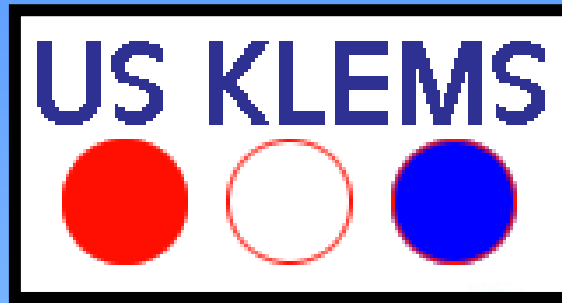


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# **Growth of U.S. Industries and Investments in Information Technology and Higher Education**

**By**

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**Harvard University, Resources for the Future, and the  
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# **Economic Growth in the Information Age**

## **INTRODUCTION:**

Prices of Information Technology

## **THE INFORMATION AGE:**

Faster, Better, Cheaper!

## **ROLE OF INFORMATION TECHNOLOGY:**

IT Prices and the Cost of Capital

## **AMERICAN GROWTH RESURGENCE:**

IT Investment and Productivity Growth

## **ECONOMICS ON INTERNET TIME:**

The New Research Agenda

# **THE INFORMATION AGE: Faster, Better, Cheaper!**

MOORE (1998): "If the automobile industry advanced as rapidly as the semiconductor industry, a Rolls Royce would get half a million miles per gallon, and it would be cheaper to throw it away than to park it."

## INVENTION OF THE TRANSISTOR:

Development of Semiconductor Technology.

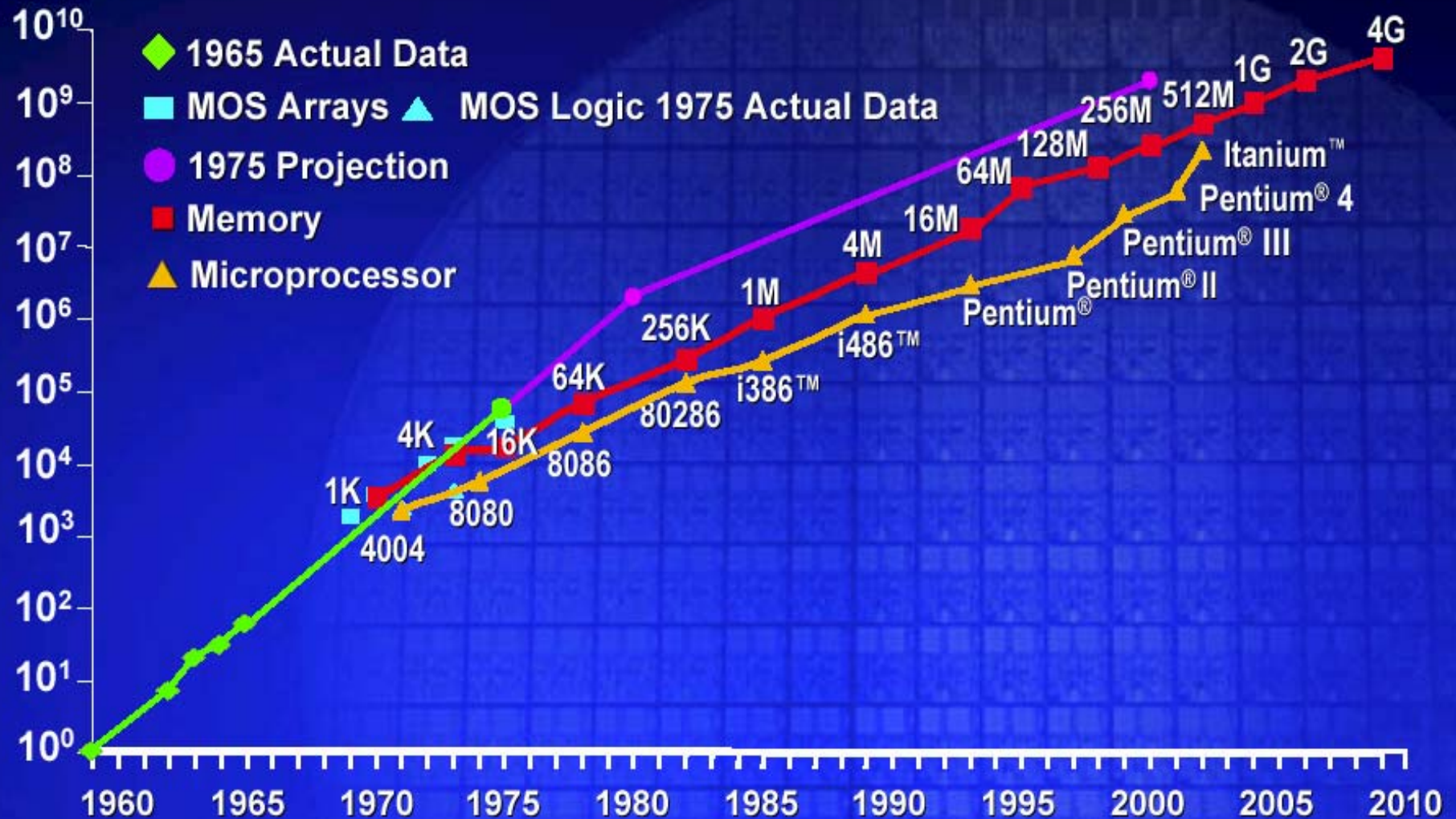
## THE INTEGRATED CIRCUIT:

Memory Chips; Logic Chips.

MOORE'S LAW: The number of transistors on a chip doubles every 18-24 months (Pentium 4, released November 20, 2000, has 42 million transistors).

# Integrated Circuit Complexity

Transistors  
Per Die



Source: No Exponential is Forever, Gordon Moore [ftp://download.intel.com/research/silicon/Gordon\\_Moore\\_ISSCC\\_021003.pdf](http://download.intel.com/research/silicon/Gordon_Moore_ISSCC_021003.pdf)

# **HOLDING QUALITY CONSTANT Matched Models and Hedonics**

## **SEMICONDUCTOR PRICE INDEXES:**

Memory and Logic Chips.

## **COMPUTER PRICE INDEXES:**

The BEA-IBM Collaboration.

## **COMMUNICATIONS EQUIPMENT:**

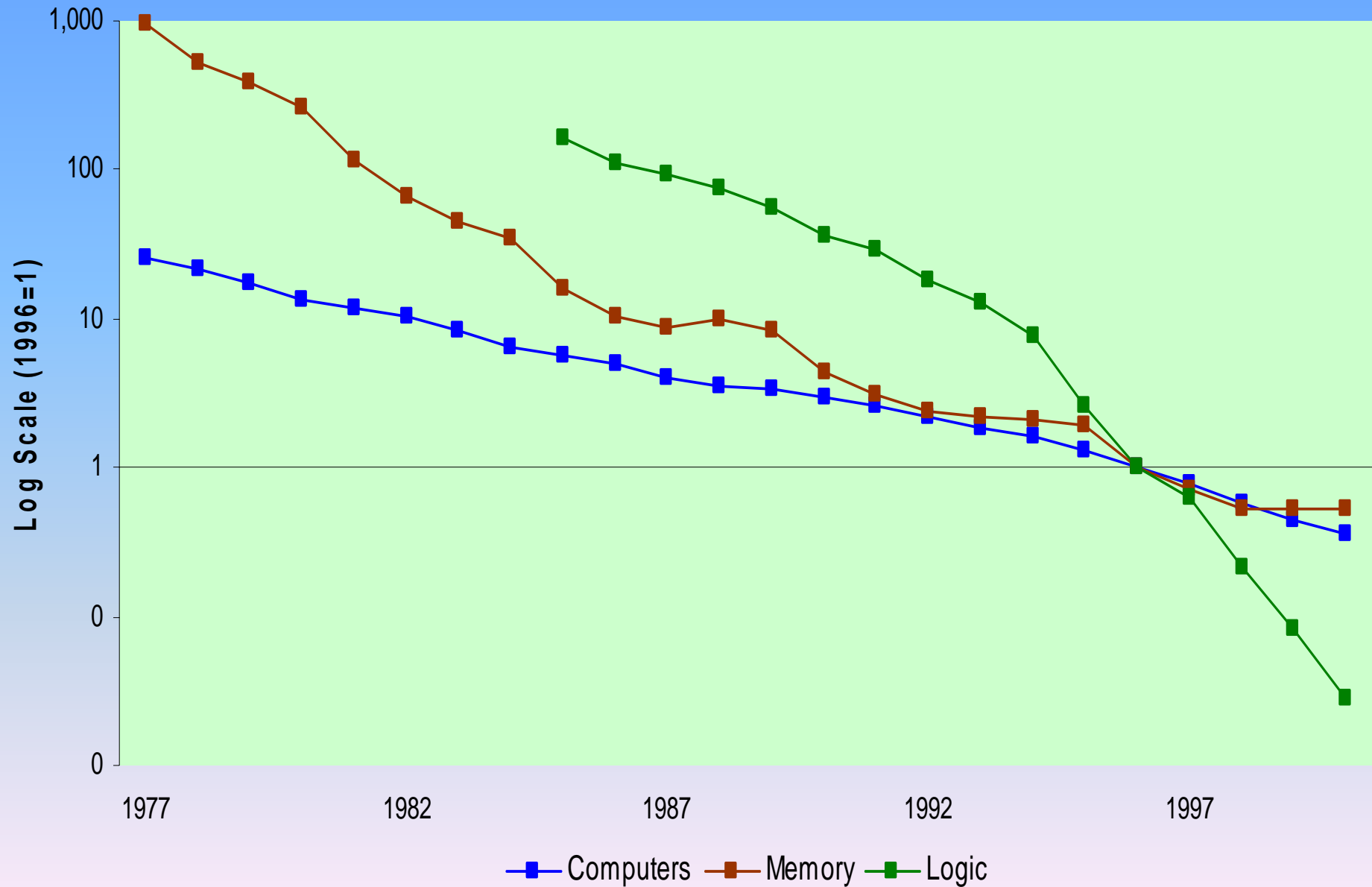
Terminal, Switching, and Transmission.

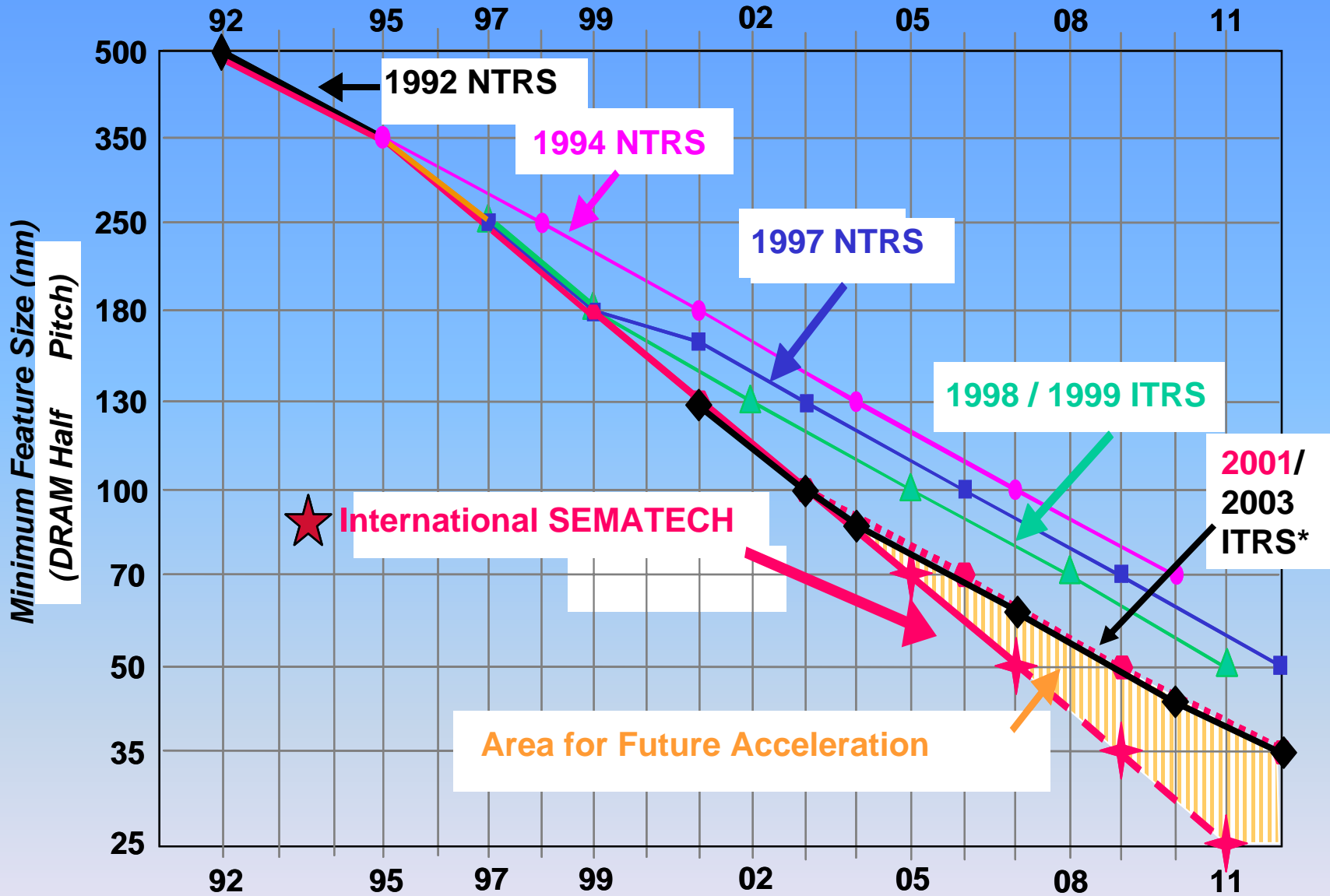
## **SOFTWARE:**

Prepackaged, Custom, and Own-Account.

# Relative Prices of Computers and Semiconductors, 1977-2000

All price indexes are divided by the output price index.



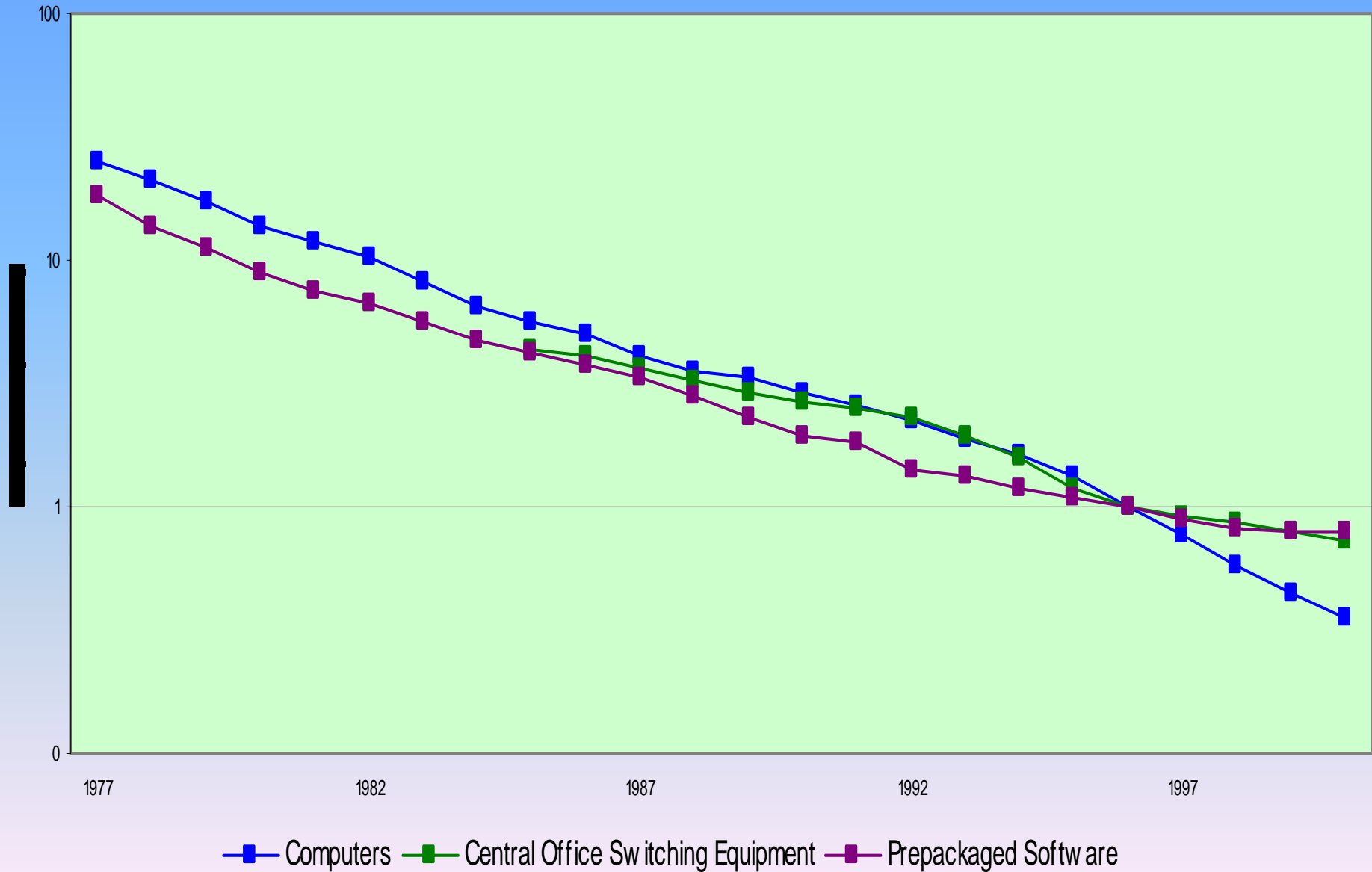


\*Note the 2003 ITRS timing is unchanged from the 2001 ITRS

## Semiconductor Roadmap Acceleration

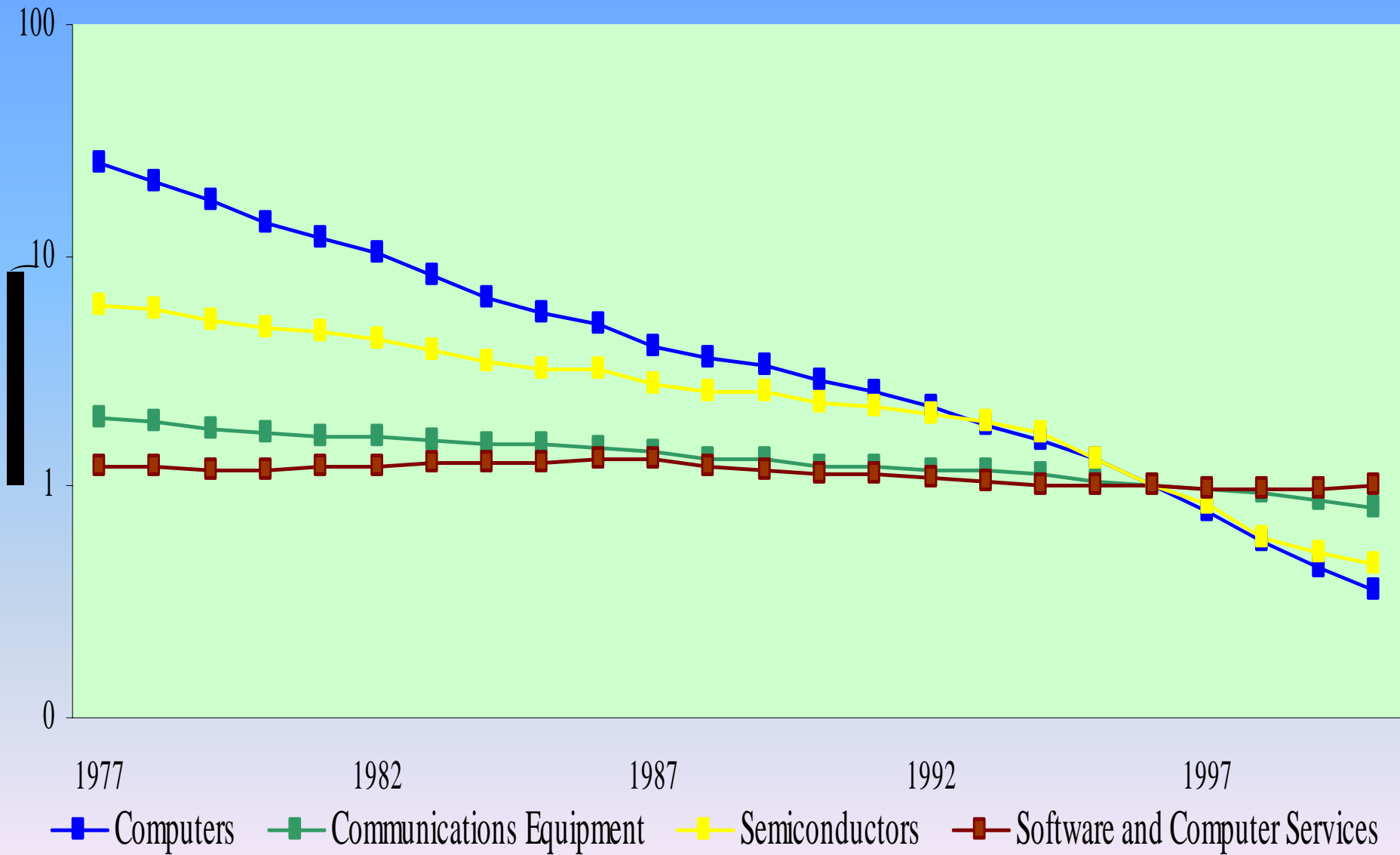
# Relative Prices of Computers, Communications, and Software, 1977-2000

All price indexes are divided by the output price index.



# Relative Prices of Computers, Communications, Semiconductors, and Software and Computer Services, 1977-2000

All price indexes are divided by the output price index.



# **ROLE OF INFORMATION TECHNOLOGY: IT Prices and the Growth of Output.**

## OUTPUT SHARES OF IT:

Computers, Communications Equipment, Semiconductors, and Software.

## OUTPUT CONTRIBUTION OF IT:

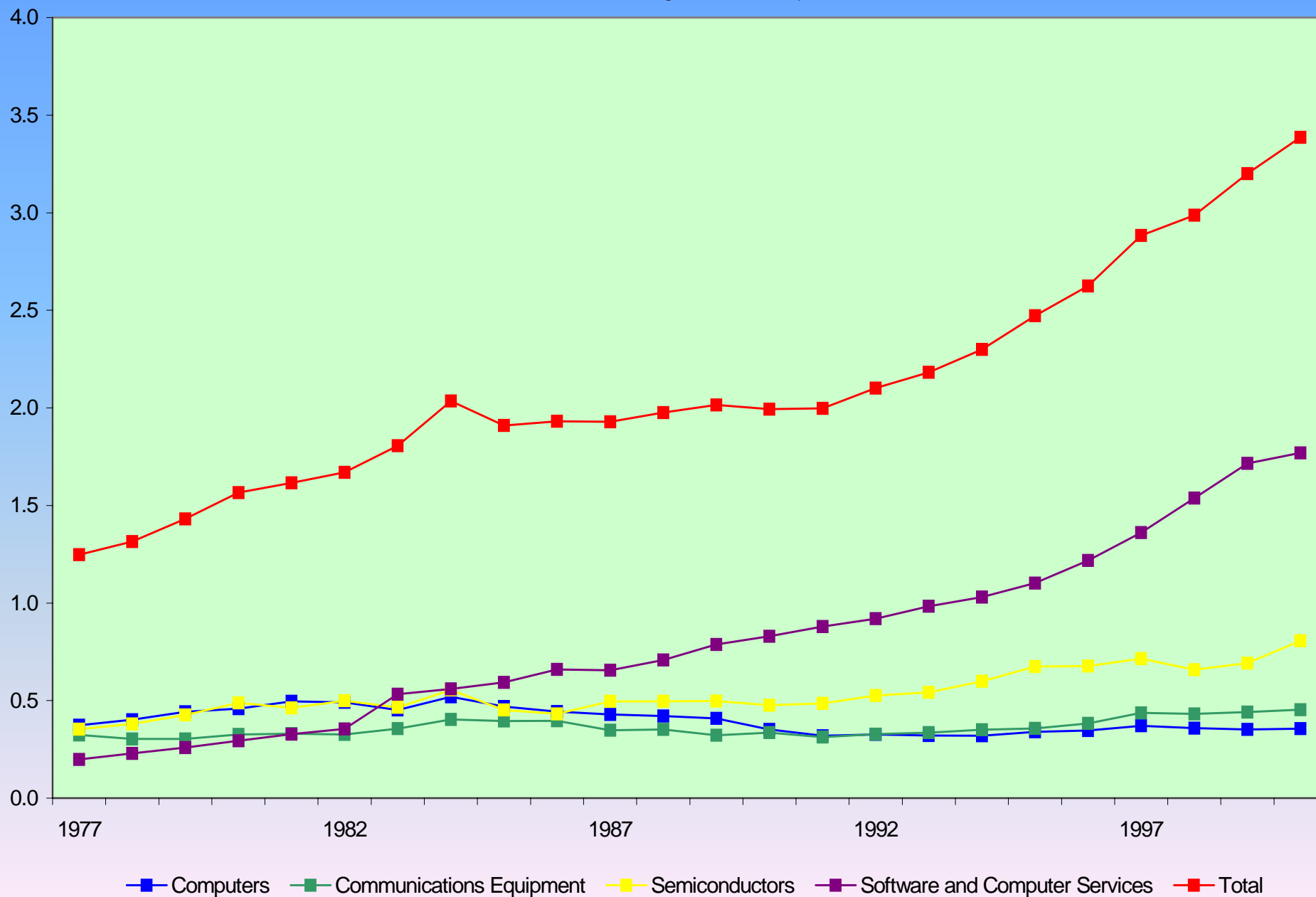
IT versus Non-IT Value Added.

## OUTPUT CONTRIBUTION BY TYPE:

Computers, Communications Equipment, Semiconductors, and Software.

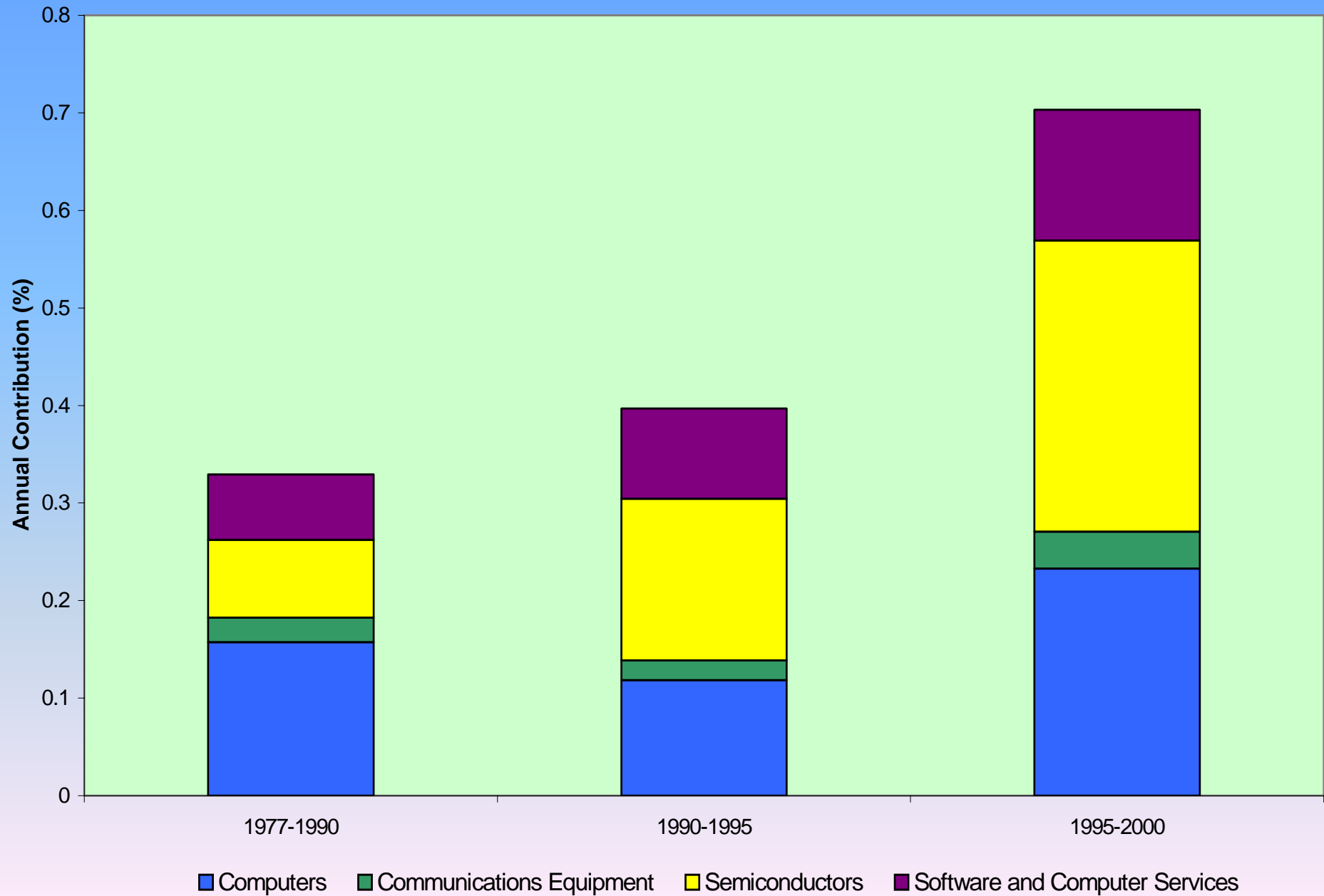
# Value Added Shares of Information Technology by Type, 1977-2000

Share of current dollar gross domestic product.



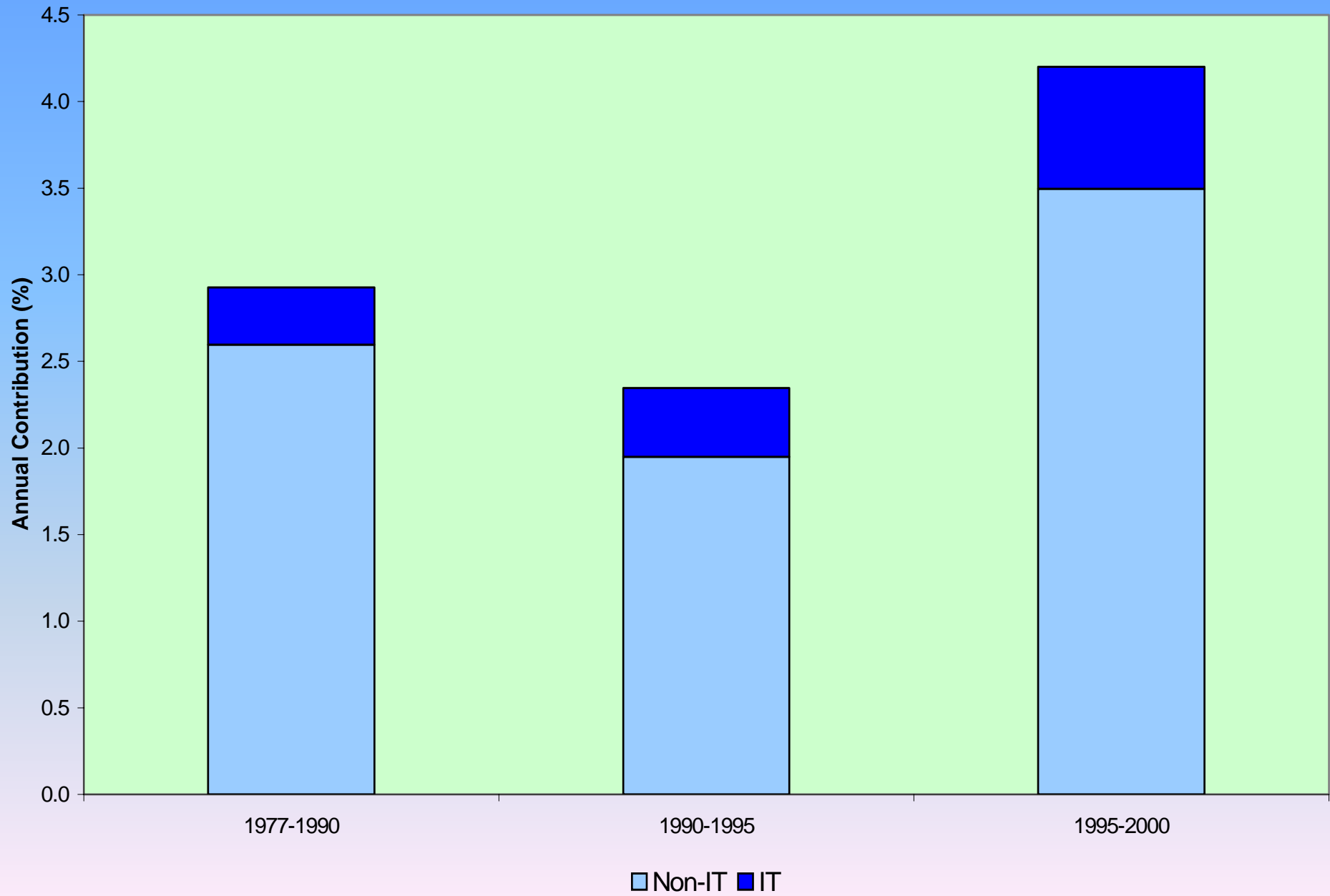
# Industry Contributions to Value Added Growth

Value added weighted contributions of industry value added.

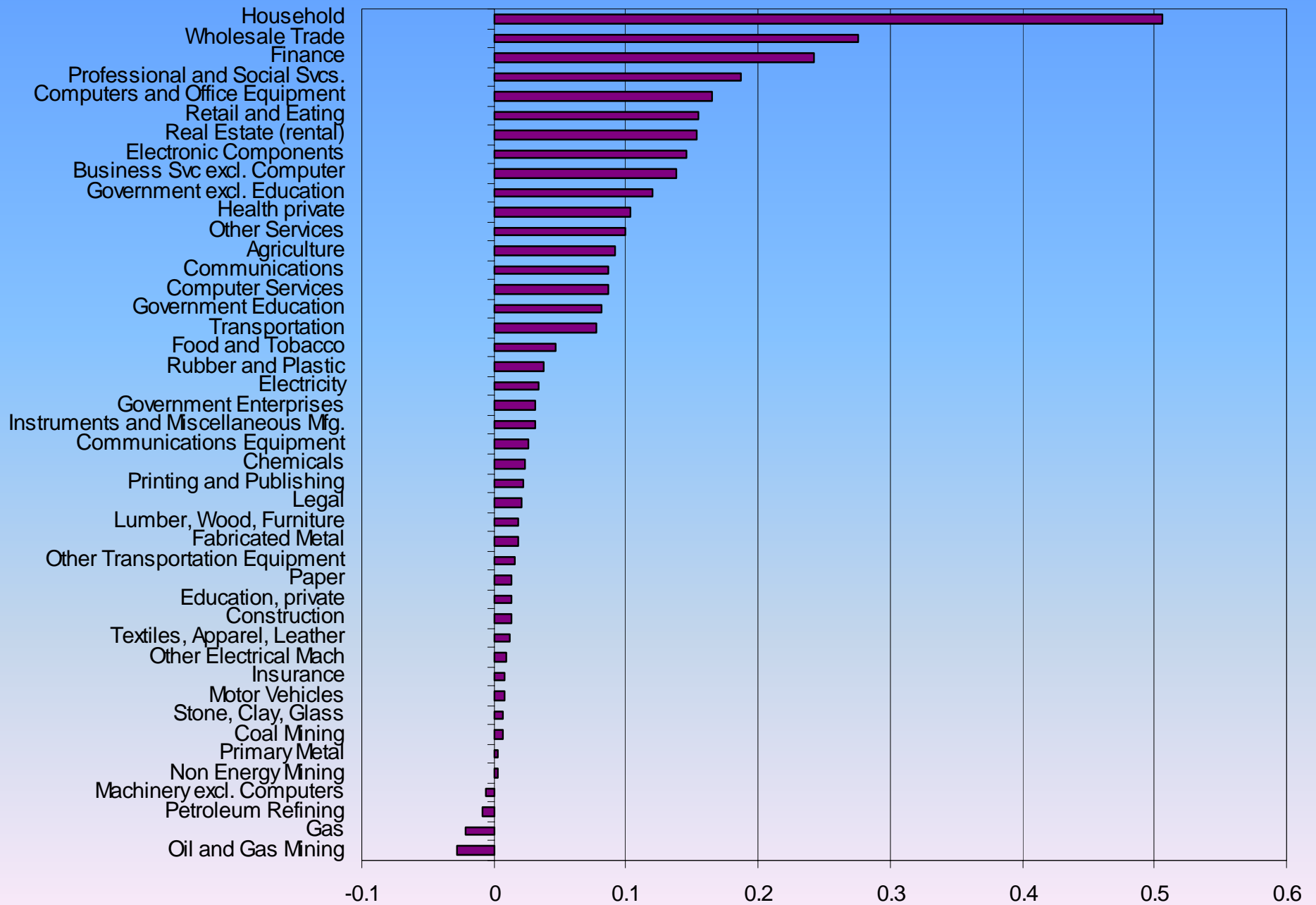


## Industry Contribution to Value Added

Average annual percentage growth rate weighted by the value share.



## Industry Contributions to Value Added Growth, 1977-2000



# **ROLE OF INFORMATION TECHNOLOGY: IT Prices, Investment, and Productivity.**

## INPUT SHARES OF IT:

Computers, Communications Equipment, and Software.

## CAPITAL CONTRIBUTION:

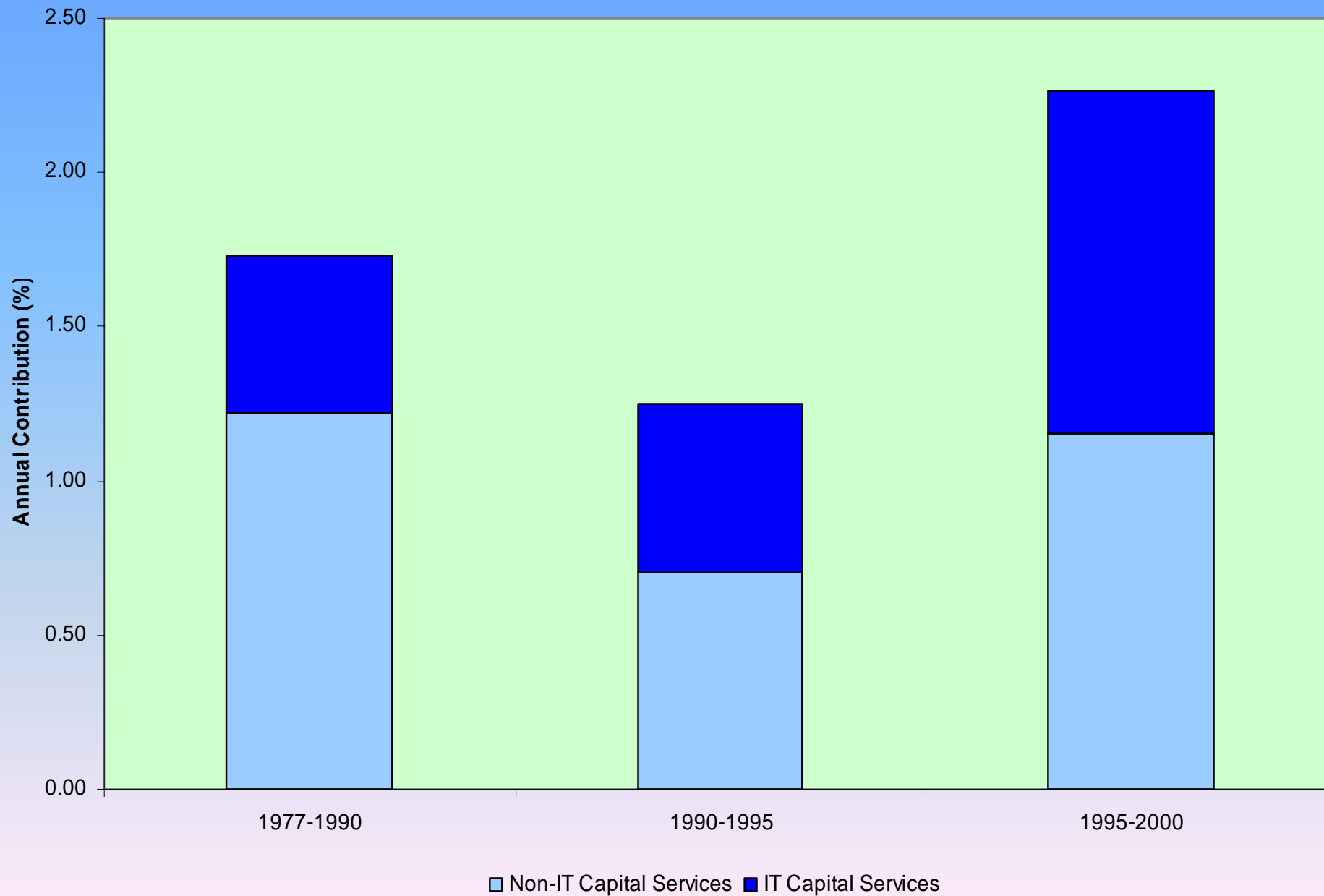
IT versus Non-IT Capital Services.

## CAPITAL CONTRIBUTION BY TYPE:

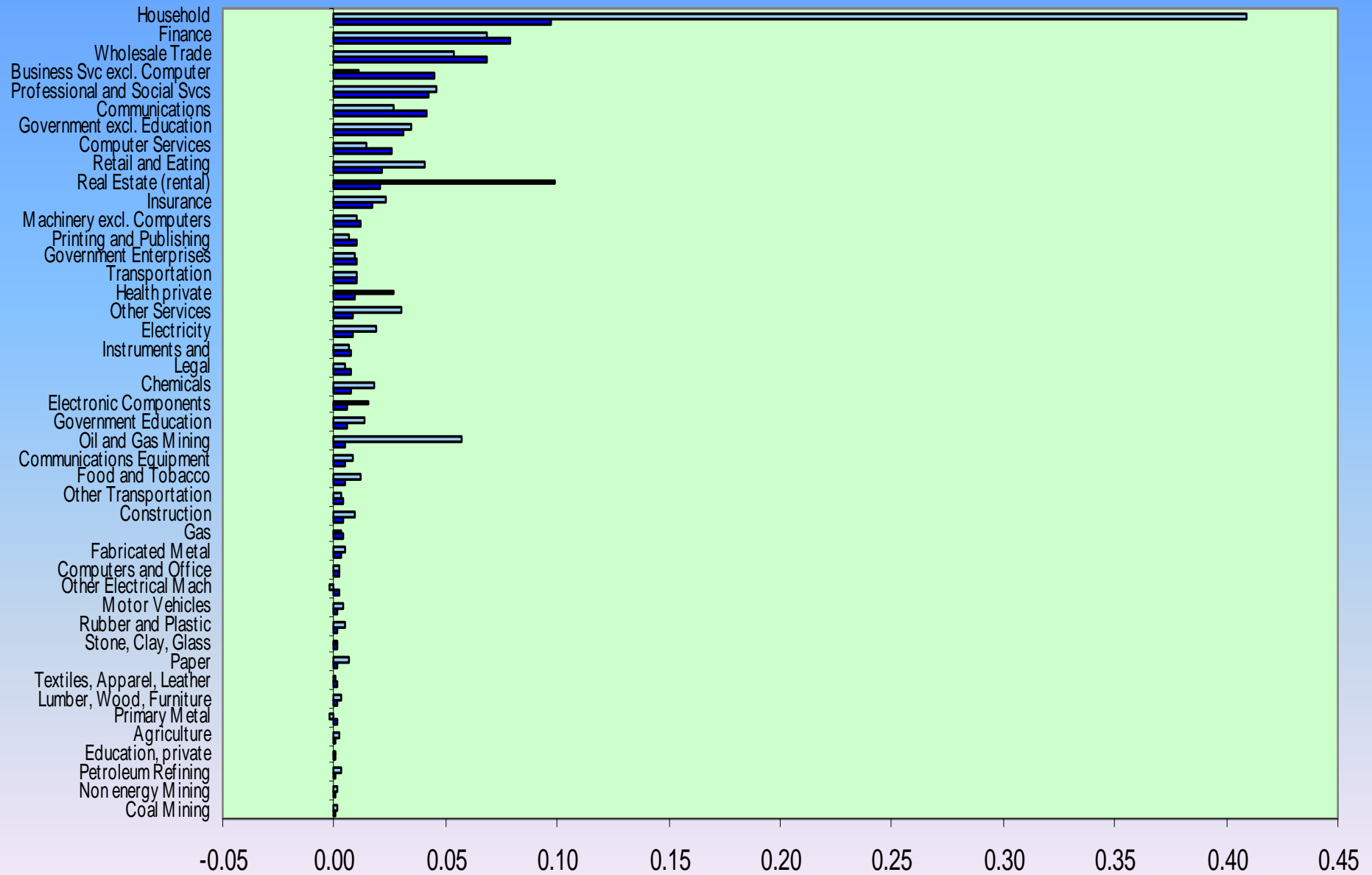
Computers, Communications Equipment, and Software.

## Capital Input Contribution of Information Technology

Average annual percentage growth rates, weighted by income shares.



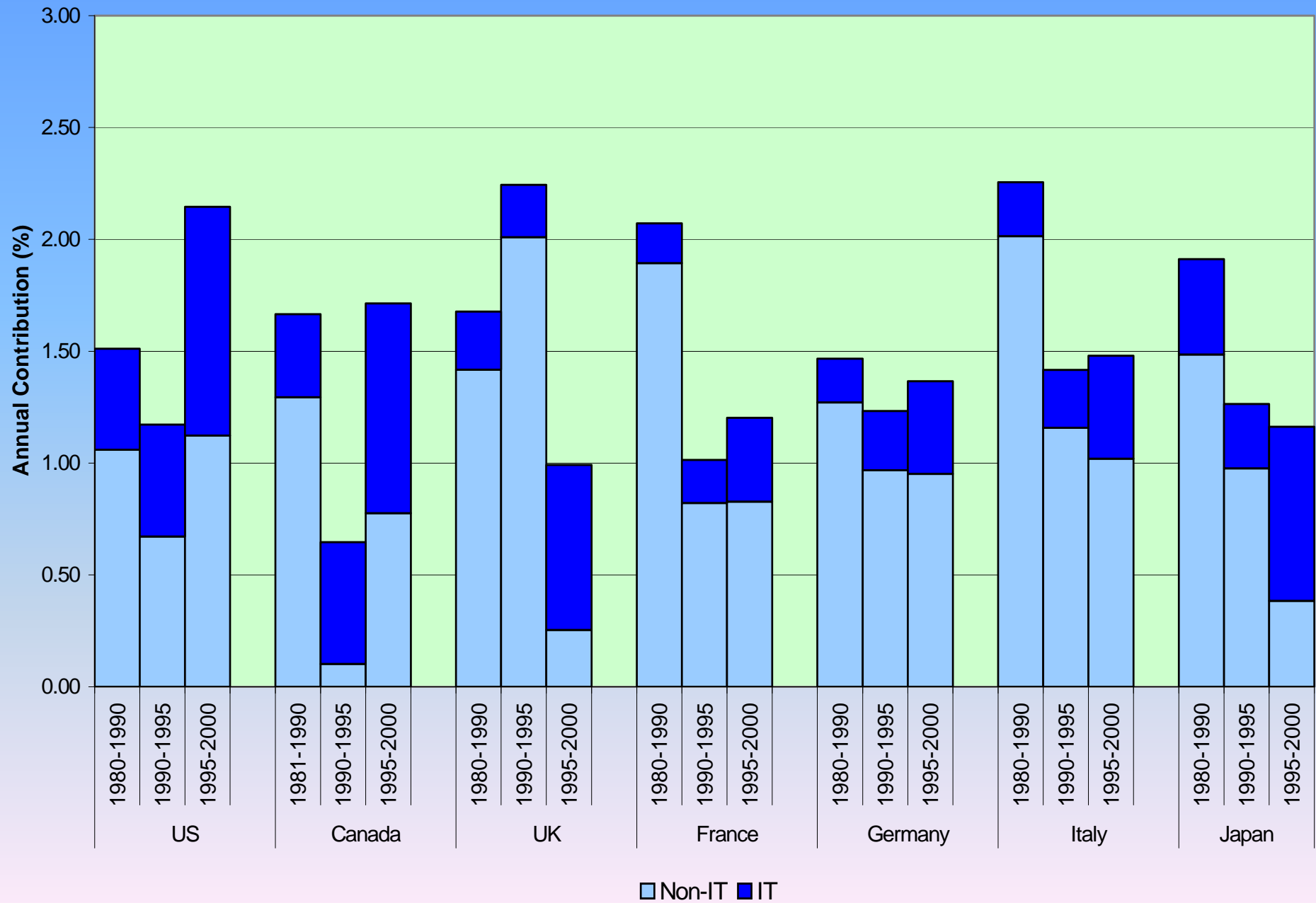
# Industry Contributions to Capital Input Growth, 1977-2000



Note: Industries sorted by IT capital contribution.

■ IT Capital ■ Non-IT Capital

## Capital Input Contribution of Information Technology by Country



# **AMERICAN GROWTH RESURGENCE: IT Investment and Productivity Growth.**

## TOTAL FACTOR PRODUCTIVITY:

IT-Production versus Non-IT Production.

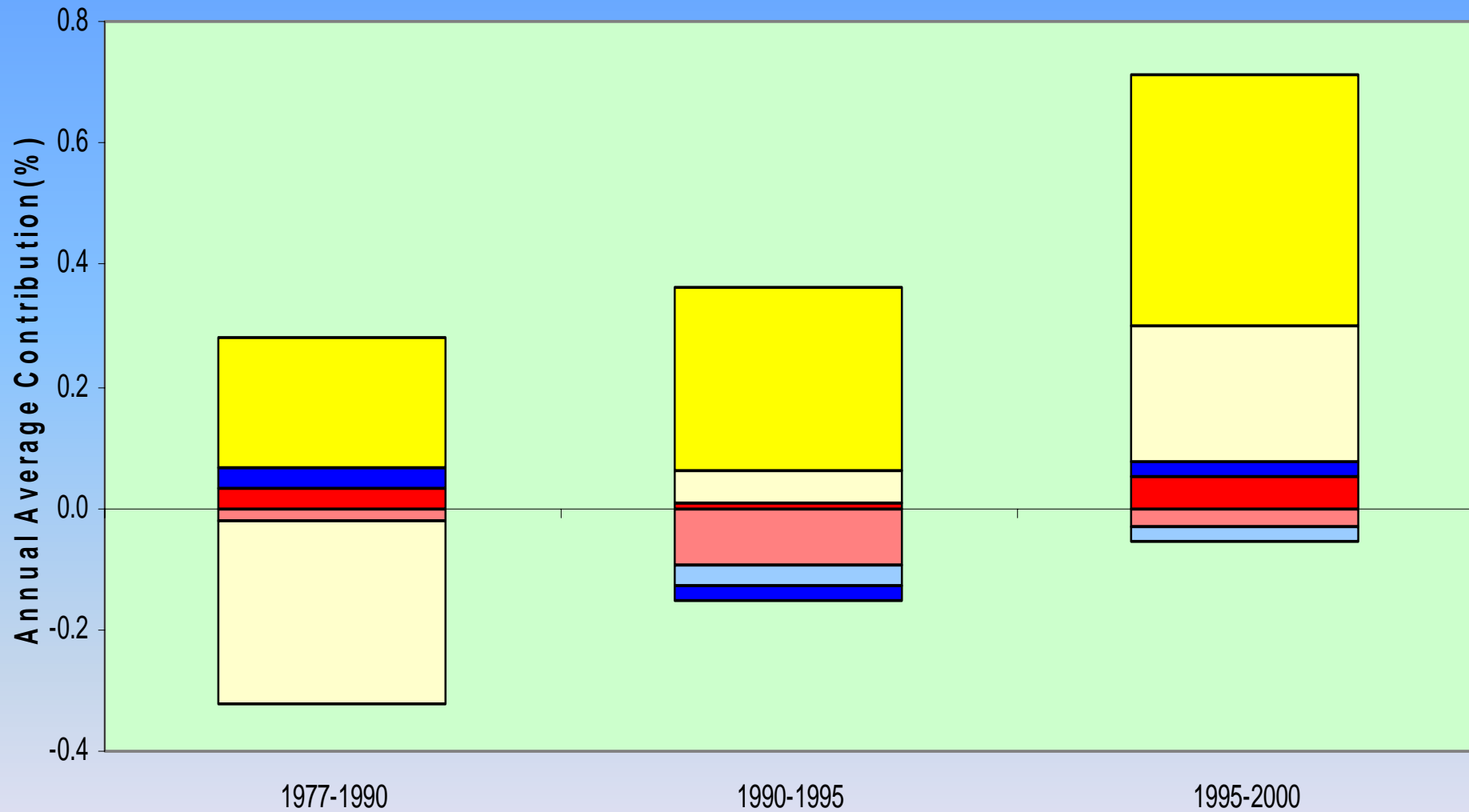
## SOURCES OF U.S. ECONOMIC GROWTH:

Capital Input, Labor Input, and TFP.

## AVERAGE LABOR PRODUCTIVITY GROWTH:

Capital Deepening, Labor Quality, TFP.

## Sources of U.S. TFP Growth



Reallocation of Non-college Educated Labor

Reallocation of College Educated Labor

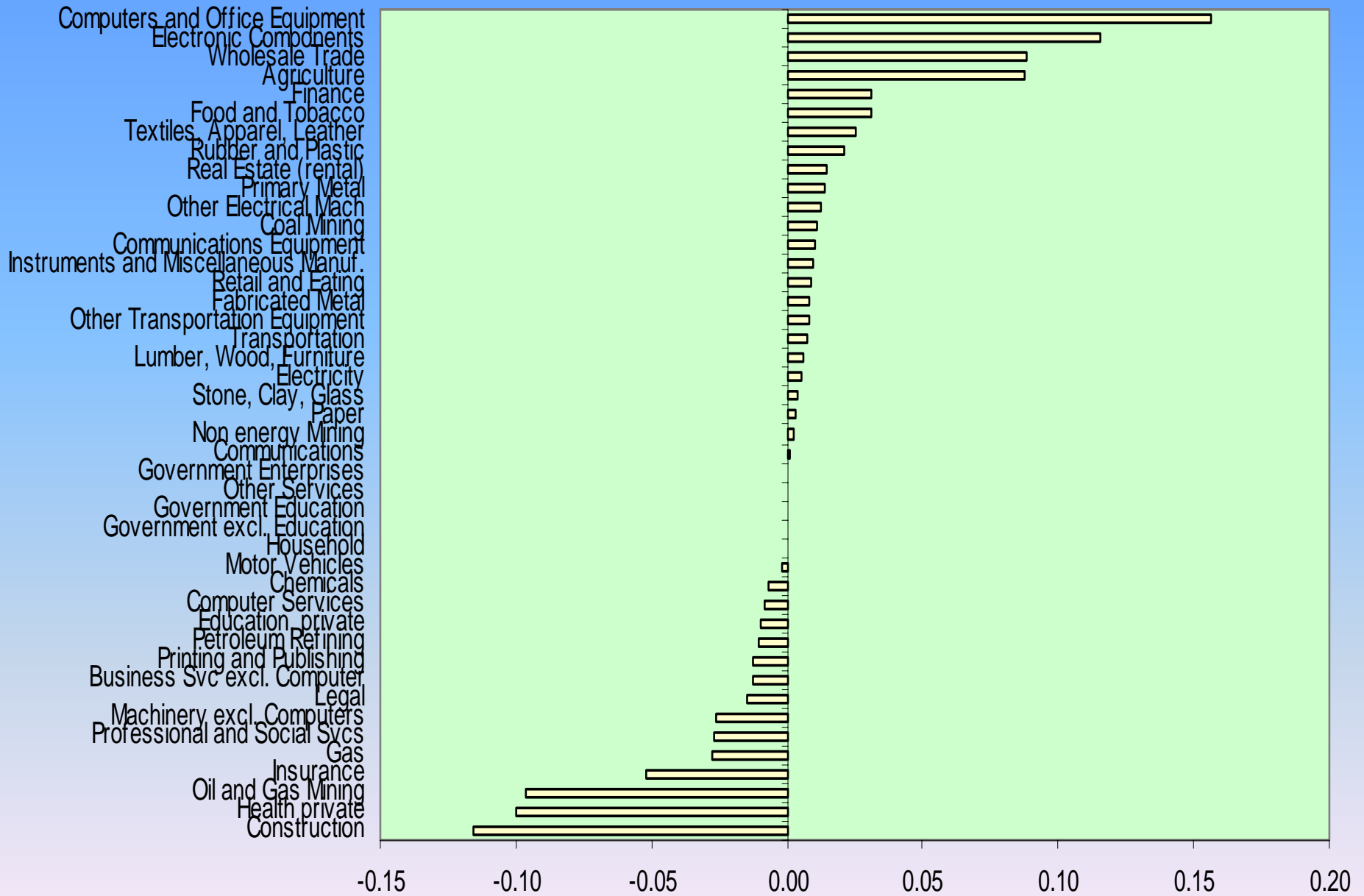
Reallocation of Non-IT Capital

Reallocation of IT Capital

Wgt Sectoral TFP (Other)

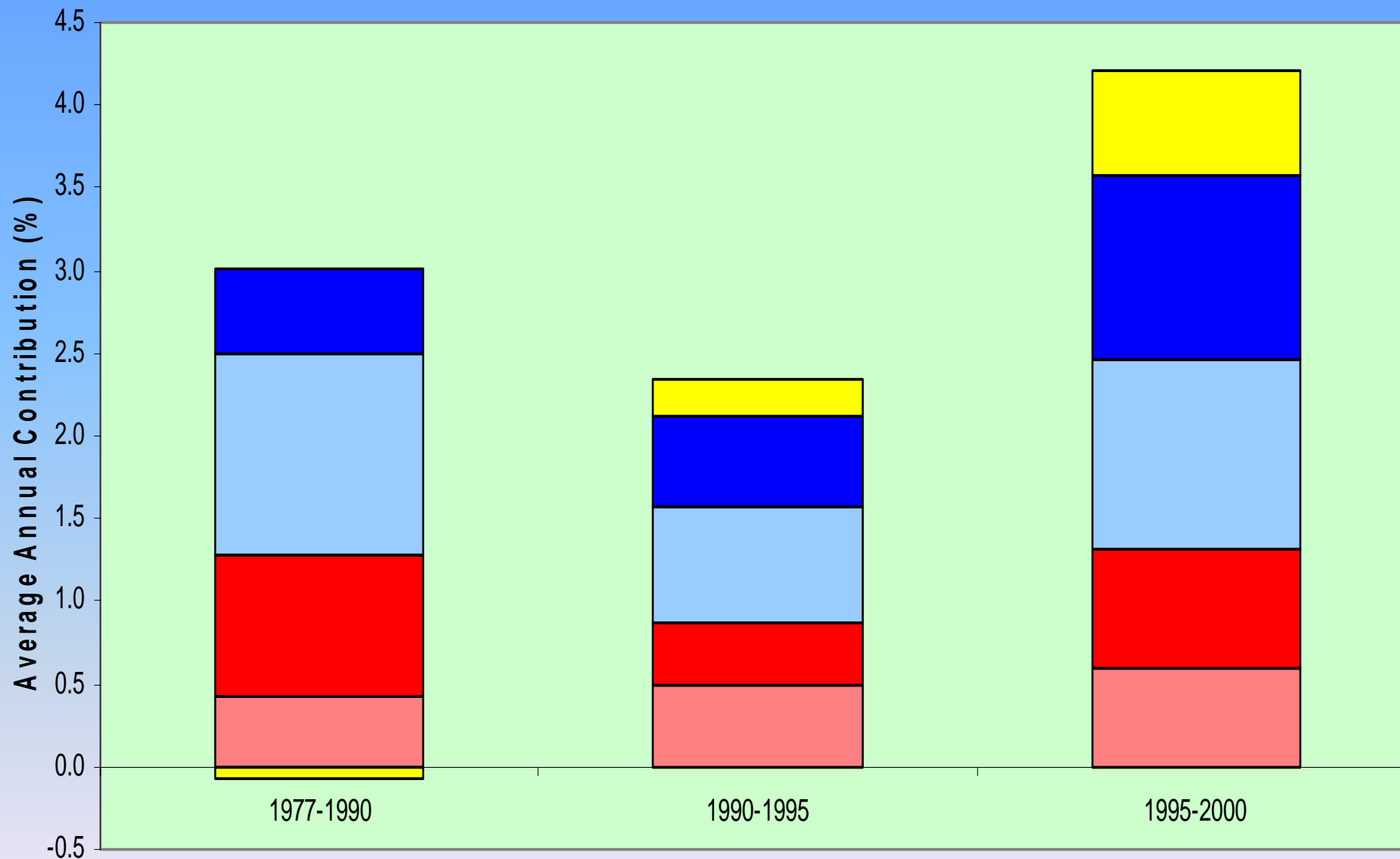
Wgt Sectoral TFP (IT Producers)

# Industry Contributions to Productivity, 1977-2000



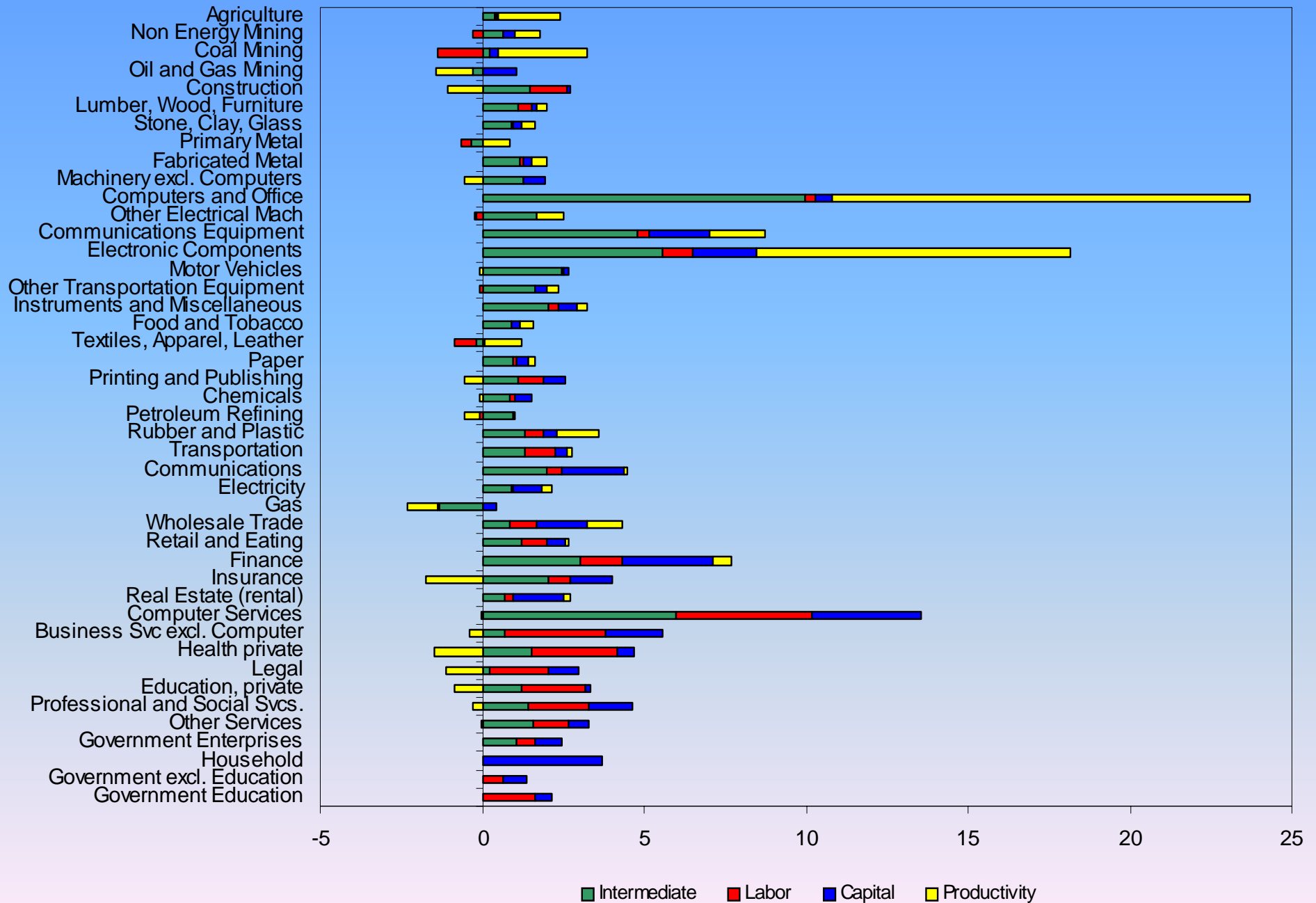
Note: Industries sorted by productivity contribution.

## Sources of U.S. Economic Growth

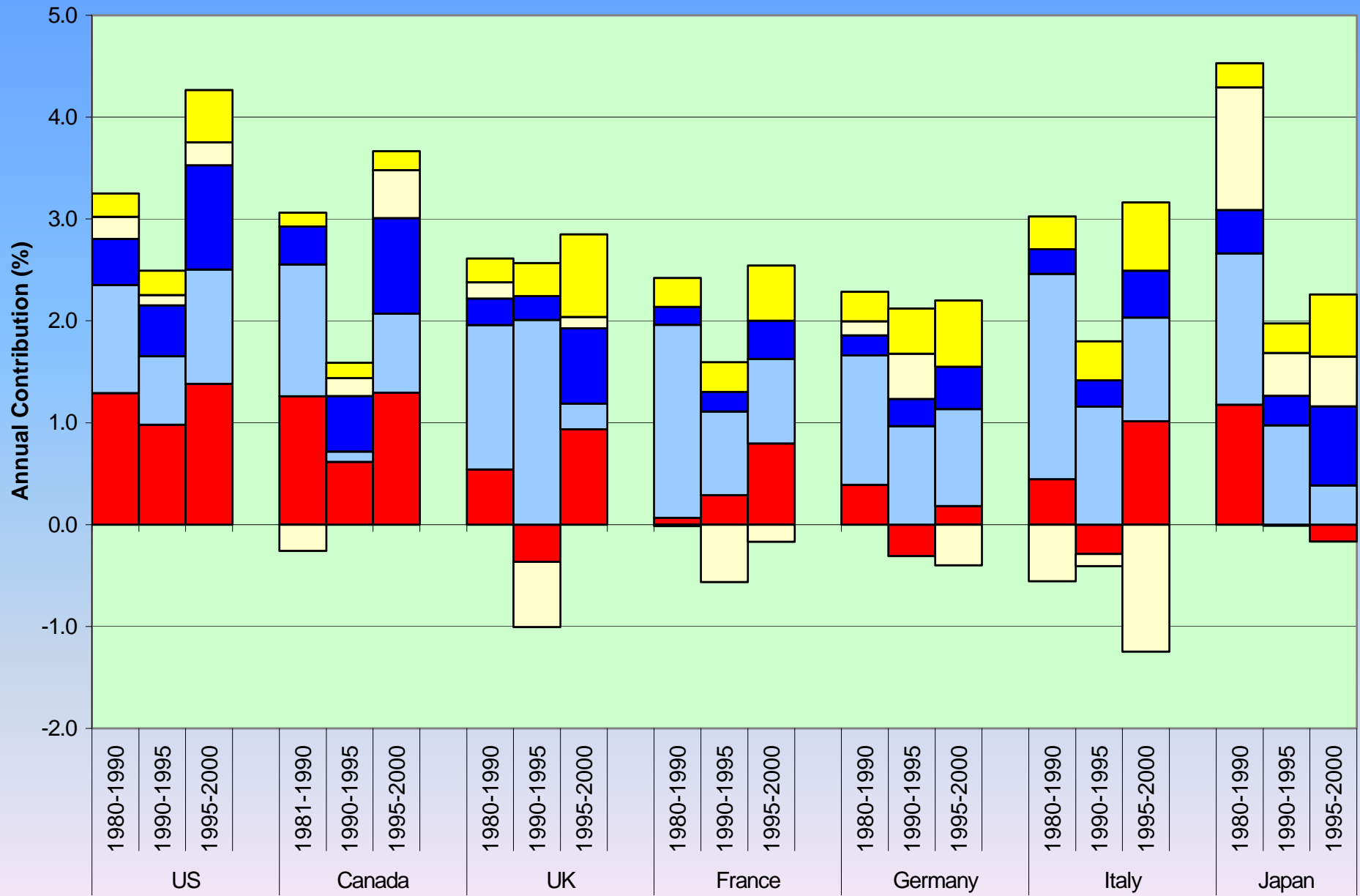


■ Non-college Educated Labor ■ College Educated Labor ■ Non-IT Capital ■ IT Capital ■ TFP

## Sources of Growth in Industry Output, 1977-2000

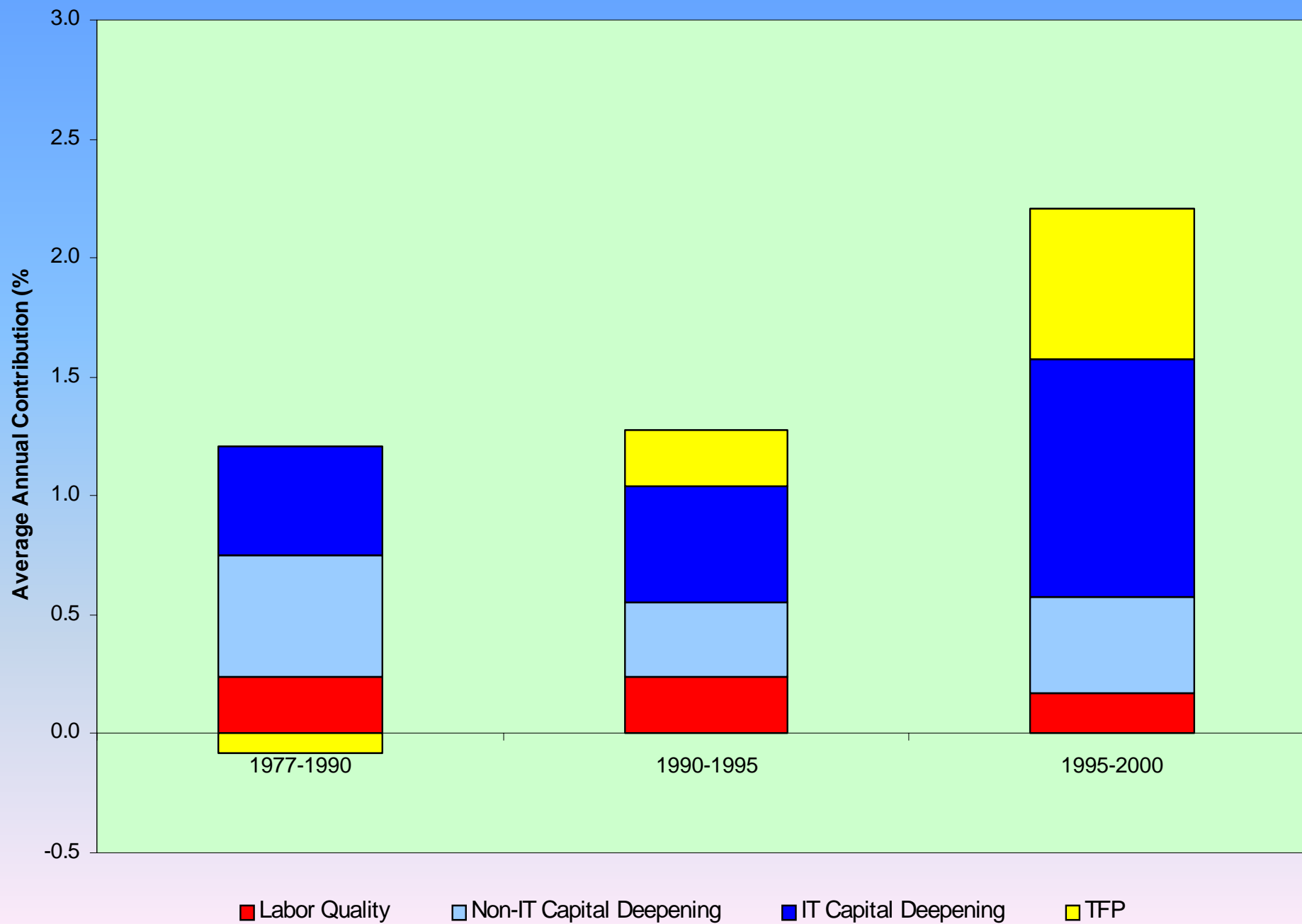


# Sources of Economic Growth by Country

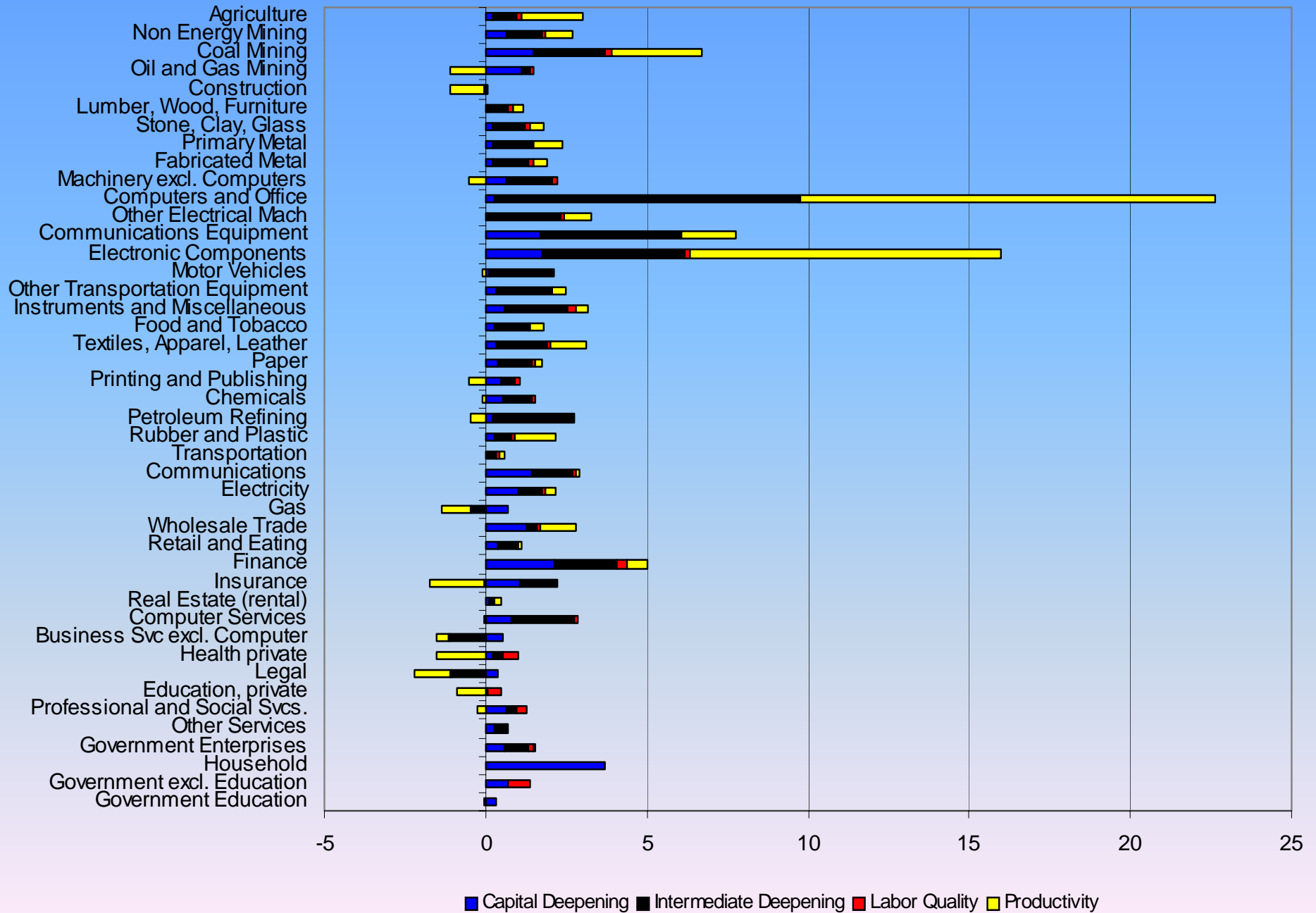


■ Labor 
 ■ Non-IT Capital 
 ■ IT Capital 
 ■ Non-IT Productivity 
 ■ IT Productivity

## Sources of U.S. Labor Productivity Growth



## Sources of Industry Labor Productivity Growth, 1977-2000



# **ECONOMICS ON INTERNET TIME: The New Research Agenda.**

- The Solow Paradox -- we see computers everywhere but in the productivity statistics -- versus the Information Age.
- Equity Valuations and Growth Prospects: accumulation of intangible assets versus irrational exuberance.
- Widening Wage Inequality: capital-skill complementarity versus skill-biased technical change.
- Modeling IT and the semiconductor industry: permanent versus transitory contributions to economic growth.