Agricultural R&D, Technological Change, and Food Security

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Effects of Agricultural R&D

For sure

- more abundant, cheaper food
- less poverty
- a decrease in the number of people going hungry
- a (perhaps smaller) decrease in the proportion of people going hungry

And perhaps

- more specialized and more intensive production on individual farms (and, for some, a greater risk of crop failure)
- a greater use of purchased inputs (and, for some, a greater risk of financial ruin)
- a faster rate of consumption of natural resource stocks
- less biological diversity and an increased risk of widespread famine

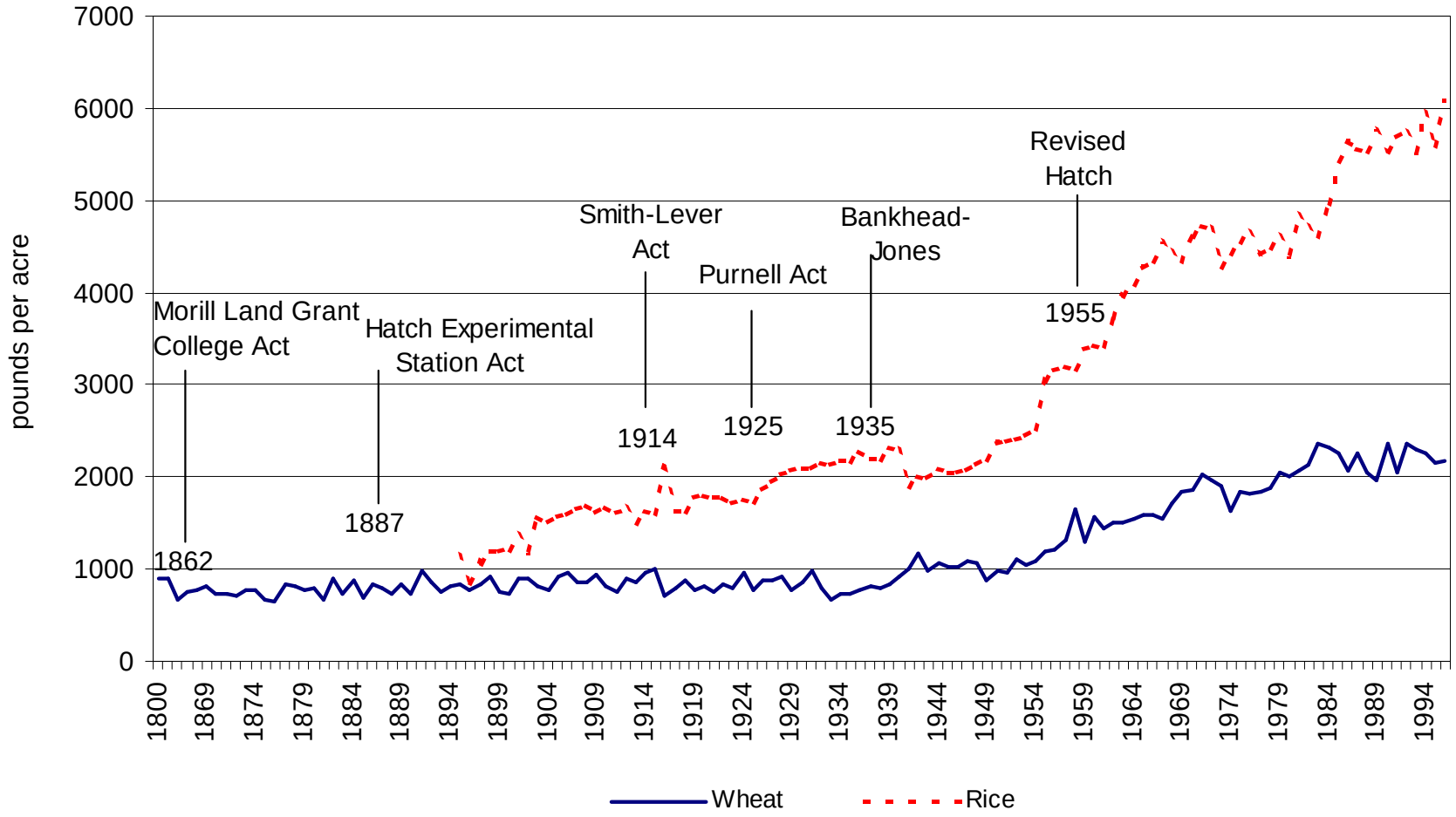
Annual Growth in Agricultural Production, 1961-1997

	Crop	Livestock	Total
		(percentage)	
Latin America and the Caribbean	2.61	2.85	2.71
Asia	3.01	4.93	3.50
Sub-Saharan Africa	2.09	2.35	2.16
Developing Countries	2.97	4.07	3.29
United States	1.98	1.23	1.61
Western Europe	1.08	1.43	1.27
Developed Countries	1.20	1.33	1.27
World	*2.23*	*2.28*	*2.25*

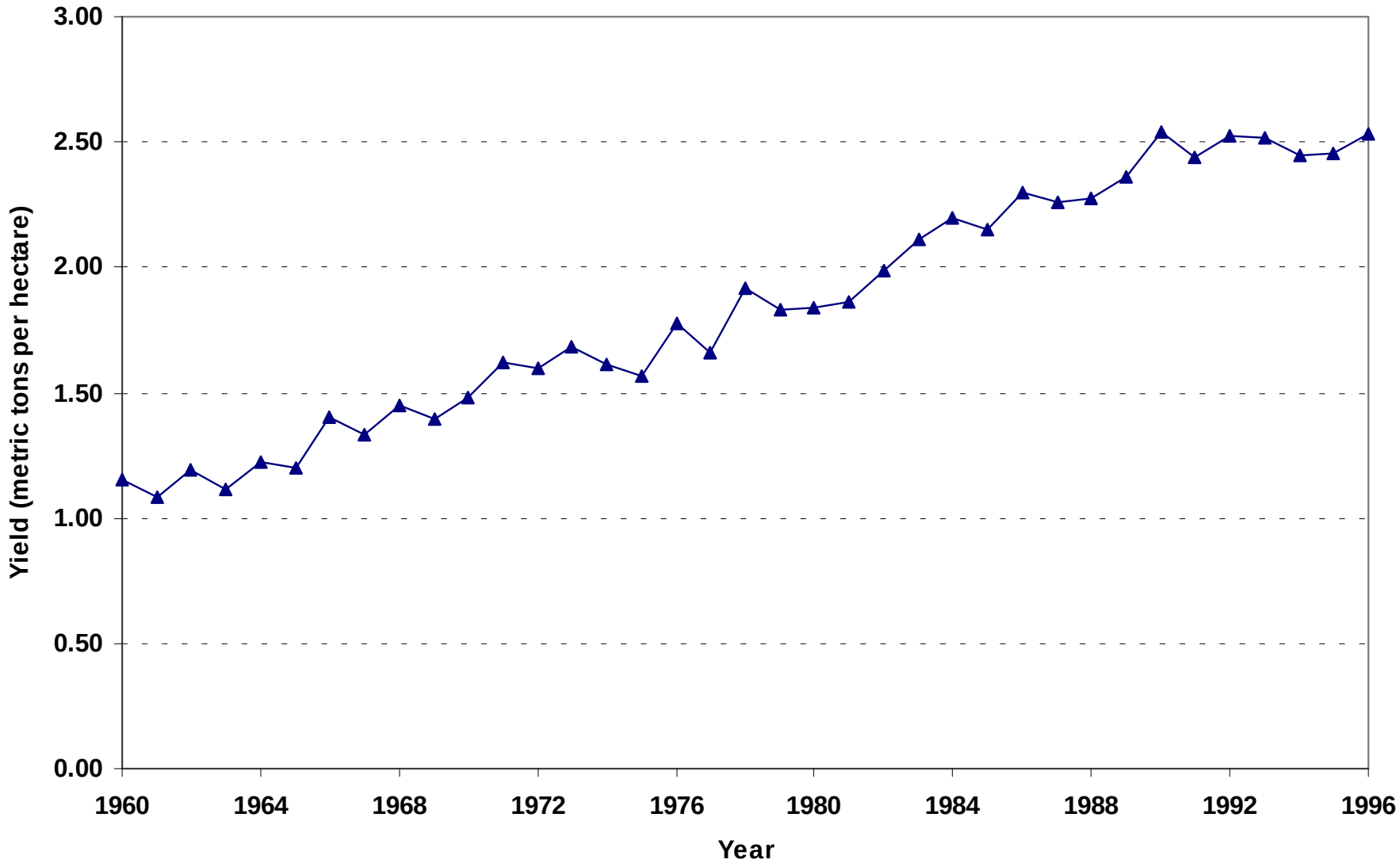
Agricultural Productivity Growth in South China, 1976-1995

Crop	Total MFP Growth	MFP Growth Due to R&D
	(percent per annum)	
Rice	1.78	1.38
Wheat	4.54	2.82
Other Grain	4.29	3.58
Cash Crops	9.27	7.26

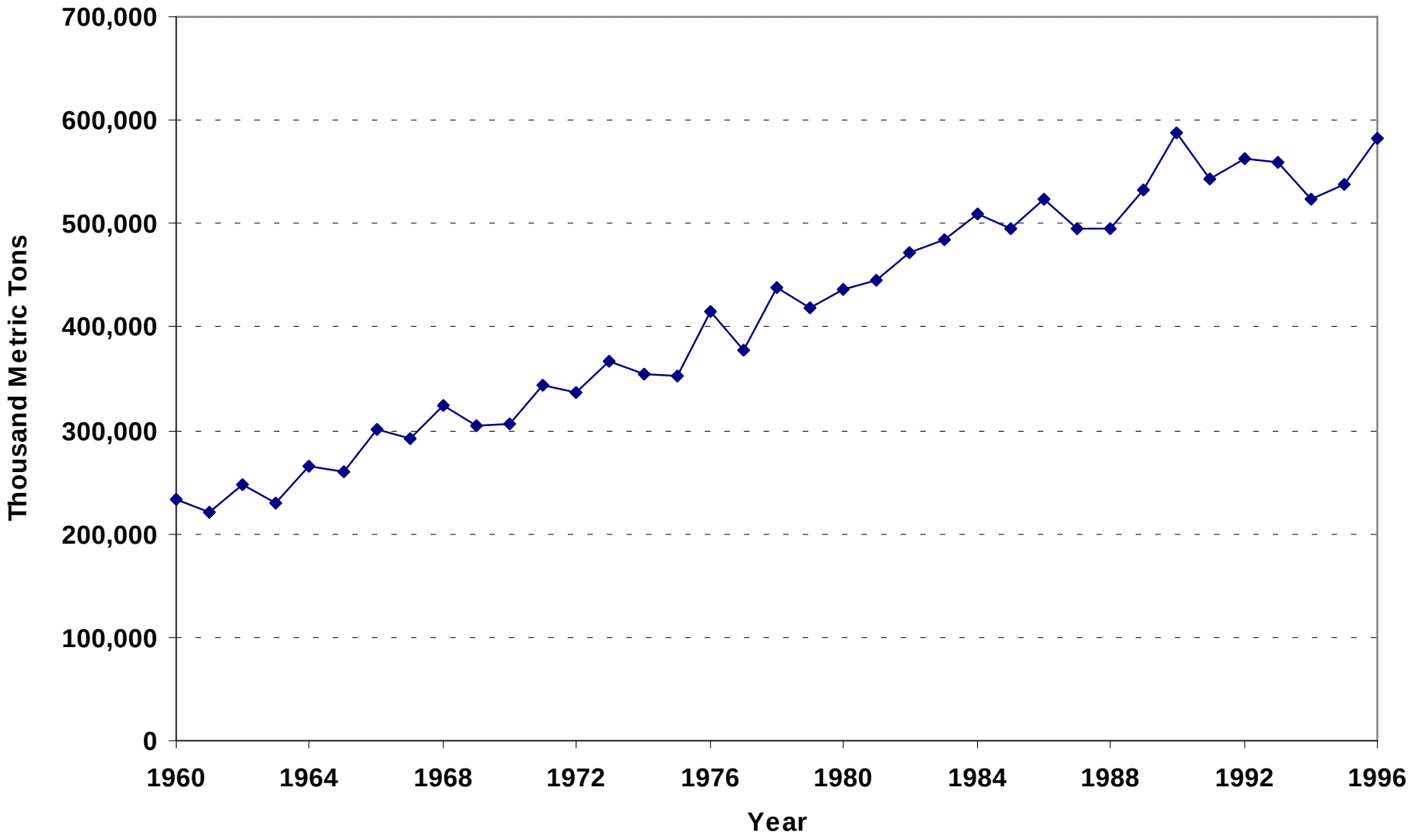
U.S. Wheat and Rice Yields, 1800-1996



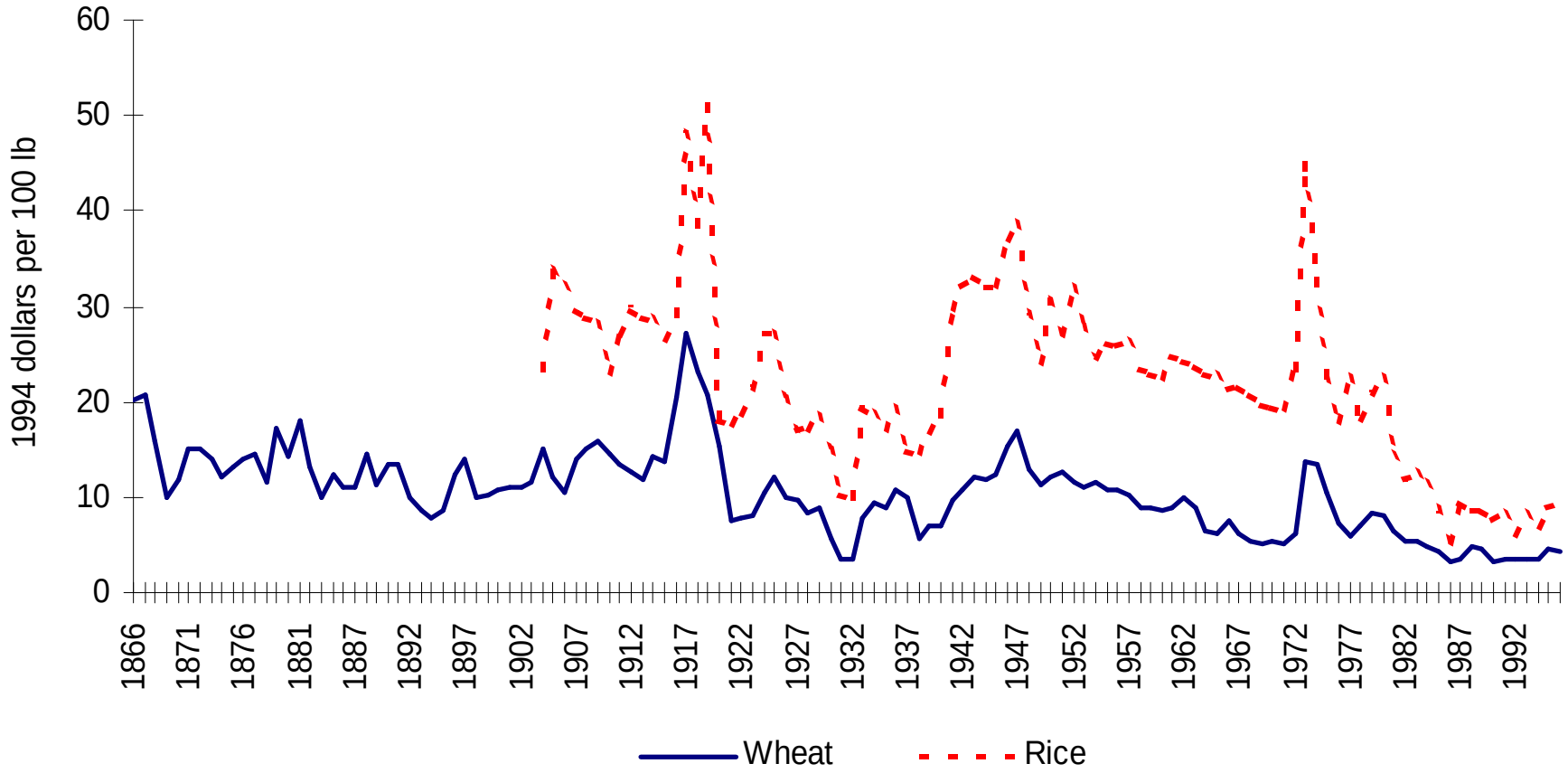
World Wheat Yields, 1960-1996



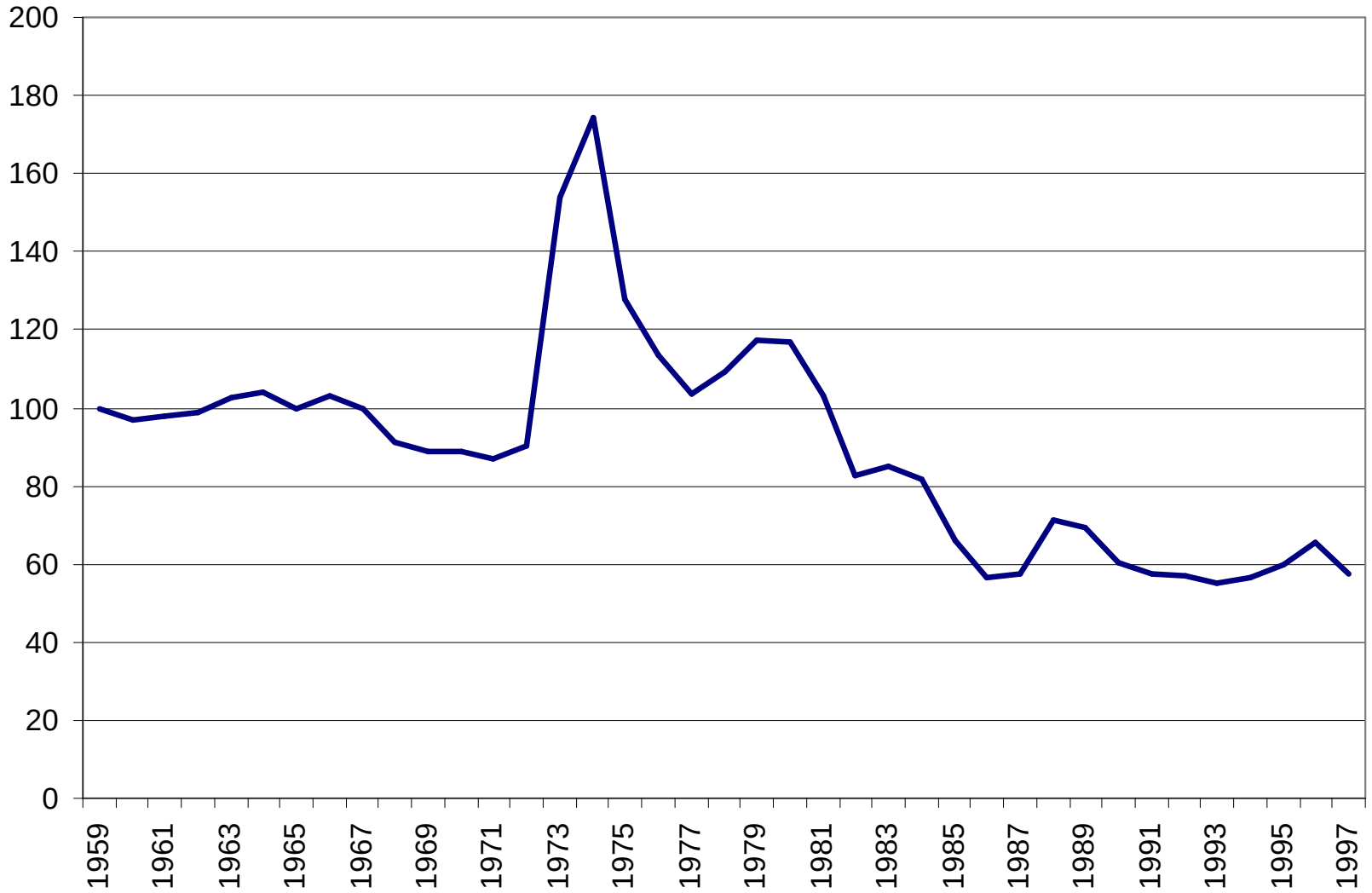
World Wheat Production, 1960-1996



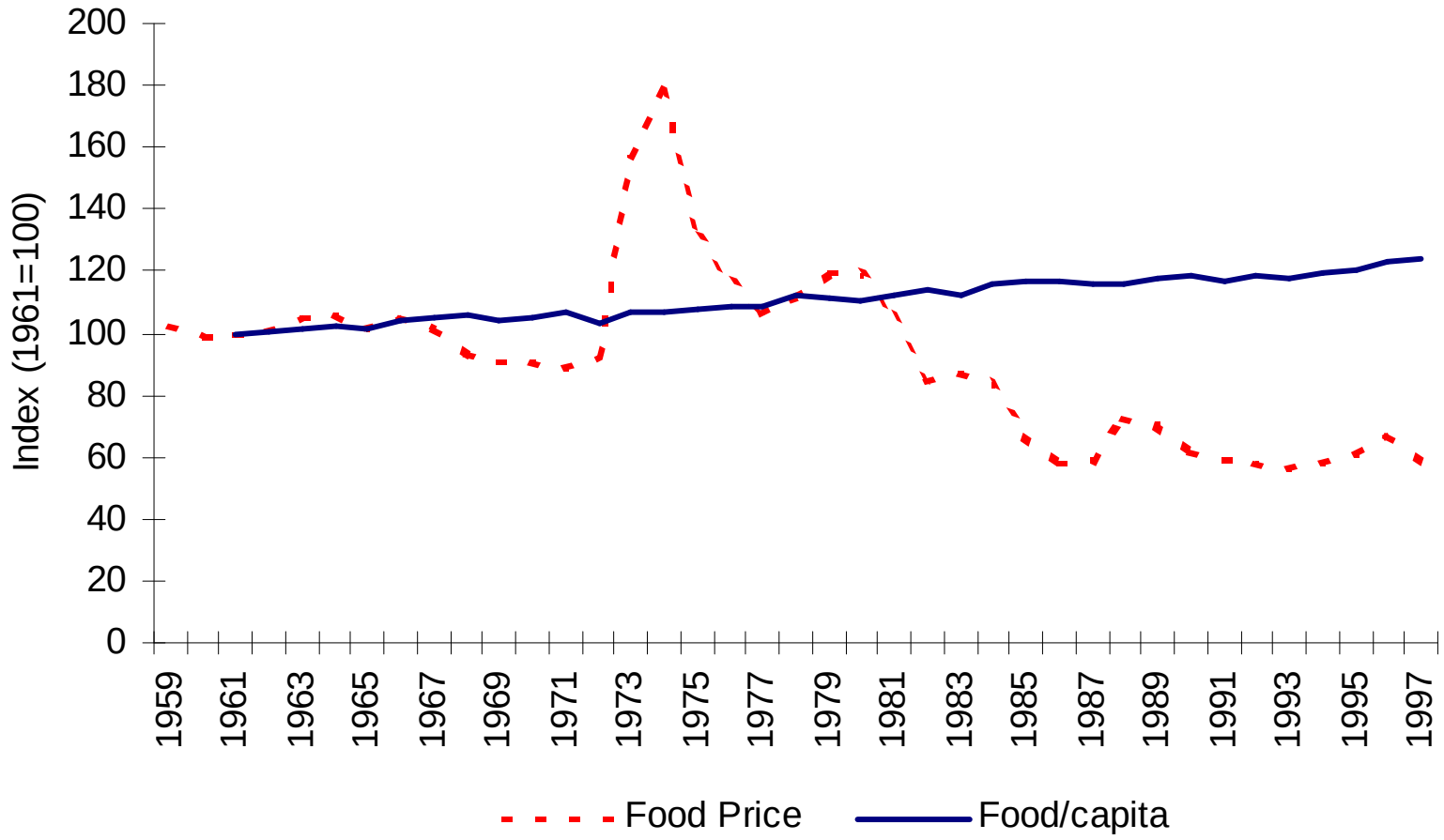
U.S. Real Wheat and Rice Prices, 1899-1996 (1994 US$)



Real World Food Price Index, 1959=100



World Food Price and per Capita Food Production



Effects of Eliminating Past R&D on Current Grain Production and Prices

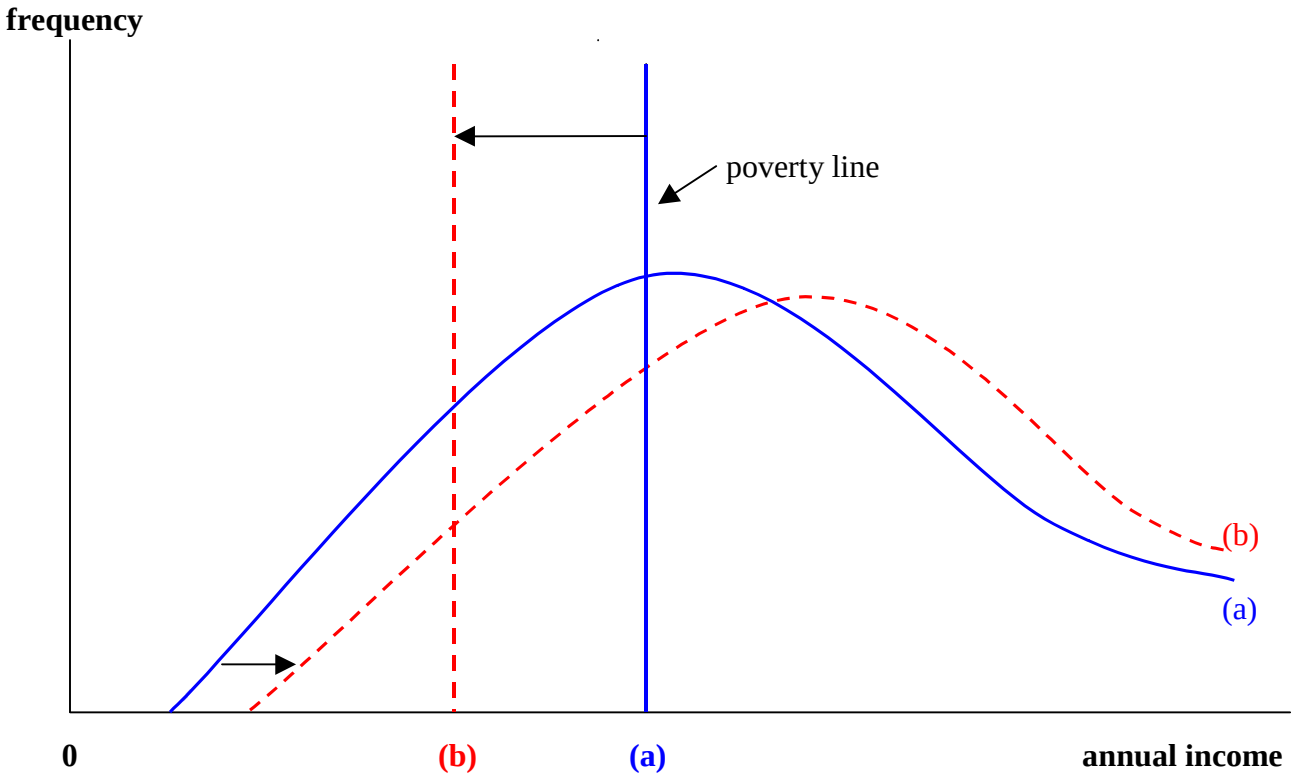
- **Past Patterns--over 35 years**
  - **q = dlnQ = 100%**
  - **p = dlnP = -50 %**
  - **g = q - ε p = 150 % (ε = 1)**
- **Assume η = - 0.2 and 2/3g = 100 % increase in supply due to research, relative to 1960**
- **Eliminate past growth in supply from R&D (reduce supply by 50 % relative to 1995)**
  - **q = $-\eta(-50\%)/(\varepsilon-\eta)$ = -8% (-16% of 1960)**
  - **p = $-(-50\%)/(\varepsilon-\eta)$ = 42% (25% of 1960)**

Distributional Considerations

- $B_i = -P_i C_i \, d\ln P_i + (k_i + d\ln P_i) P_i Q_i > 0?$
  - *consumers:* $-P_i C_i \, d\ln P_i > 0$
  - producers: $(k_i + d\ln P_i) P_i Q > 0?$

- $B_i = k_i P_i Q_i + (P_i Q_i - P_i C_i) \, d\ln P_i > 0?$
  - *adopters:* $k_i P_i Q_i > 0$
  - *deficit households:* $(P_i Q_i - P_i C_i) \, d\ln P_i > 0$
  - *surplus households:* $(P_i Q_i - P_i C_i) \, d\ln P_i < 0$
- **Households who produce a surplus and cannot adopt are the only sure losers**

Agricultural R&D and Household Income Distributions



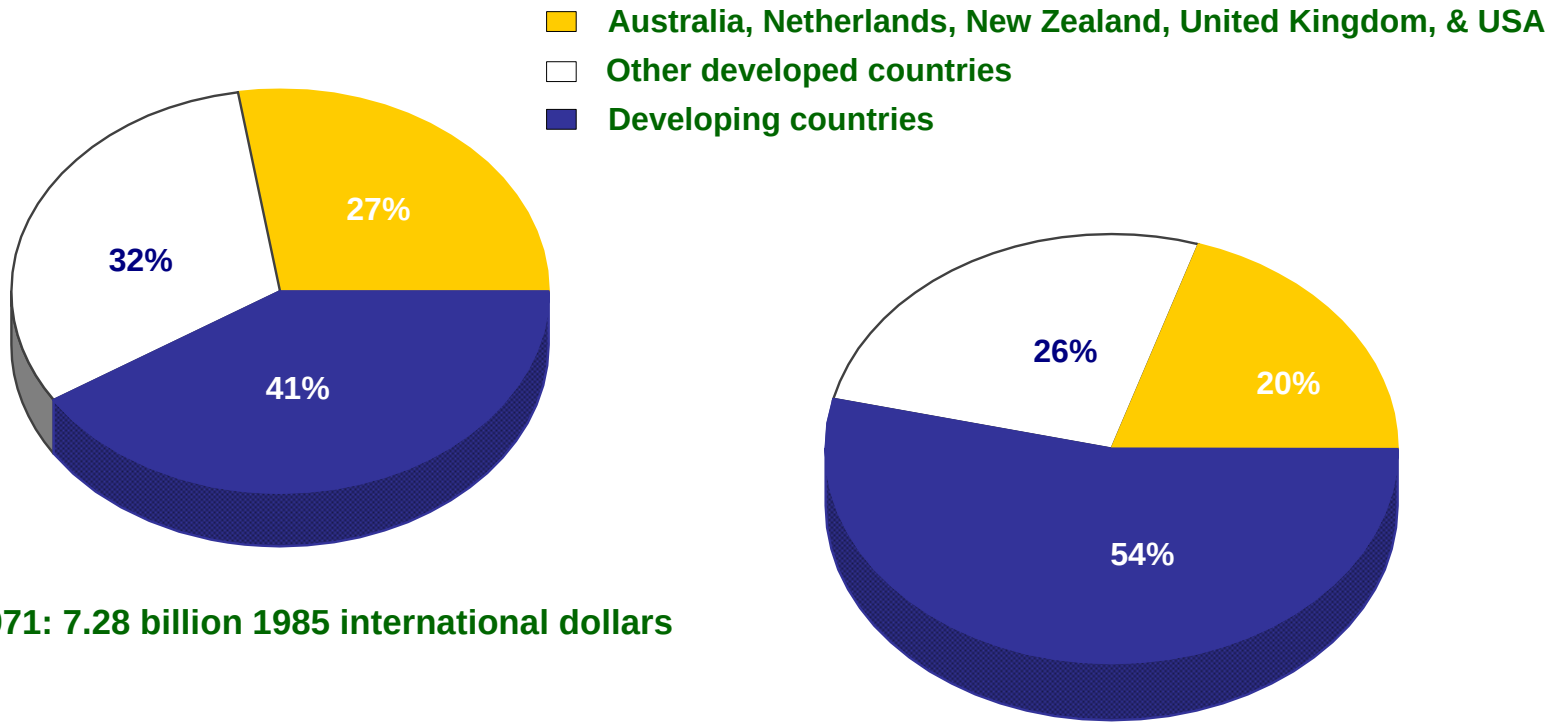
IFPRI Projections: 1995-2020

- world population will increase by 32% to 7.5 billion, mostly in cities in developing countries
- per capita incomes will increase in all regions
- 85% of total food demand growth will come from developing countries
- demand for meat (and for grain for feeding livestock) in developing world will double
- world grain production will have to increase 40 percent (through yield improvement)
- food prices will remain steady or fall slightly

Agricultural Research Investments: 1971 to 1991

- Global public ag. R&D increased from $7.3 billion to $15 billion
- In developing countries: from $3 billion to $8 billion
- In developed countries: from $4.3 billion to $7 billion
- ARIs in developed countries increased from $1.38 to $2.39 per $100 of output
- ARIs in developing countries increased from $0.38 to $0.50 per $100 of output
- Slower growth in the 1980s than the 1970s
- Spending in IARCs grew rapidly in the 1970s, stalled in the 1990s
- Relatively rapid growth of private agricultural research, in developed countries, in particular areas

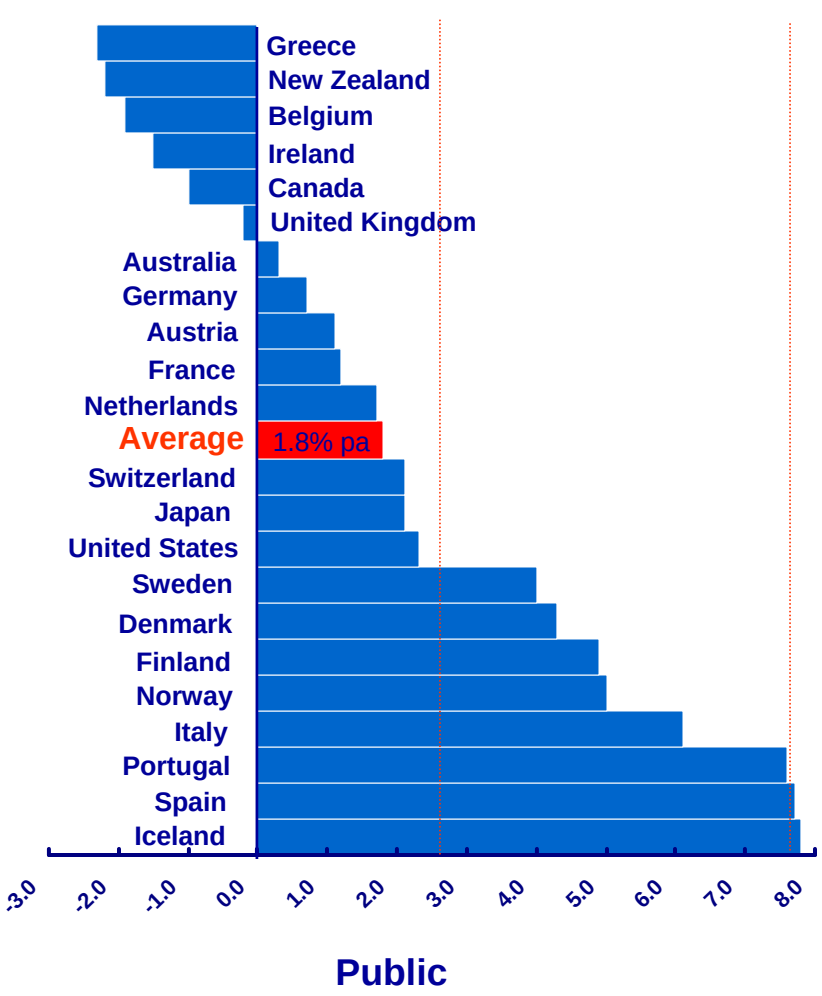
Public Agricultural R&D Spending: Global Perspectives, 1971 and 1991

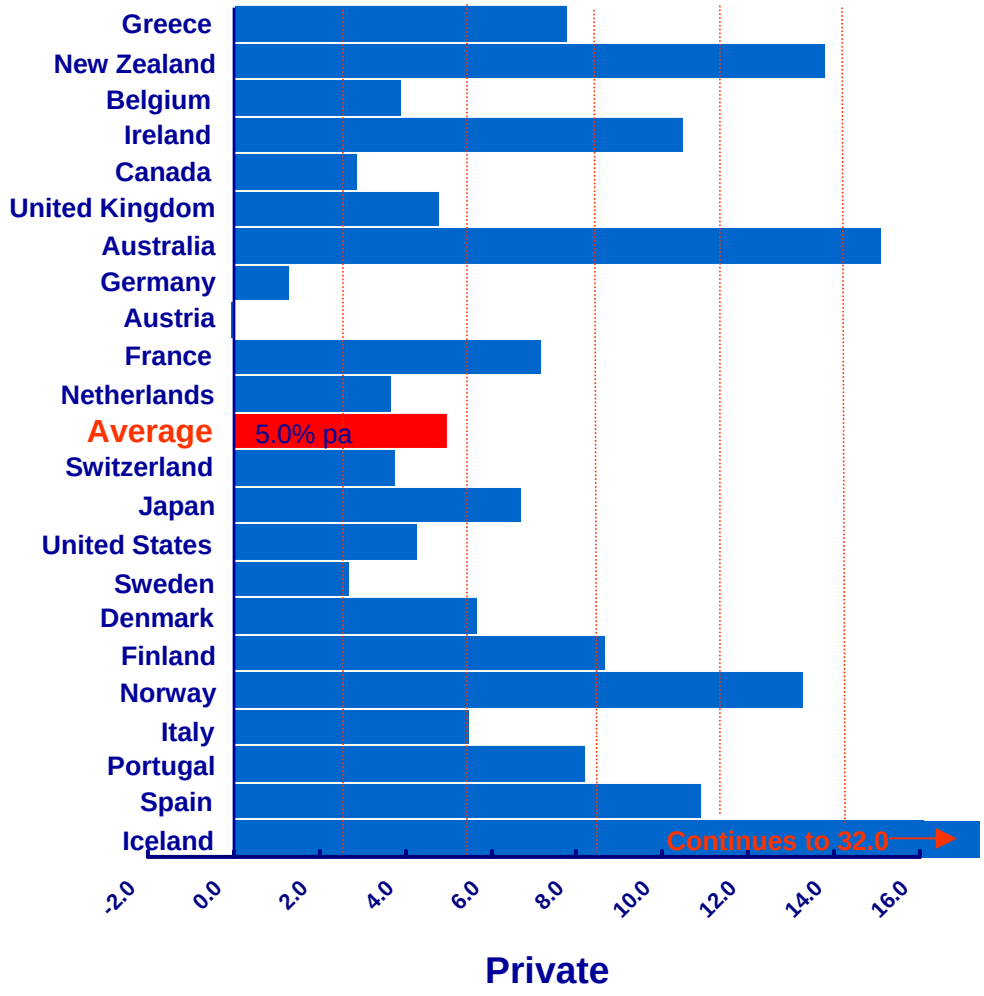


1971: 7.28 billion 1985 international dollars

1991: 14.95 billion 1985 international dollars

Public vs. Private R&D in OECD Countries (1981-93 growth rates)

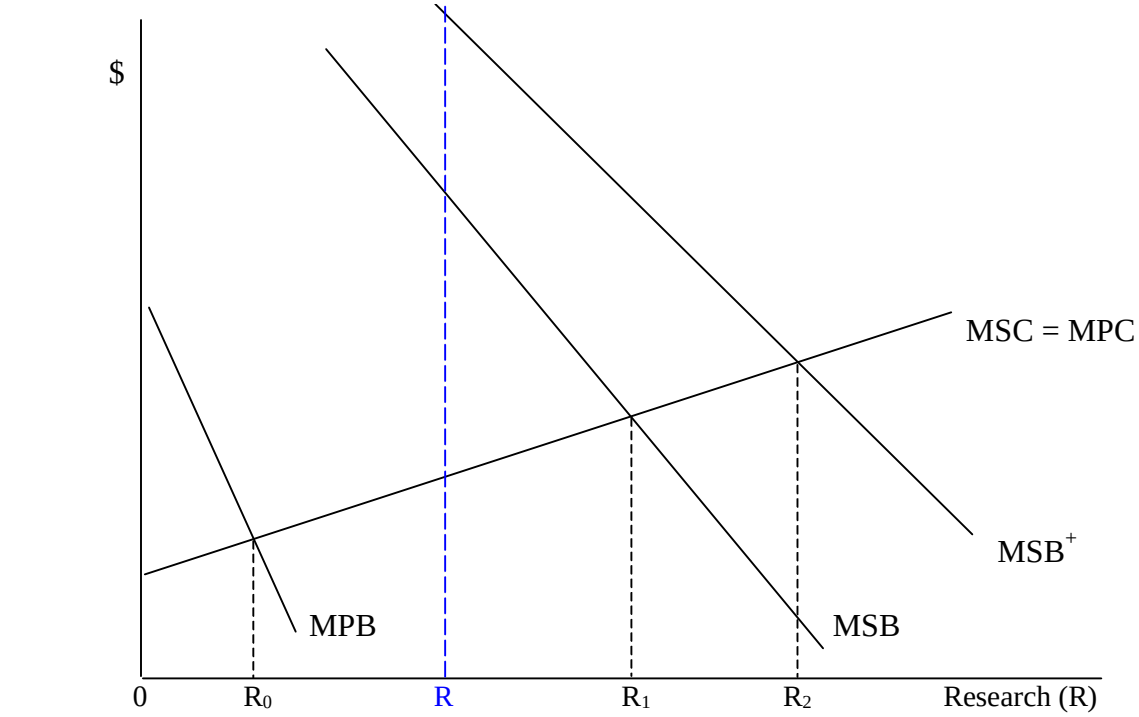


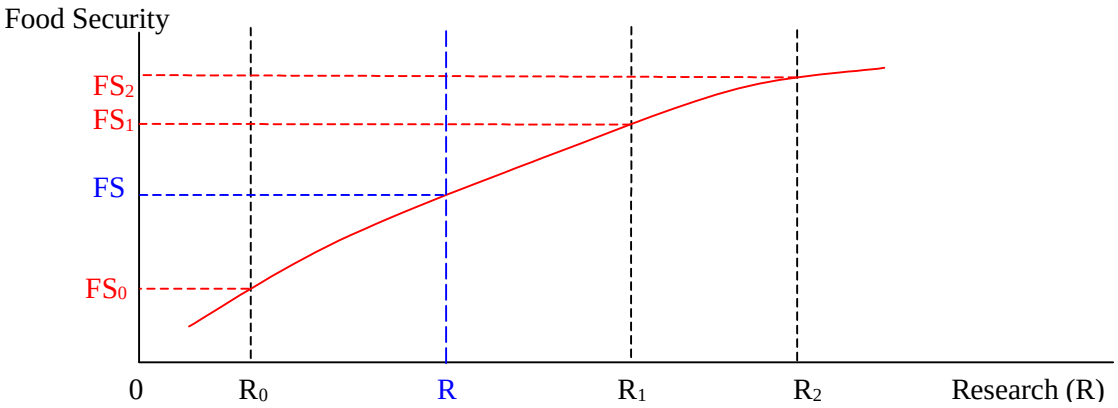


Policy Issues

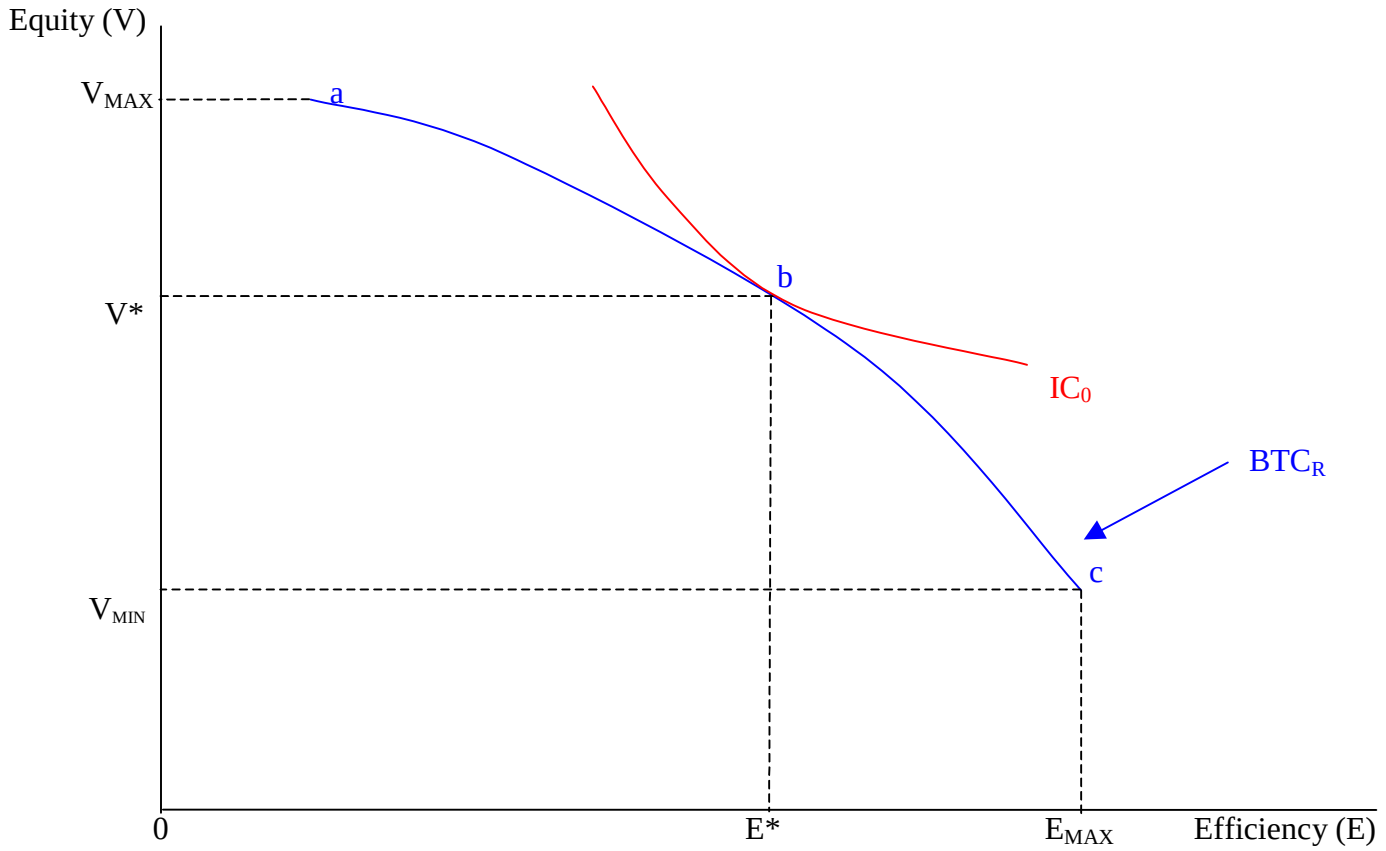
- How much total R&D?
- Which types of R&D?
- Who should pay for it?
- Who should do it?
- What institutional arrangements?
- What incentive mechanisms?

A Supply and Demand Model

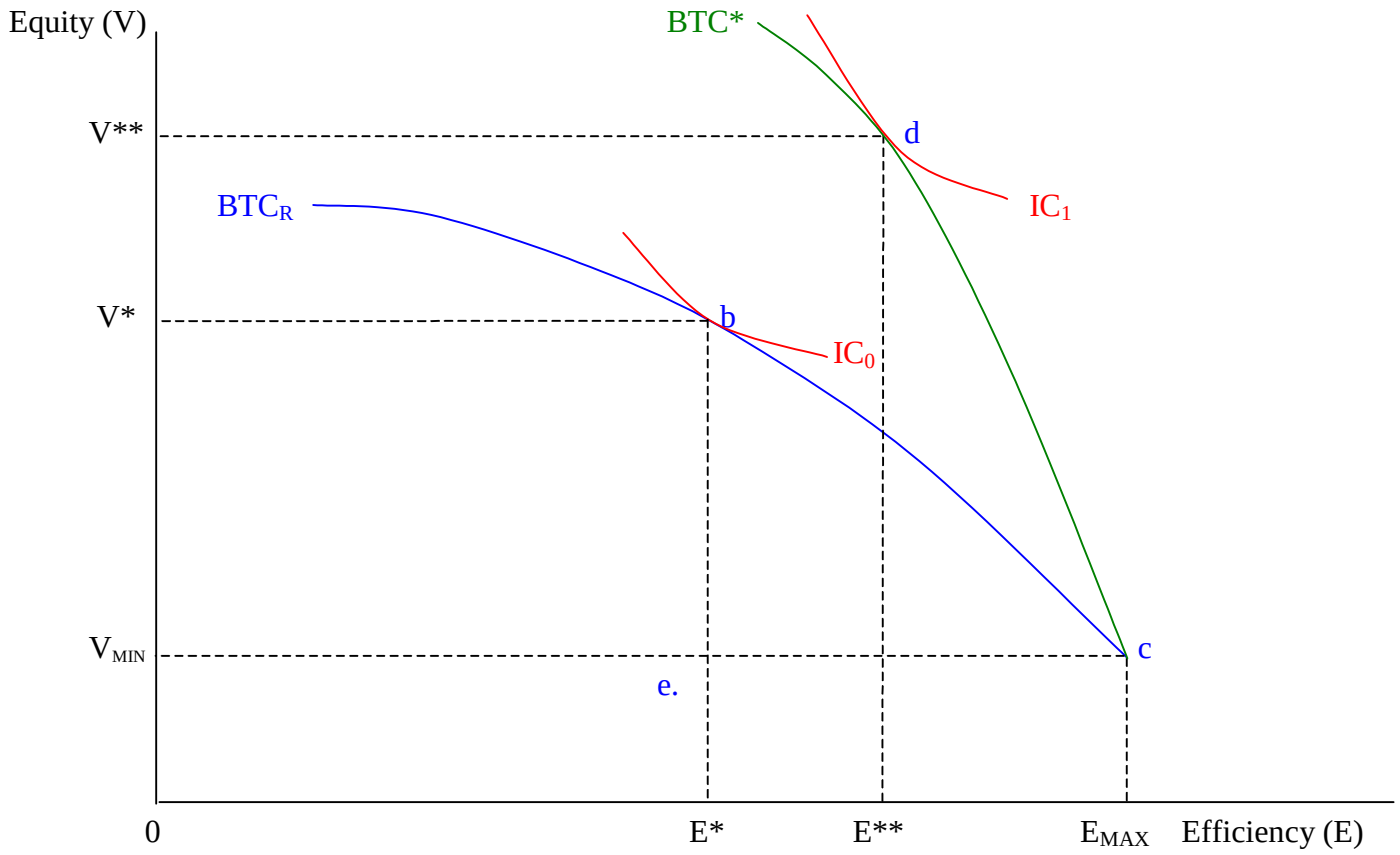




A Trade-off of Equity and Efficiency Using Research Policy Alone



A Trade-off of Equity and Efficiency Using the Least-Cost Policy Combination



Targeted versus Traditional Research

- Will “targeted” research be effective?
- Will it yield smaller total benefits?
- Will it yield greater food security (or other distributional) benefits?
- Is “targeted” research the least-cost way of achieving the food security (or other distributional) objective?
- Need a better understanding of technological possibilities and consequences for different types if research

Conclusion: Main Points

- Agricultural R&D has increased total availability of food, and enhanced access by the poor
- Important effects: Without past 35 years of growth in grain supply from R&D quantity would be 8% lower, price 42 % higher
- Projections imply grain yields “have to” increase 40 % by 2020 through productivity increases
- Funds for public R&D
  - Is the current rate of investment adequate?
  - Will “targeted” R&D be effective?
  - Is it the best instrument for distributional objectives?
- Information is lacking on implications of targeting for
  - Total benefits
  - Distributional outcomes