United States Department of Agriculture

U.S. Agricultural Productivity Growth: Measurement, Trends, and Drivers (1948-2019)

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Outline

- ❑Background and issues
- ❑What is productivity?
- ❑Trends and sources of growth in U.S. agriculture
- ❑Factors that may affect productivity growth—short term vs. long term.
- ❑Projected U.S. agricultural productivity growth (under different R&D scenarios)
- ❑Future Productivity Growth and Challenges

Background and Issues

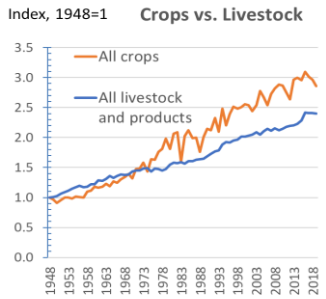
- Farm sector provides human food and fiber needs. Its role in the economy is essential and irreplaceable.
- In 2020, agriculture, food, and related industries provided 10.3% of U.S employment (USDA-ERS 2021).
- Population increase, income increase worldwide → Food demand increase. Unsustainable productivity growth could lead to food price increase and affect the environment.
- Maintaining a substantial agricultural productivity growth is critical to feeding the world and preserving environmental quality.
- Developing proper productivity measurement and understanding sources of growth and productivity drivers are crucial for agricultural policy development.

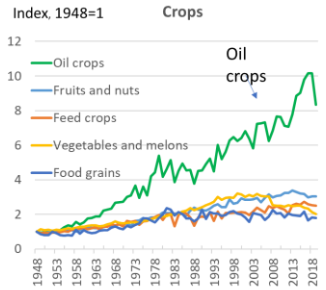
What is productivity?

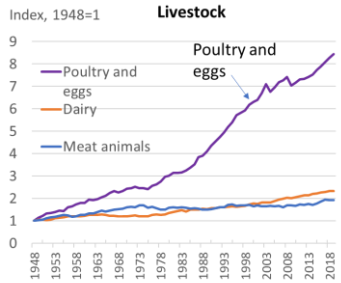
- A measure that shows how efficiently an input or total input is/are used to produce an output or total output
- Single factor productivity (considers only one input)
  - Crop yield—total output/land
  - Labor productivity—total output/labor
- Total factor productivity (TFP, considers all input use)
  - Total output/total input
  - An indicator of overall technical change

(Photos provided by Getty images)

Trends of U.S. Agricultural Output Growth



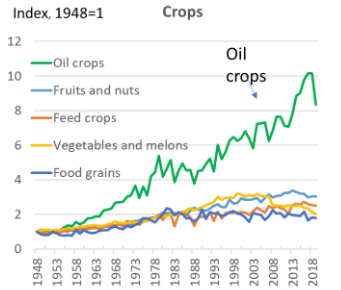


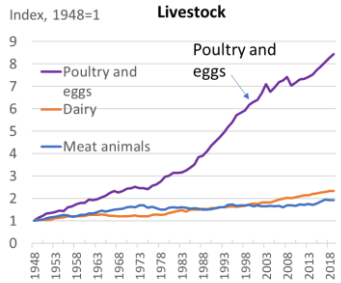


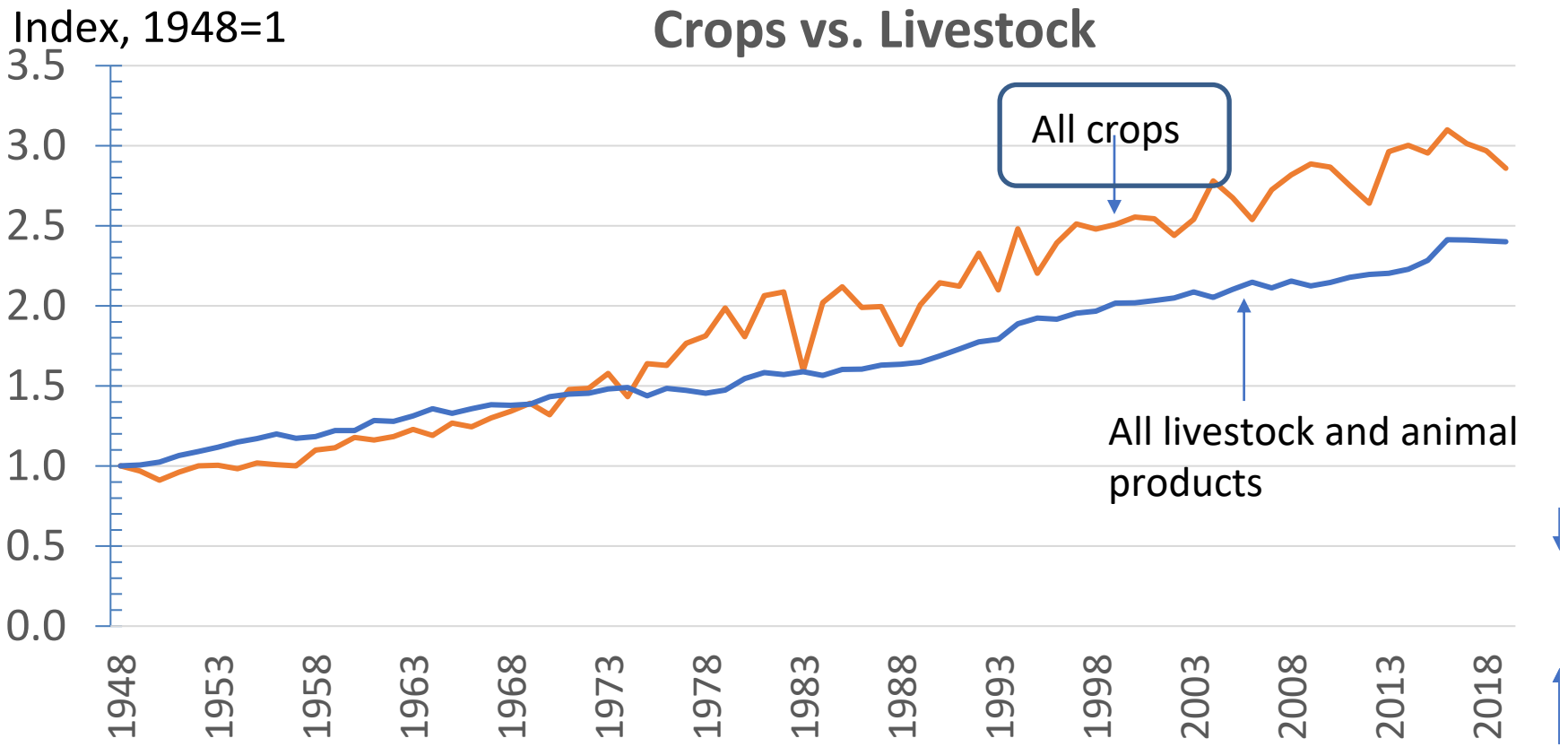
(Photos provided by Getty images)

Trends of U.S. Agricultural Output Growth

U.S. agricultural output has more than doubled
—with crop output growing faster and more volatile than livestock output



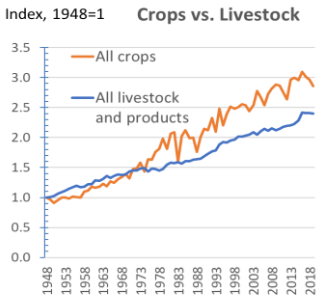


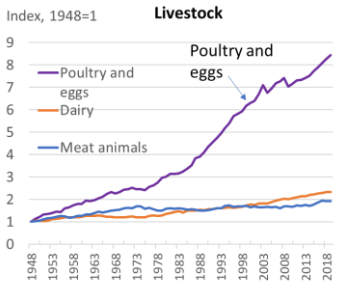


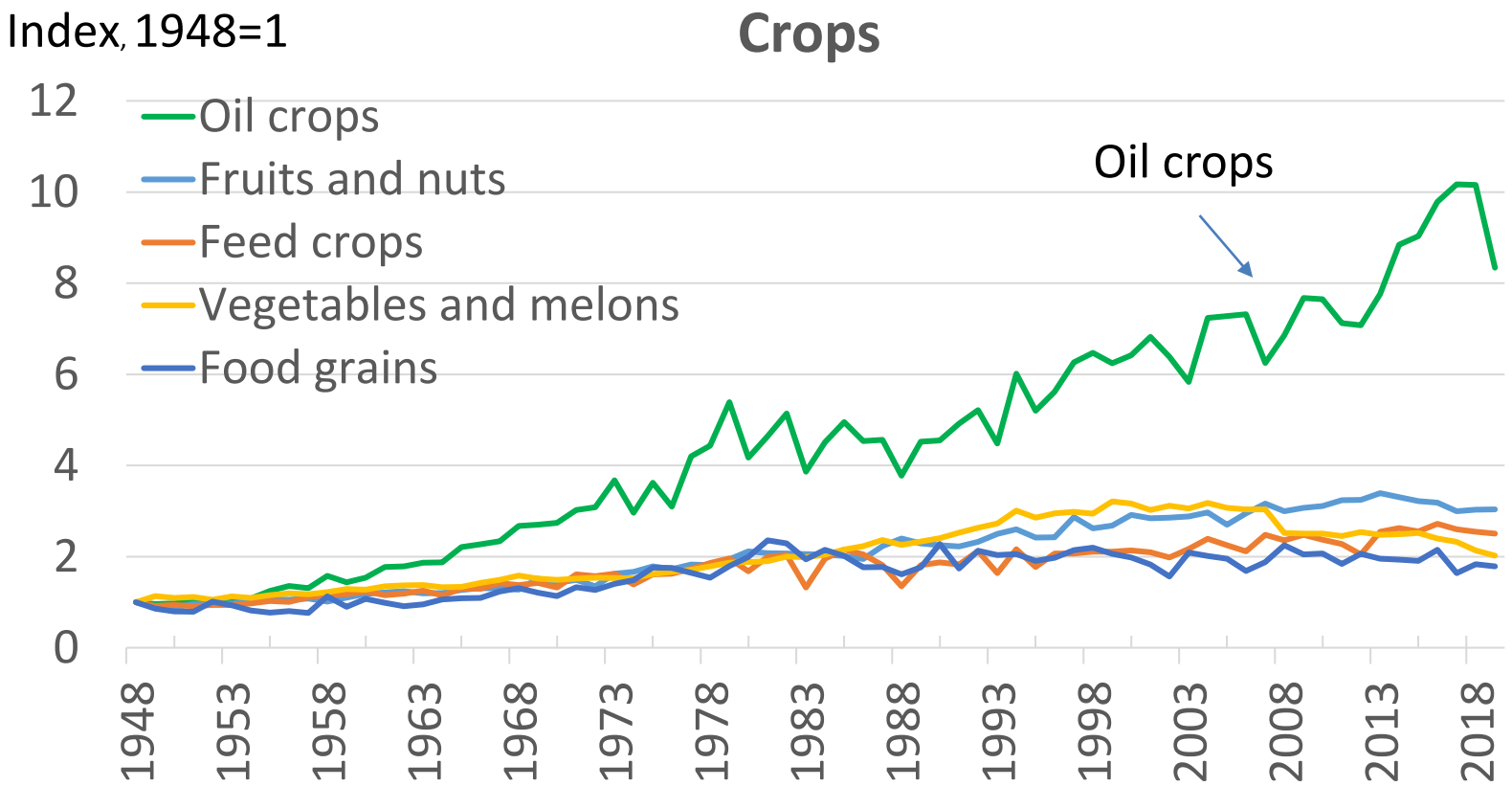
Source: Economic Research Service, Agricultural Productivity in the U.S.

Trends of U.S. Agricultural Output Growth

From 1948 to 2019, oil crops grew at the highest rate among all crops, and soybeans account for about 90% of US oilseed production.







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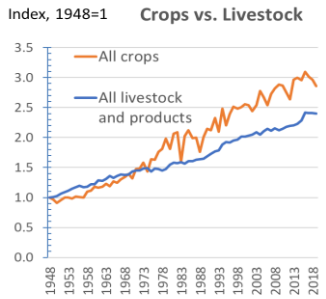
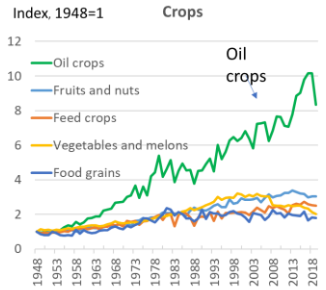
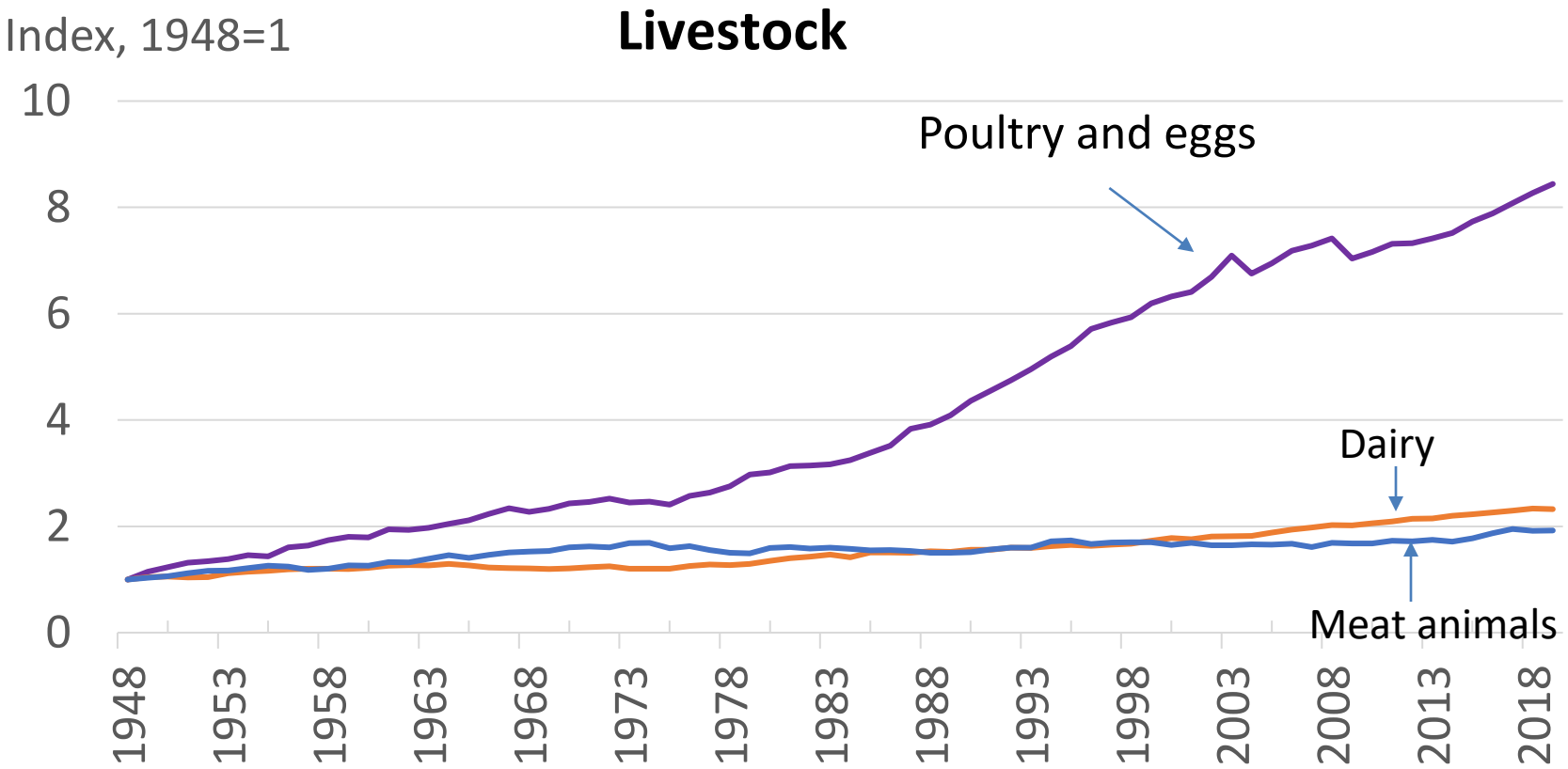
Trends of U.S. Agricultural Output Growth



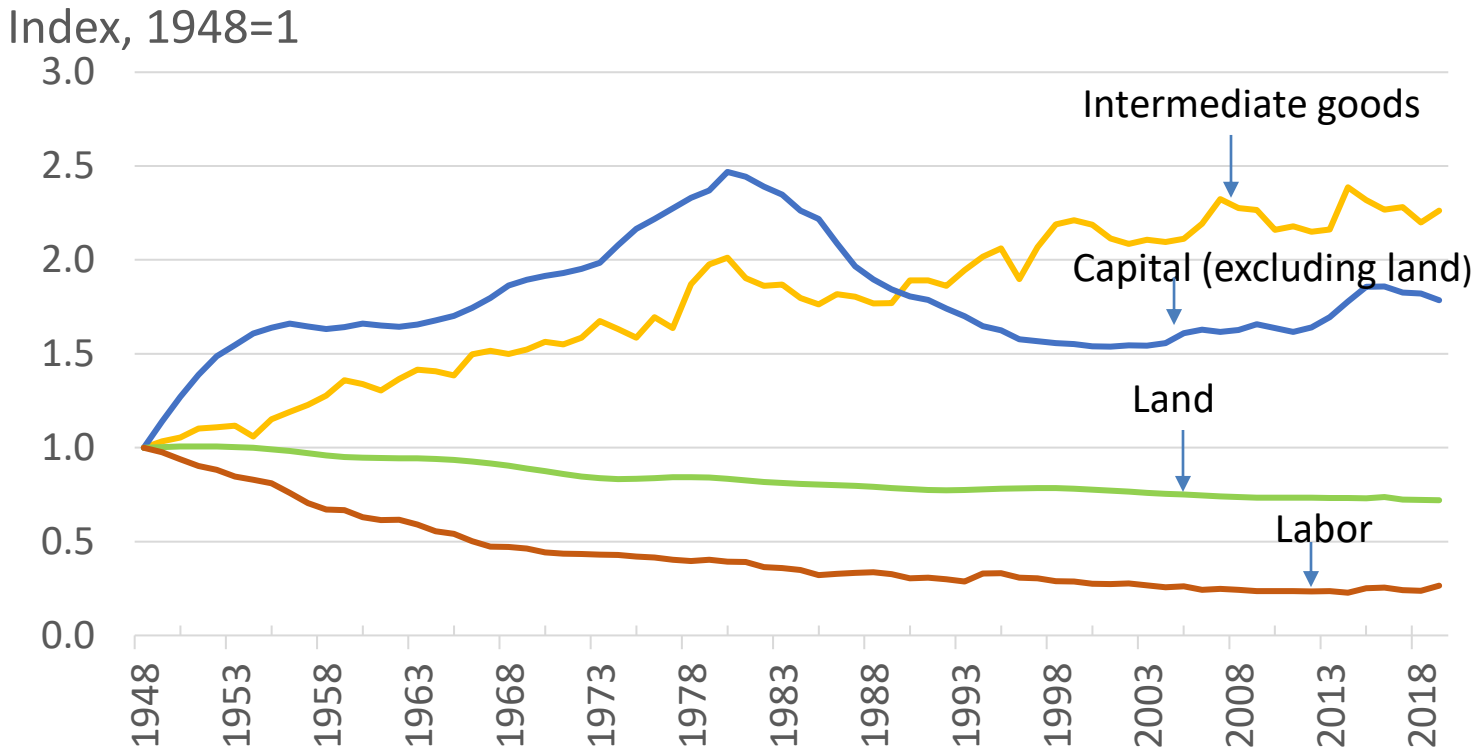


While meat animals accounted for the largest share of livestock production "Poultry and eggs" grew much faster than other subcategories.



Source: Economic Research Service, Agricultural Productivity in the U.S.

Trends of US Agricultural Input Growth

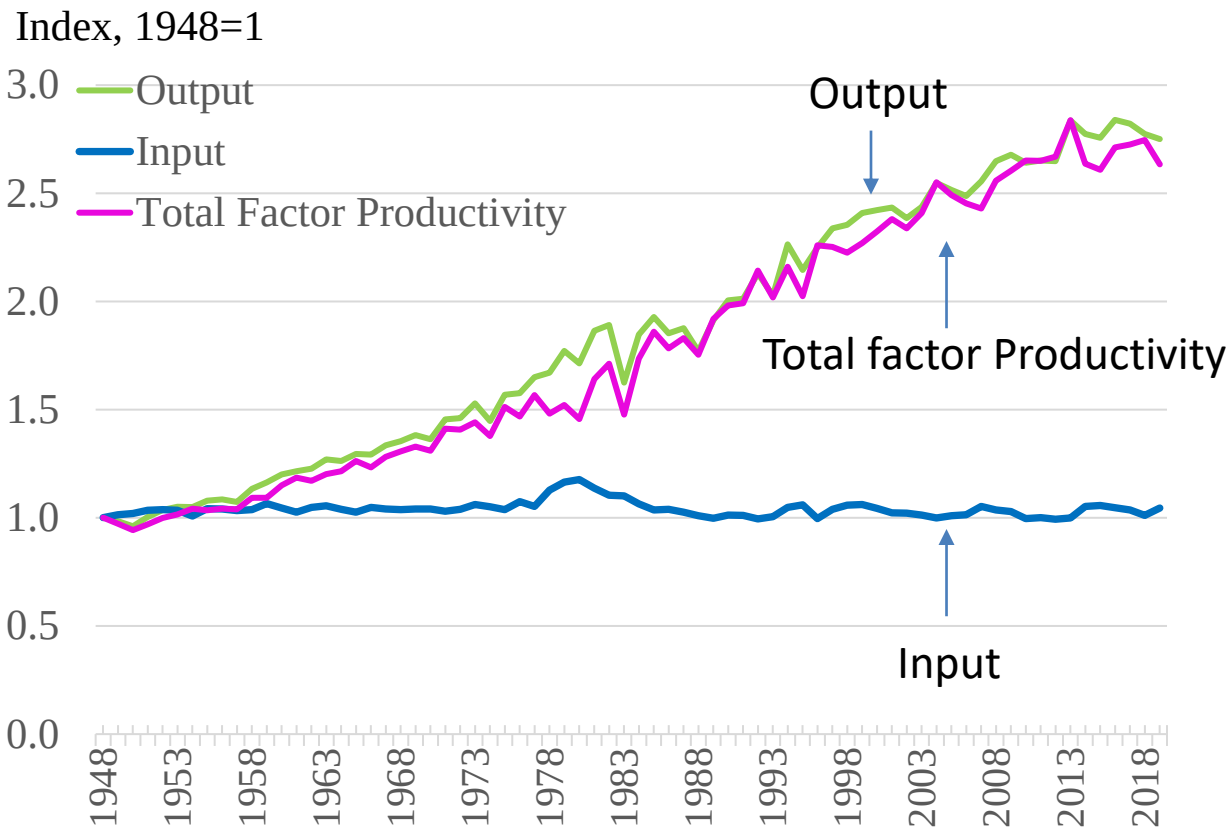


Source: Economic Research Service, Agricultural Productivity in the U.S.

Between 1948 and 2019

- Intermediate goods (feed and seed, energy, agricultural chemicals, and purchased services, etc.) increased by 126%.
- Capital (excluding land) increased by 79%.
- Land decreased by 28%.
  - Land productivity grew nearly four times.
- Labor decreased by 74%
  - Labor productivity grew more than ten times (Wang et al. 2022a; Wang et al. 2022b).

Total Output, Total Input, and Total Factor Productivity in the US

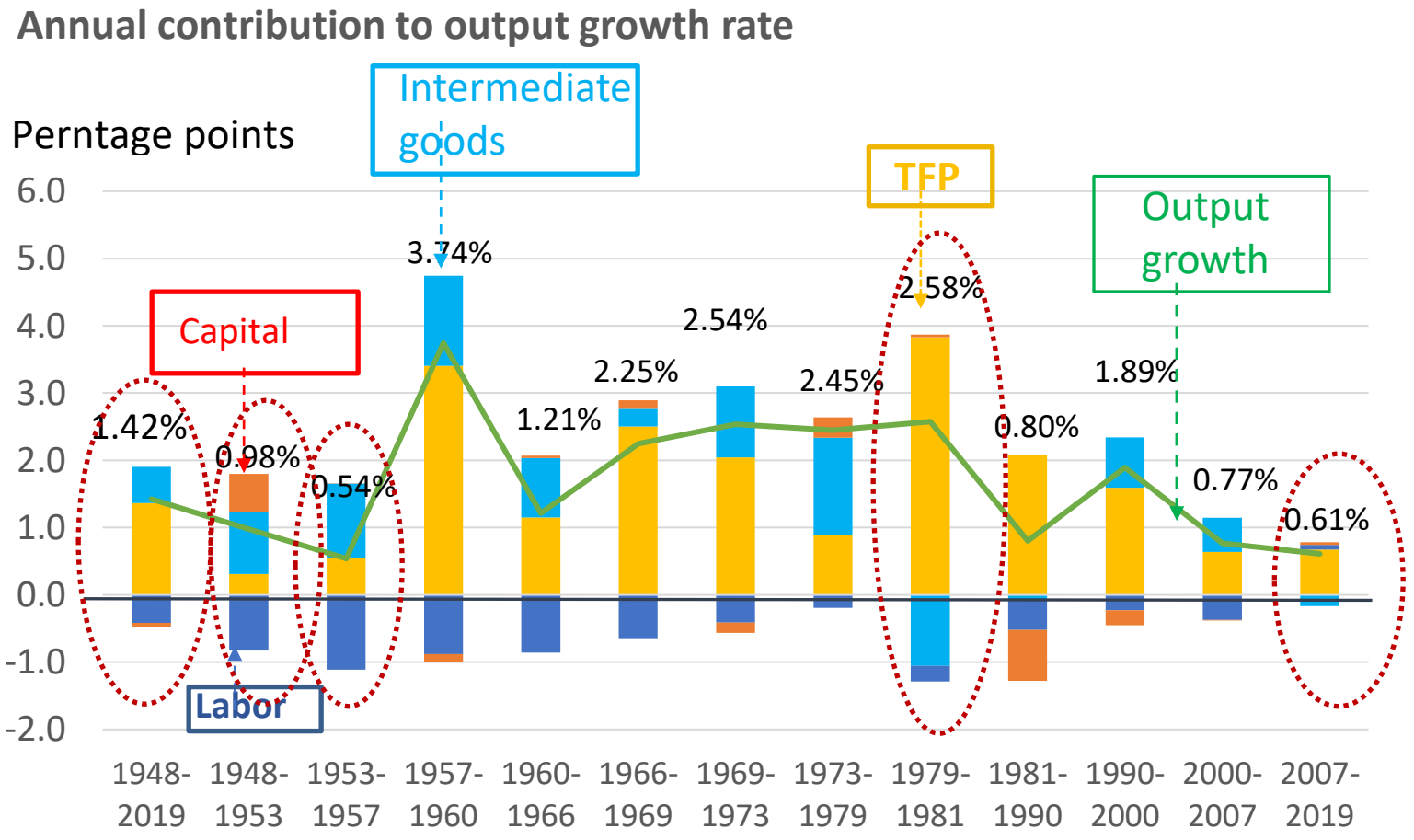


Source: Economic Research Service, Agricultural Productivity in the U.S. (http://www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx

Between 1948 and 2019:

- ❑Agricultural output increased by 175%, at an average annual rate of 1.42%.
- ❑Total input use increased slightly by 4%, at an average annual rate of 0.06%.
- ❑TFP growth accounted for almost all output growth during the period, increased by 163%, at an average annual rate of 1.36%.
- ❑Agricultural TFP growth rate is among the highest in the US sectors (Jorgenson et al. 2014).

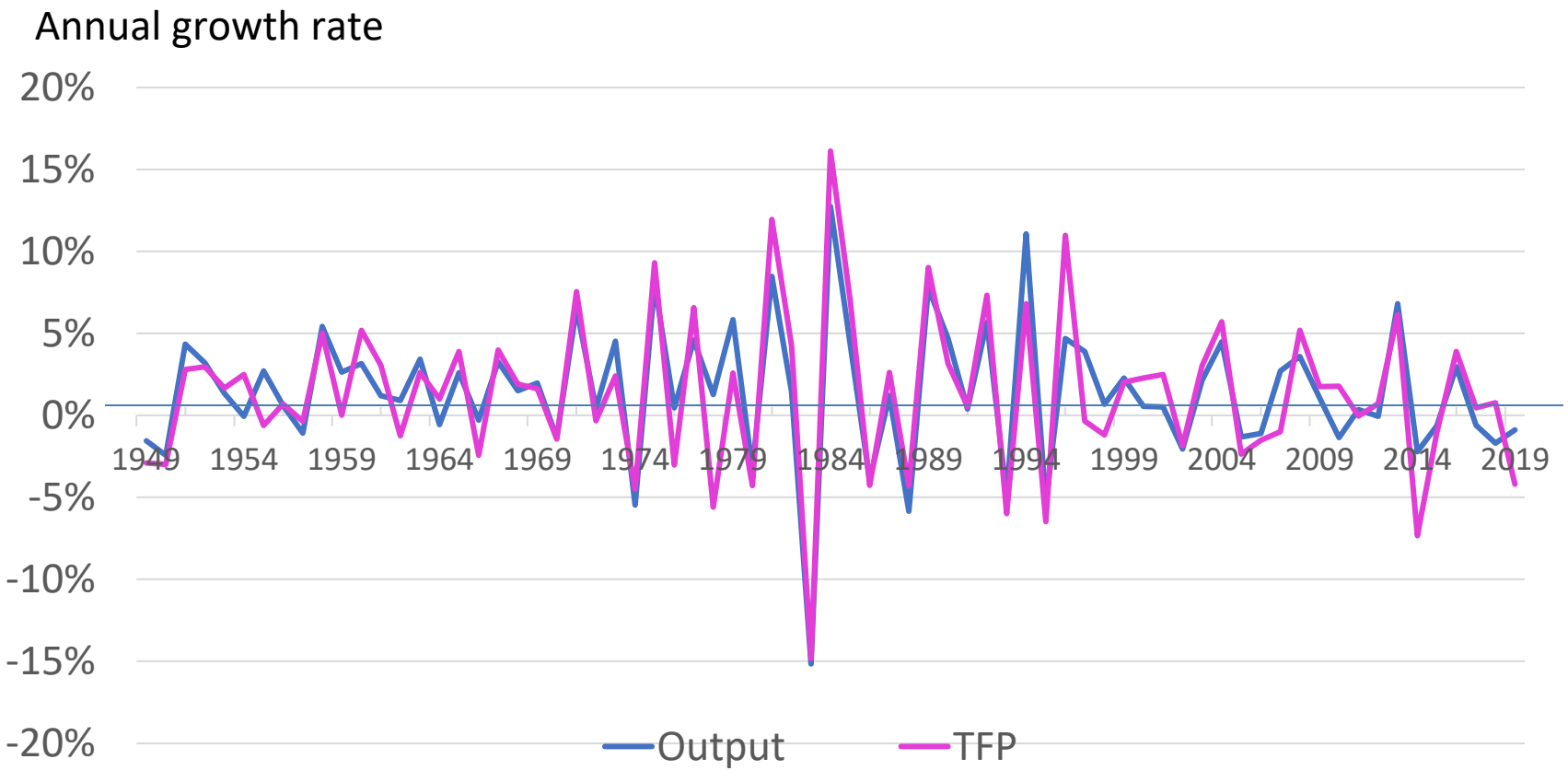
Sources of Agricultural Output Growth



Source: Economic Research Service, Agricultural Productivity in the U.S. (http://www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx

- The subperiods are measured from cyclical peak to peak in aggregate economic activity.
- **Intermediate goods**' contribution was **positive in 9 of the 12 subperiods**.
- The persistent shrinking use in farmland has resulted in a negative contribution to output growth from the overall **capital** growth at **-0.06** percentage points per year.
- The contraction in **labor** input contributes **-0.42** percentage point per year to output growth.
- **TFP** growth caused agricultural output to grow significantly in every subperiod.
- **Sources of growth changed** overtime.

Short term TFP growth rates fluctuate from year to year



Source: Economic Research Service, Agricultural Productivity in the U.S.

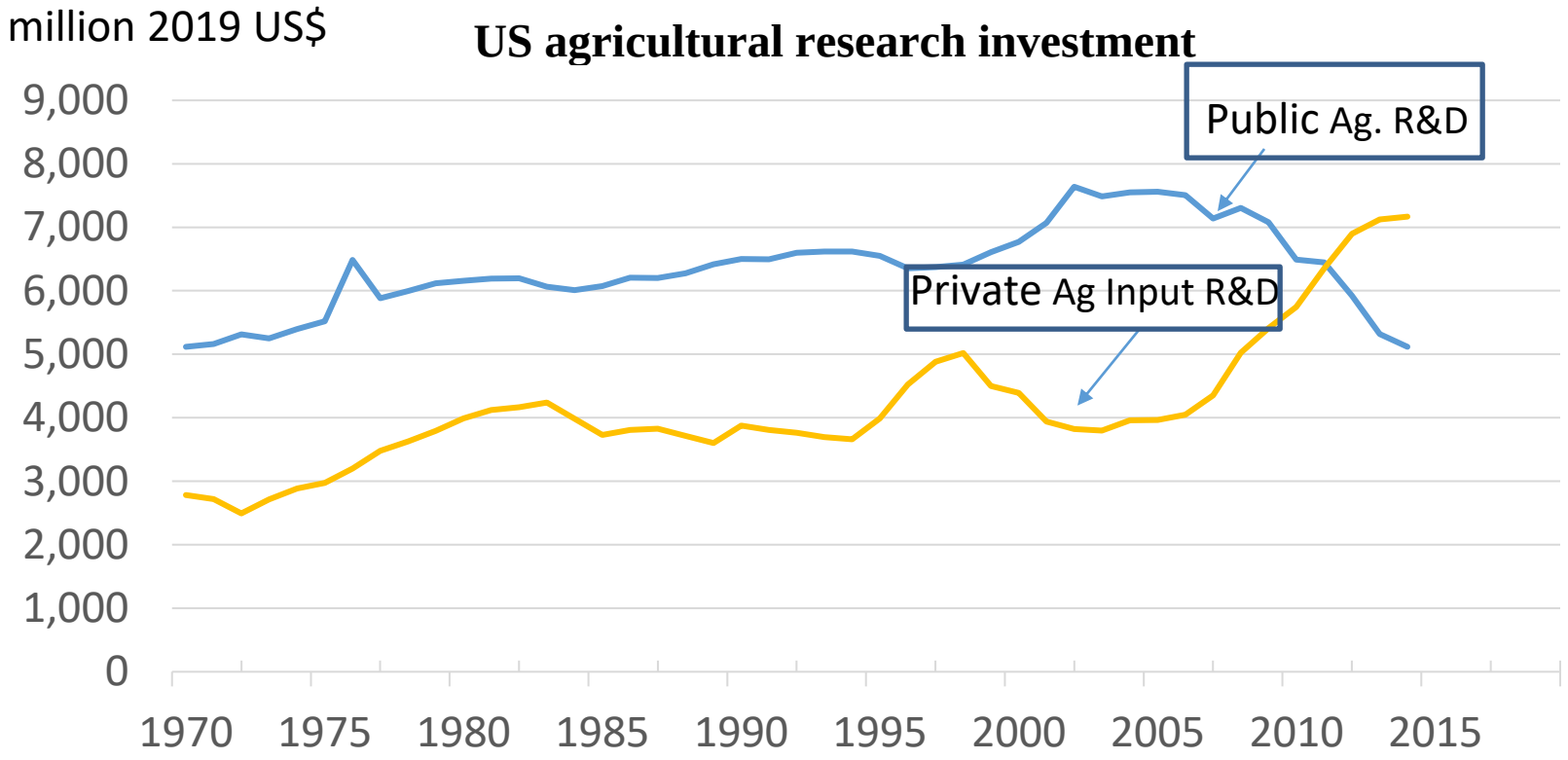
- The major driver of long-term TFP growth is R&D but estimates of **annual TFP growth rate can be affected by transitory events**, such as adverse weather (Wang et al. 2015; Liang et al. 2017), energy shocks (Wang and McPhail, 2014), etc.
- TFP growth rate moves more closely with the volatile output growth rate.

Source: Economic Research Service productivity accounts

Long Term Drivers of TFP growth

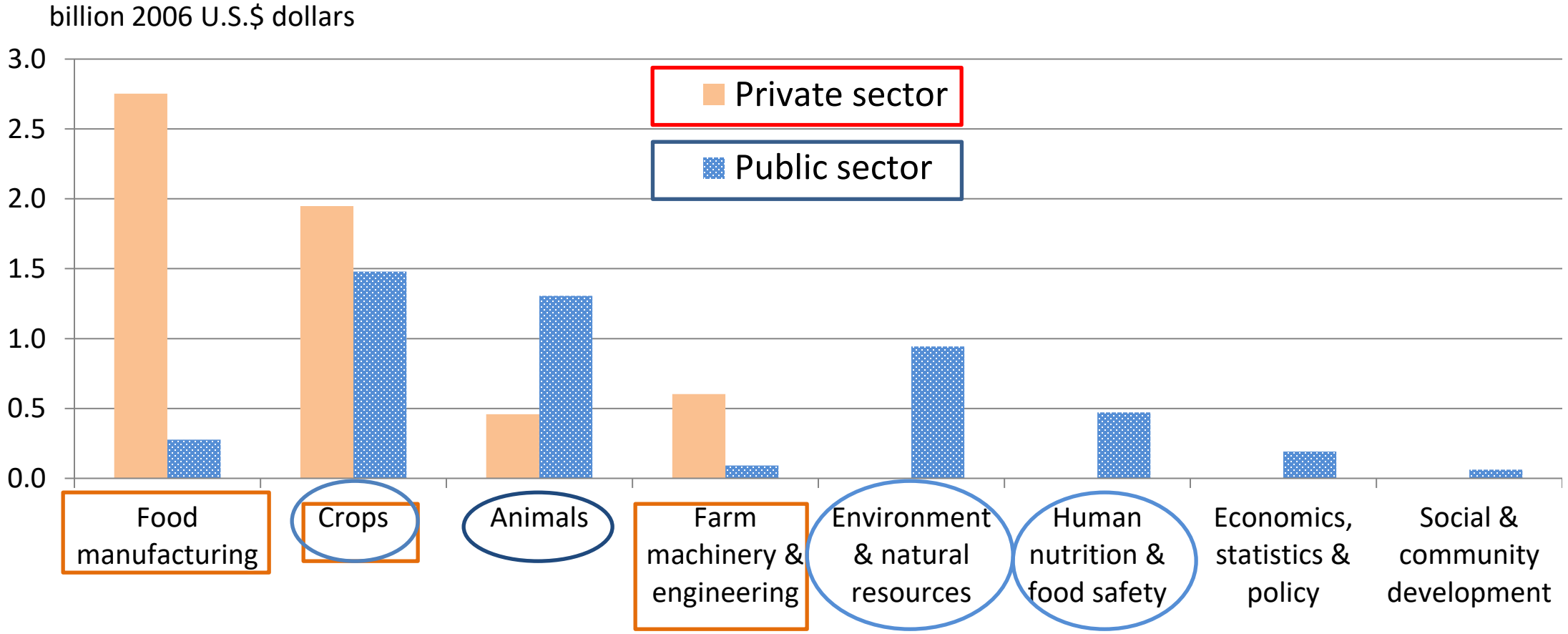
- The major driver is R&D
  - Public R&D investment– it has declined since 2007 (USDA-ERS 2019)
  - Private R&D investment
- Other factors:
  - Extension
  - Infrastructure—such as roads, irrigation system, broadband, electricity, etc.

(Huffman and Evenson 2006; Fuglie and Heisey 2007; Alston et al. 2010; Wang et al. 2012; among others)



Source: Economic Research Service. Agricultural Research Funding in the Public and Private Sectors.

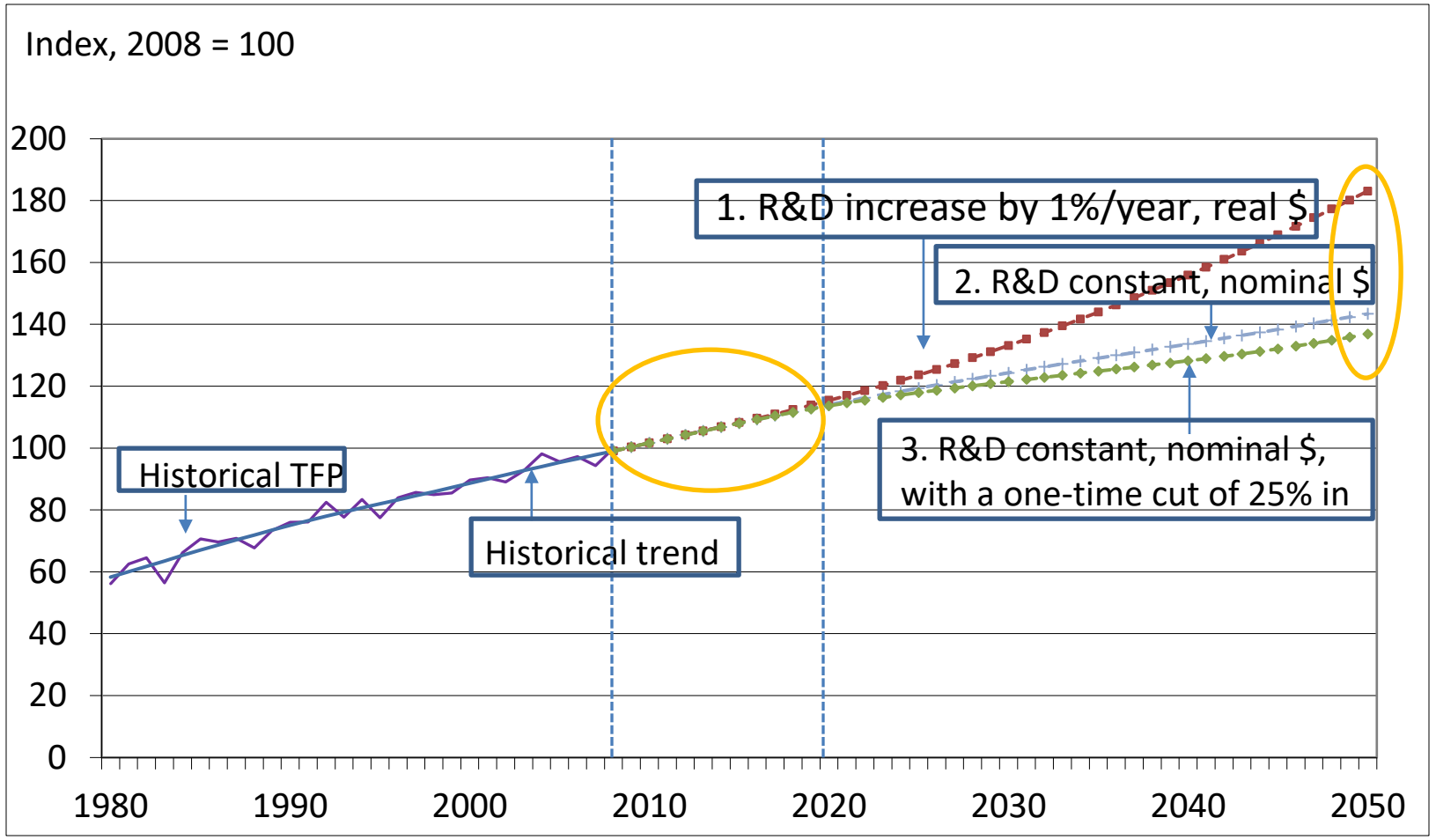
Private and public sectors have different focuses in their food and agricultural research investment



Sources: Wang et al. (2015), Economic Research Service

Source: Economic Research Service.

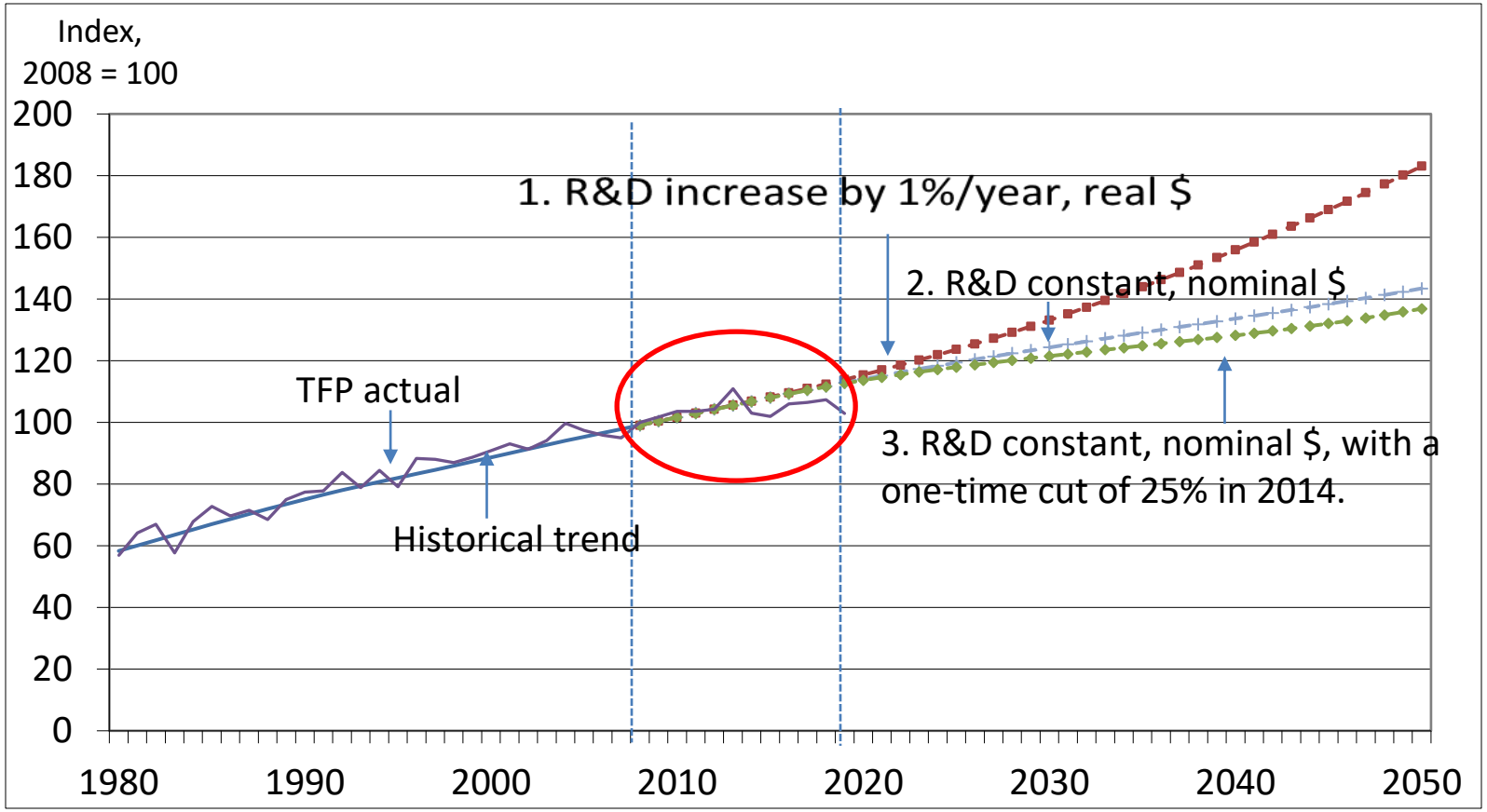
TFP Projections under Alternative Public R&D Scenarios



Sources: Wang et al. (2015), Economic Research Service

- The TFP impacts under different scenarios during early stages are rather small as it takes time for research investment to affect TFP growth.
- However, between 2010 and 2050, agricultural productivity grows differently--by about 80 percent, 40 percent, and 30 percent under scenarios 1, 2, and 3, respectively.

TFP Projections under Alternative Public R&D Scenarios



Sources: Economic Research Service.

- Since 2005, public research funding has declined at 3% per year on average.
- TFP growth rate has slowed in recent years.

Future Productivity Growth and Challenges

- Under climate change the frequency of extreme weather has increased and may result in more impacts on short term productivity growth rate.
- Agricultural productivity growth is among the highest in US industries. US farm sector also depends more on TFP growth than other sectors. Can this TFP growth persist? Is the US TFP growth rate sustainable in supporting future needs.
- Public agricultural R&D investment has been stagnant. Is the increase in private R&D investment enough and adequate to substitute for the role of public R&D?
- It may become increasingly difficult for TFP to catch up even if public R&D increase again as there is a long lag between a research investment and the resulting TFP growth.

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