

# Long-term Estimates of U.S. Productivity and Growth

by

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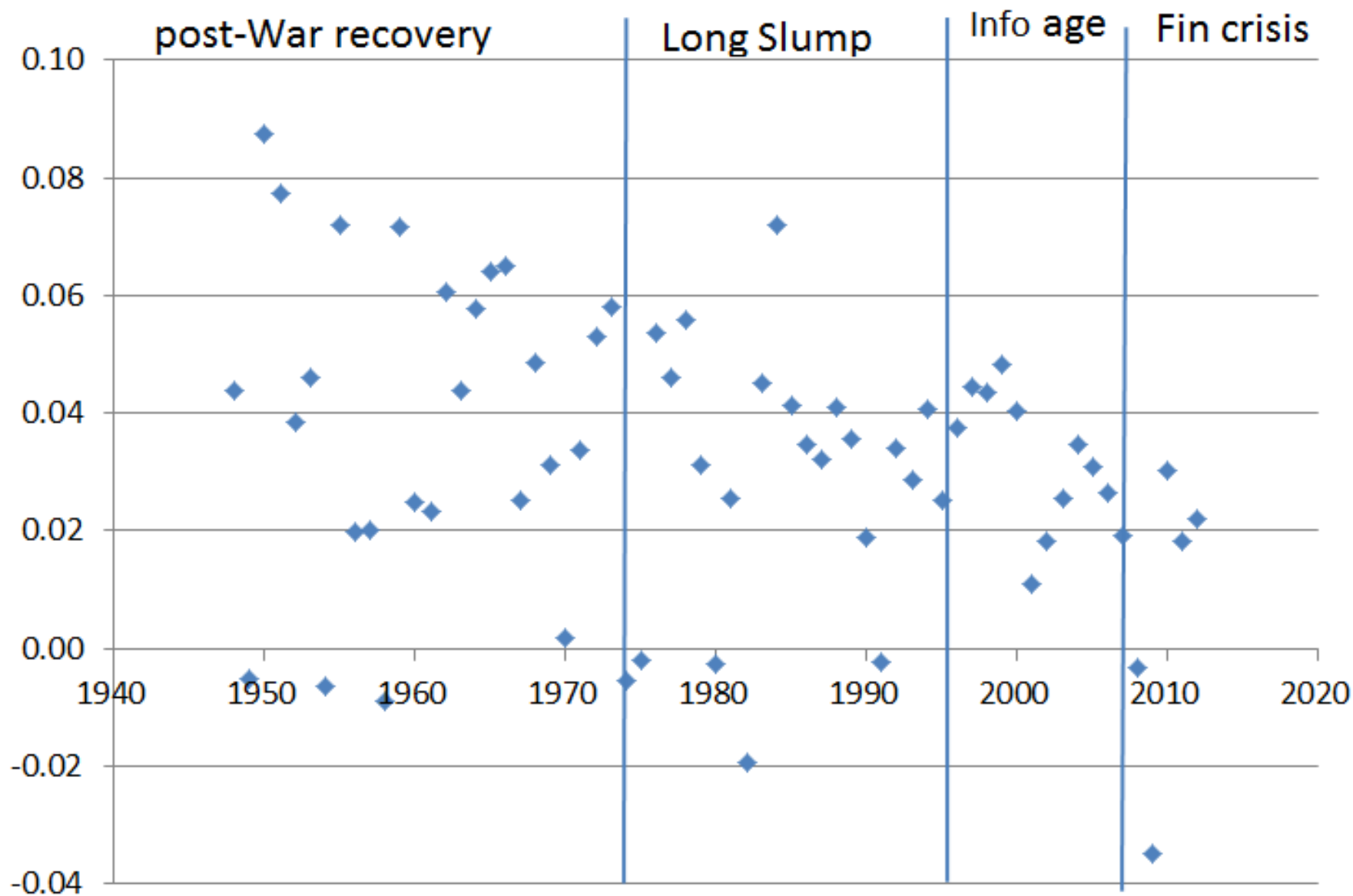
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*The views expressed in this paper are solely those of the authors and are not necessarily those of the Bureau of Economic Analysis of the U.S. Department of Commerce.*

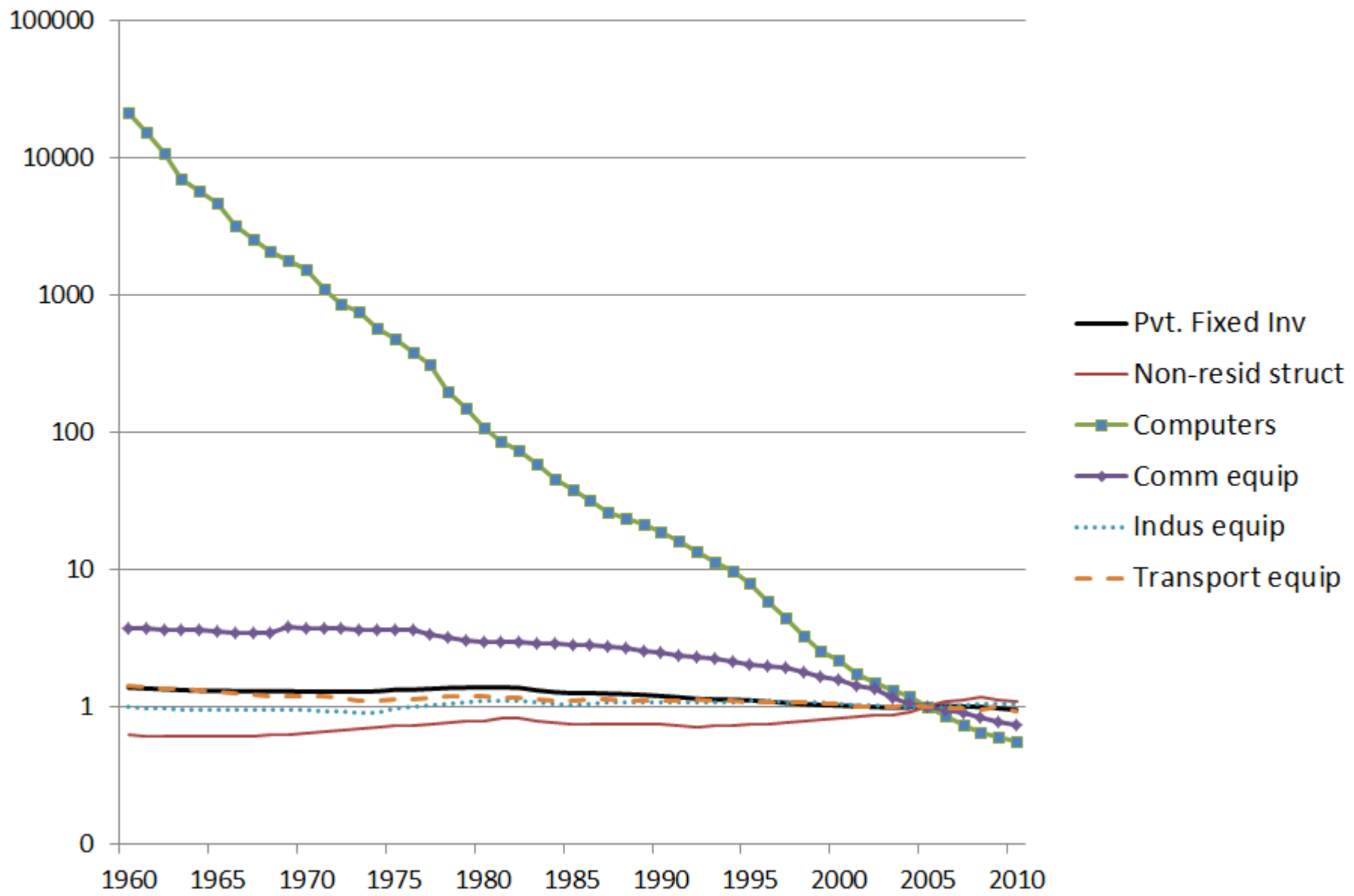
# U.S. GDP growth rates



# Agenda

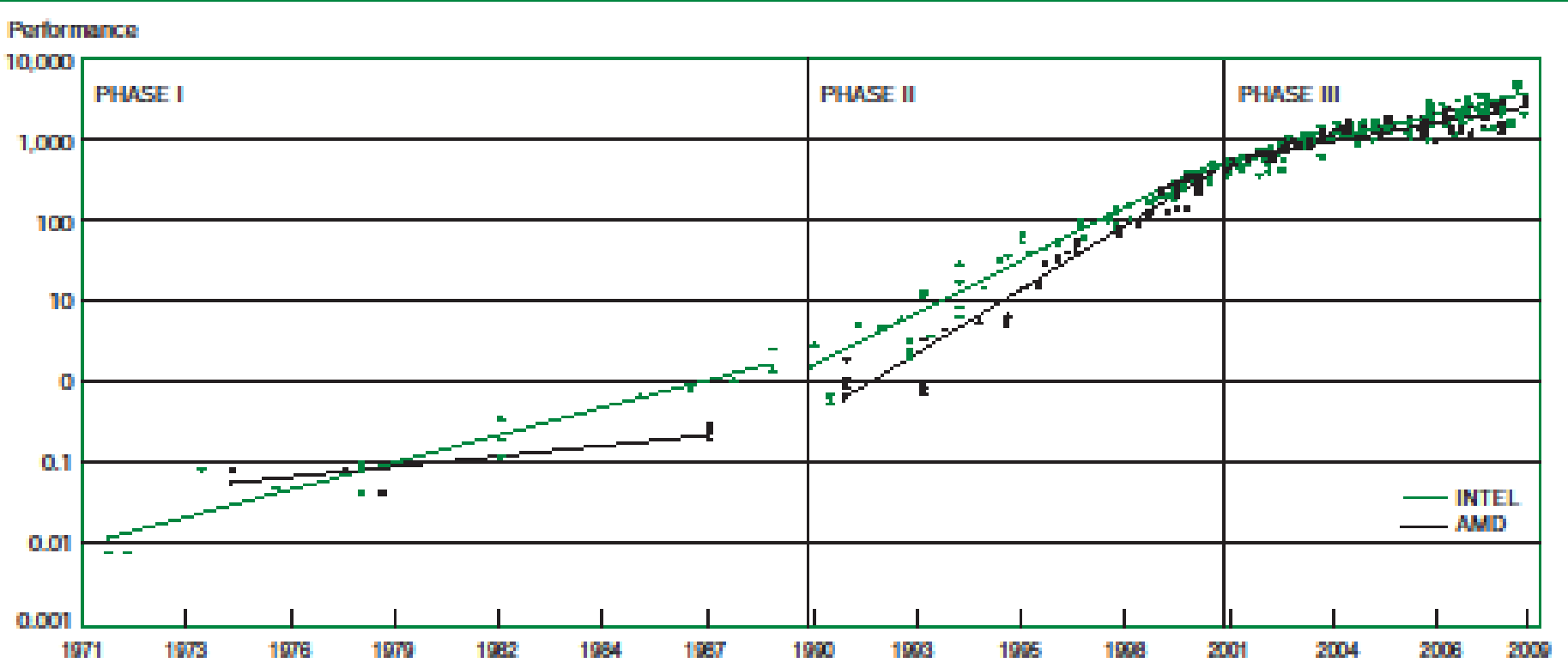
- 63-year Economic History, 1947-2010
  - The Sources of Growth
- Divide into 3 sub-periods:
  - 1947-73 Post-war Recovery
  - 1973-95 The Long Slump
  - 1995-2010 Information Age and Recession
- Transformation of capital input; IT capital and TFP
- Educational attainment of workers; evolution of wage premium
- Effect of 2007 Financial Crisis

# Price of investment relative to GDP deflator (log scale)

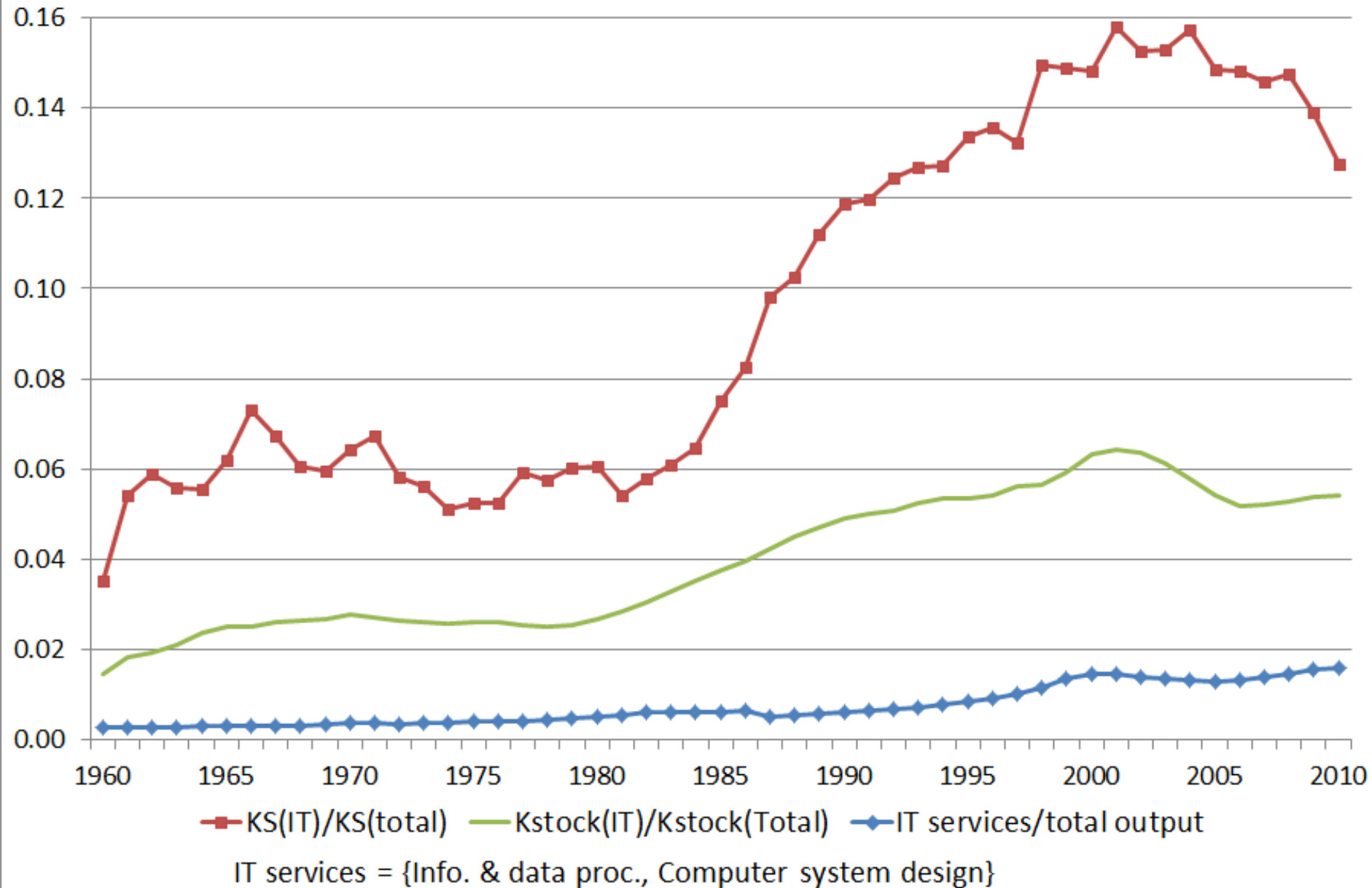


# Pillai (SCB 2011) Tech. Progress in Microprocessor Indus.

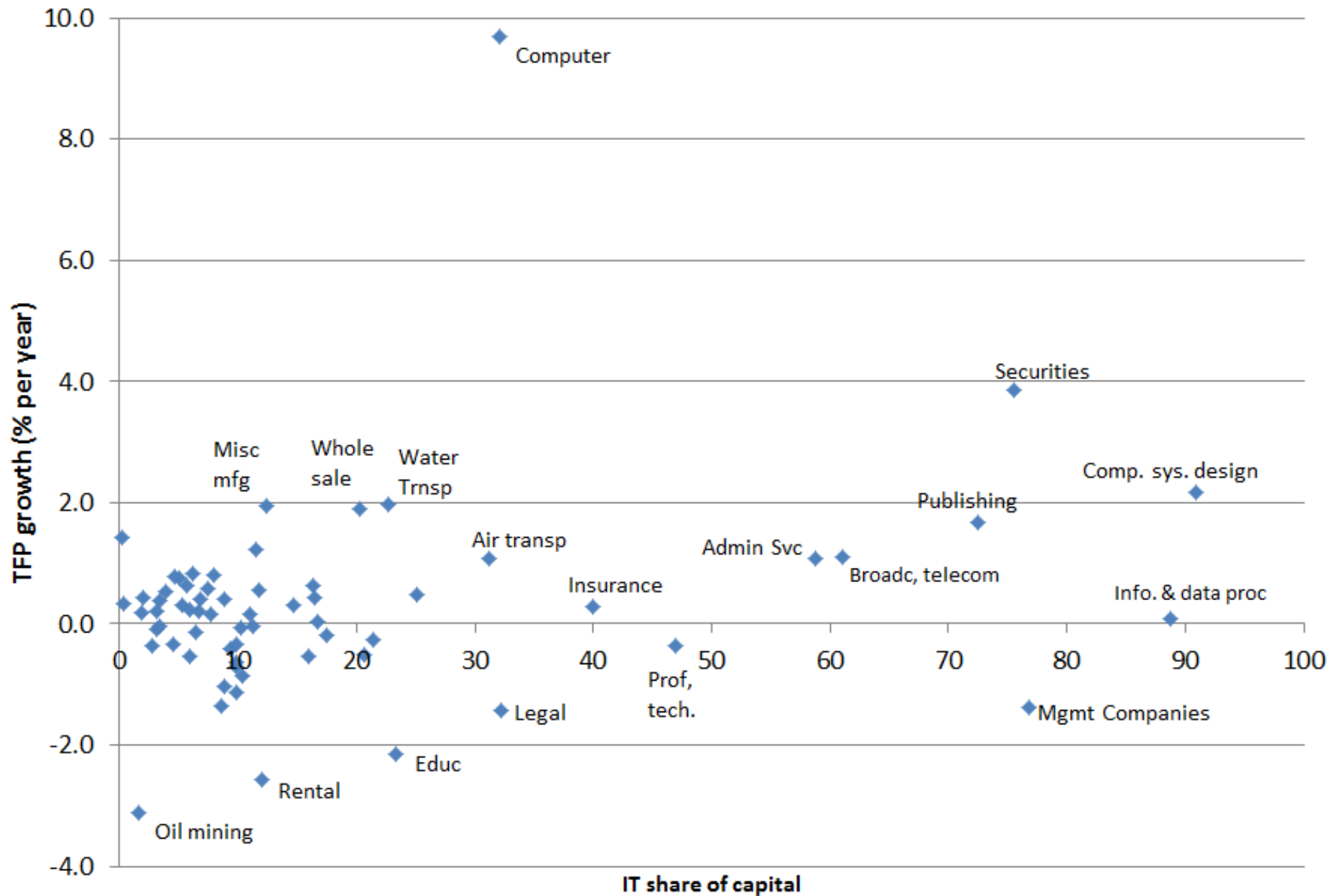
## Chart 1. Acceleration and Slowdown in Growth of Microprocessors Performance



**Fig K2. Shares of IT stock, IT capital services, IT service output in total economy**



**Fig K4. TFP growth 1995-2010 vs IT share (2005)**



# THE ROLE OF INNOVATION

Total Factor Productivity

IT-Producing, IT-Using and Non-IT Industries

Reallocation of Factor Inputs

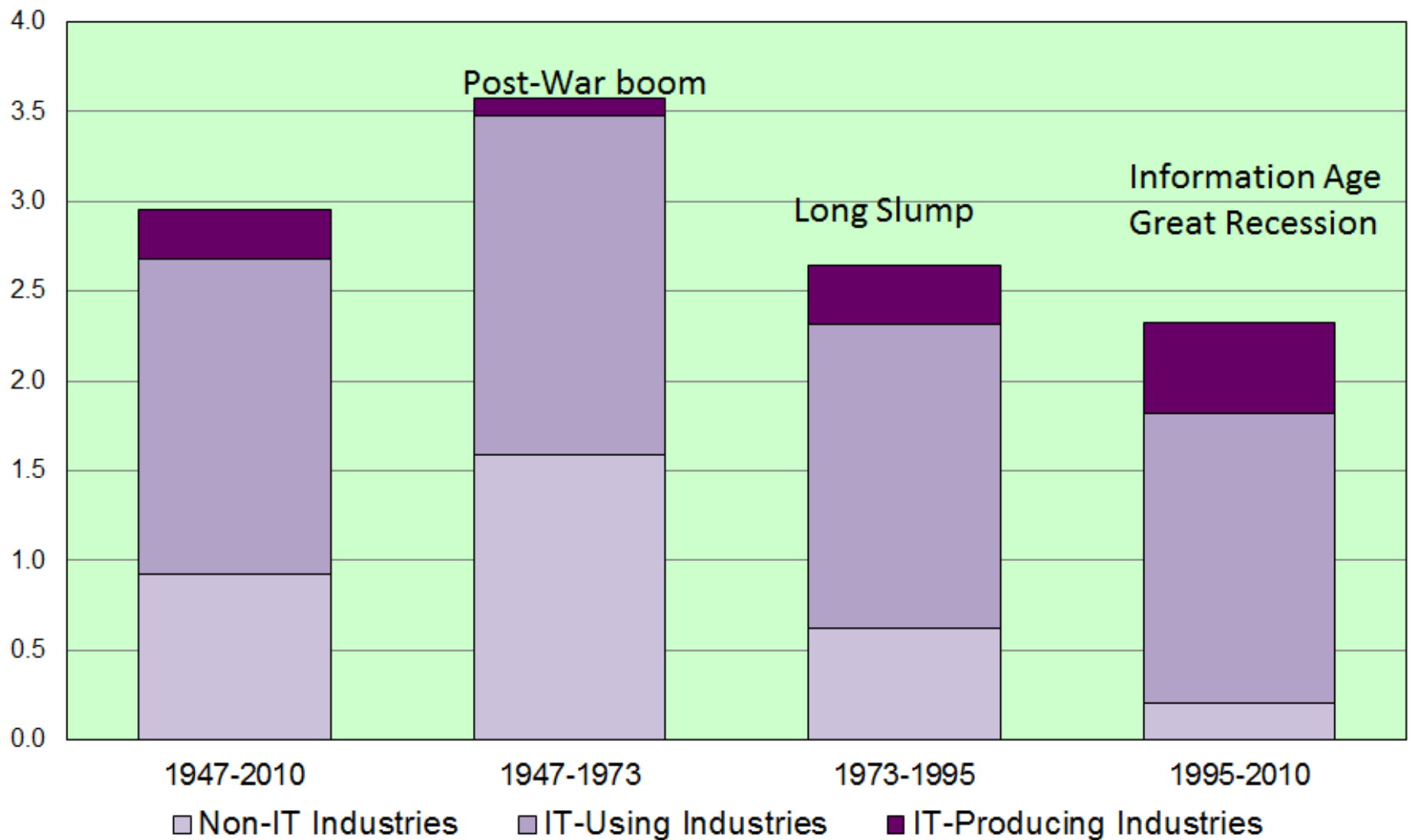
Capital Input and Labor Input

Aggregate Productivity Growth

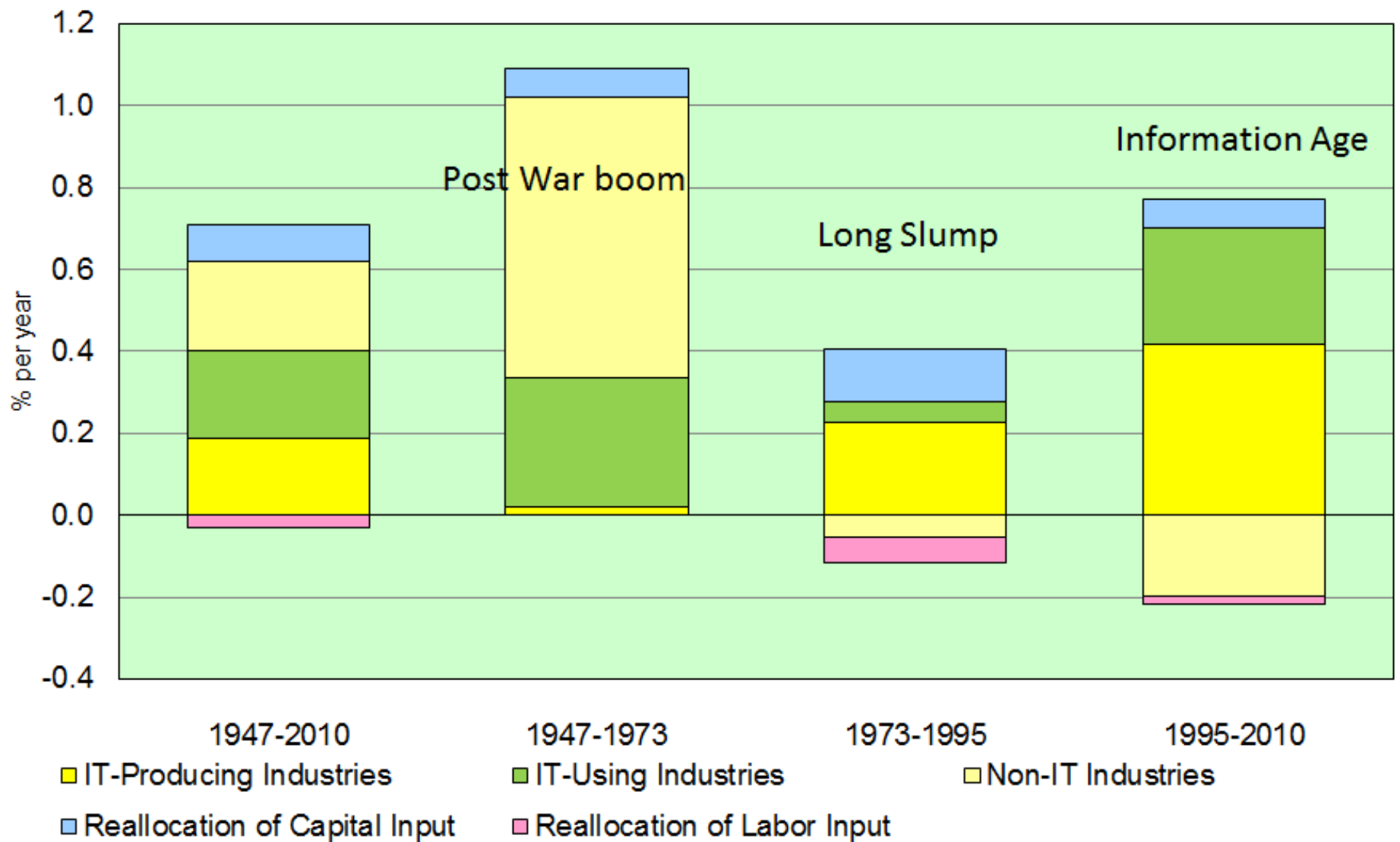
Industry Productivity and Factor Reallocations



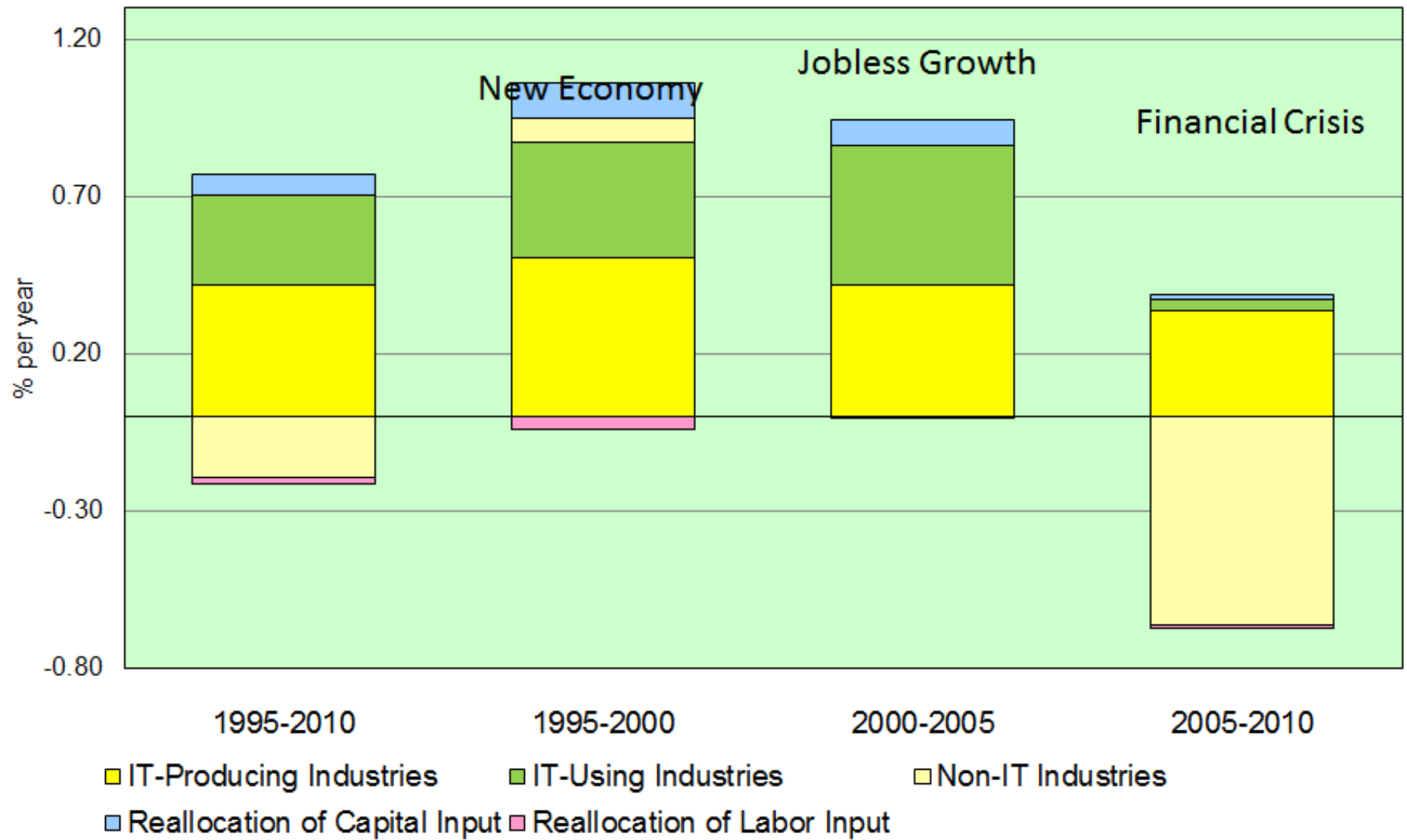
**Fig. 1. Contributions of Industry Groups to Value Added Growth, 1947-2010**



## Contribution of Industry Groups to Aggregate Productivity Growth, 1947-2010

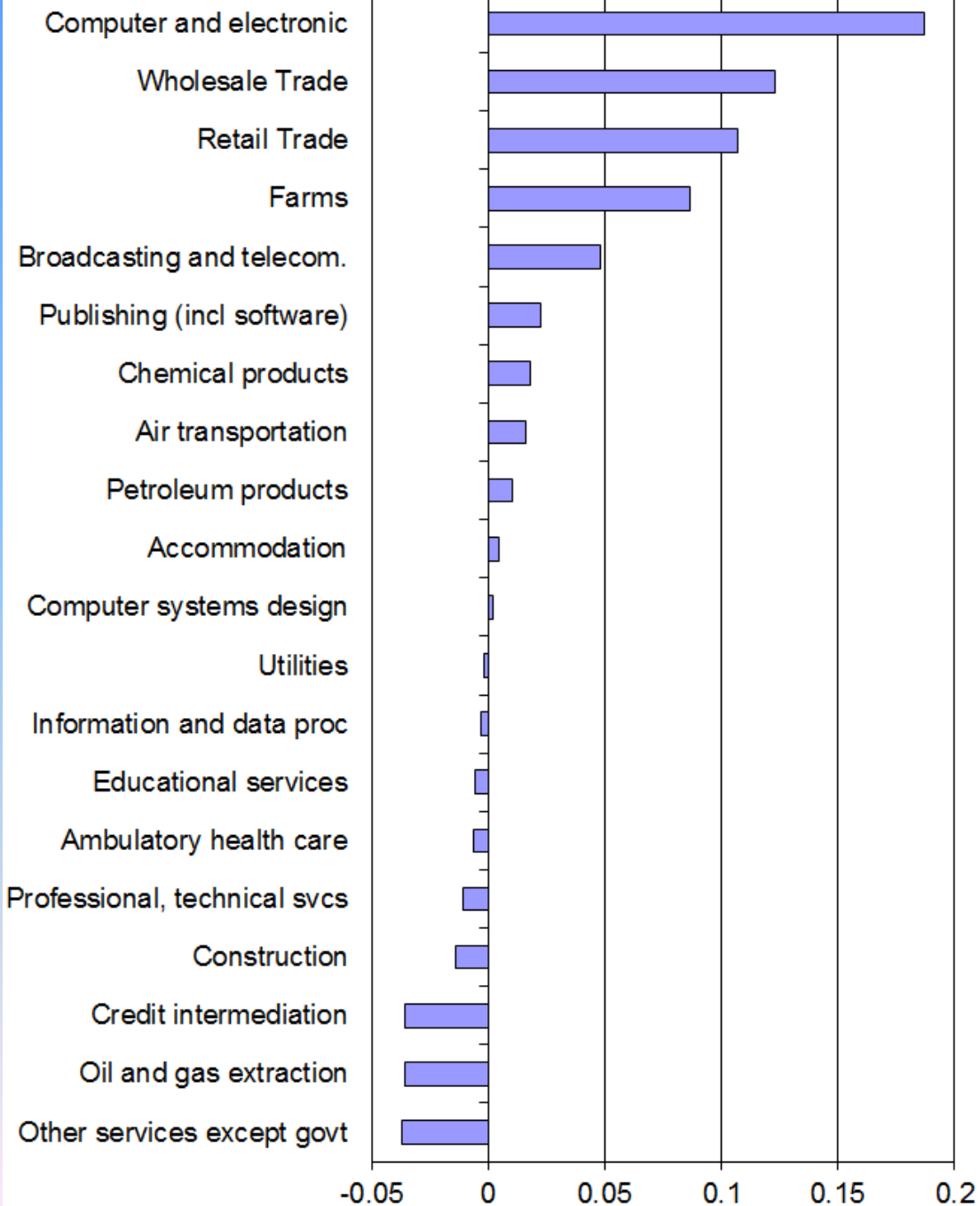
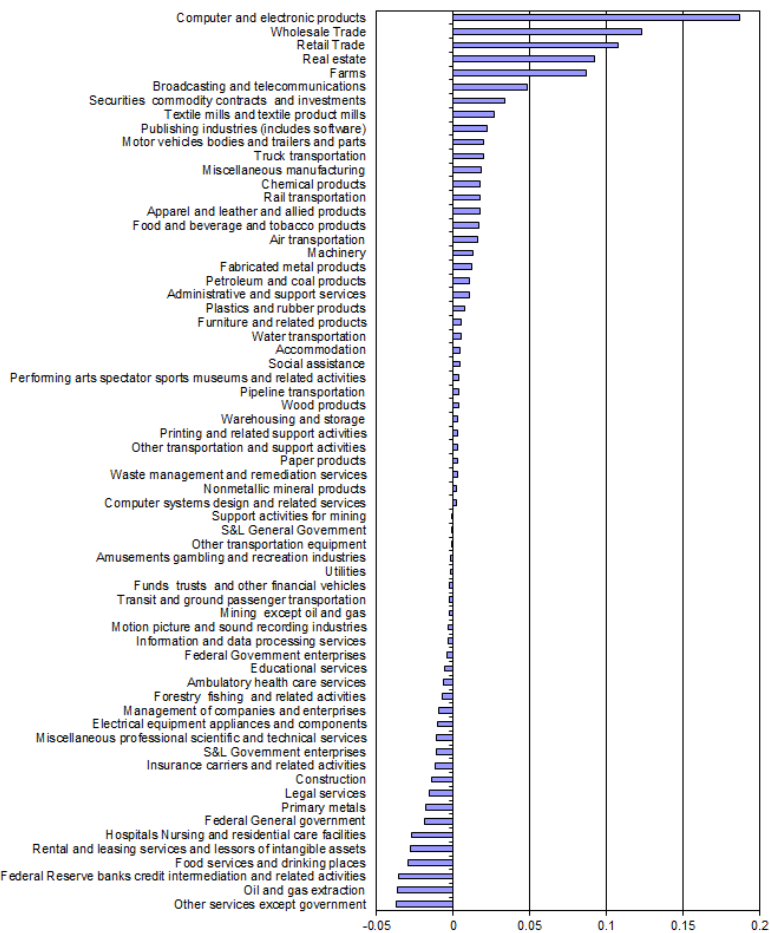


## Contributions to Aggregate Productivity Growth in the Information Age



# Contributions of Individual Industries to Productivity Growth, 1947-2010

Fig. 6. Industry Contributions to Productivity, 1947-2010



# SOURCES OF U.S. ECONOMIC GROWTH

## Contribution of Capital Input

IT and Non-IT Capital

## Contribution of Labor Input

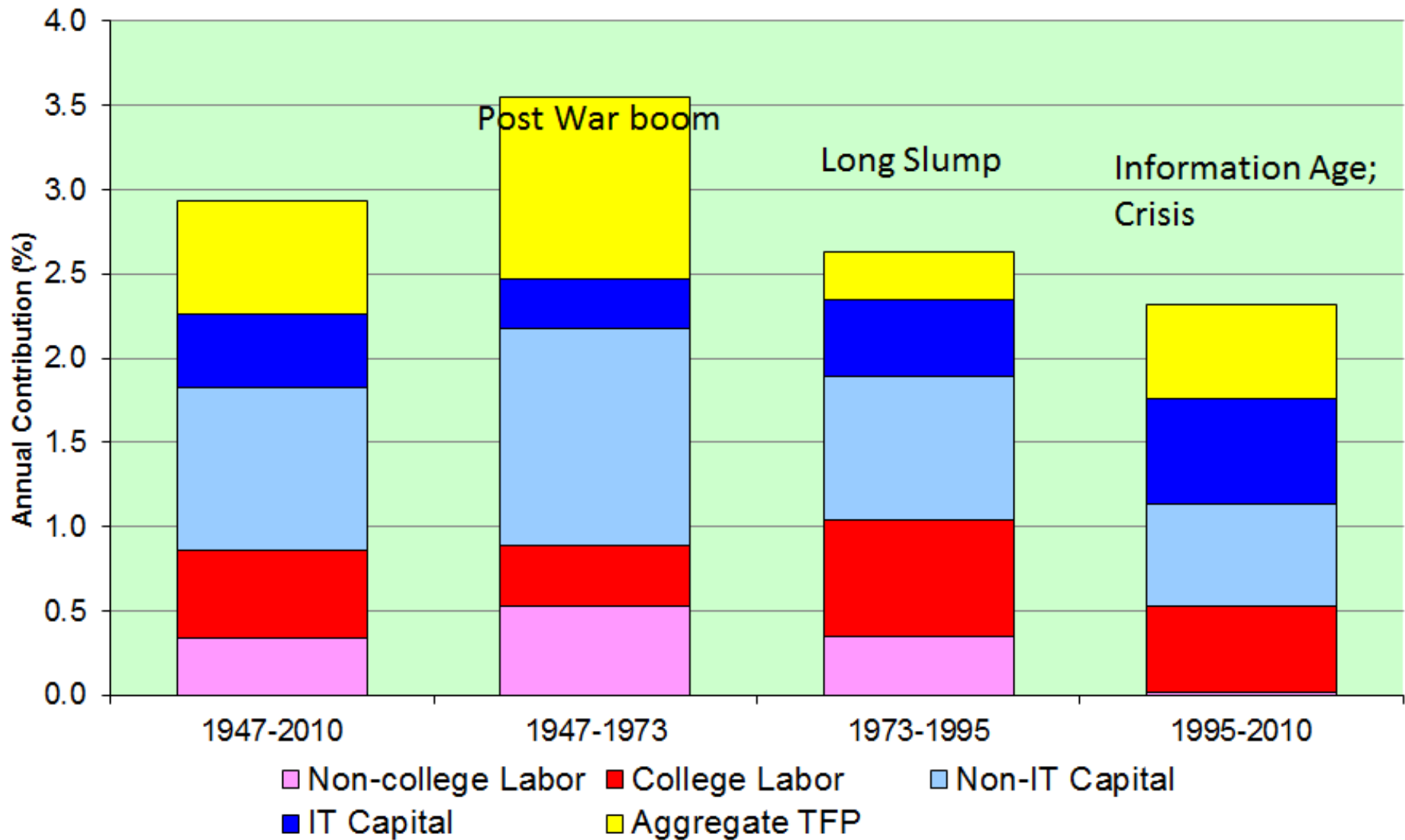
College educated and Non-college

## Contribution of Productivity

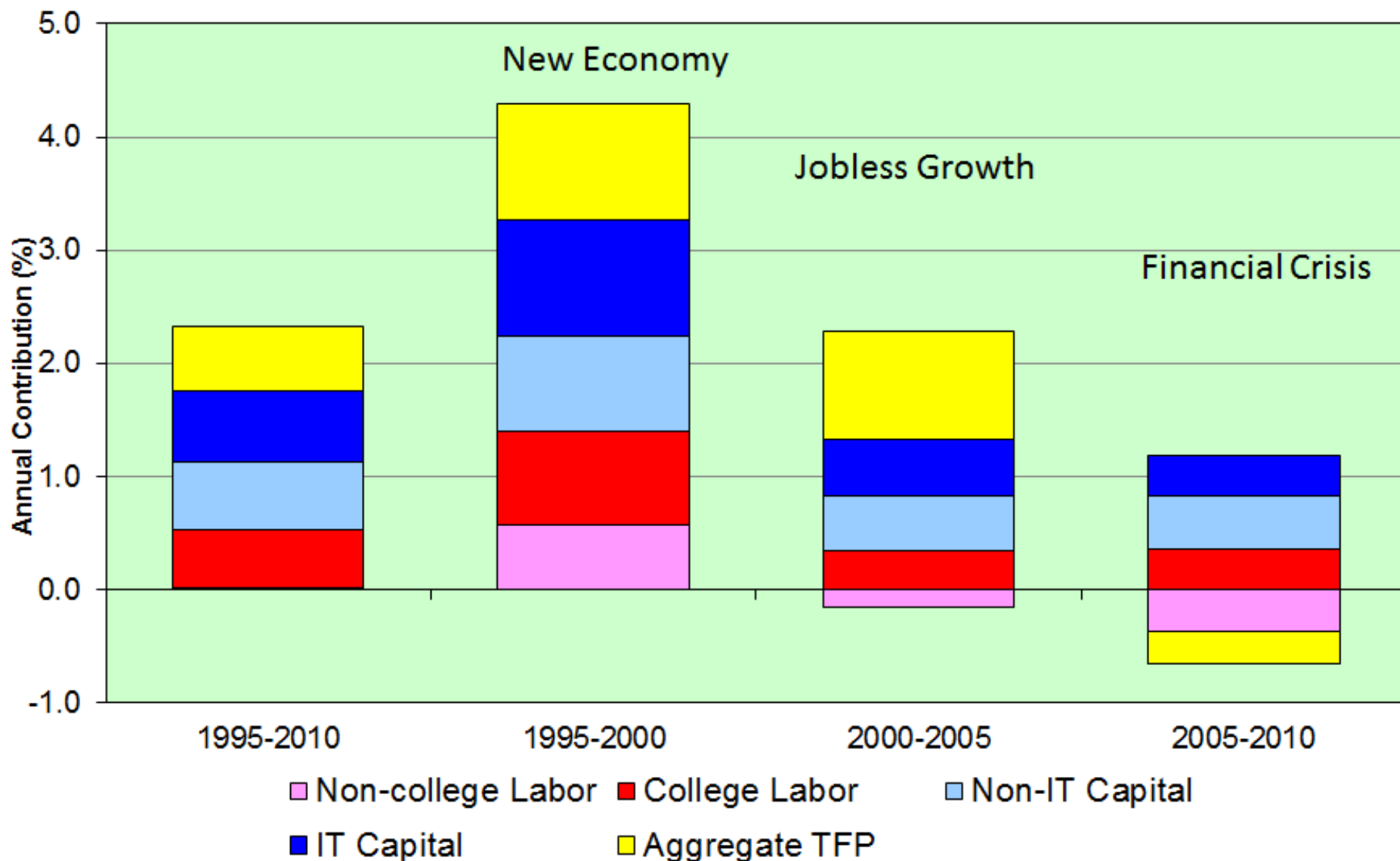
Replication vs. Innovation

$$\begin{aligned}\Delta \ln V_t = & \bar{v}_{KIT} \Delta \ln K_t^{IT} + \bar{v}_{non} \Delta \ln K_t^{non} \\ & + \bar{v}_{L,Col} \Delta \ln L_t^{college} + \bar{v}_{L,nC} \Delta \ln L_t^{noncol} + v_{Tt}\end{aligned}$$

**Fig 7. Sources of U.S. Economic Growth, 1947-2010**



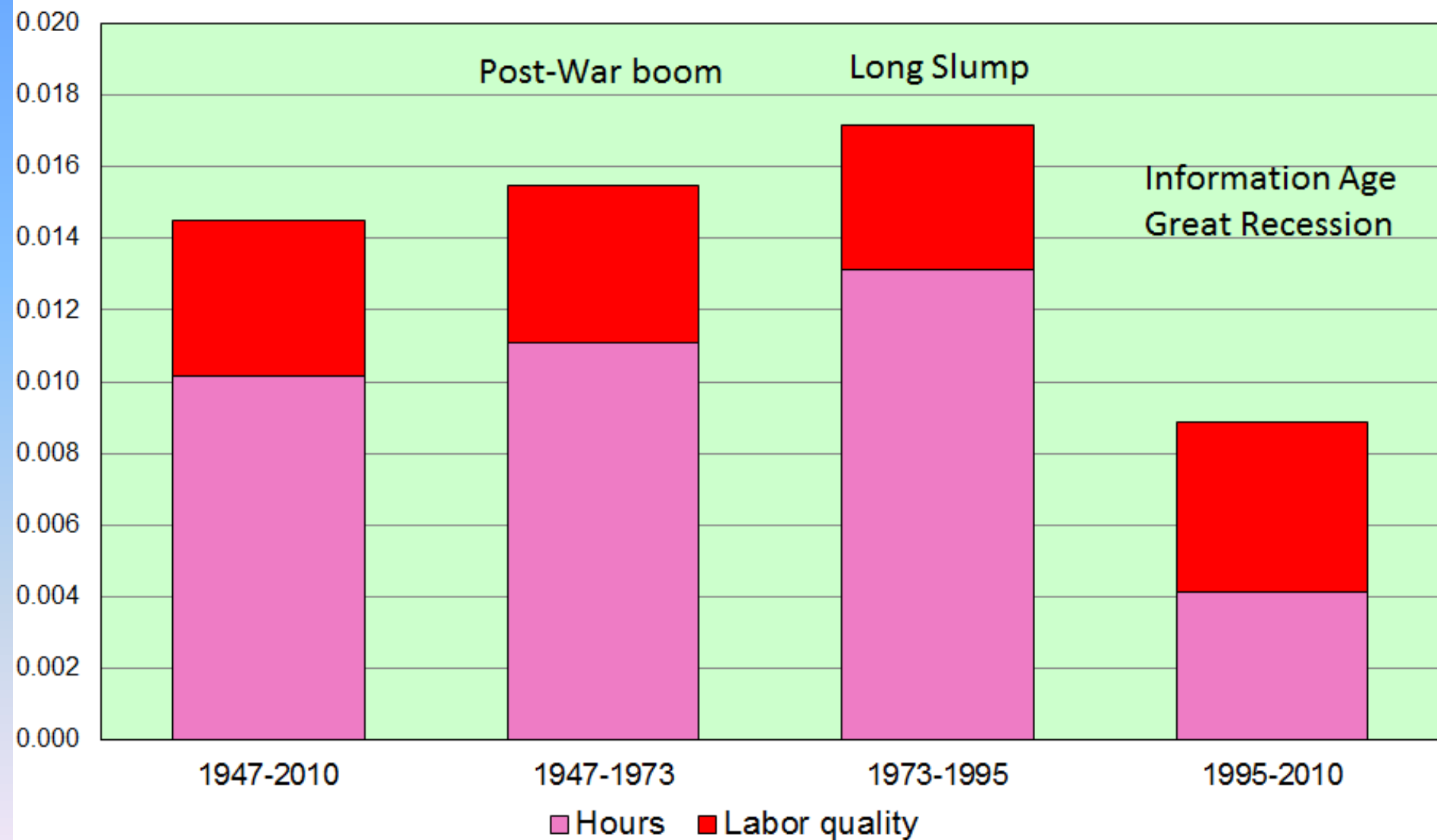
**Fig. 8. Sources of U.S. Economic Growth, 1995-2010**



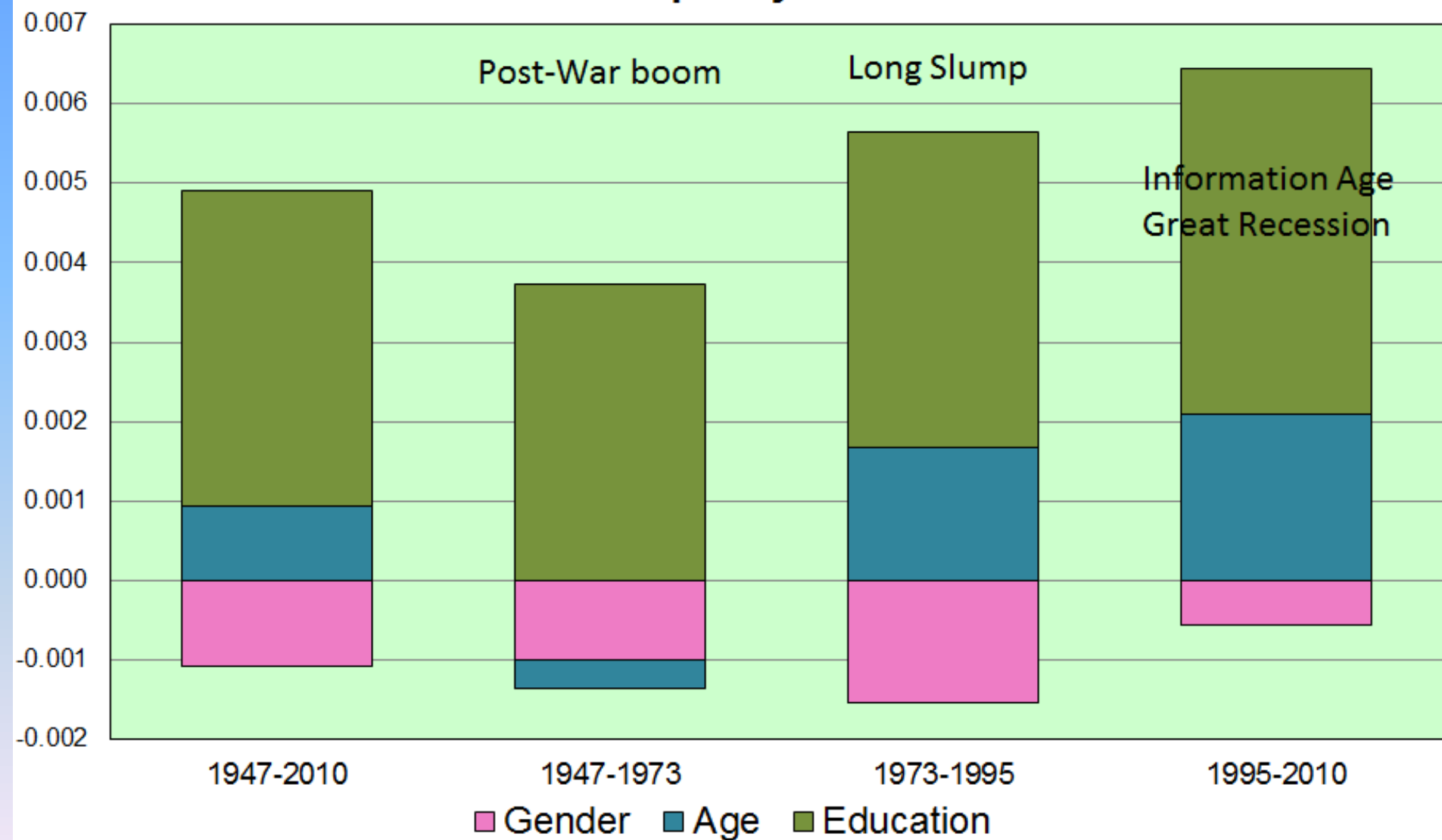
The Evolution of Labor Input.  
More Information Technology and  
more Educated workers



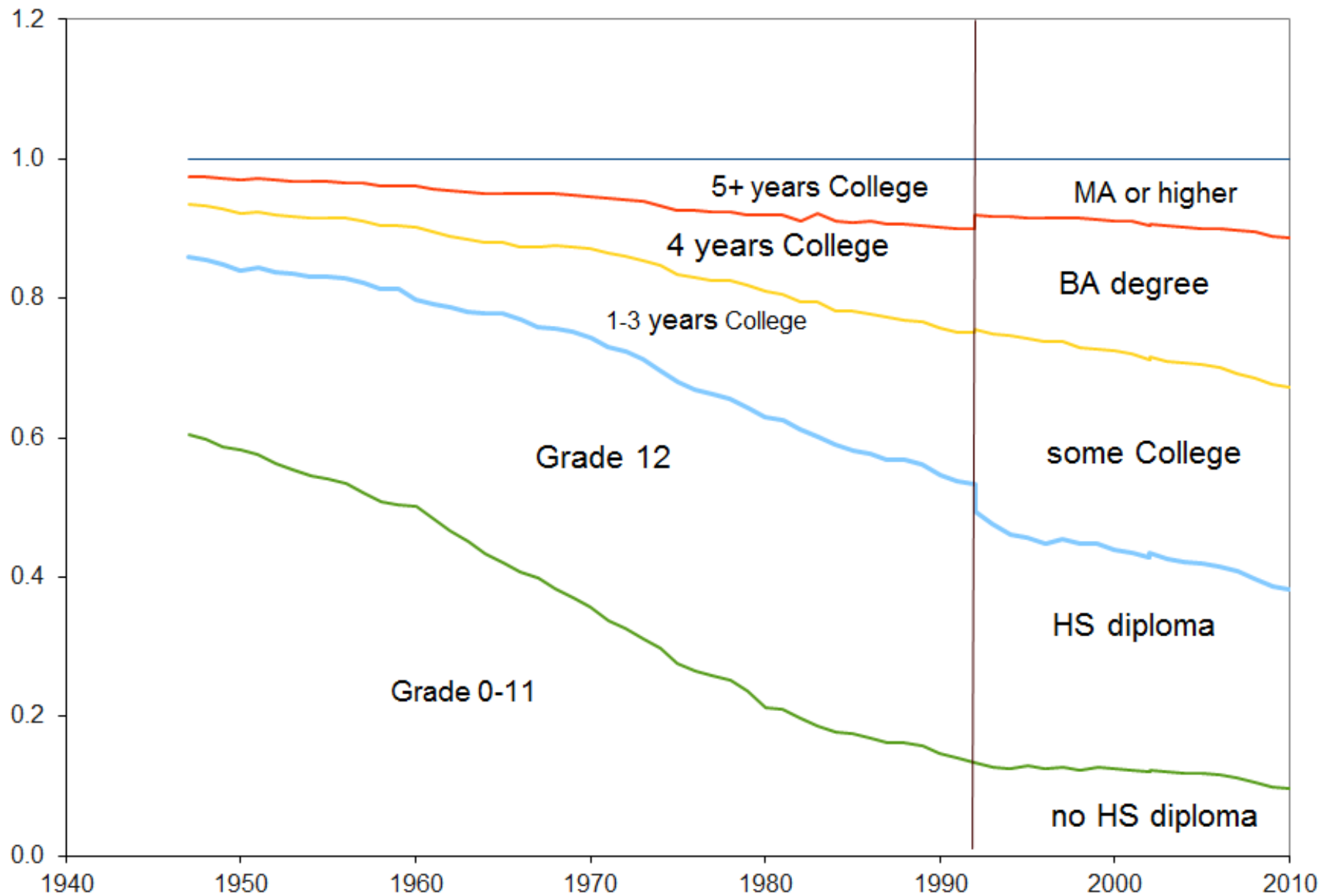
# Contribution of labor quality to total labor input growth



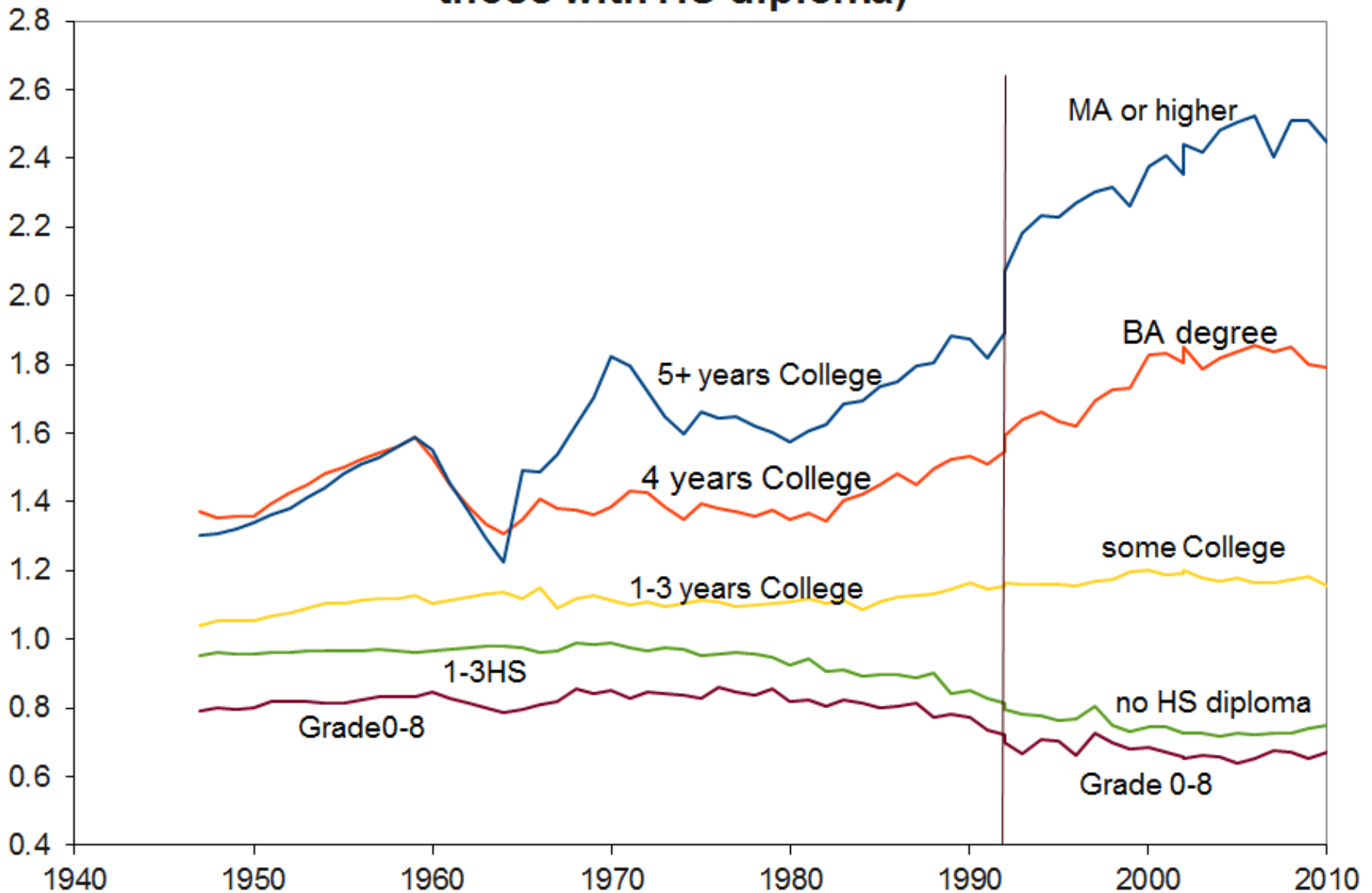
## Contribution of education, age and gender to labor quality



# Distribution of education attainment of work force



# Compensation by education attainment (relative to those with HS diploma)



# SUMMARY

- Historically, input growth in the major source of growth, in the New Economy TFP contribution has jumped.
- Unusual high TFP growth during the Jobless Recovery period of low investment and growth
- Effect of Financial Crisis.
  - \* IT-Production productivity relatively unchanged.
  - \* Big fall in productivity of non-IT group leading to negative aggregate TFP.

Extra slides

# Highlighting the role of Information Technology

Divide industries into 3 groups:

- 1) IT producing
- 2) IT-intensive using
- 3) non-IT intensive using

IT-intensity index is the ratio of IT capital input plus IT intermediates to total capital input plus IT intermediates:

$$III_j = \frac{K_{jT}^{IT} + A_{IT,j,T}}{K_{jT} + A_{IT,j,T}}$$

# Classification of Industries (IT Intensity 2005)

IT Producing	Computer & peripheral equip	0.331
	Communications equip	0.364
	Semiconductor & Electr comp.	0.353
	Software publishing	0.734
	Information & data proc. svc	0.897
	Computer systems design	0.929
IT-intensive using	Aircraft and spacecraft	0.223
	Other transportation equip.	0.257
	Printing and related activities	0.262
	Wholesale trade	0.223
	Retail trade; other	0.143
	Air transportation	0.320
	Newspaper & book publishers	0.756
	Broadcasting	0.619
	Telecommunications	0.623
	Fed res.; credit intermediation	0.226
	Educational services	0.301
	Hospitals, nursing	0.220
	Federal gen govt excl health	0.343



# Growth of Value Added and Productivity

Following graphs show contribution by the 3 industry groups to the growth of aggregate value added (GDP from PPF):

$$\Delta \ln V_t = \sum_{j \in ITprod} \bar{w}_{jt} \Delta \ln V_{jt} + \sum_{j \in ITusing} \bar{w}_{jt} \Delta \ln V_{jt} + \sum_{j \in nonIT} \bar{w}_{jt} \Delta \ln V_{jt}$$

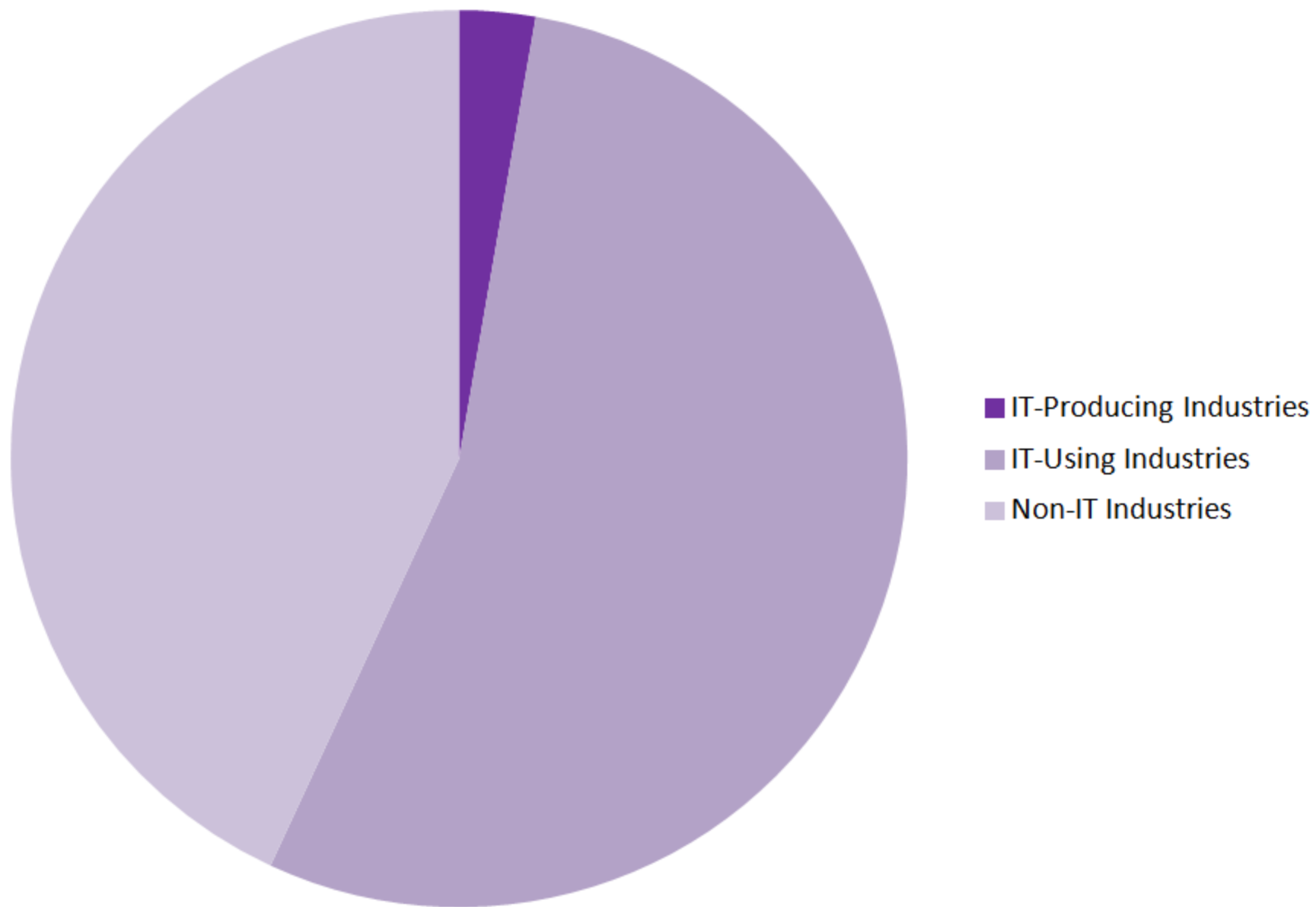
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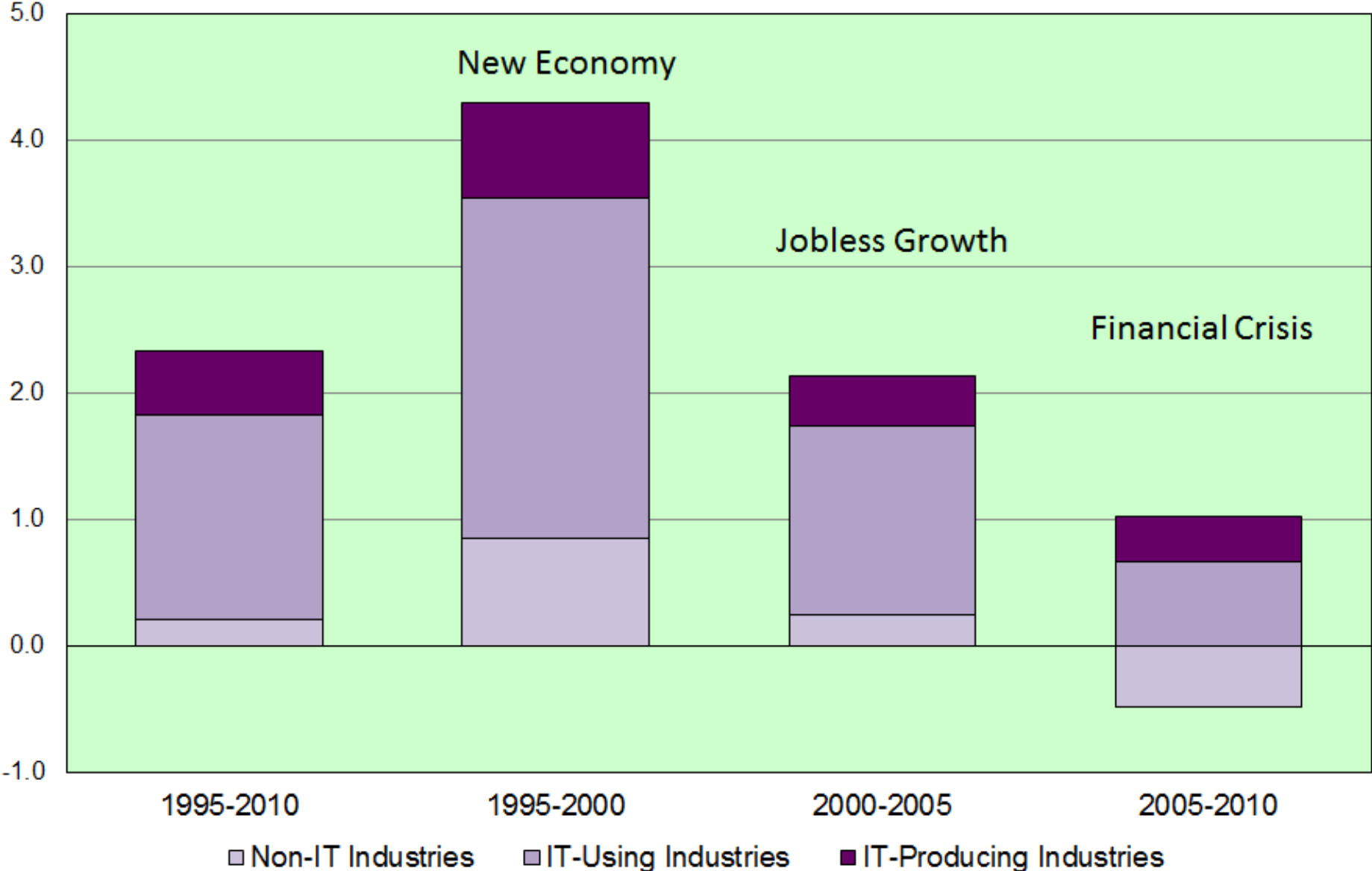
# Classification of Industries (IT Intensity 2005)

Non-IT intensive	Farms	0.008
	Oil and gas extraction	0.027
	Electric utilities	0.059
	Construction	0.124
	Primary metals; iron and steel	0.068
	Electrical equipment	0.130
	Motor vehicles and parts	0.093
	Textile & textile product mills	0.092
	Petroleum and coal products	0.040
	Chemicals; excl pharma	0.109
	Other transportation & support	0.114
	Amusements and gambling	0.119
	Food services	0.062
	Automobile repair	0.123

## Share of value added, average 2000-2005



**Fig 2. Contributions to Value Added Growth in the Information Age (1995-2010)**



# Industry Contributions to Value Added Growth; 1947-2010

Figure 3. Industry Contributions to Value Added 1947-2010

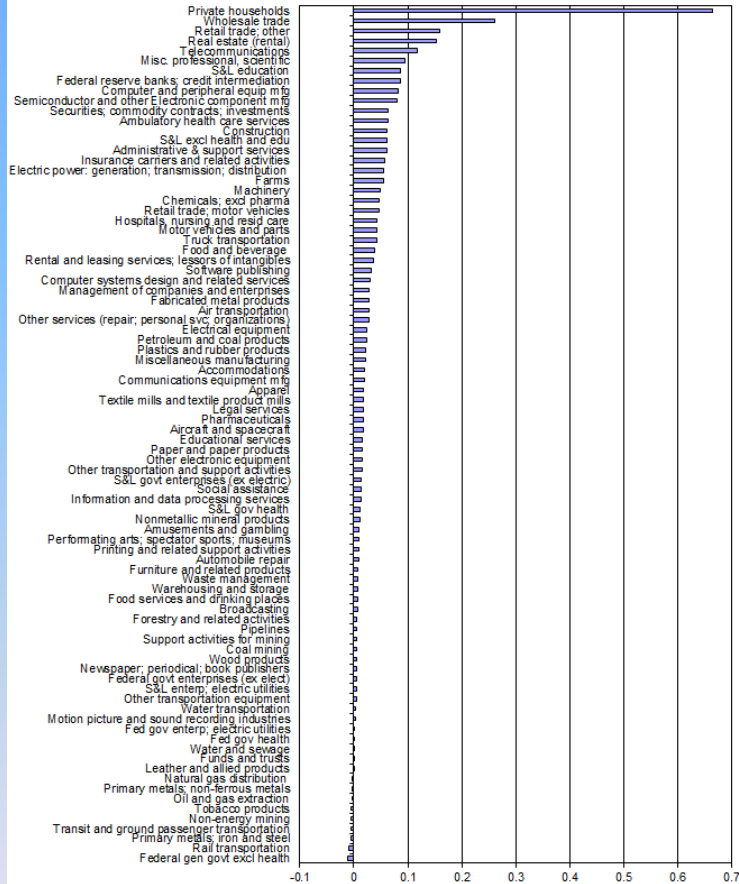
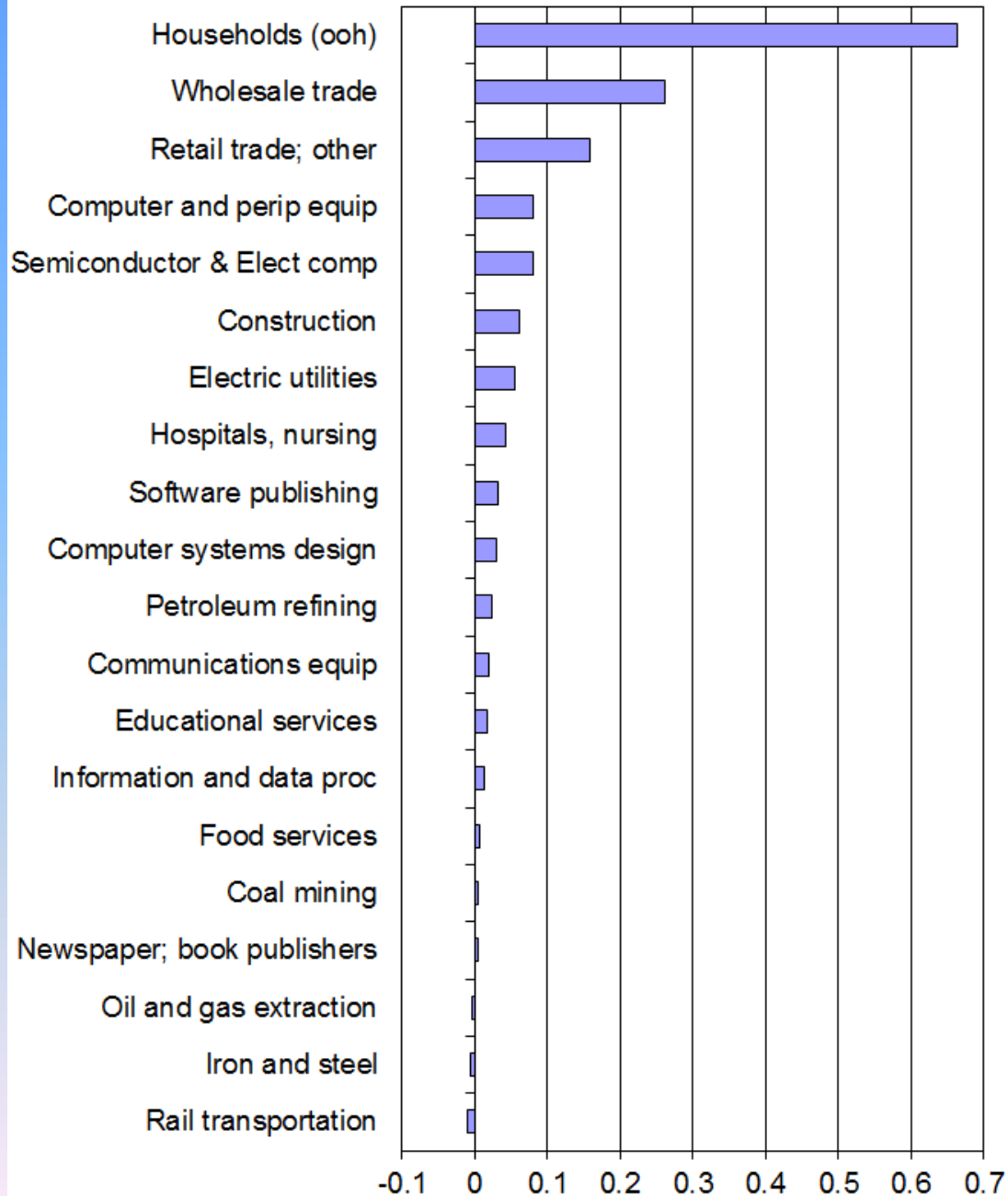


Figure 3. Industry value-added contributions to aggregate GDP growth



# ROLE OF TOTAL FACTOR PRODUCTIVITY

## Total Factor Productivity

For industry  $j$  and IT-groups:

$$v_{tj} \equiv \Delta \ln Y_{jt} - \bar{v}_{Kj} \Delta \ln K_{jt} - \bar{v}_{Lj} \Delta \ln L_{jt} - \bar{v}_{Xj} \Delta \ln X_{jt}$$

## Aggregate Productivity Growth

Domar-weighted Industry Productivity and Factor  
Reallocations

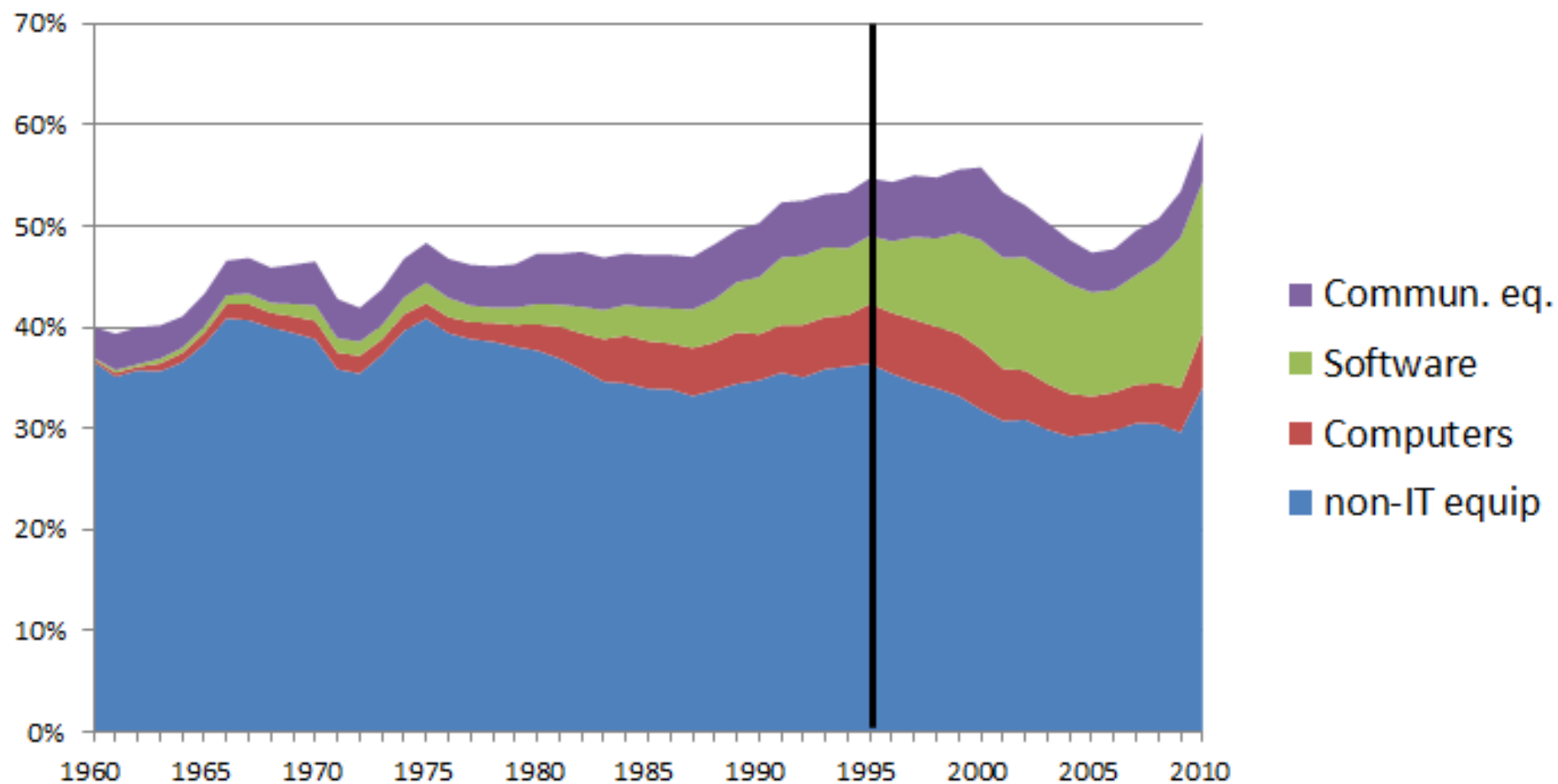
$$\begin{aligned} v_{Tt} &= \sum_j \frac{\bar{w}_j}{\bar{v}_{V,j}} v_{tj} + REALL_K + REALL_L \\ &= \sum_{j \in ITprod} (.) + \sum_{j \in ITusing} (.) + \sum_{j \in nonIT} (.) + \dots \end{aligned}$$

## Industry Contributions to Aggregate TFP Growth, 1947-2010

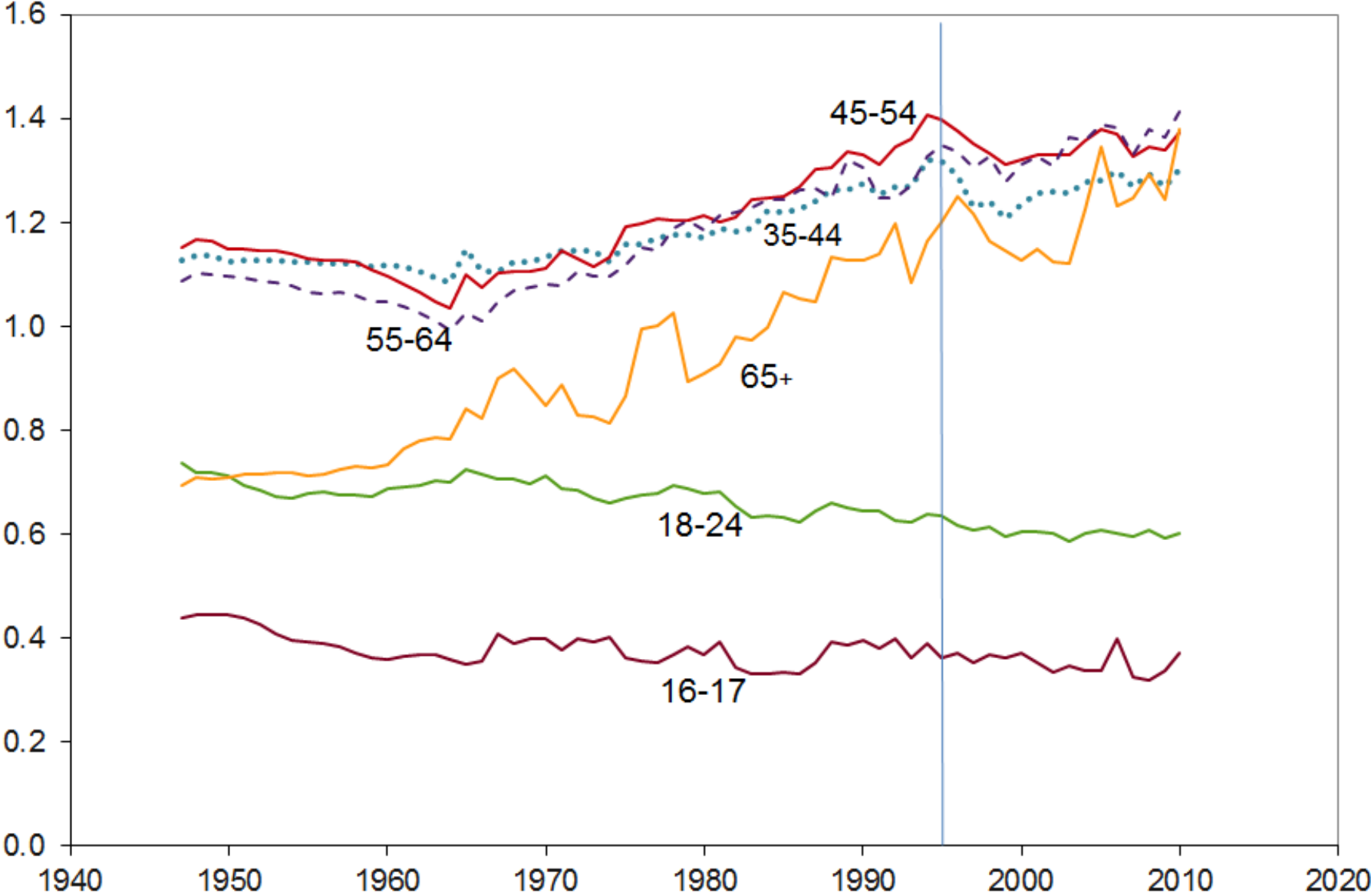
	Domar Weight	TFP Growth	Contrib to Agg TFP
Wholesale trade	0.074	1.400	0.104
Retail trade; other	0.067	1.435	0.097
Farms	0.053	1.625	0.089
Semiconductor & Electronic com	0.009	6.412	0.070
Computer & peripheral equip	0.007	8.863	0.069
Real estate (rental)	0.063	0.831	0.054
Truck transportation	0.019	0.964	0.018
Software publishing	0.004	5.659	0.017
Chemicals; excl pharma	0.042	0.284	0.014
Electric Utilities	0.020	0.668	0.011
Communications equip	0.008	0.955	0.006
Computer systems design	0.006	-0.252	0.003
Information & data proc. svc	0.004	-0.813	0.001
Transit, ground passenger transp.	0.005	-0.247	-0.003
Educational services	0.011	-0.617	-0.007
Ambulatory health care	0.029	-0.420	-0.010
Fed. res. banks; credit intermedia	0.036	-0.614	-0.020
Construction	0.110	-0.361	-0.025
Hospitals, nursing and resid care	0.032	-1.171	-0.039
Total			0.479



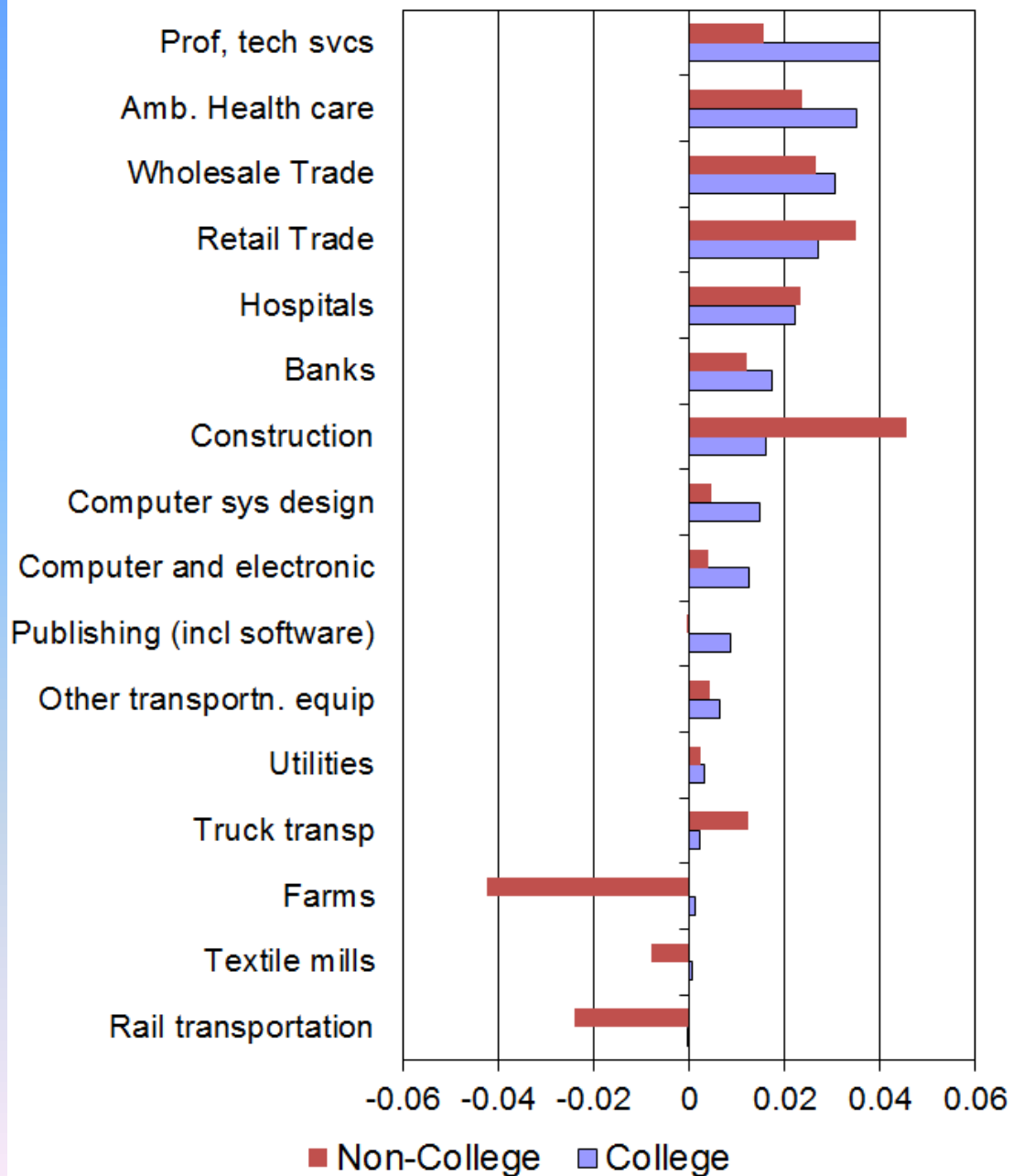
## Composition of Private Fixed Investment (%)



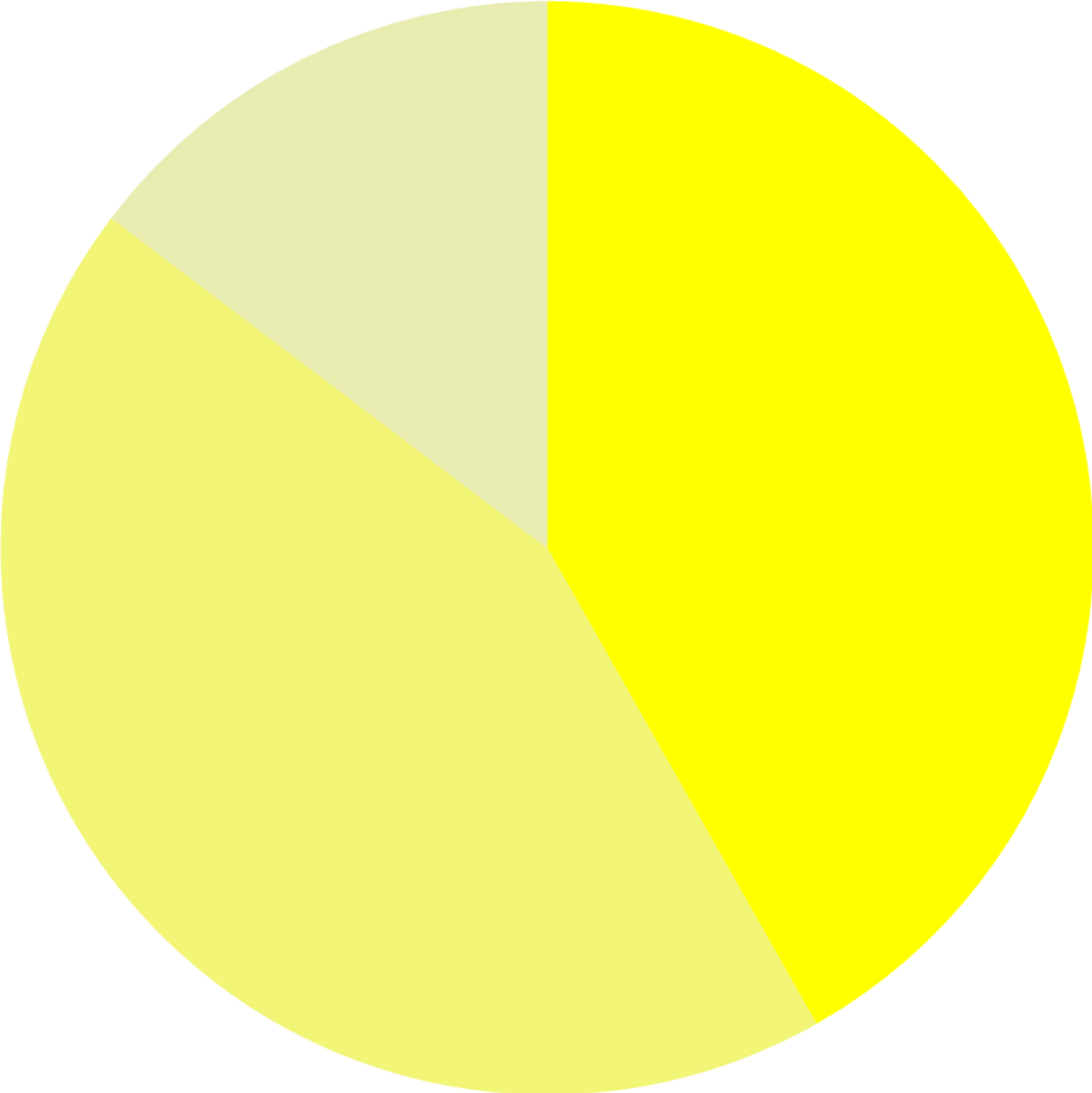
# Compensation by age relative to 25-34 year olds



# Industry labor growth, college vs. non-college



# Share of Domar-weighted Productivity, 2000-2005



- IT-Producing Industries
- IT-Using Industries
- Non-IT Industries

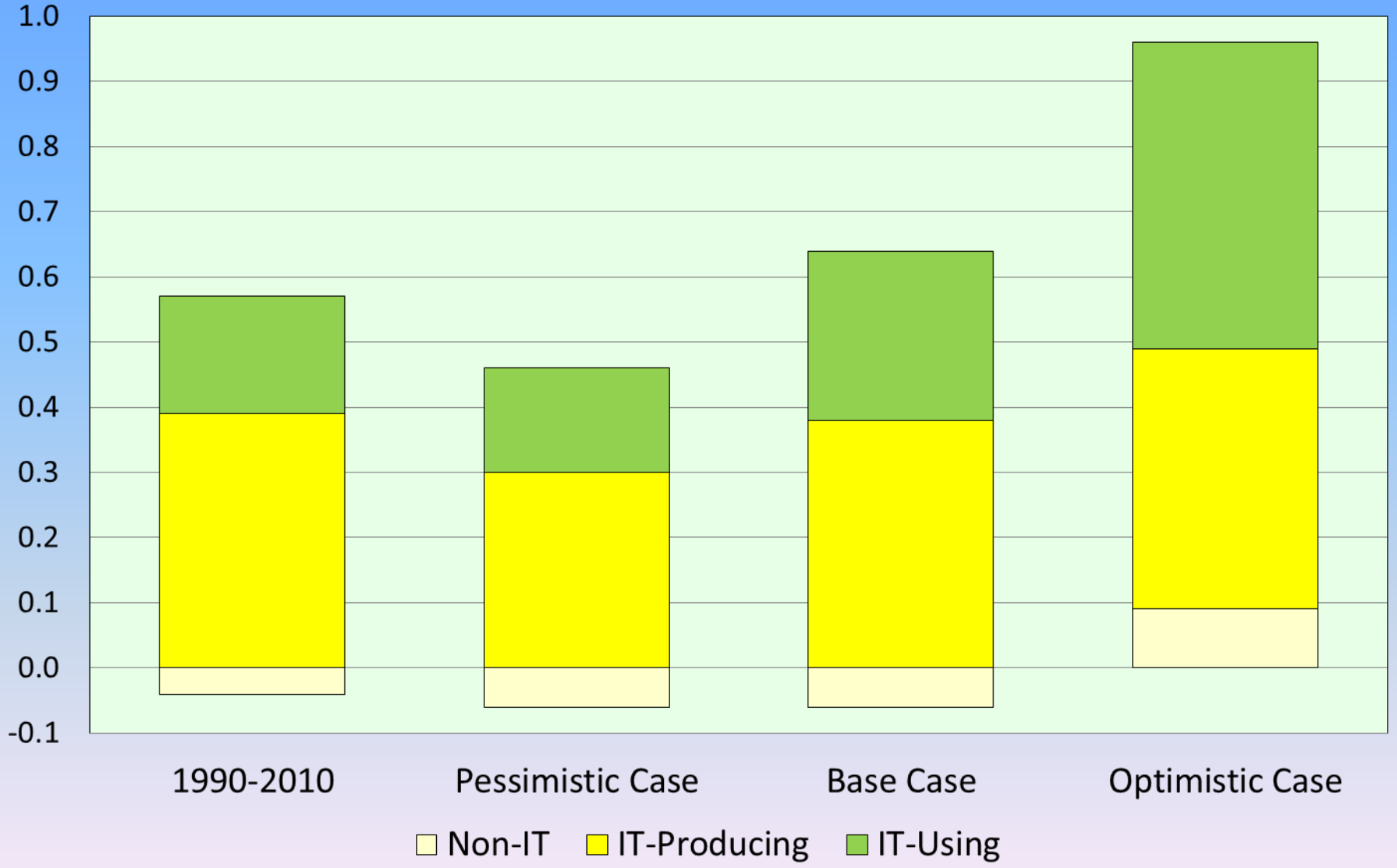
# **PROJECTING PRODUCTIVITY AND ECONOMIC GROWTH**

Contribution of Industry Groups to  
Productivity Growth

Range of Labor Productivity  
Growth Projections

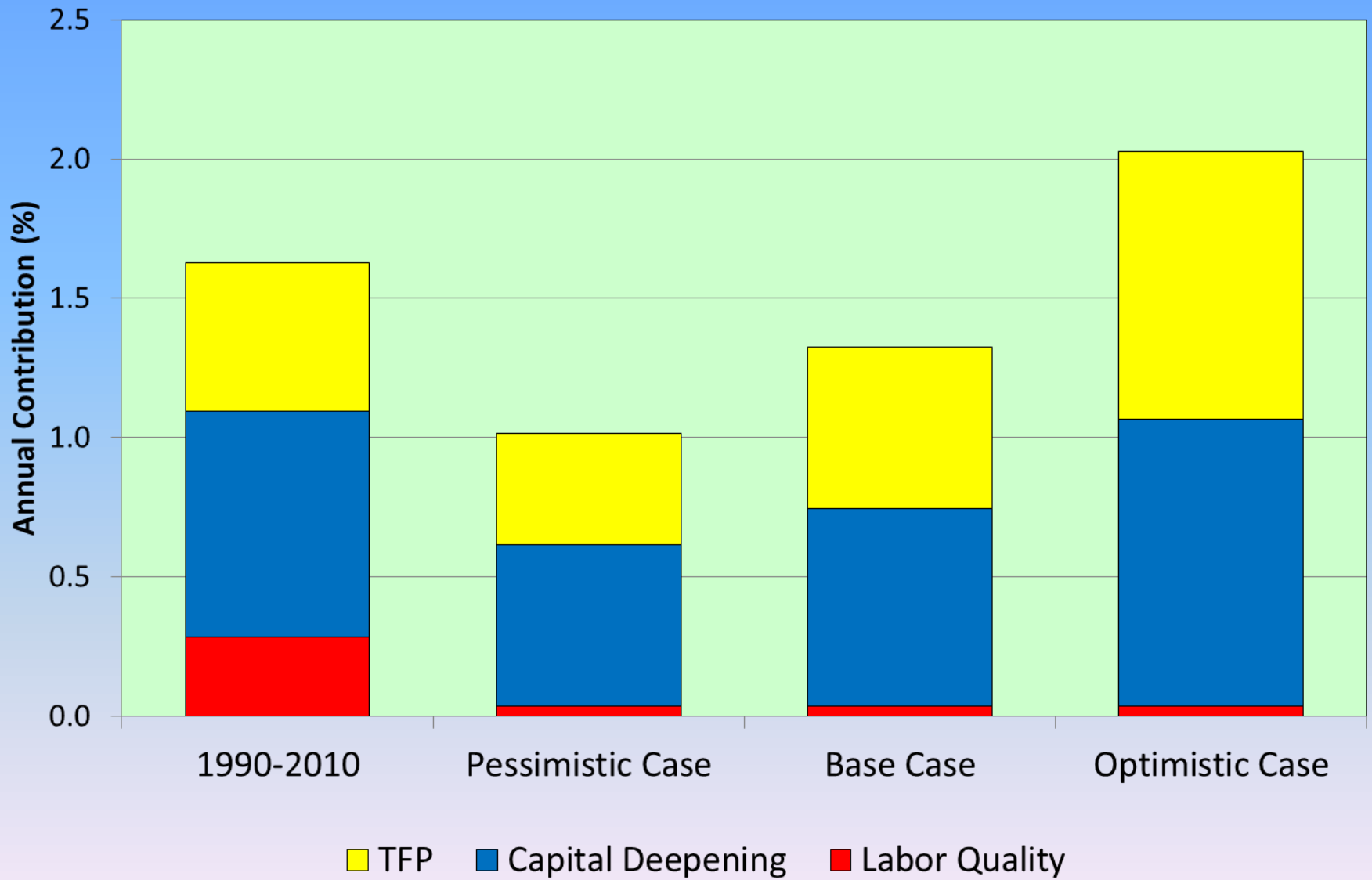
Range of Potential Output Projections

# Contribution of Industry Groups to Productivity Growth, 2010-2020



# Range of Labor Productivity Projections, 2010-2020

## Annual percentage growth rates



# Range of U.S. Potential Output Projections, 2010-2020

## Annual percentage growth rates

