

**EU KLEMS**



**Data Coordination  
Group Meeting**

# **Productivity Growth in the New Millennium and its Industry Origins**

**By**

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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.

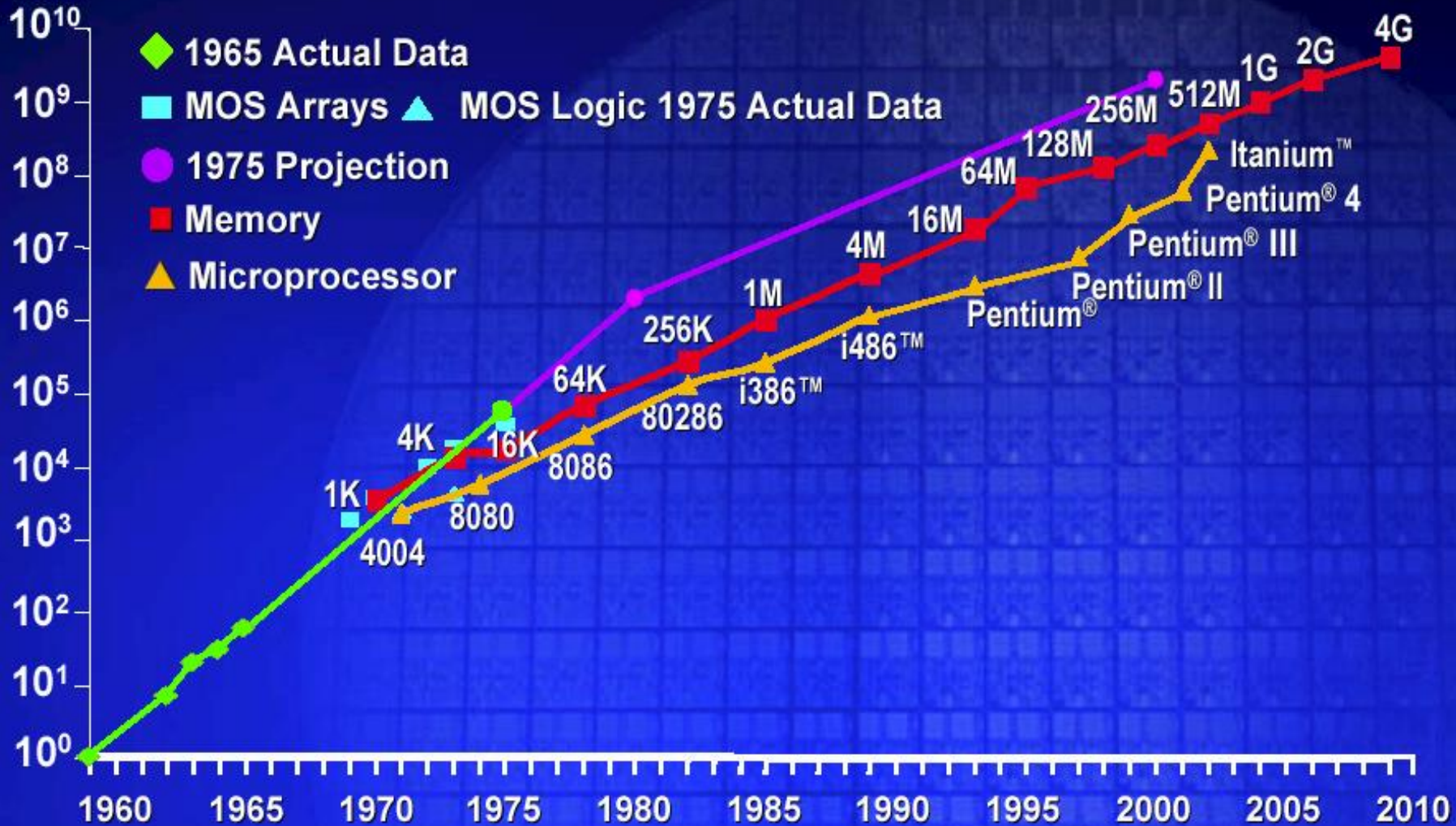
## THE INTEGRATED CIRCUIT:

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



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

## **SEMICONDUCTOR PRICE INDEXES:**

Memory and Logic Chips.

## **COMPUTER PRICE INDEXES:**

The BEA-IBM Collaboration.

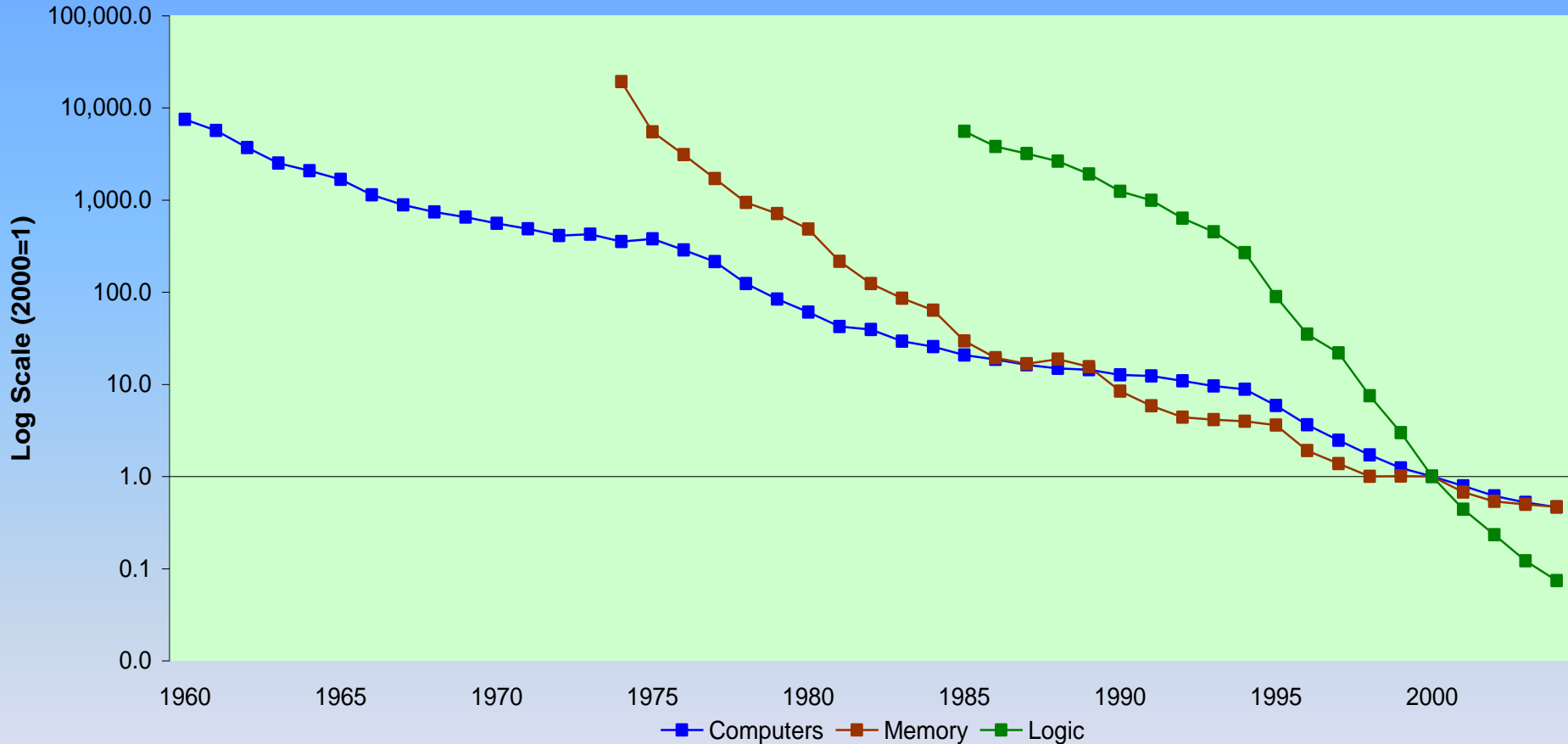
## **COMMUNICATIONS EQUIPMENT:**

Terminal, Switching, and Transmission.

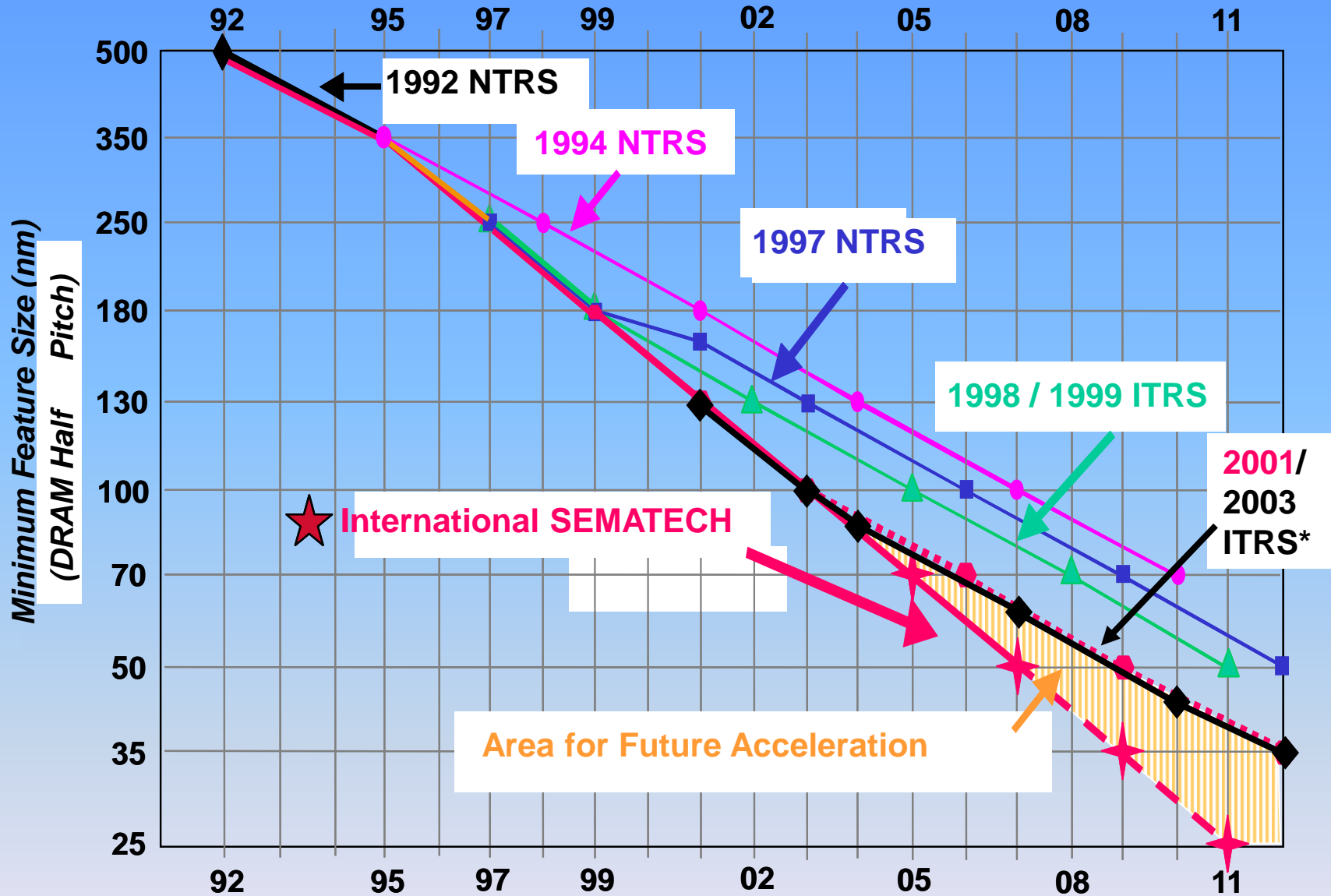
## **SOFTWARE:**

Prepackaged, Custom, and Own-Account.

## Relative Prices of Computers and Semiconductors, 1960-2004



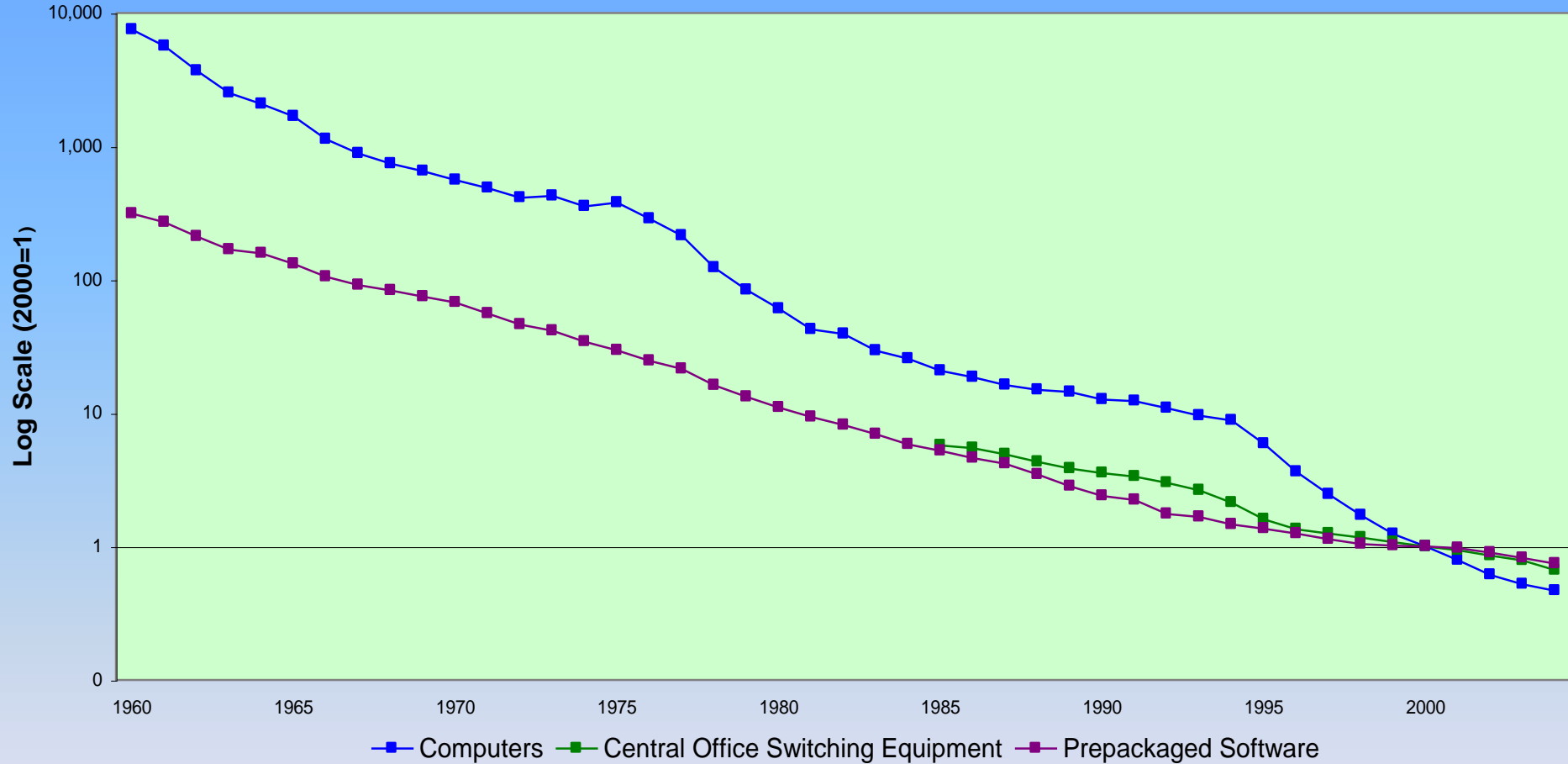
Note: All price indexes are divided by the output price index.



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

## Semiconductor Roadmap Acceleration

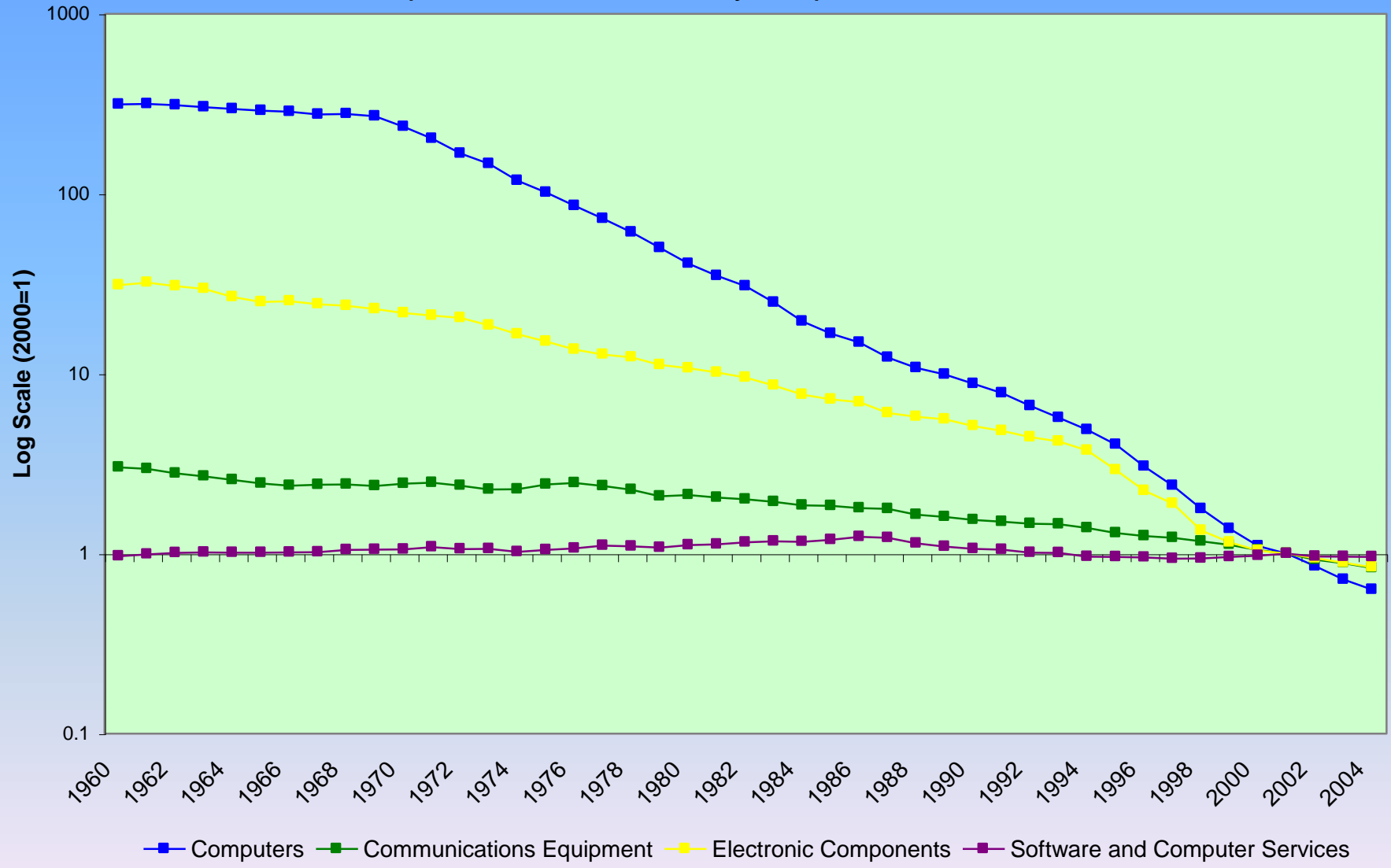
## Relative Prices of Computers, Central Office Switching Equipment, and Prepackaged Software, 1960-2004



Note: All price indexes are divided by the output price index.



# Relative Prices of Computers, Communications, Semiconductors, and Software and Computer Services Industry Output, 1960-2004



# **ROLE OF INFORMATION TECHNOLOGY: Growth of Output.**

## OUTPUT SHARES OF IT:

Computers, Communications Equipment, Semiconductors, and Software.

## OUTPUT CONTRIBUTION BY TYPE:

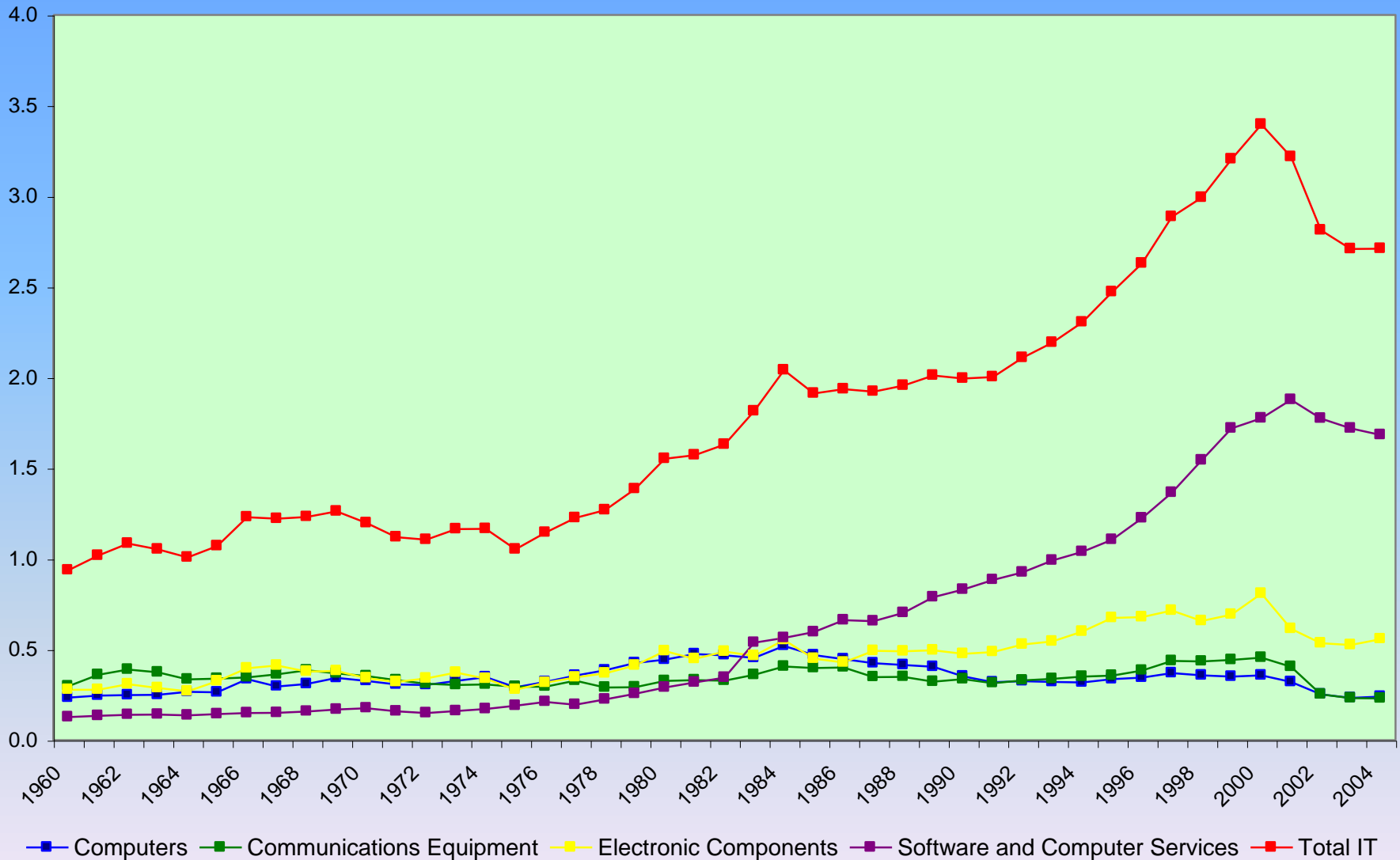
Computers, Communications Equipment, Semiconductors, and Software.

## OUTPUT CONTRIBUTION OF IT:

IT-Producing, IT-Using, and Non-IT Value Added.

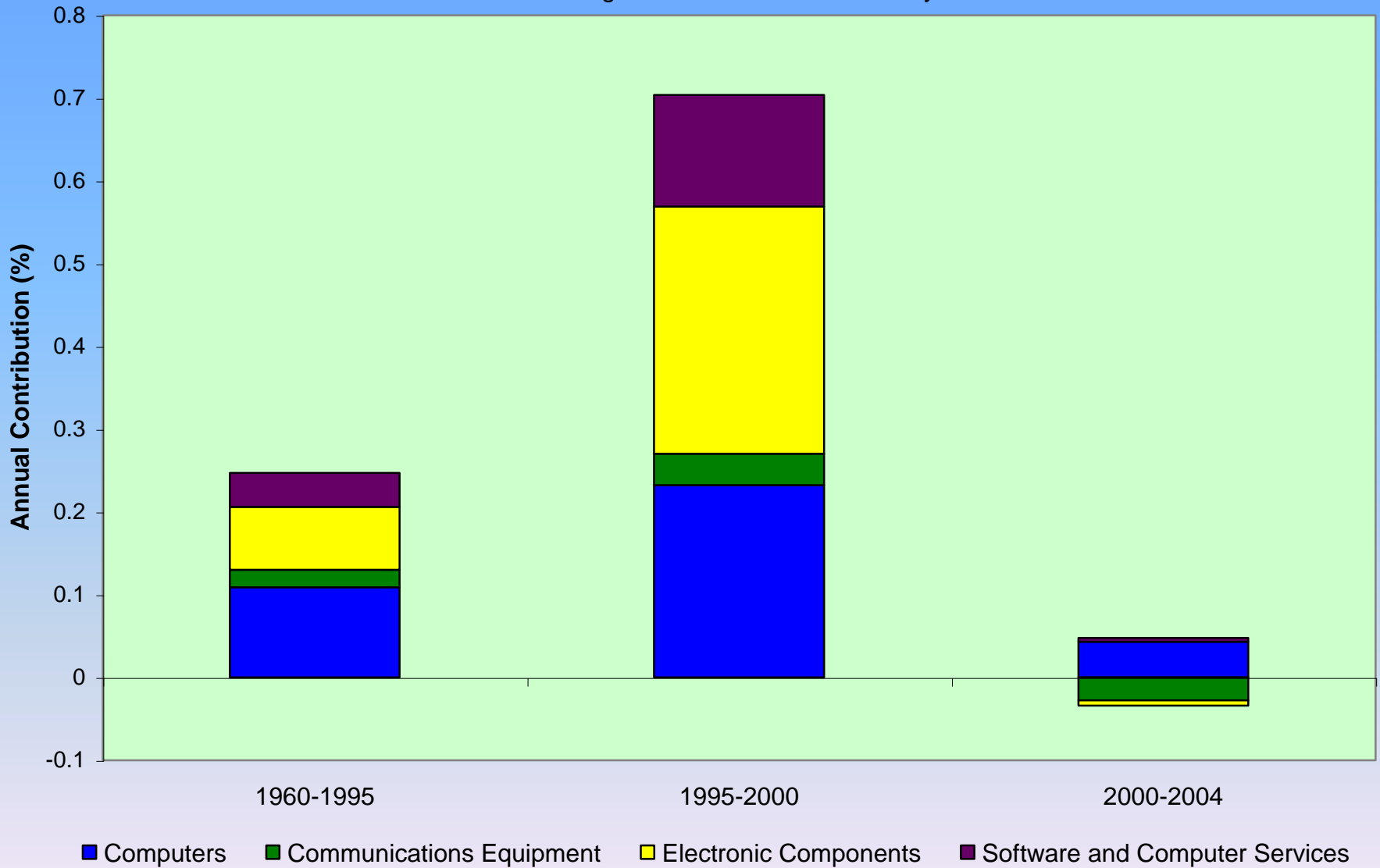
# Value Added Shares of Information Technology by Type, 1960-2004

Share of Current Dollar GDP.



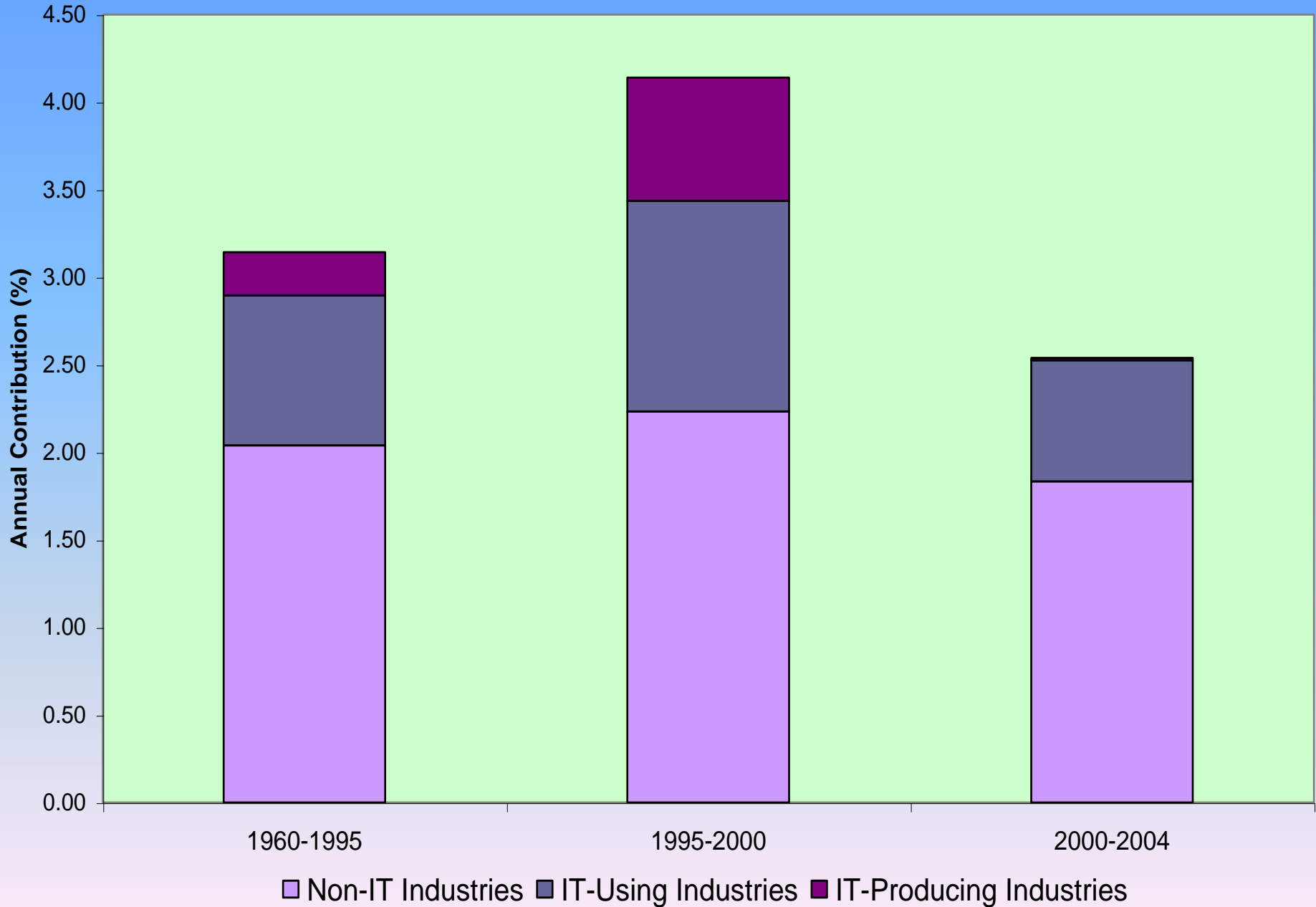
# Industry Contributions to Value Added

Value added weighted contributions of industry value added.

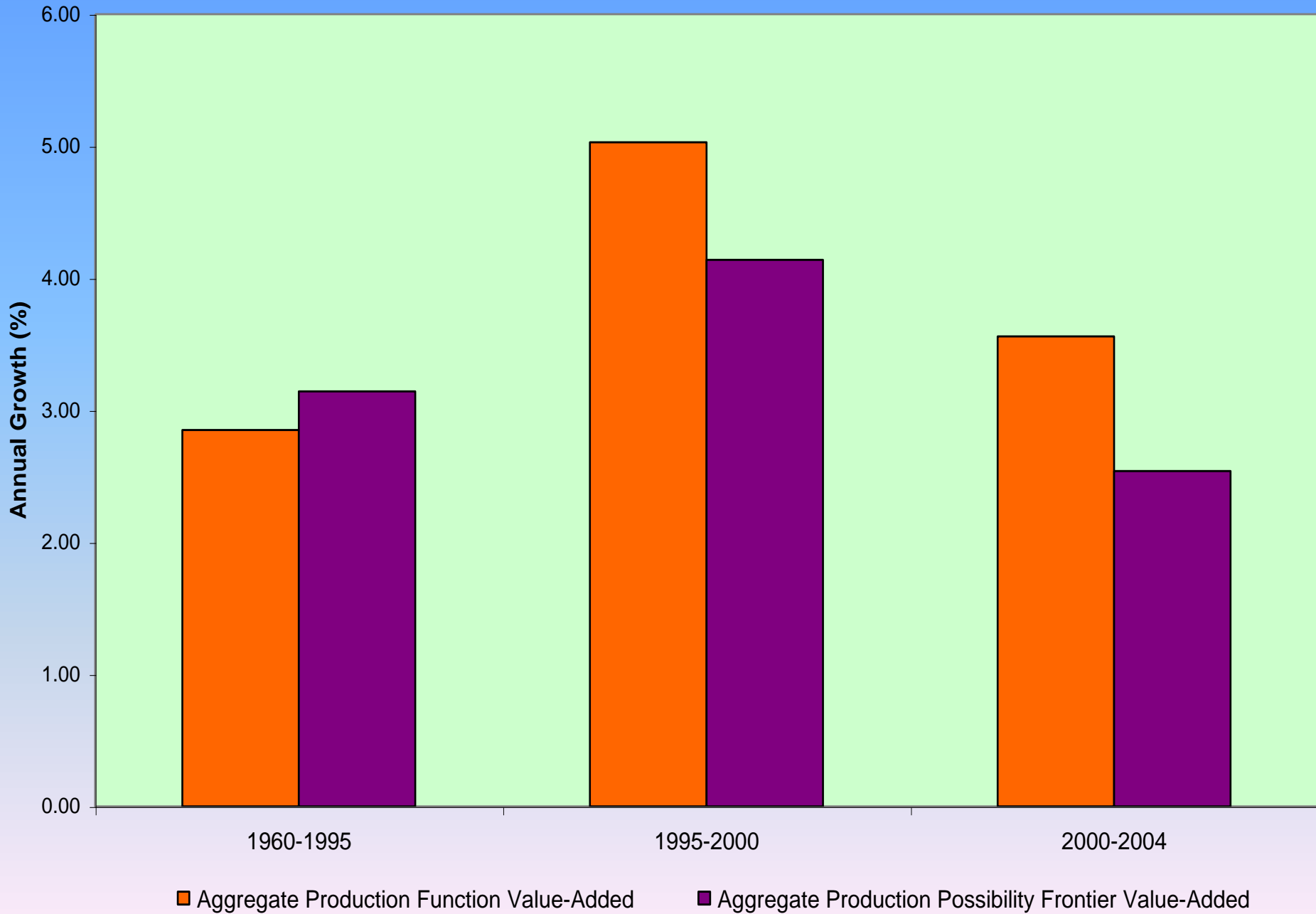


# Industry Contributions to Value Added Growth

Value added weighted contributions of industry value added.



# Comparison of Production Possibility Frontier and Aggregate Production Function



# **ROLE OF INFORMATION TECHNOLOGY: Contribution of Capital Input.**

## INPUT SHARES OF IT:

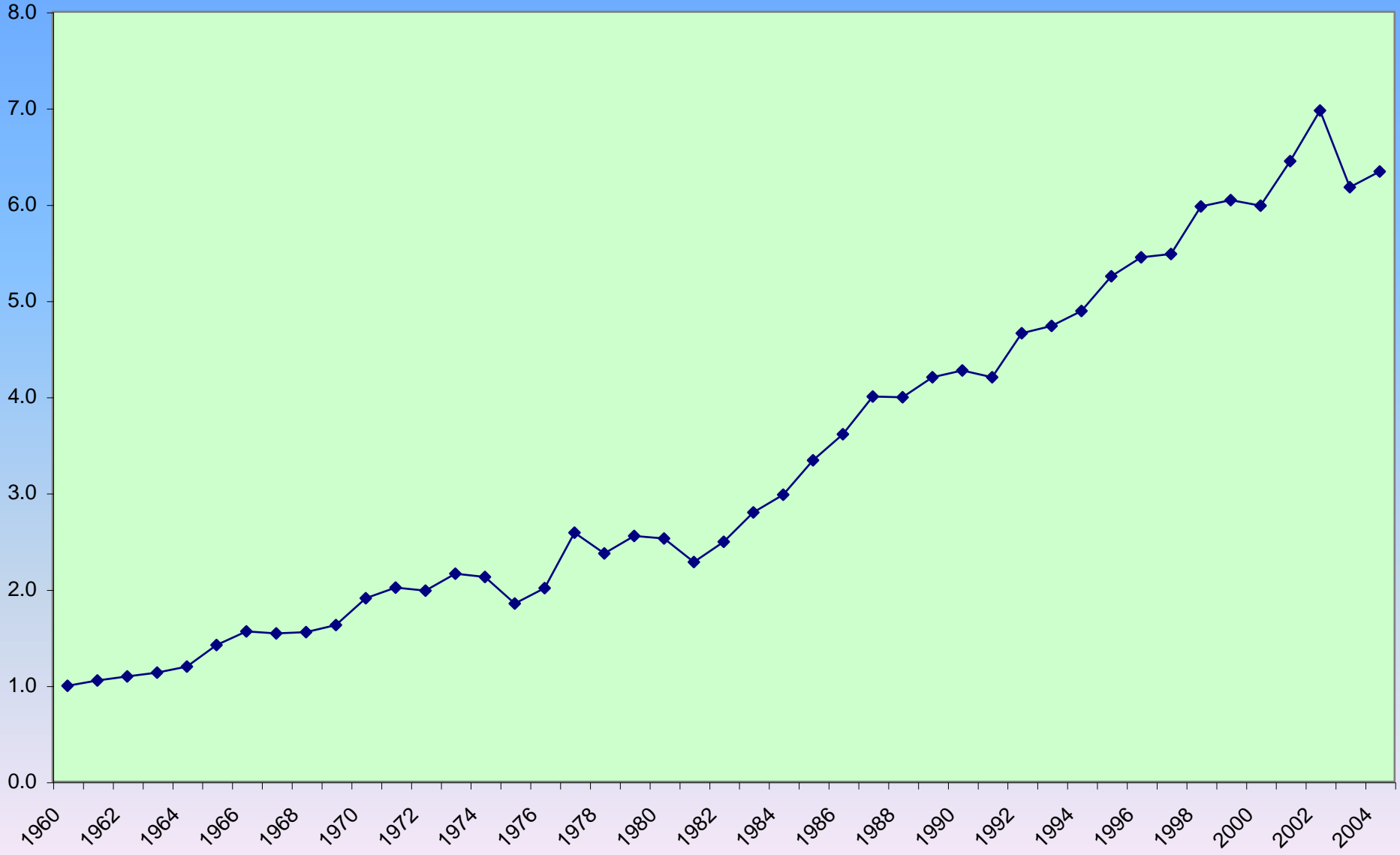
Computers, Communications Equipment, and Software.

## CAPITAL CONTRIBUTION:

IT versus Non-IT Capital Services.

# IT Share of Capital Input, 1960-2004

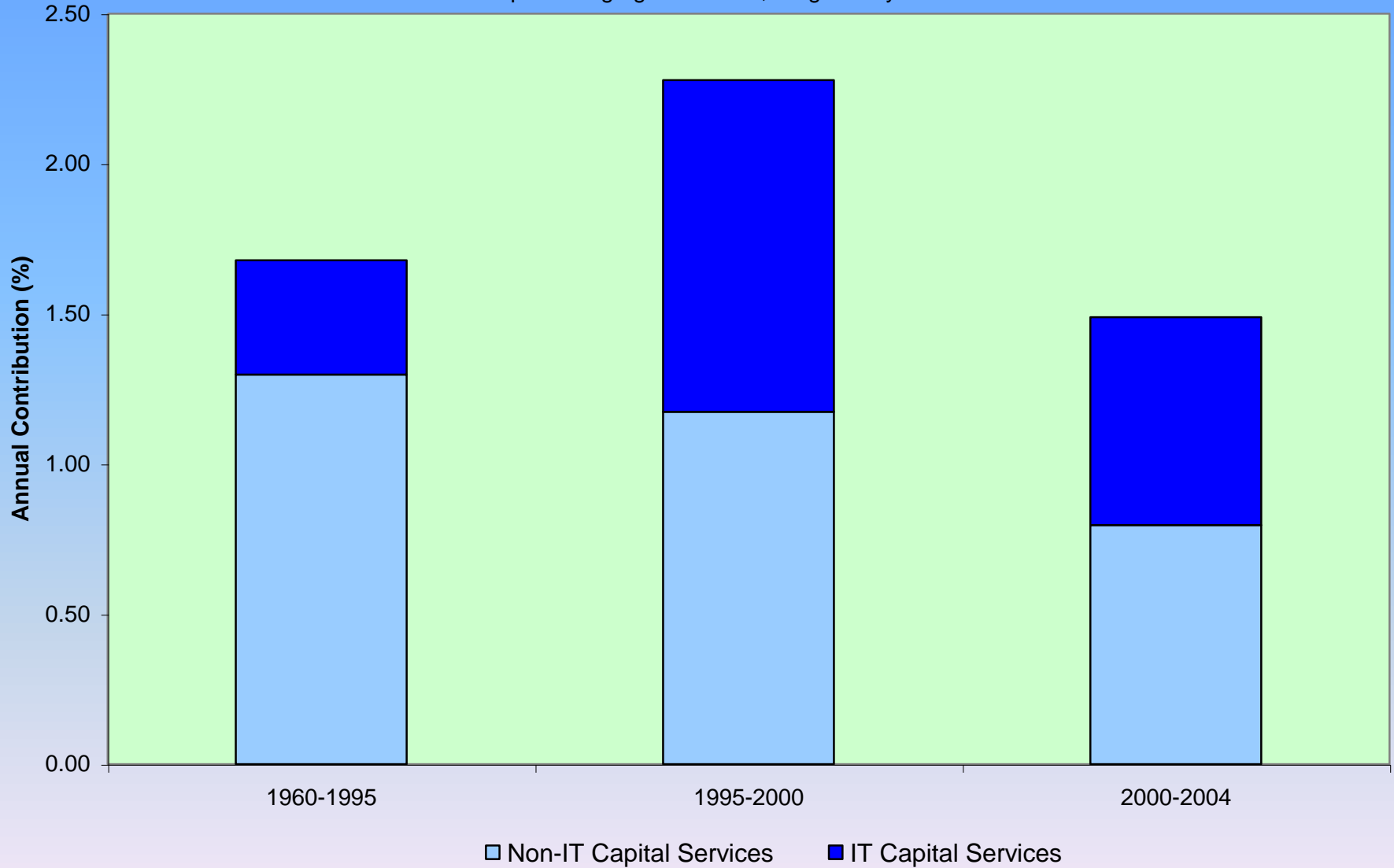
Share of Current Dollar GDP.





# Capital Input Contribution of Information Technology

Annual percentage growth rates, weighted by income shares.



# **GROWTH IN THE NEW MILLENNIUM: IT Investment and Productivity Growth.**

## TOTAL FACTOR PRODUCTIVITY:

IT-Producing, IT-Using, and Non-IT Production.

## SOURCES OF U.S. ECONOMIC GROWTH:

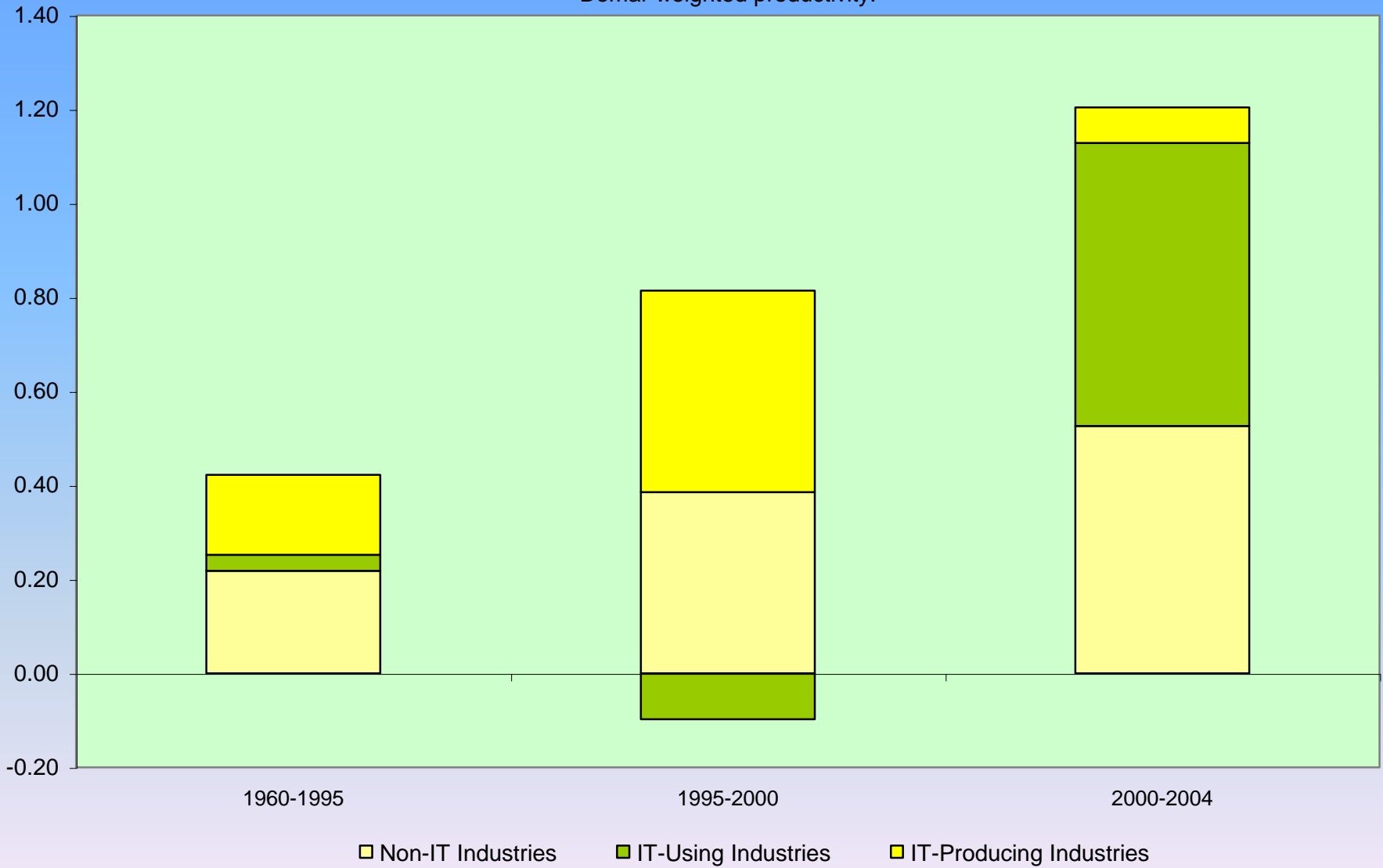
Capital Input, Labor Input, and TFP.

## AVERAGE LABOR PRODUCTIVITY GROWTH:

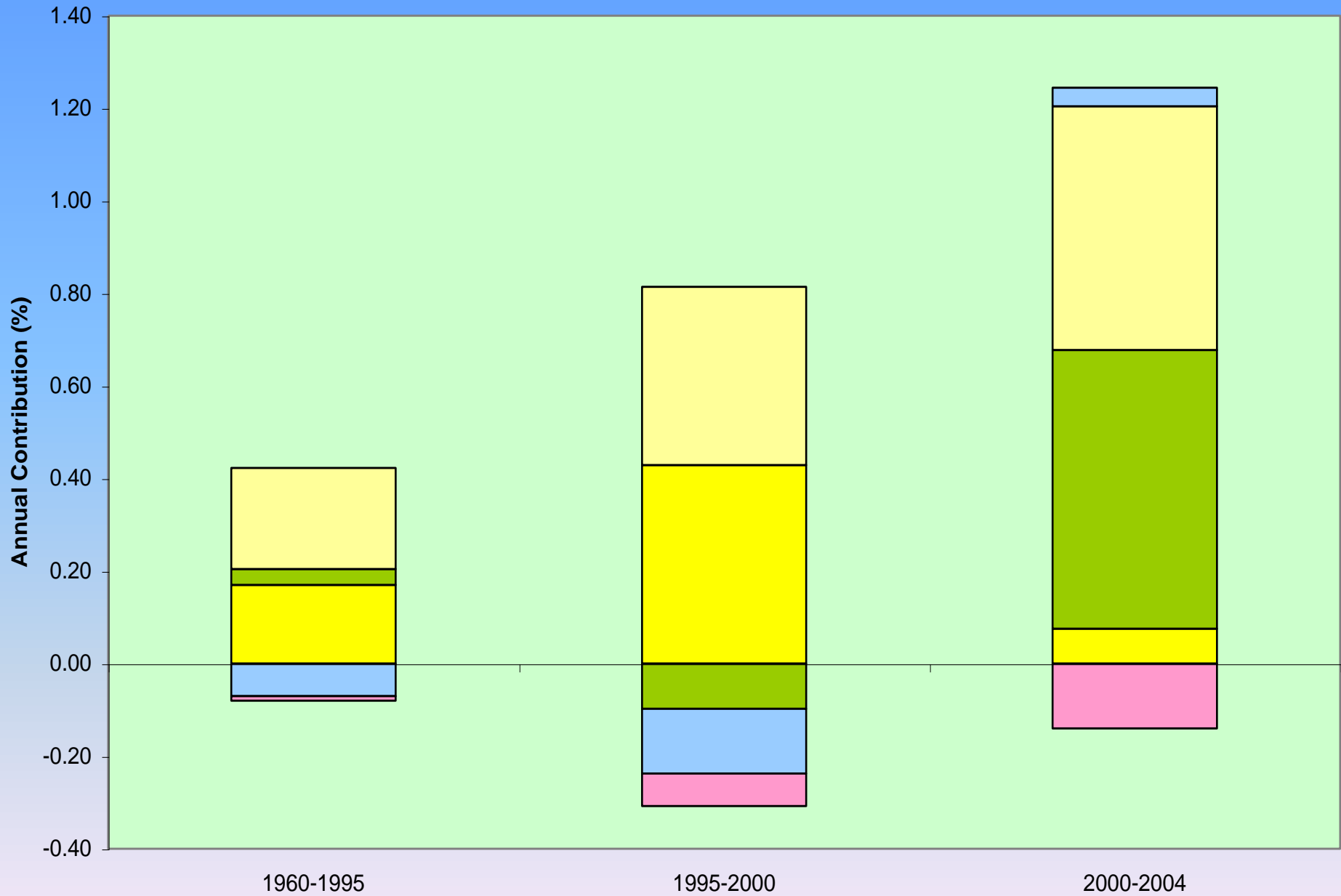
Capital Deepening, Labor Quality, TFP.

# Industry Contributions to Productivity Growth

Domar weighted productivity.



# Sources of Aggregate TFP Growth

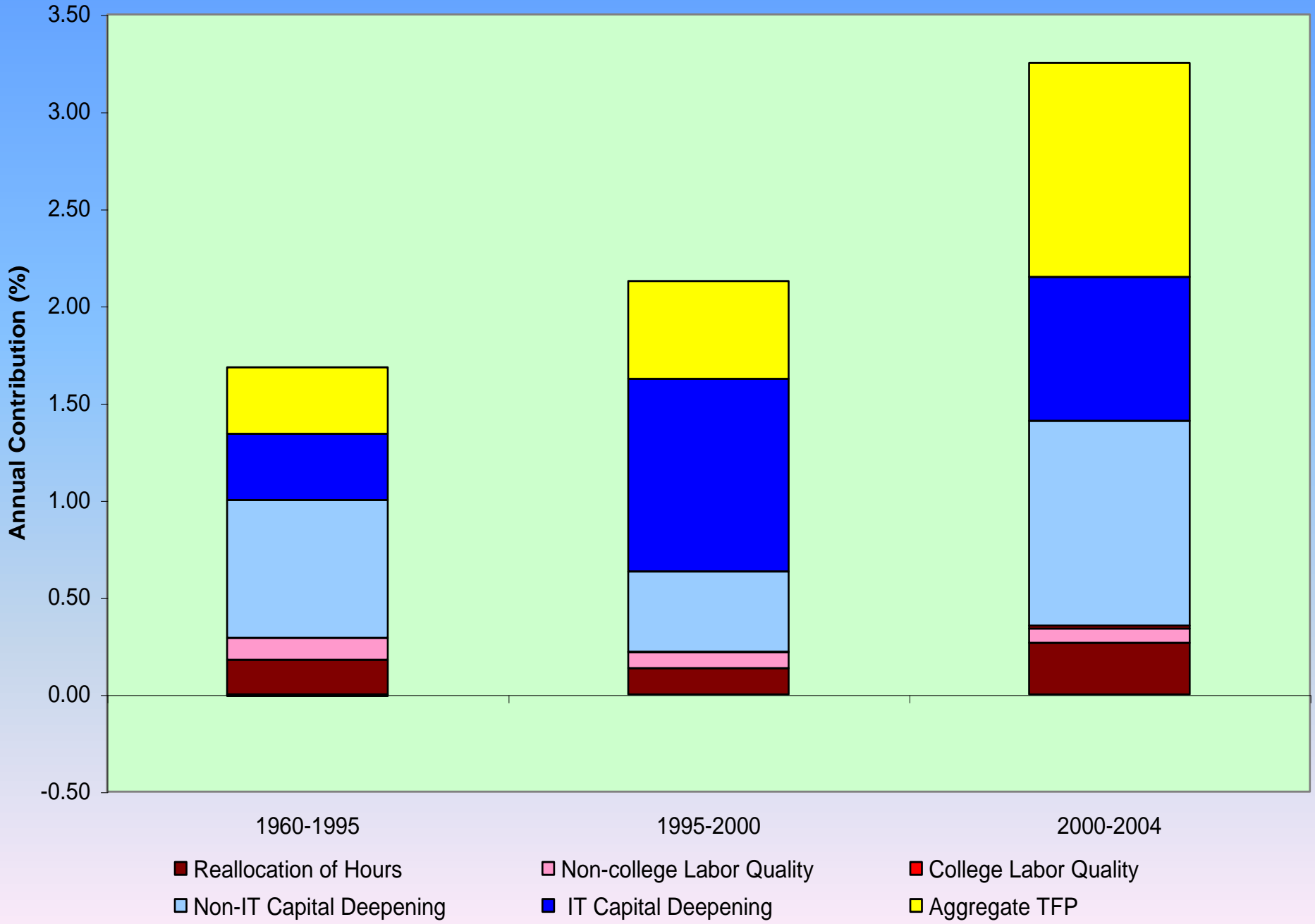


■ IT-Producing Industries ■ IT-Using Industries ■ Non-IT Industries ■ Reallocation of Capital Input ■ Reallocation of Labor Input

# Sources of U.S. Economic Growth



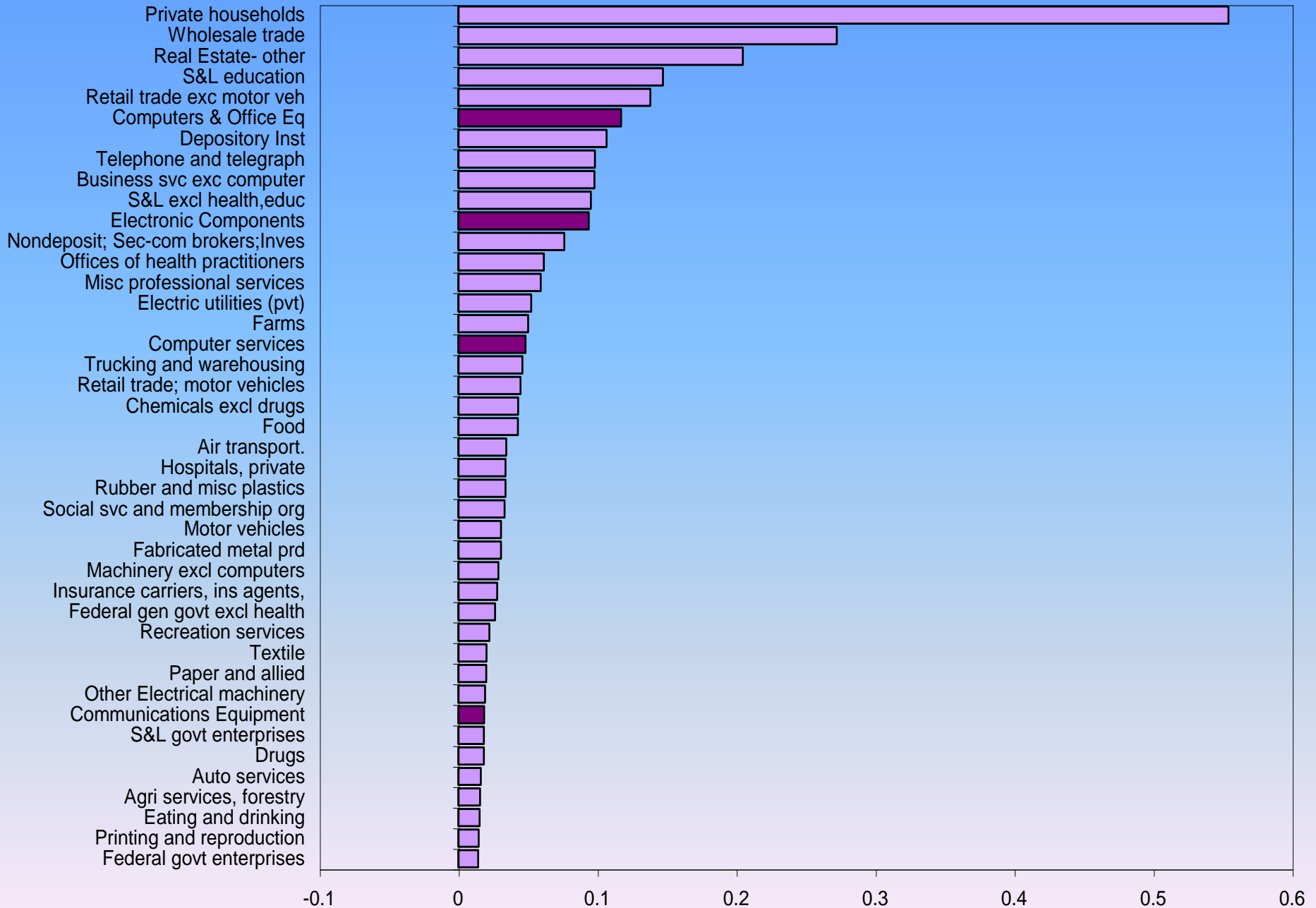
# Sources of U.S. Labor Productivity Growth



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

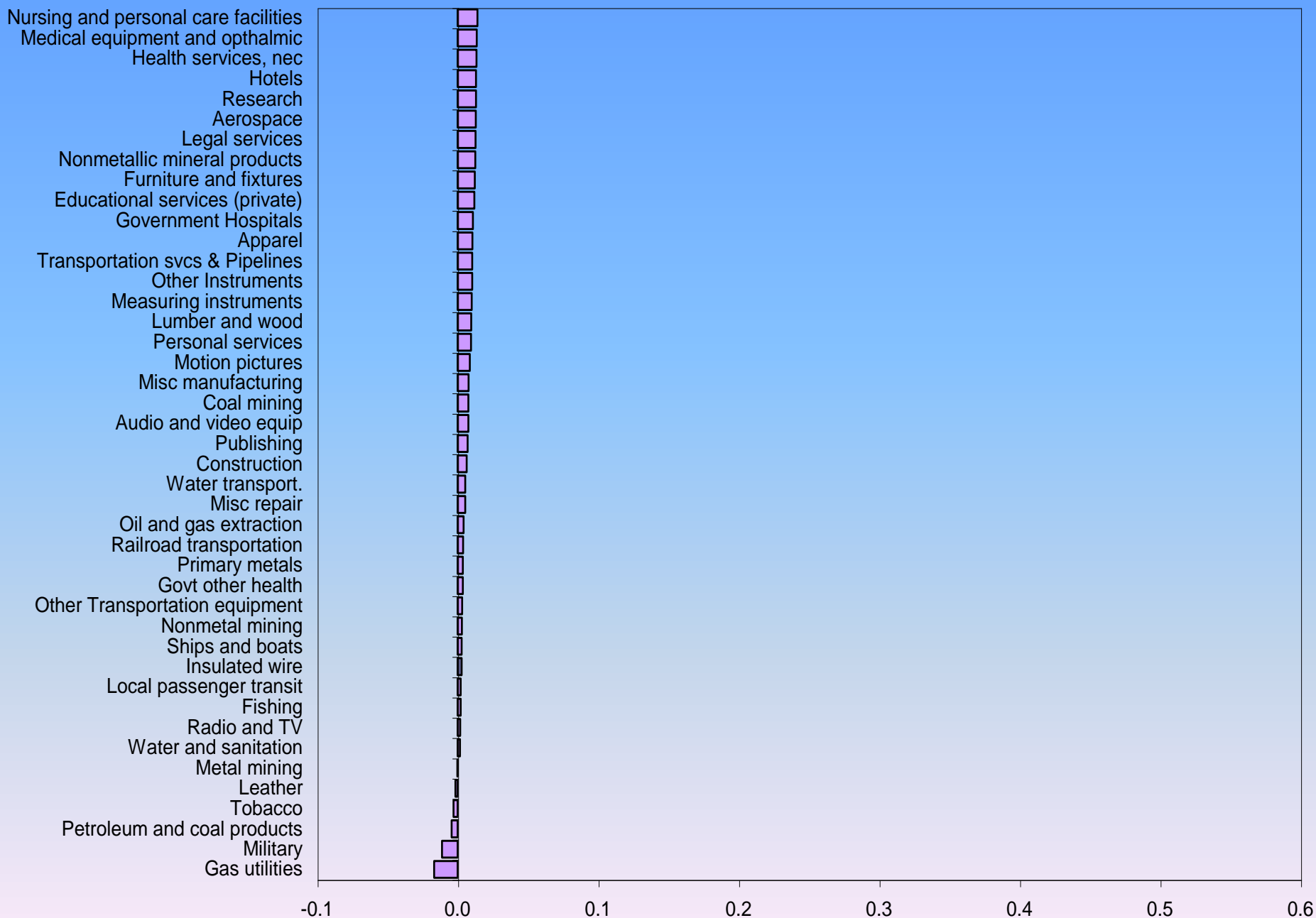
- The Solow Paradox -- we see computers everywhere but in the productivity statistics -- versus the Information Age.
- Equity Valuations and Growth Prospects: accumulation of intangible assets versus irrational exuberance.
- Widening Wage Inequality: capital-skill complementarity versus skill-biased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

# Industry Contributions to Value Added Growth, 1960-2004

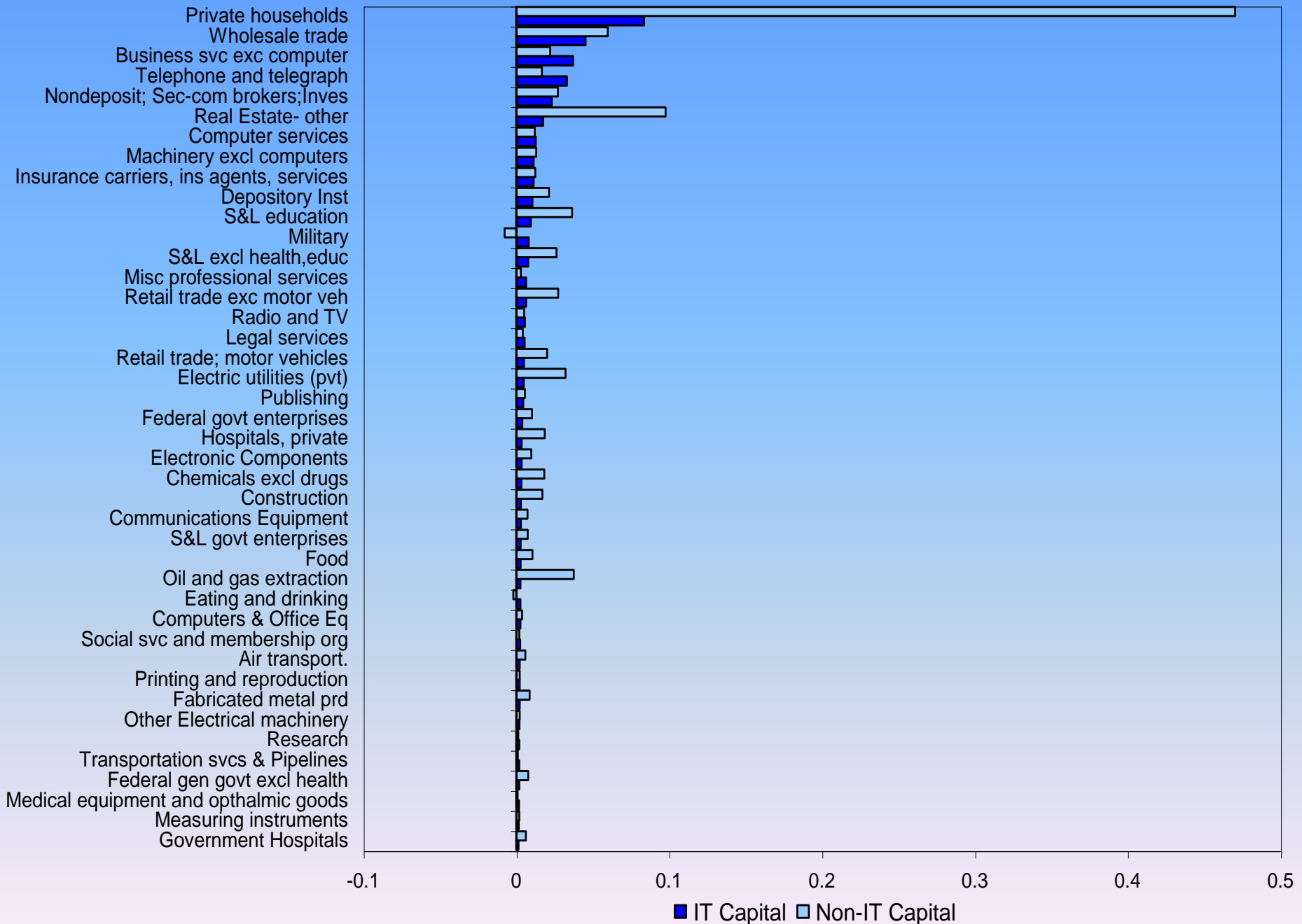




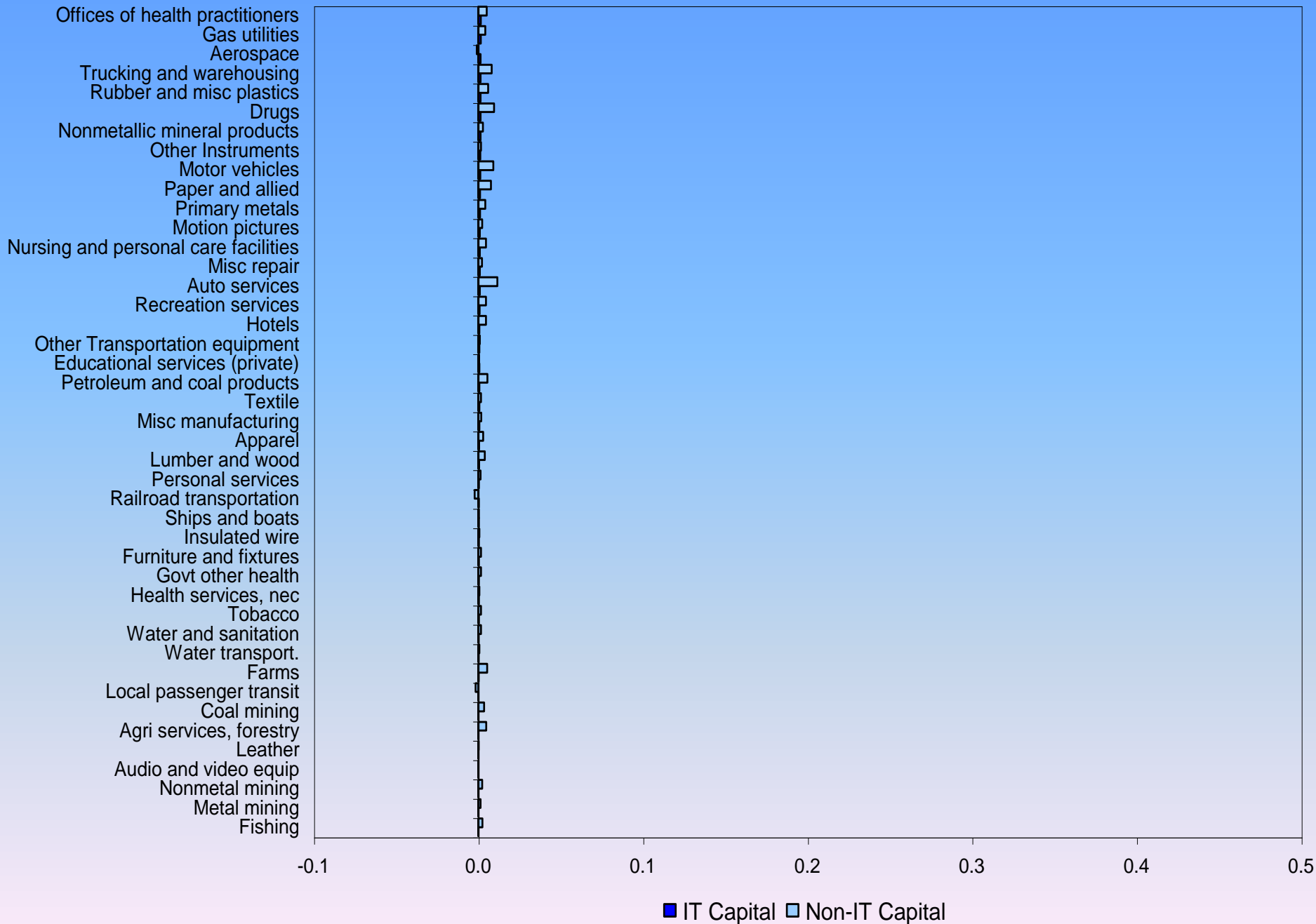
# Industry Contributions to Value Added Growth, 1960-2004 (cont.)



# Industry Contributions to Capital Input Growth, 1960-2004

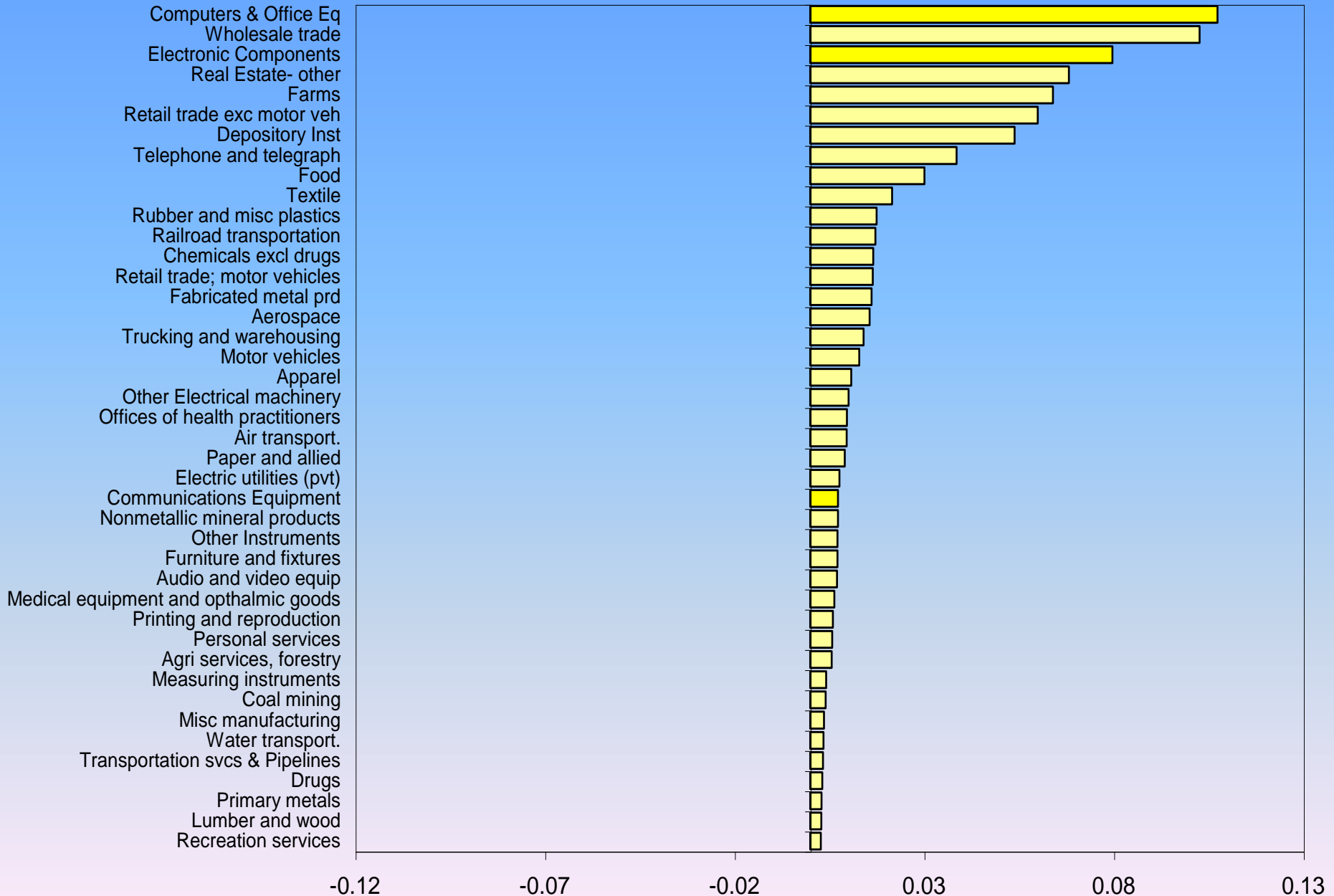


# Industry Contributions to Capital Input Growth, 1960-2004 (cont)



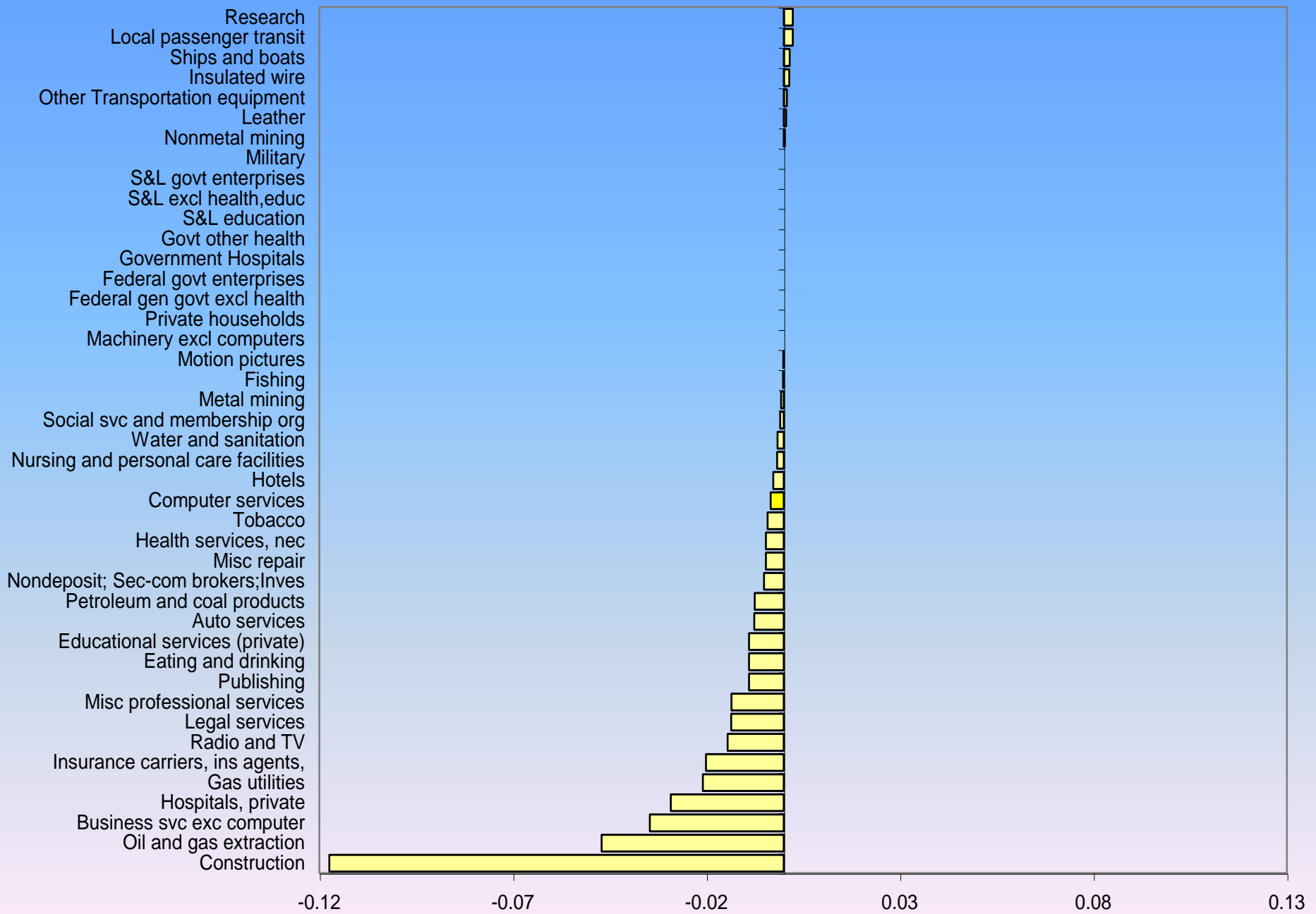
# Industry Contributions to Productivity Growth

Domar weighted contribution.



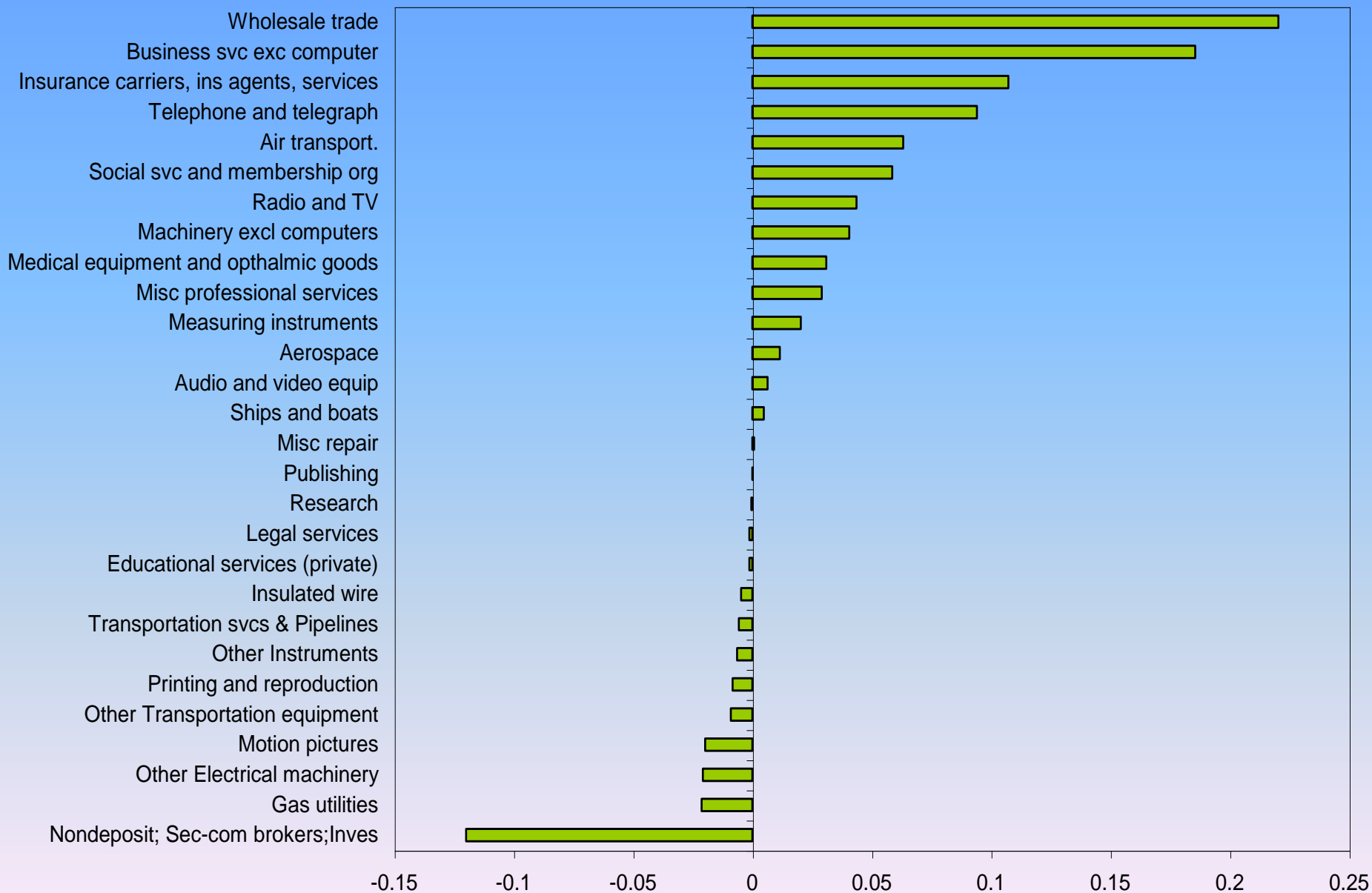
# Industry Contributions to Productivity Growth (cont.)

Domar weighted contribution.



# Change in Contribution to Productivity: 2000-2004 less 1960-1995

## IT-Users



# IT Producing Industries

Communications Equipment

Computer services

Computers & Office Eq

Electronic Components

# IT Using Industries

Audio and video equip  
Insulated wire  
Other Electrical machinery  
Aerospace  
Air transport.  
Business svc exc computer  
Educational services (private)  
Gas utilities  
Insurance carriers, ins agents, services  
Legal services  
Machinery excl computers  
Measuring instruments  
Medical equipment and ophthalmic goods  
Misc professional services  
Misc repair  
Motion pictures  
Nondeposit; Sec-com brokers;Inves  
Other Instruments  
Other Transportation equipment  
Printing and reproduction  
Publishing  
Radio and TV  
Research  
Ships and boats  
Social svc and membership org  
Telephone and telegraph  
Transportation svcs & Pipelines  
Wholesale trade

\* Industries with an IT Capital Share of 15% or greater in 1995.



# Non-IT Industries

Agri services, forestry  
Apparel  
Auto services  
Chemicals excl drugs  
Coal mining  
Construction  
Depository Inst  
Drugs  
Eating and drinking  
Electric utilities (pvt)  
Fabricated metal prd  
Farms  
Fishing  
Food  
Furniture and fixtures  
Government  
Health services, nec  
Hospitals, private  
Hotels  
Leather  
Local passenger transit  
Lumber and wood  
Metal mining

Misc manufacturing  
Motor vehicles  
Nonmetal mining  
Nonmetallic mineral products  
Nursing and personal care facilities  
Offices of health practitioners  
Oil and gas extraction  
Paper and allied  
Personal services  
Petroleum and coal products  
Primary metals  
Railroad transportation  
Real Estate- other  
Recreation services  
Retail trade exc motor veh  
Retail trade; motor vehicles  
Rubber and misc plastics  
Textile  
Tobacco  
Trucking and warehousing  
Water and sanitation  
Water transport.