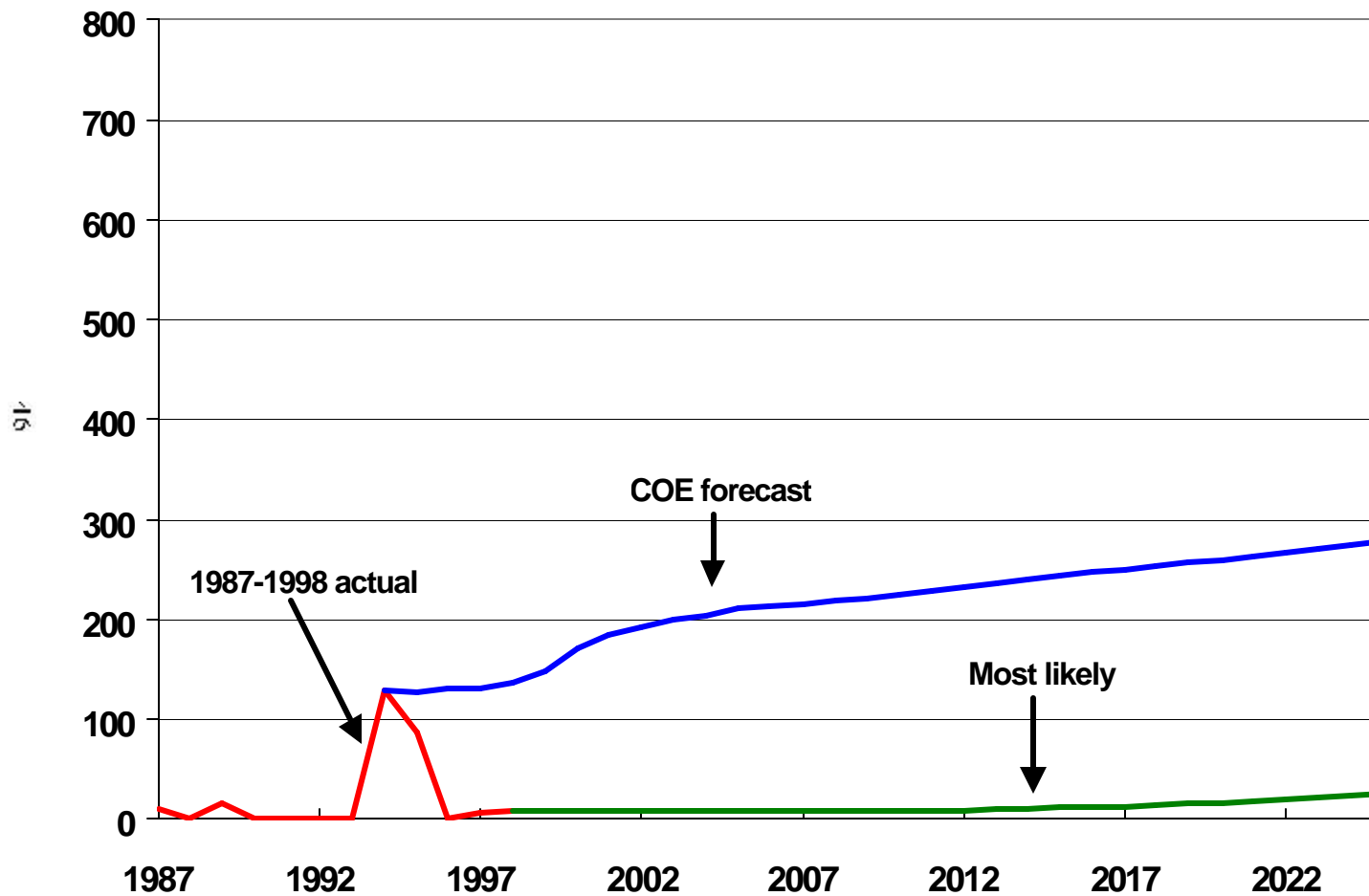
Figure 21. US Soybean Exports to Japan: 1987-2025



Sources: (4), (12)

Million  
bushels

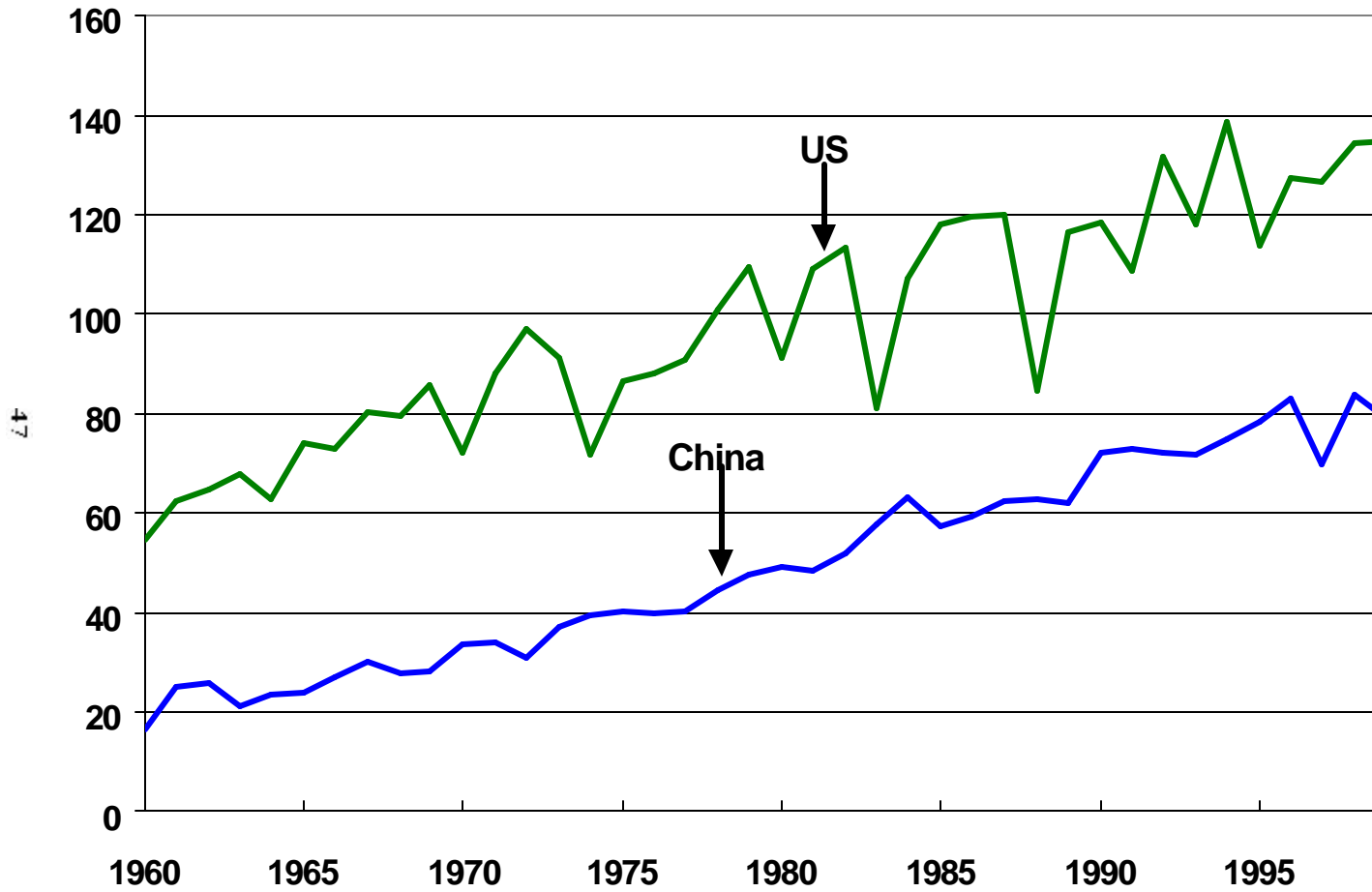
Figure 22. US Corn Exports to China: 1987-2025



Sources: (4), (12)

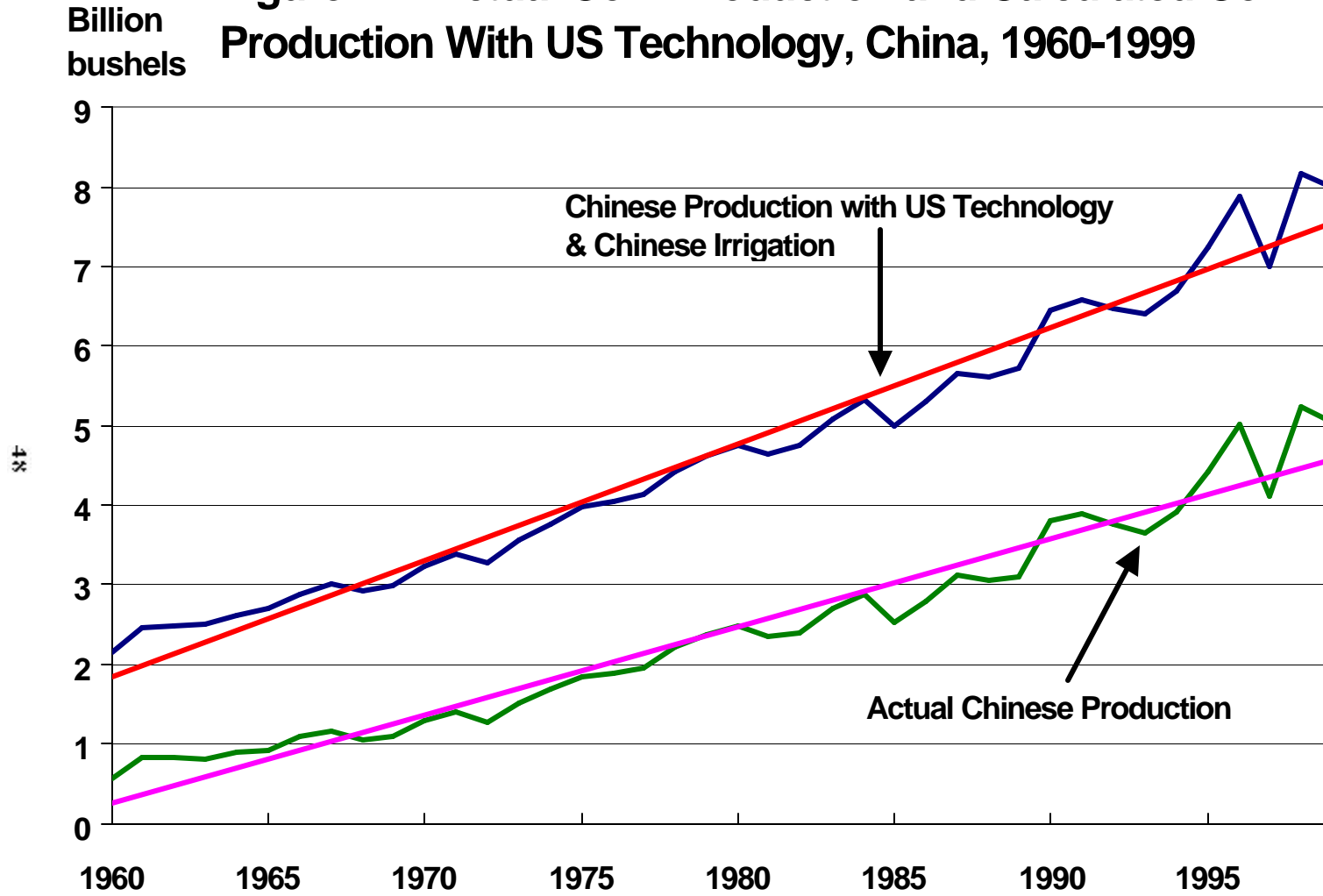
Bushels/  
acre

Figure 23. US and China Corn Yields: 1960-1999



Sources: (2), (9)

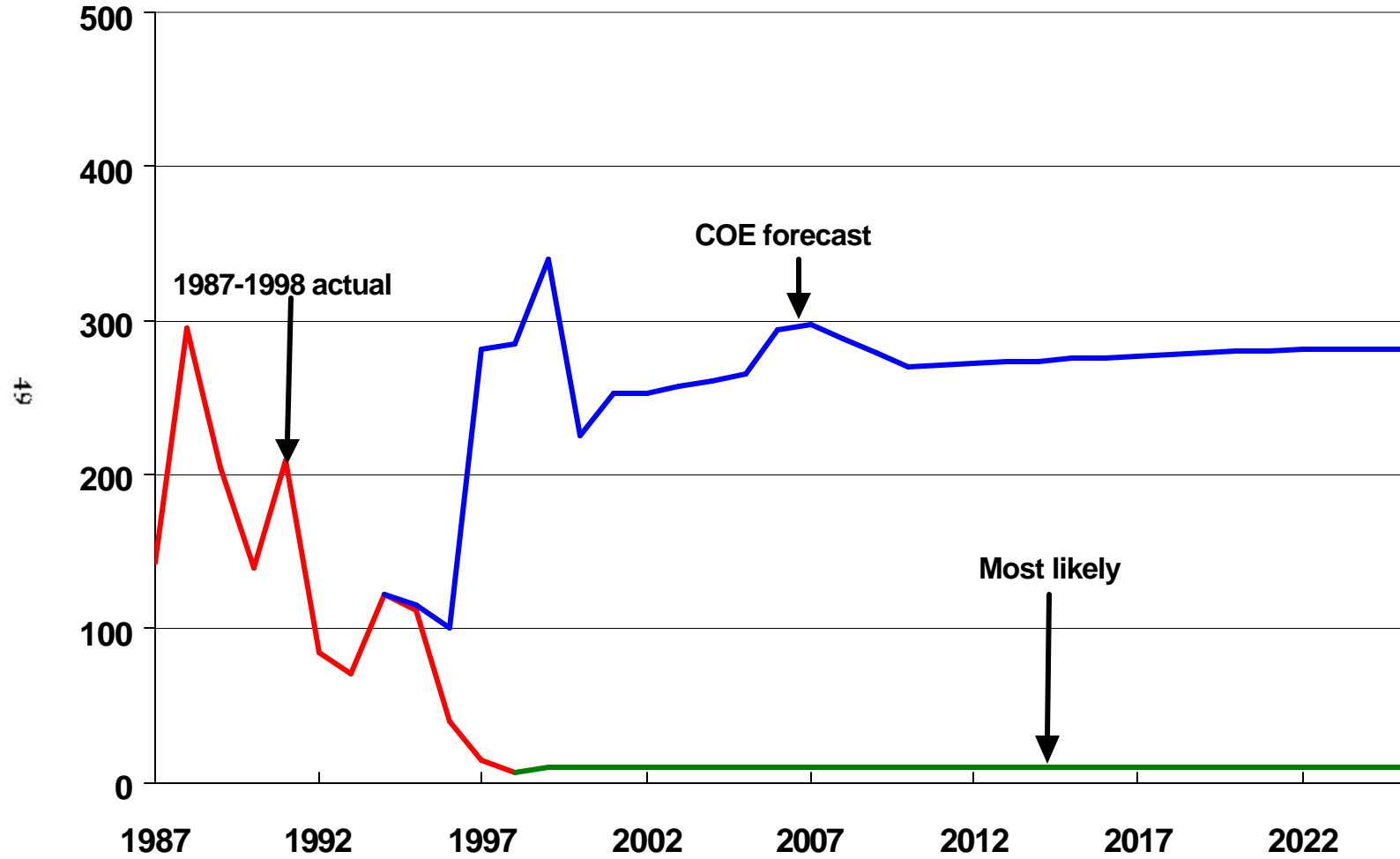
**Figure 24. Actual Corn Production and Calculated Corn Production With US Technology, China, 1960-1999**



Sources: (2), (9)

Million bushels

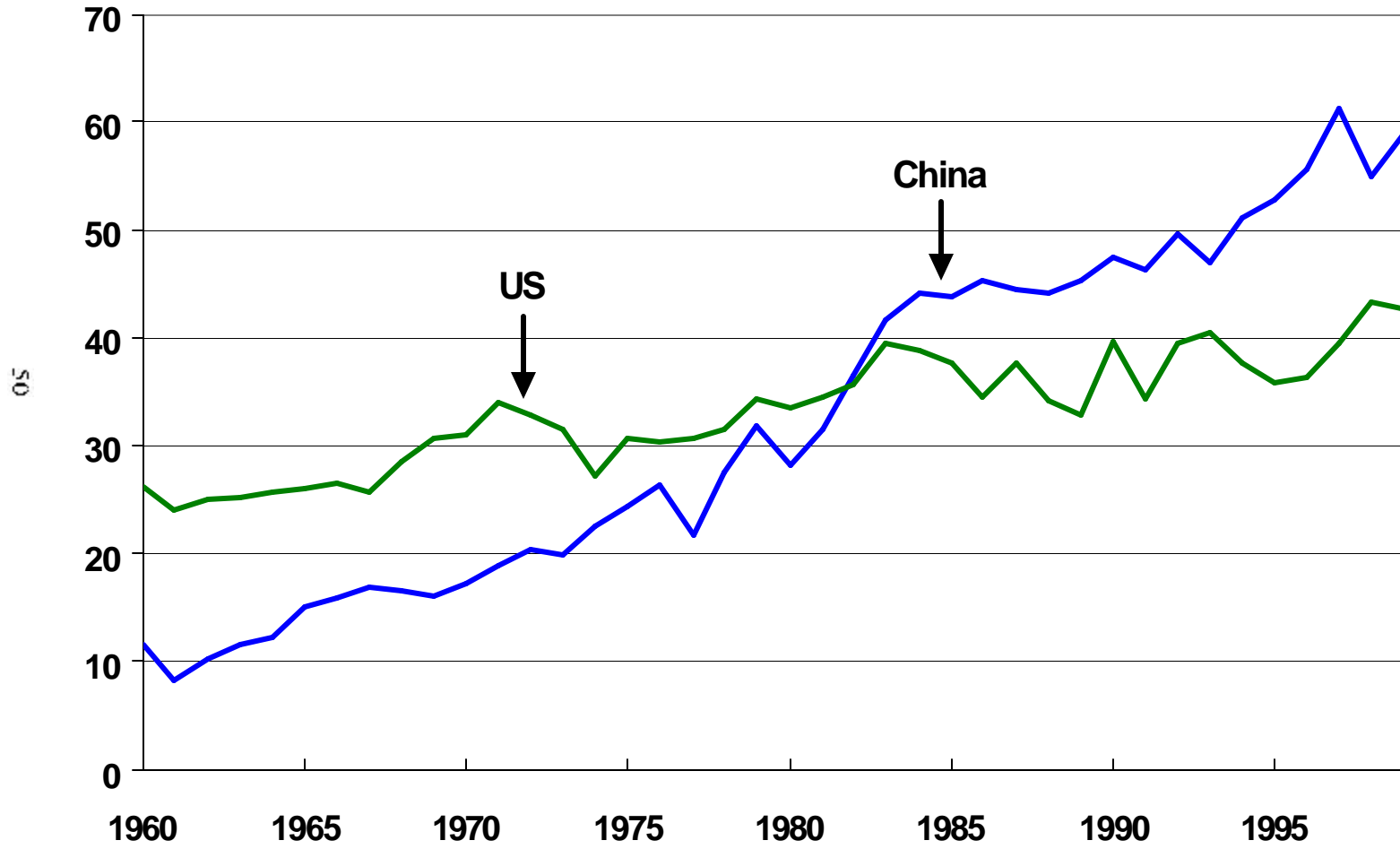
Figure 25. US Wheat Exports to China: 1987-2025



Sources: (4), (12)

Bushels/  
acre

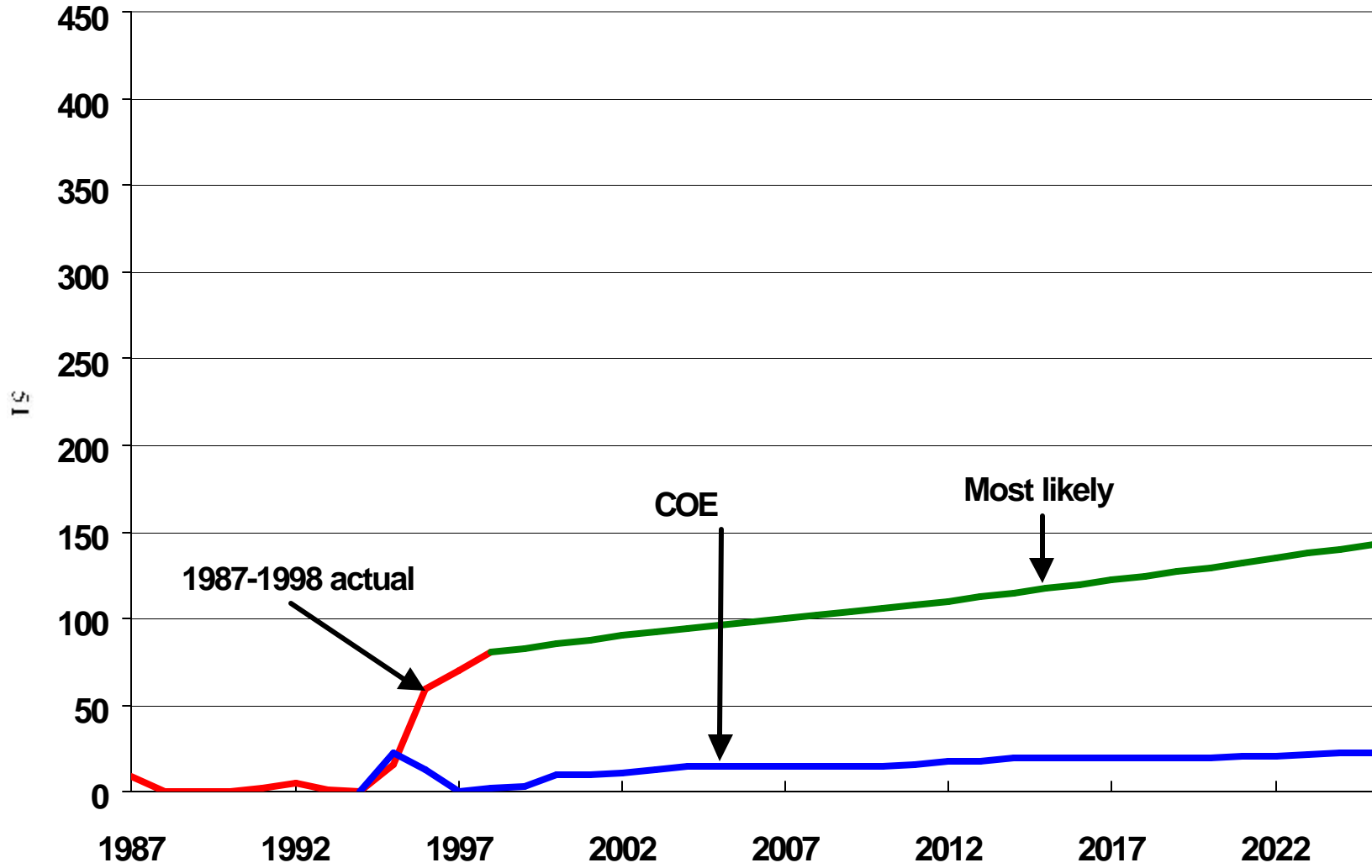
Figure 26. US and China Wheat Yields: 1960-1999



Sources: (2), (9)

Million  
bushels

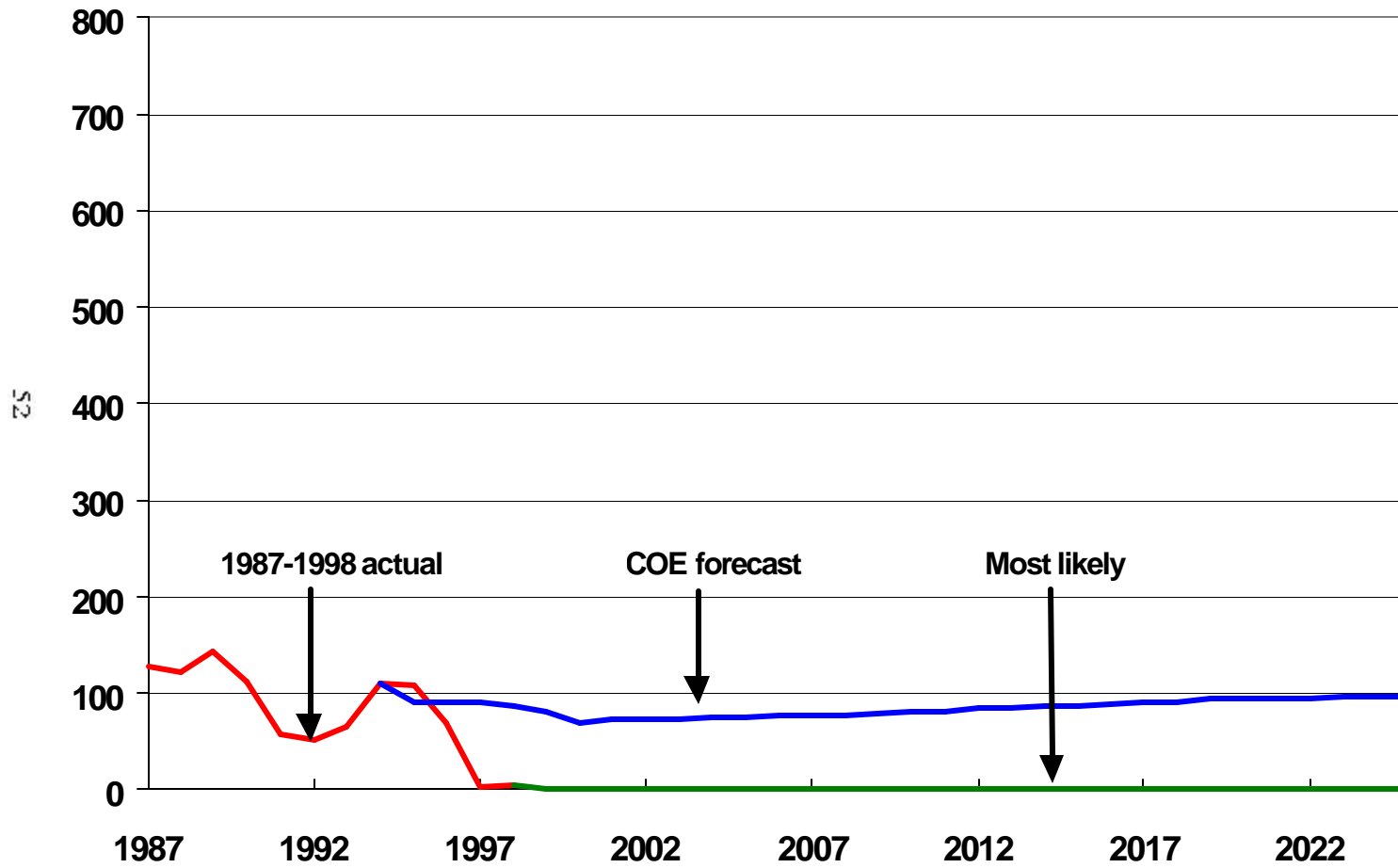
Figure 27. US Soybean Exports to China: 1987-2025



Sources: (4), (12)

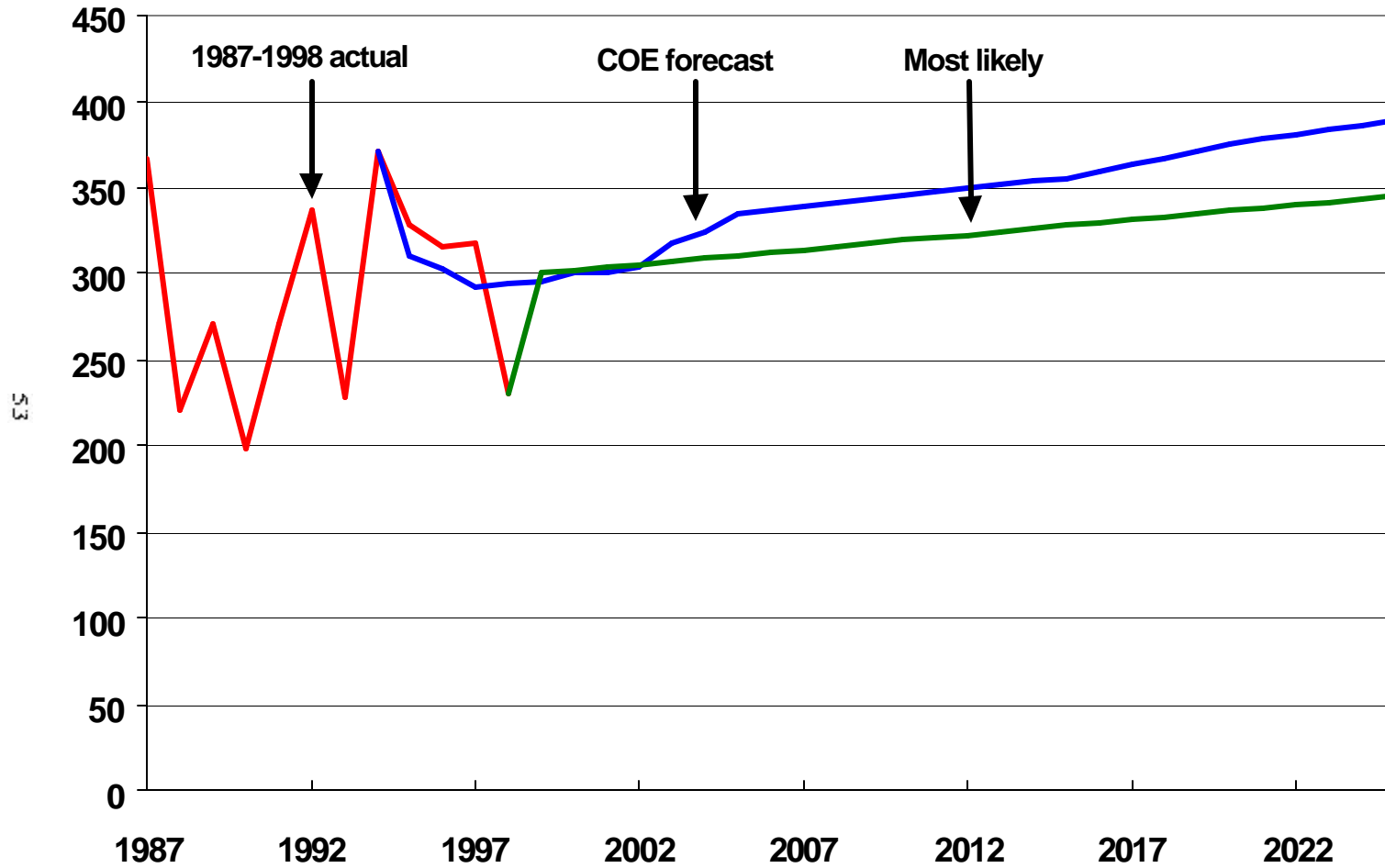
Million bushels

Figure 28. US Corn Exports to EU-15: 1987-2025



Sources: (4), (12)

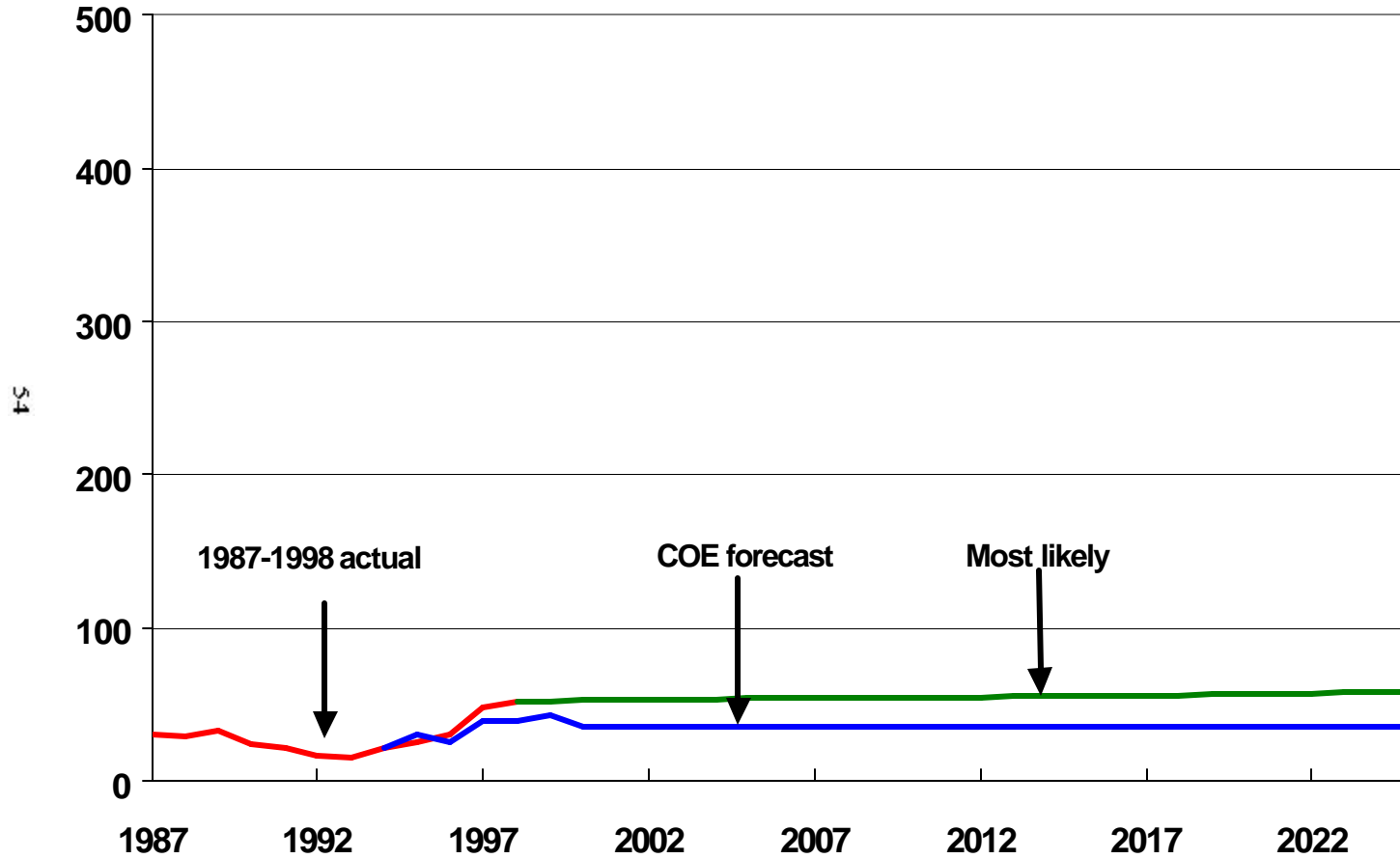
**Figure 29. US Soybean Exports to EU-15: 1987-2025**



Sources: (4), (12)

Million bushels

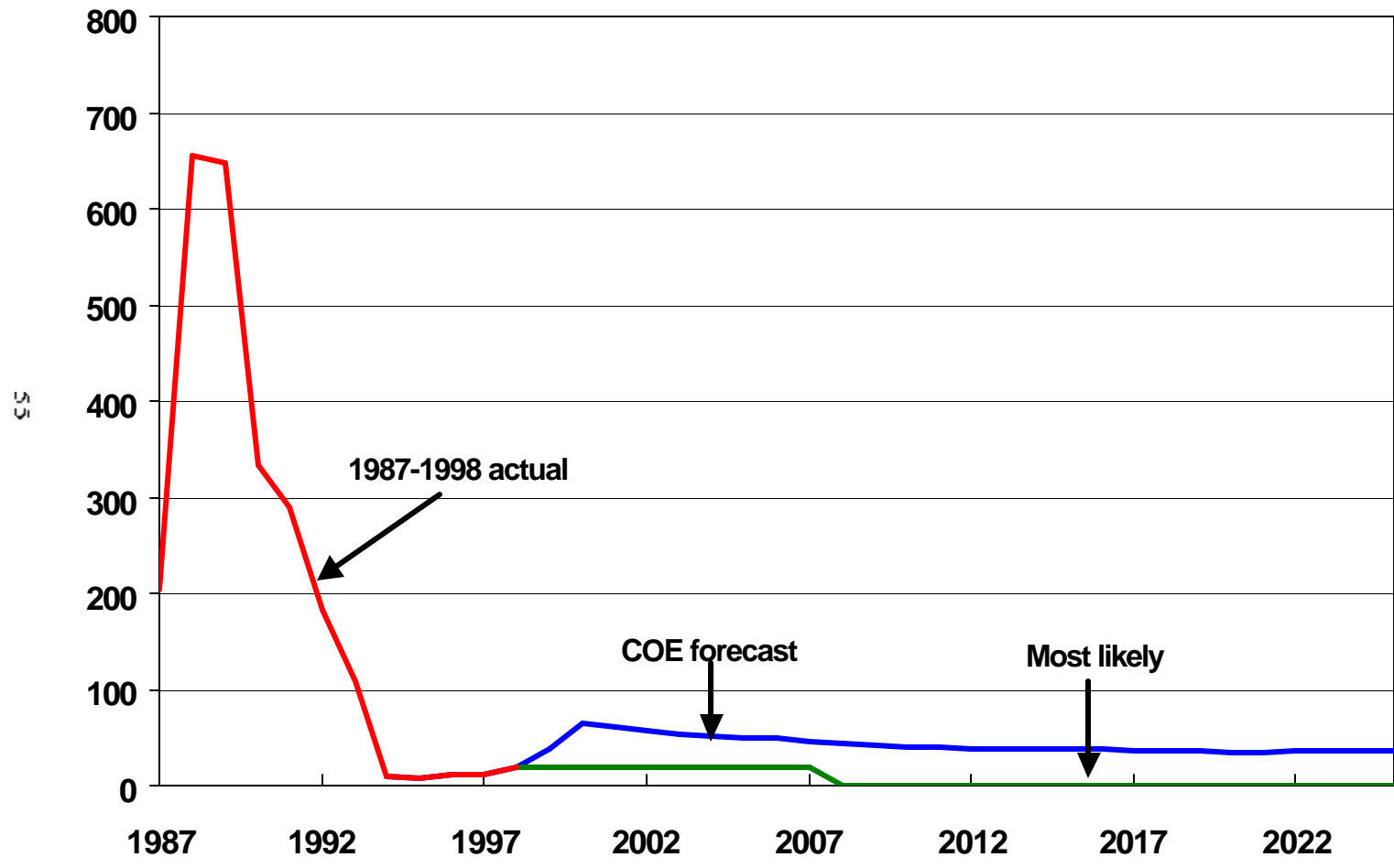
Figure 30. US Wheat Exports to EU-15: 1987-2025



Sources: (4), (12)

Million bushels

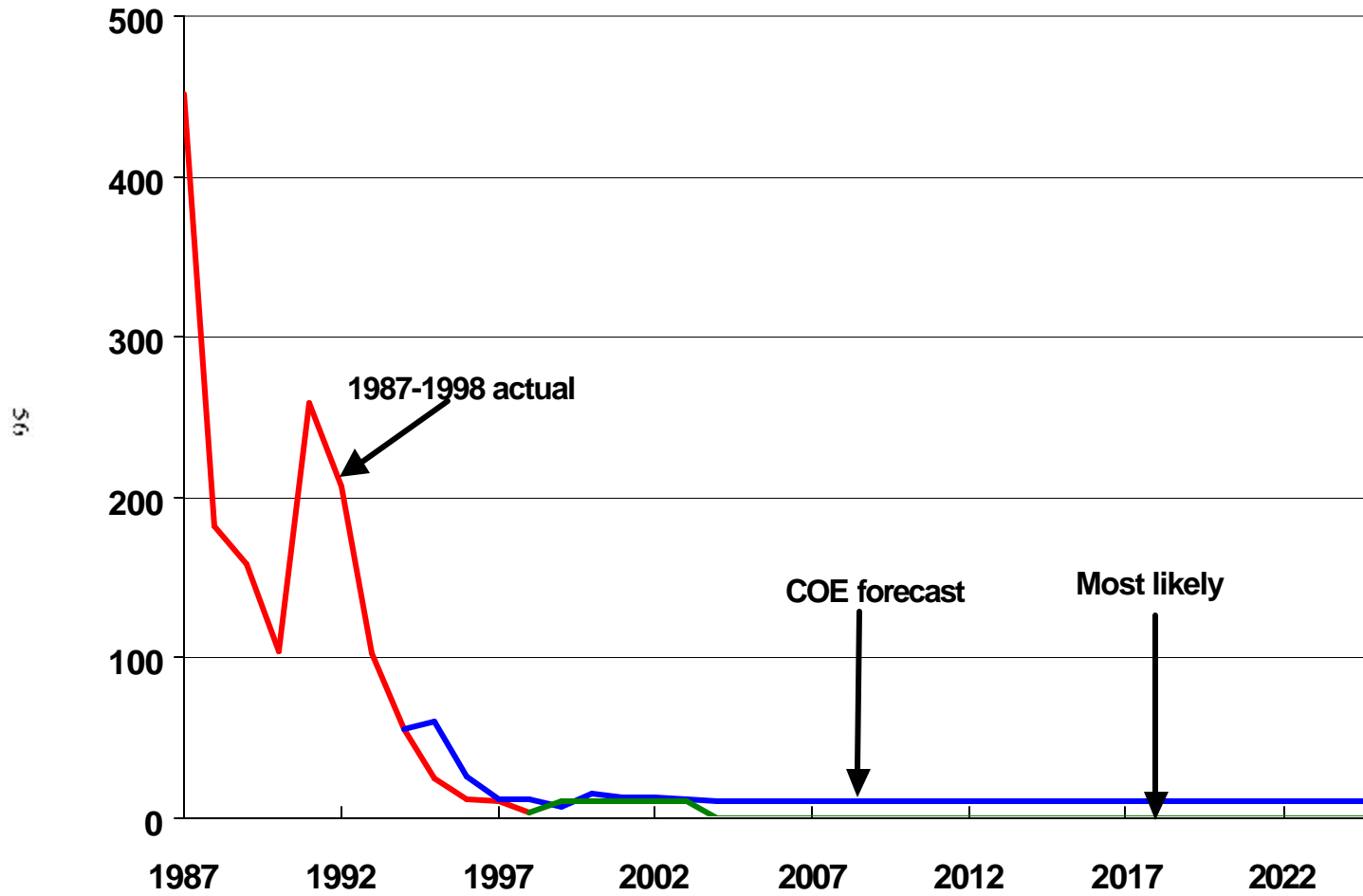
### Figure 31. US Corn Exports to FSU-15: 1987-2025



Sources: (4), (12)

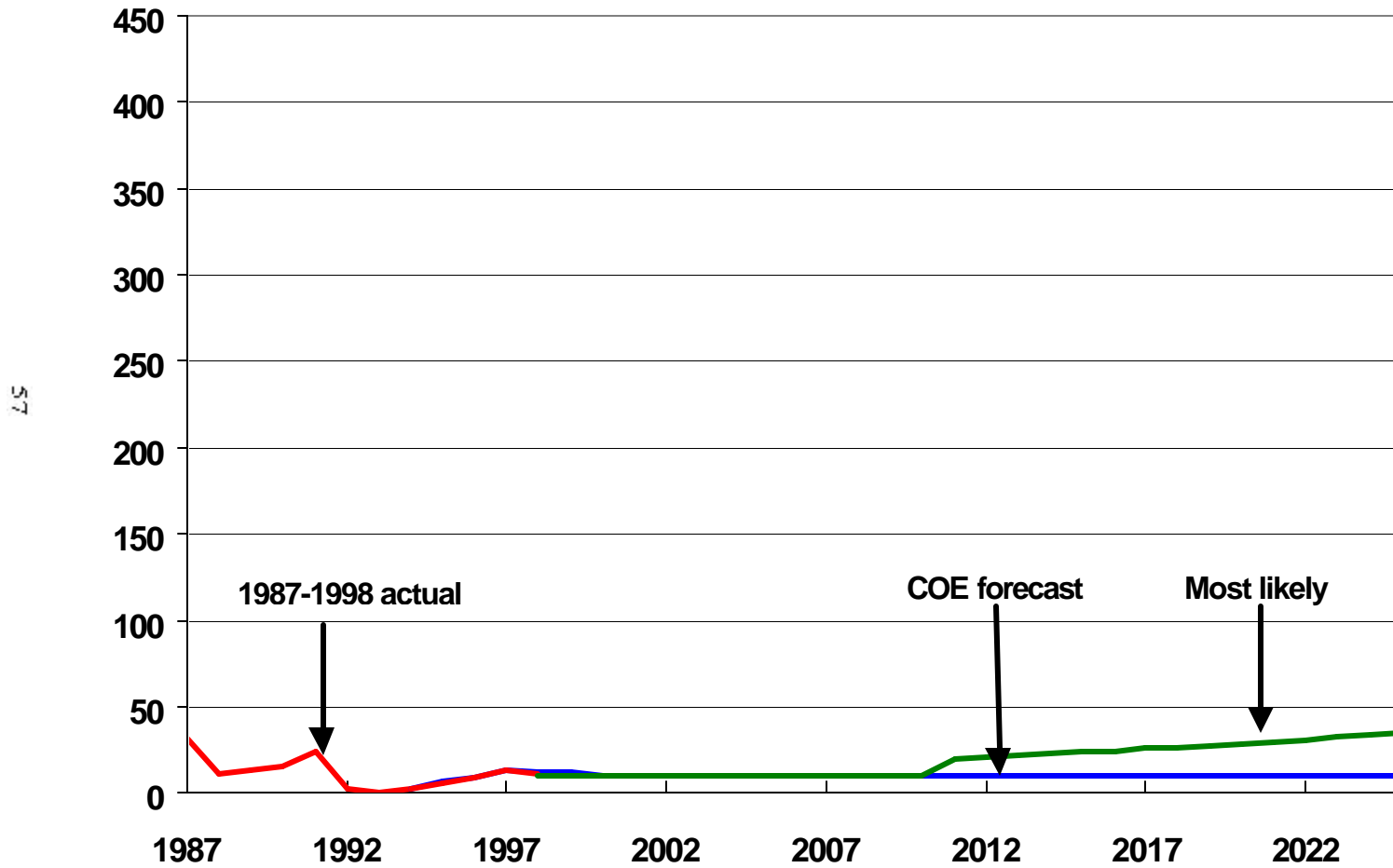
Million bushels

Figure 32. US Wheat Exports to FSU-15: 1987-2025



Sources: (4), (12)

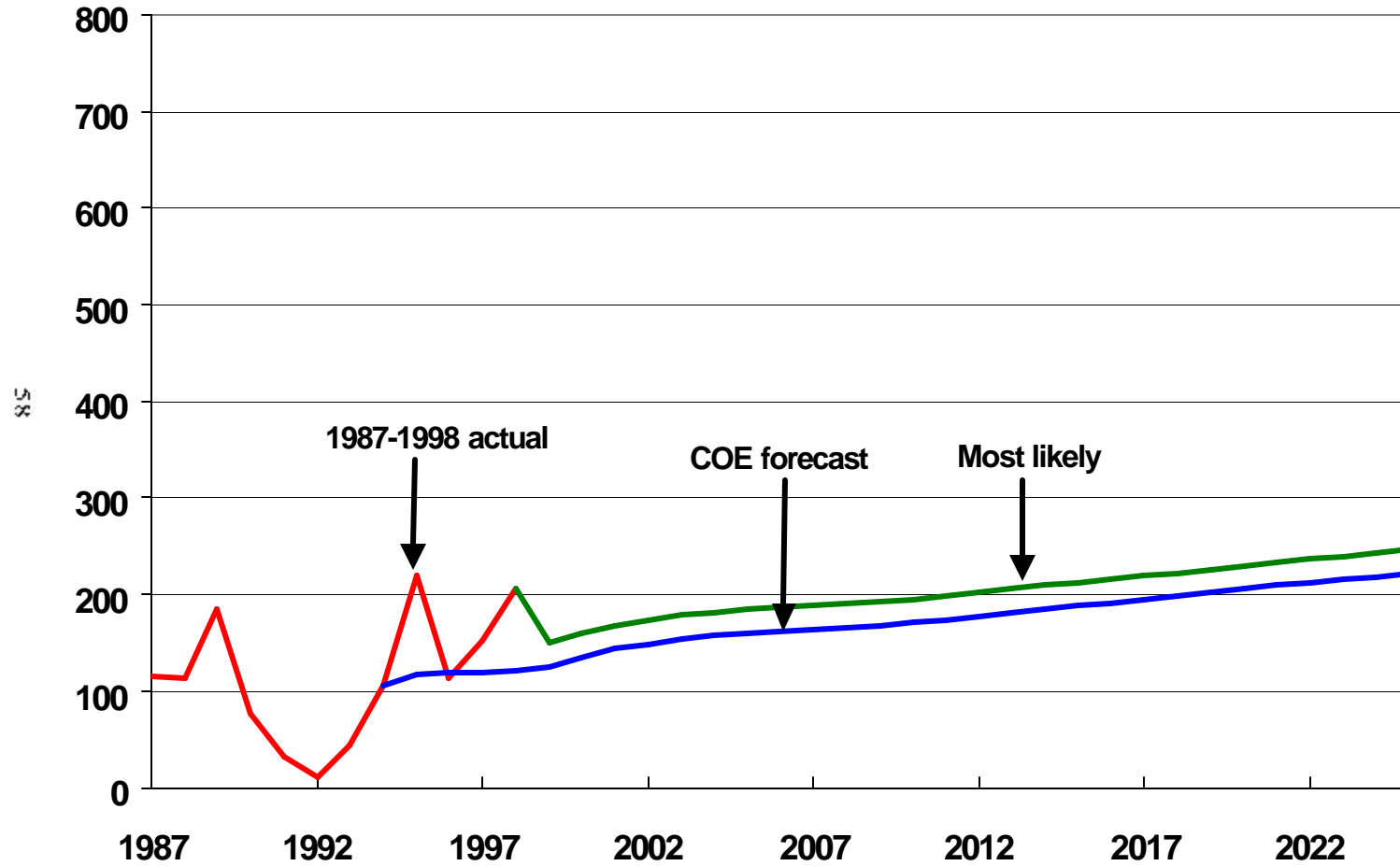
Million bushels **Figure 33. US Soybean Exports to FSU-15: 1987-2025**



Sources: (4), (12)

Million  
bushels

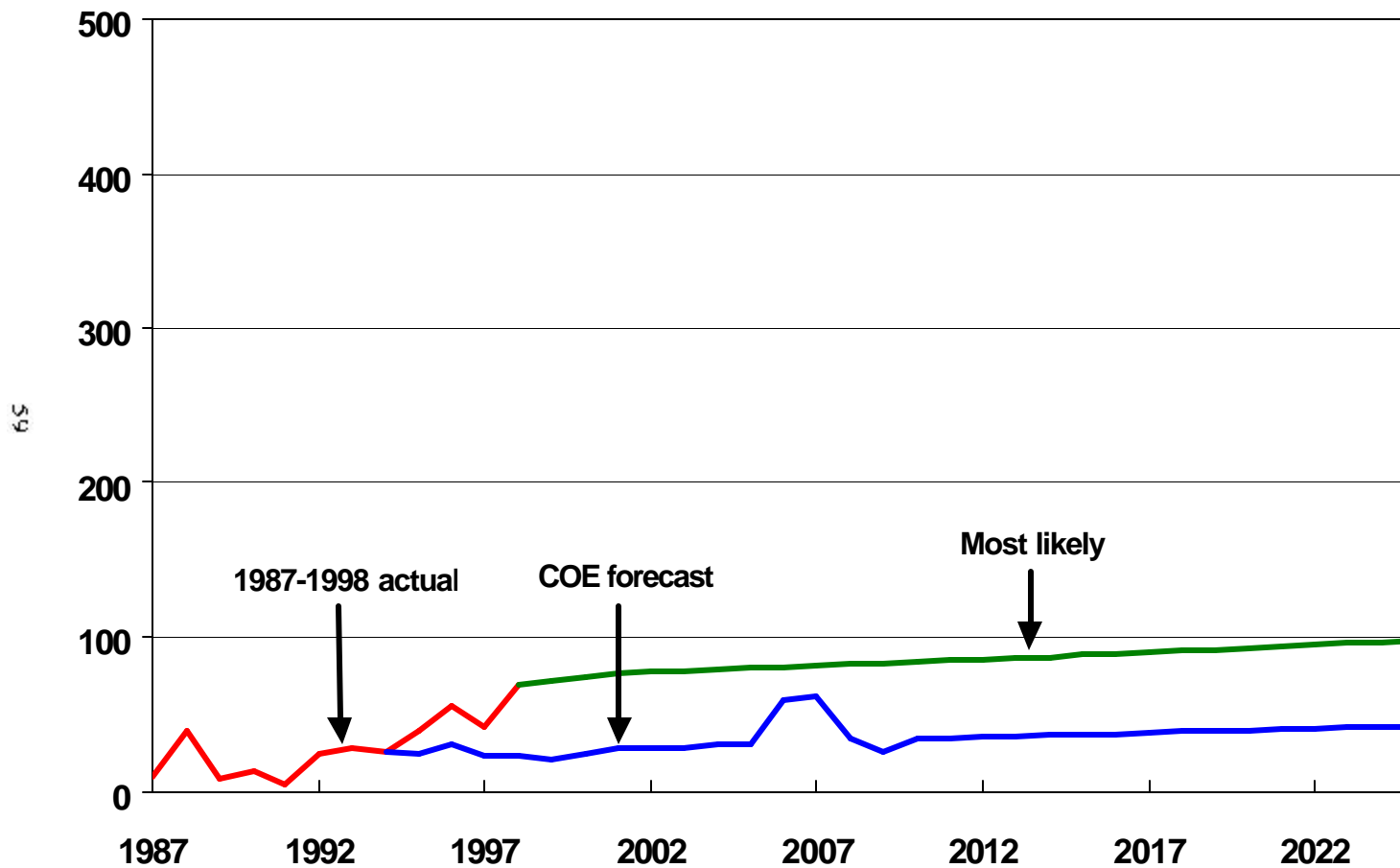
**Figure 34. US Corn Exports to Mexico: 1987-2025**



Sources: (4), (12)

Million bushels

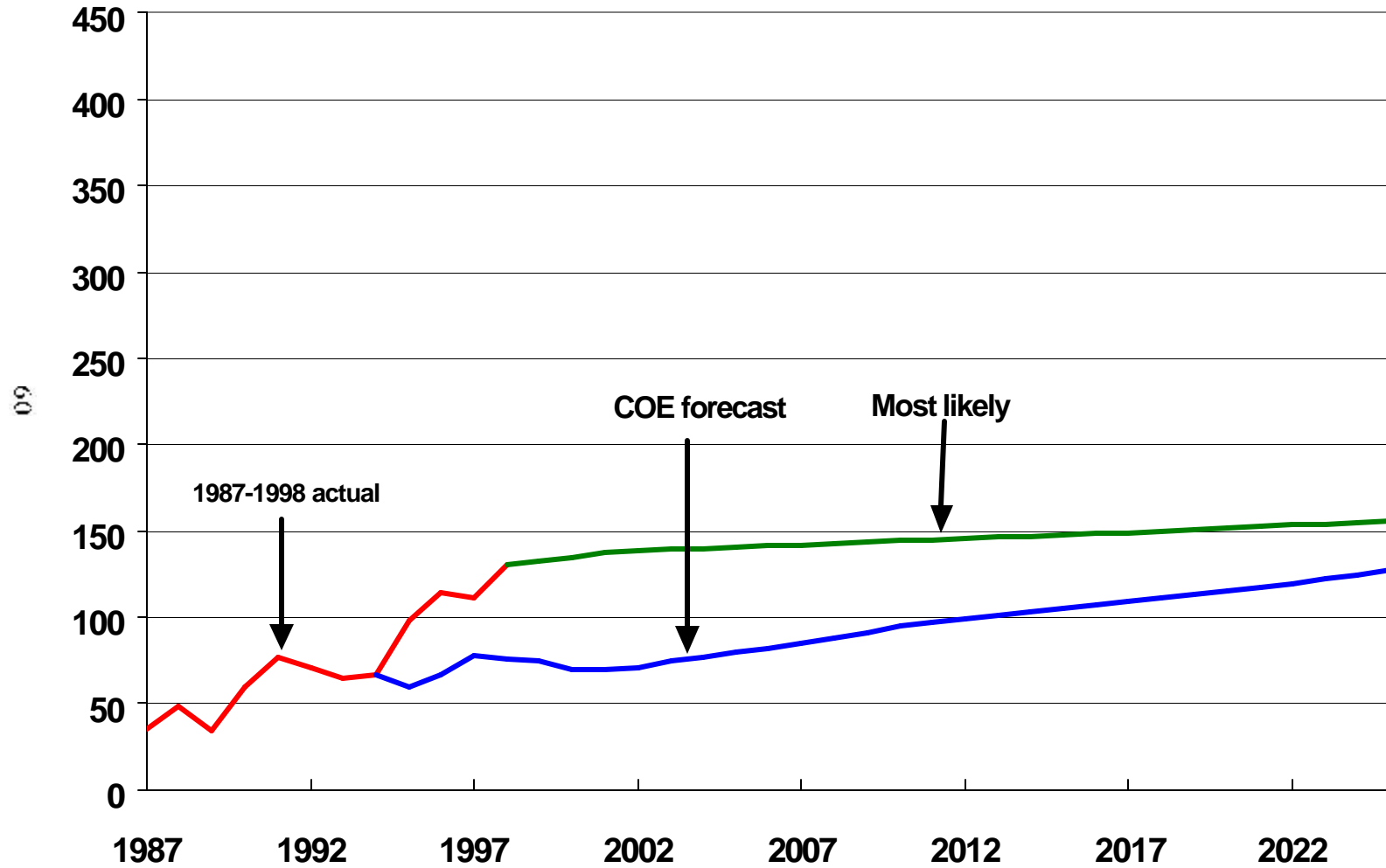
Figure 35. US Wheat Exports to Mexico: 1987-2025



Sources: (4), (12)

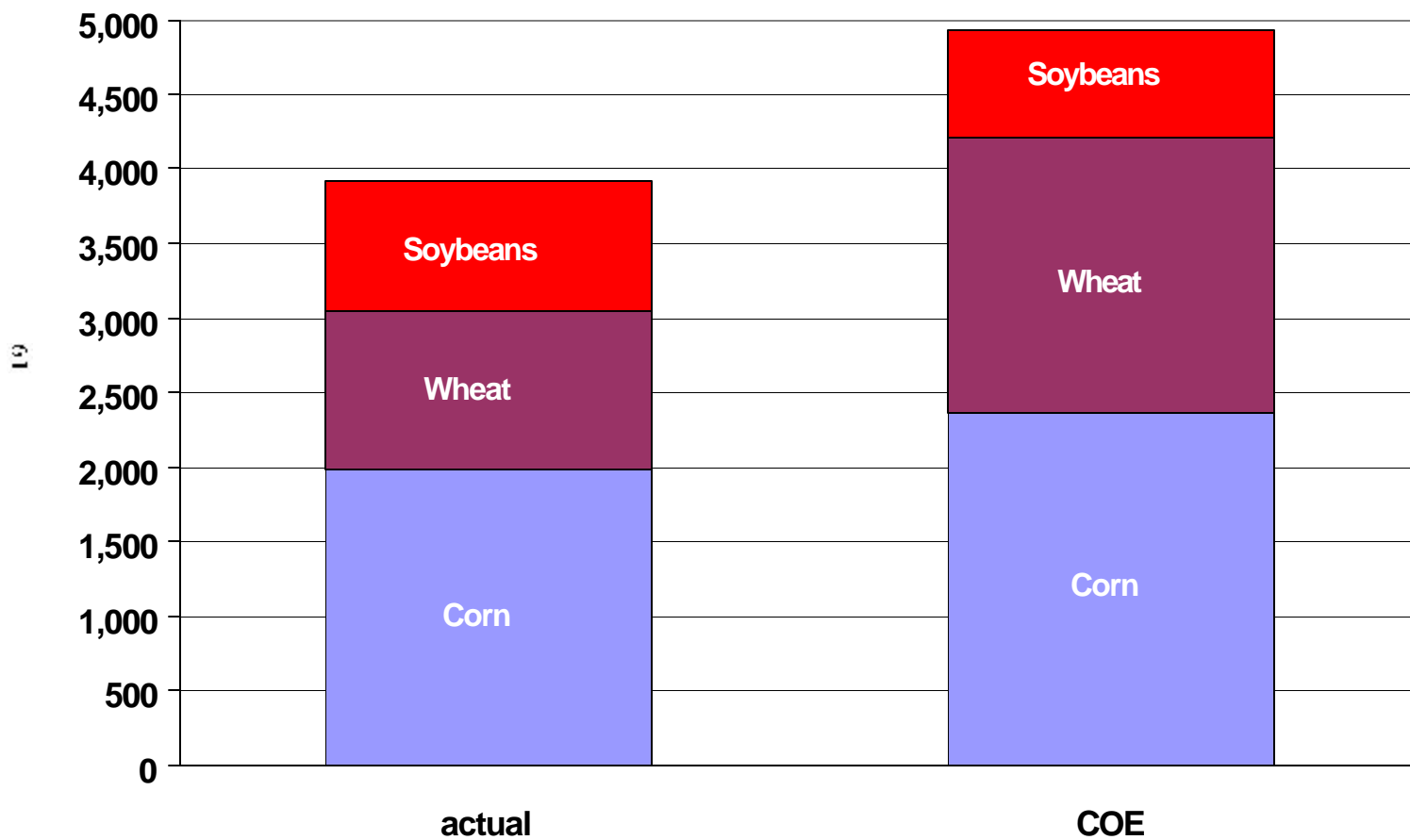
Million bushels

Figure 36. US Soybean Exports to Mexico: 1987-2025



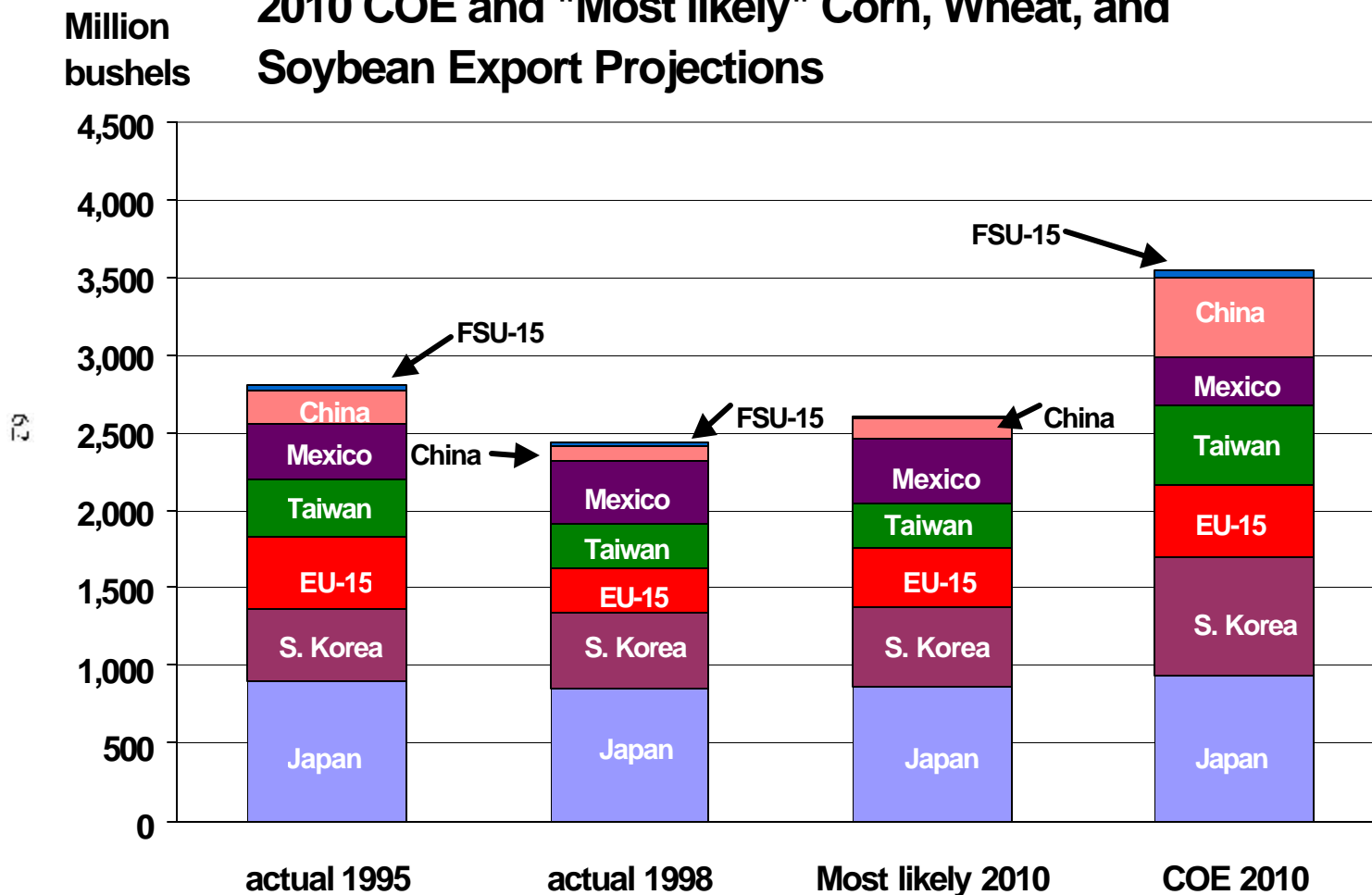
Sources: (4), (12)

**Figure 37. Comparison of COE Projections and Actual Corn, Wheat, and Soybean Exports, 1999**



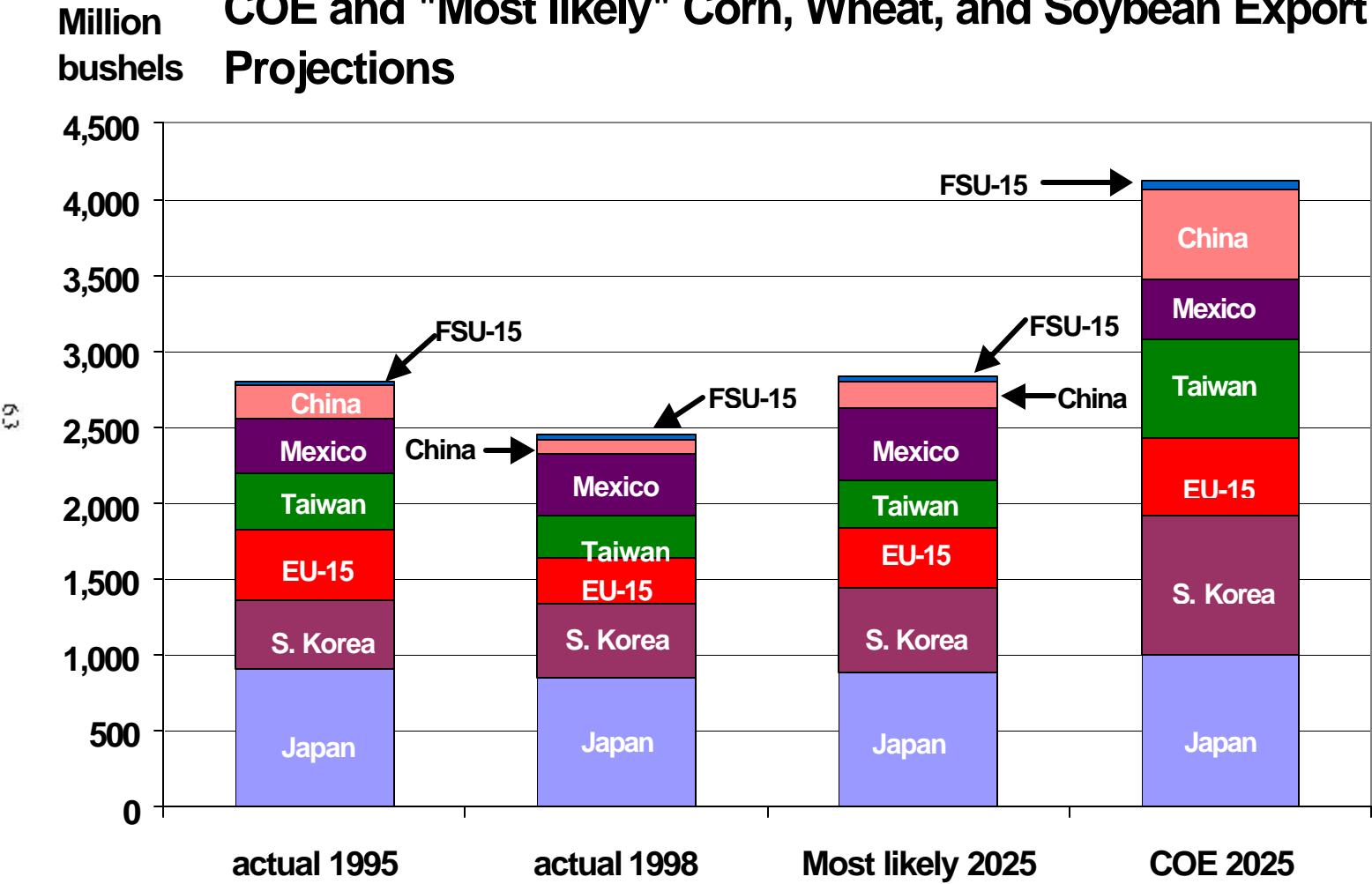
Sources: (4), (12)

**Figure 38. Comparison of 1995 and 1998 Actual and 2010 COE and "Most likely" Corn, Wheat, and Soybean Export Projections**



Sources: (4), (12)

**Figure 39. Comparison of 1995 and 1998 Actual and 2025 COE and "Most likely" Corn, Wheat, and Soybean Export Projections**



Sources: (4), (12)