UNDERSTANDING THE KNOWLEDGE ECONOMY

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UNDERSTANDING THE KNOWLEDGE ECONOMY

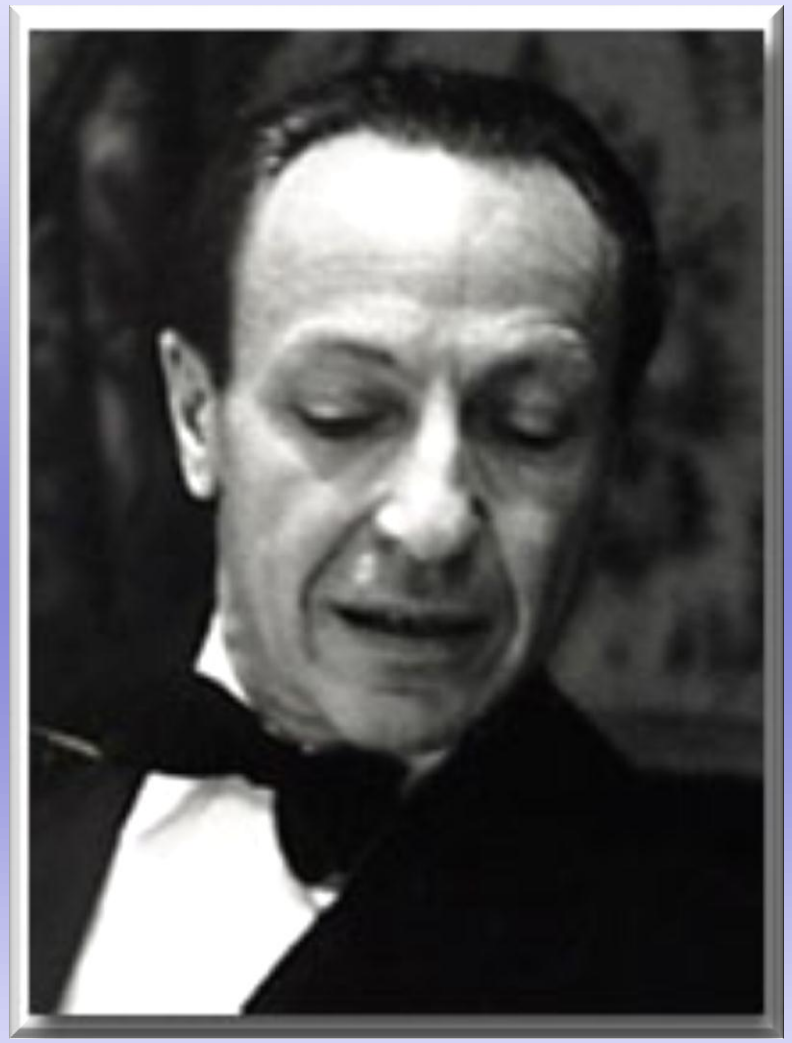
THREE PILLARS OF THE KNOWLEDGE ECONOMY: innovation, investment in information technology and investment in human capital.

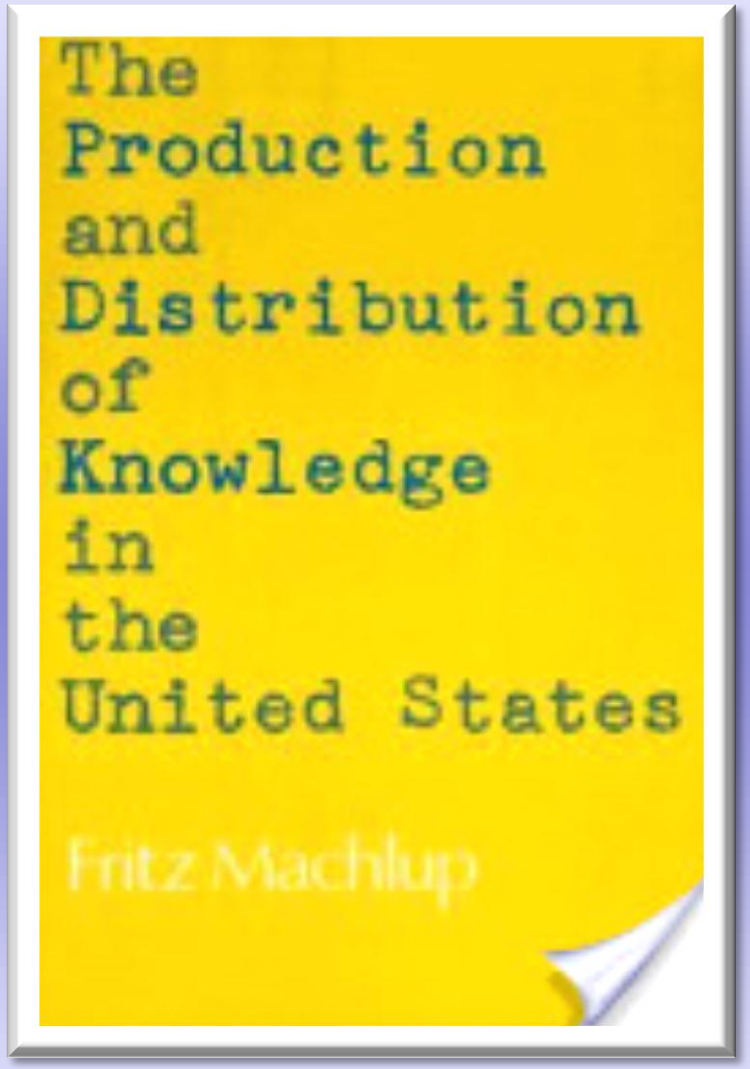
INNOVATION VS. REPLICATION: investment in existing technologies vs. innovation through new technologies.

INVESTMENT IN INFORMATION TECHNOLOGY: capital services vs. capital stock and the distinctive features of information technology.

INVESTMENT IN HUMAN CAPITAL: labor services vs. hours worked and the lifetime income approach.

CONCLUSION. financial and economic crisis and barriers to resumption of economic growth.




The
Production
and
Distribution
of
Knowledge
in
the
United States
Fritz Machlup

MODEL OF PRODUCTION: Production Possibility Frontier.

$$\overline{w_{I,t}}\Delta \ln I_t + \overline{w_{C,t}}\Delta \ln C_t = \overline{v_{K,t}}\Delta \ln K_t + \overline{v_{L,t}}\Delta \ln L_t + \Delta \ln A_t$$

where:

I - Investment

C – Consumption

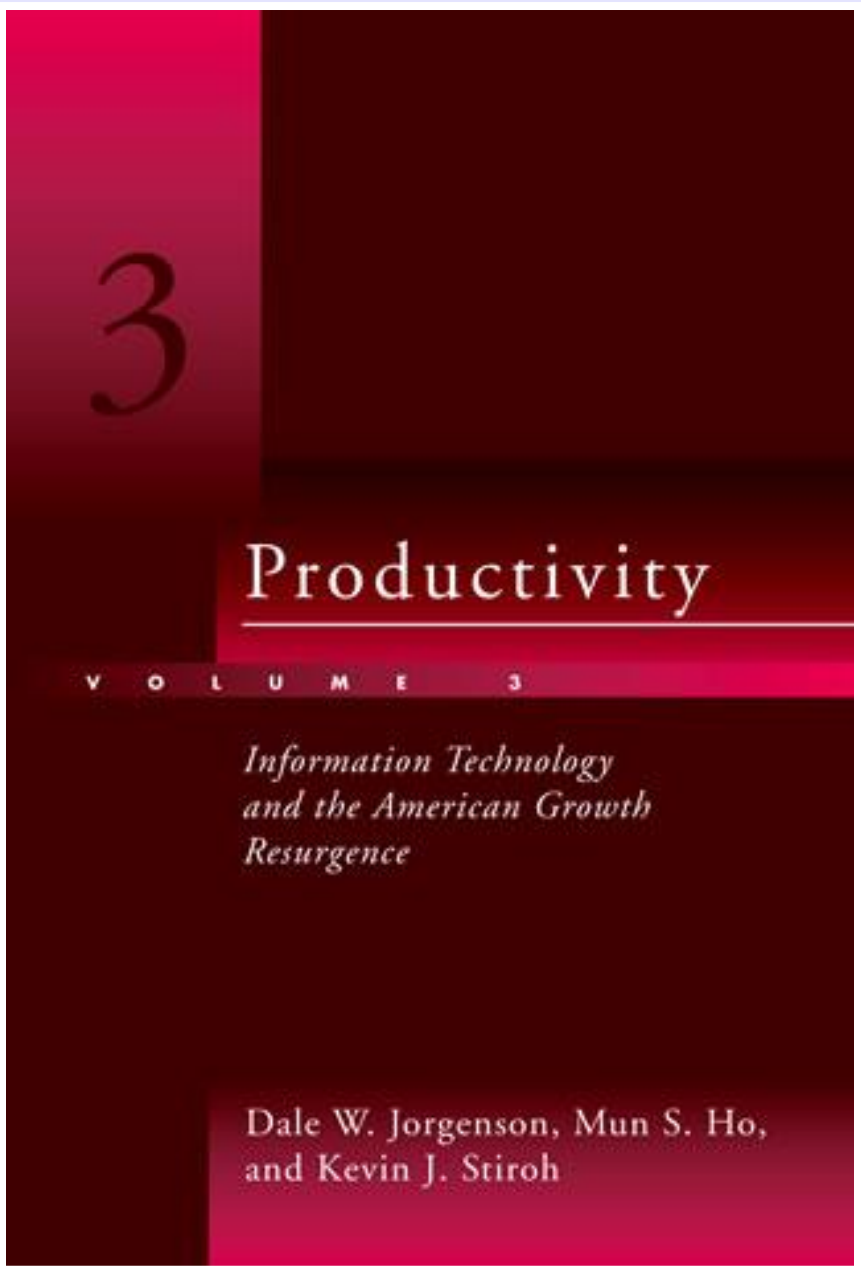
$w_I, w_C - Shares\ of\ Investment, Consumption$

K – Capital

L – Labor

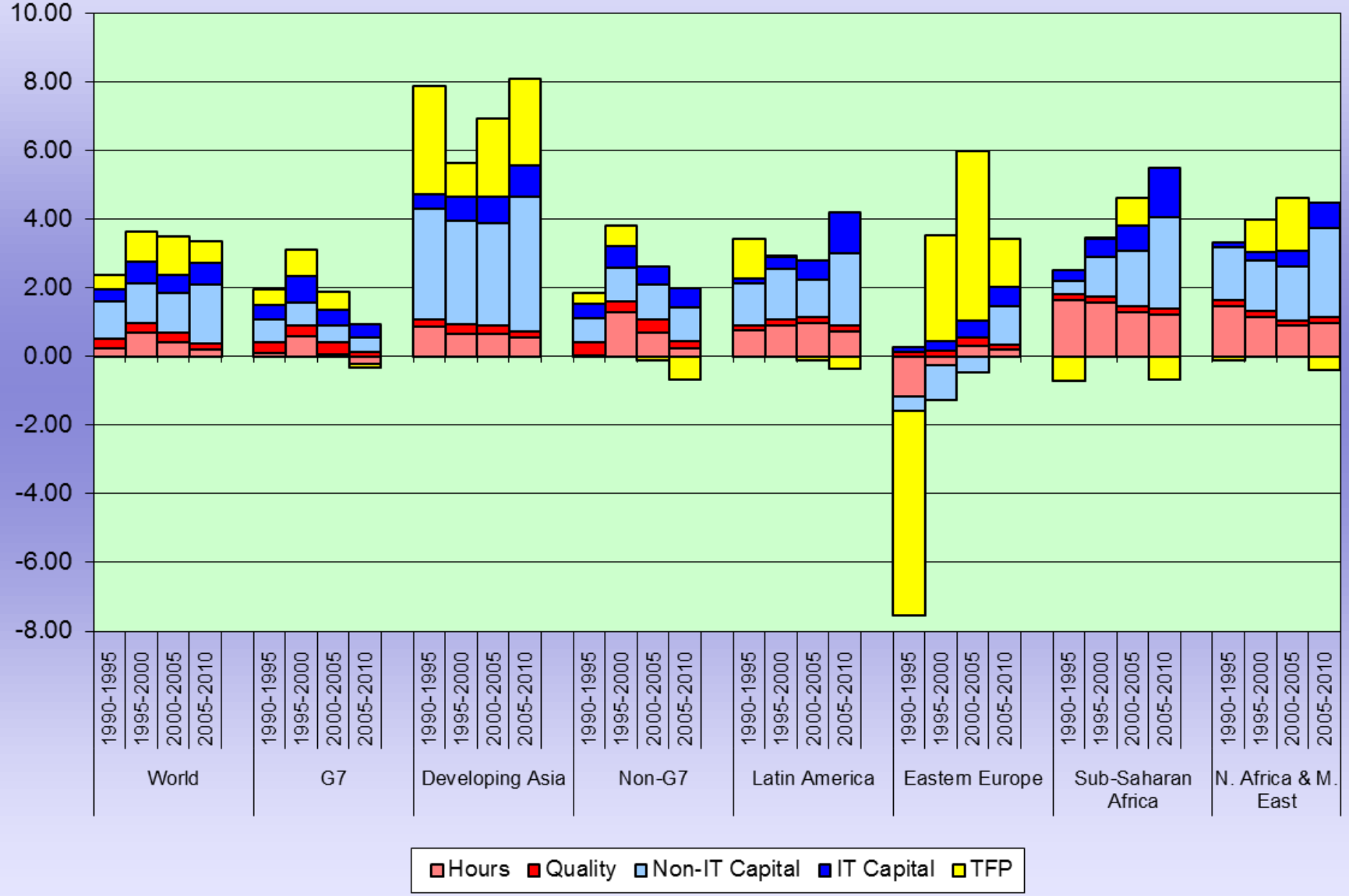
$v_K, v_L - Shares\ of\ Capital, Labor$

A - Total Factor Productivity (TFP)


3
Productivity
VOLUME 3
Information Technology and the American Growth Resurgence
Dale W. Jorgenson, Mun S. Ho, and Kevin J. Stiroh

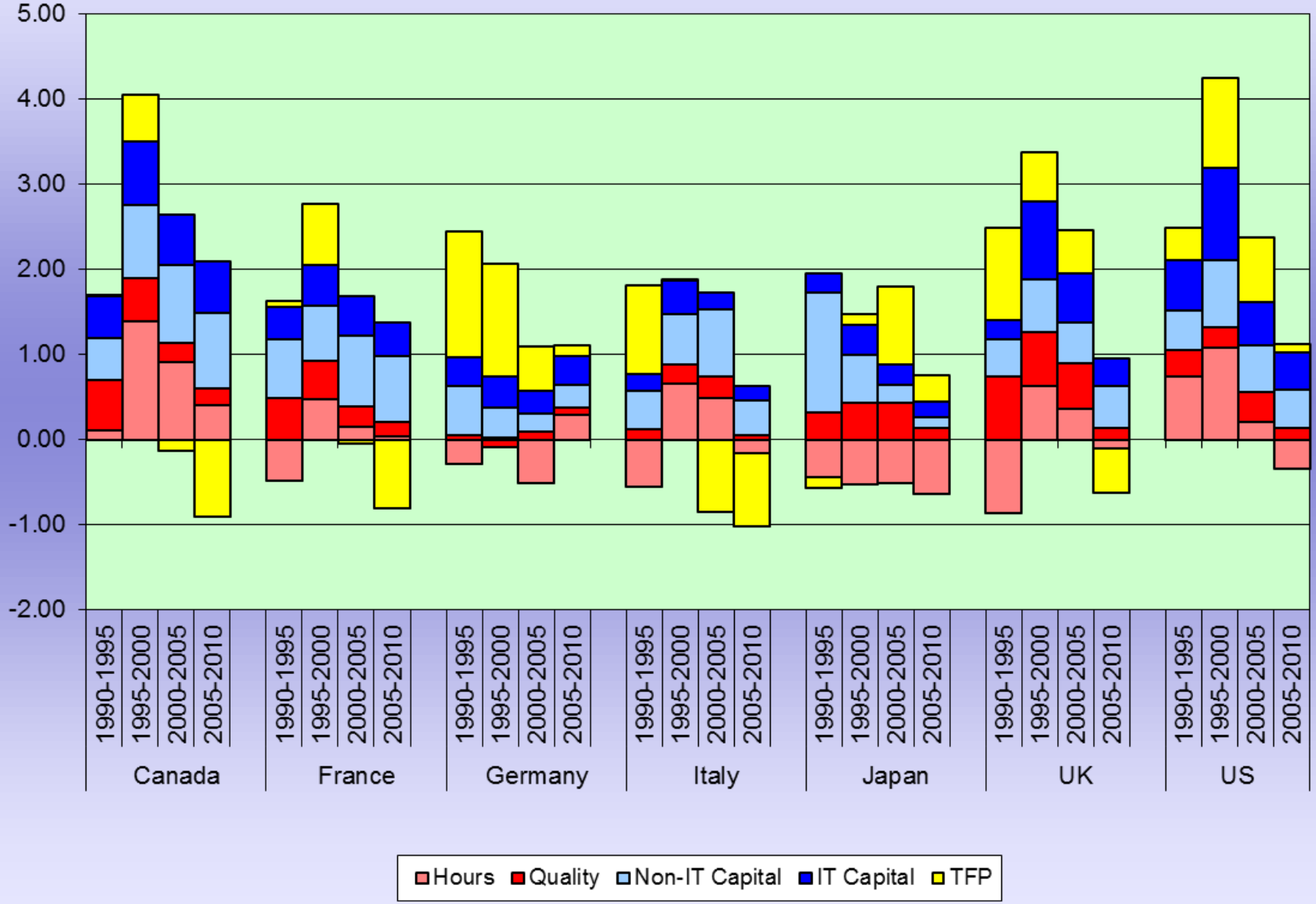
Sources of World Economic Growth

Annual percentage growth rates



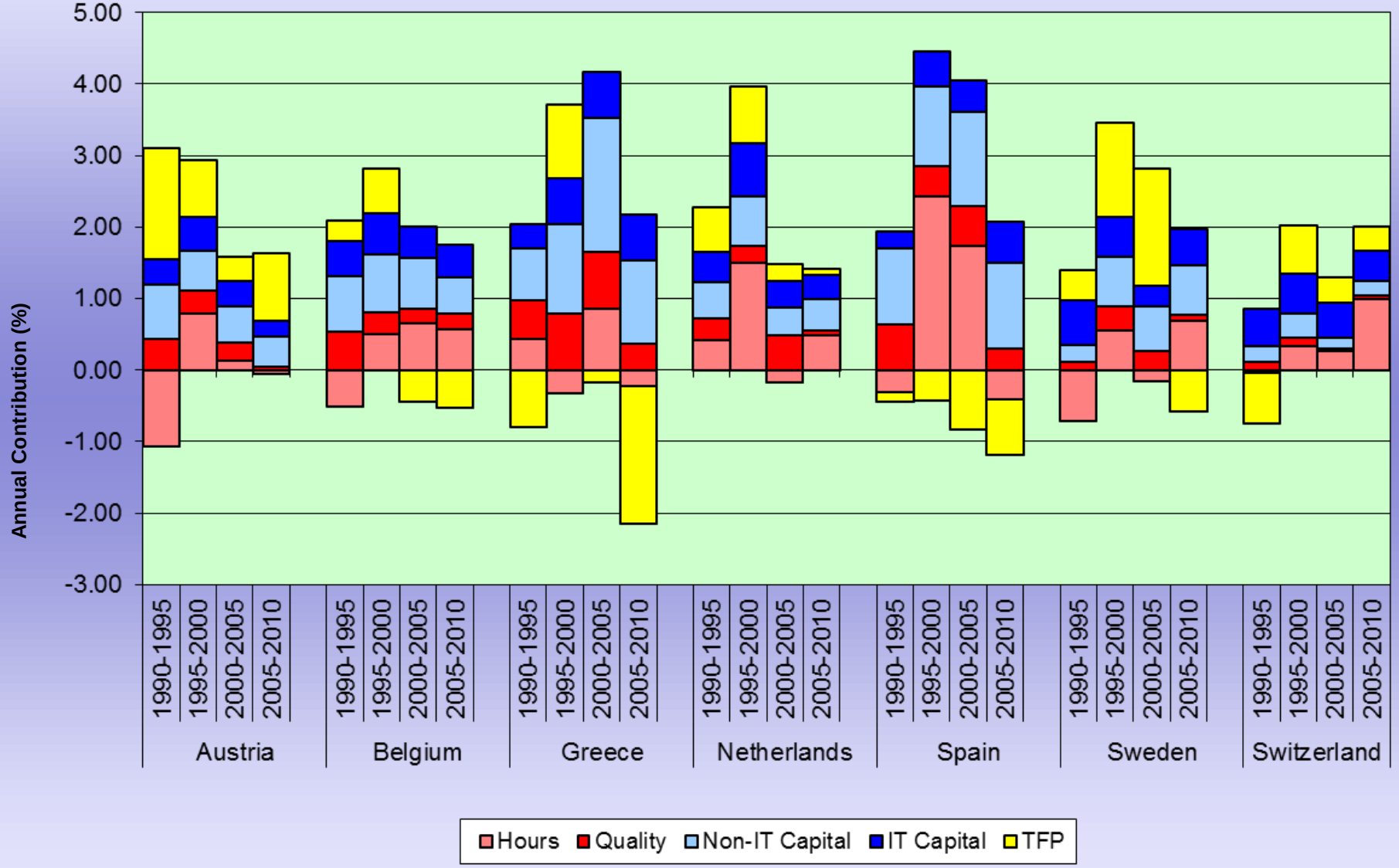
Sources of G7 Economic Growth

Annual percentage growth rates



Sources of Non-G7 Economic Growth

Annual percentage growth rates



INNOVATION VS. REPLICATION: Conclusions

REPLICATION OF EXISTING TECHNOLOGIES IS THE MAIN SOURCE OF ECONOMIC GROWTH.

REPLICATION REQUIRES INVESTMENT IN INFORMATION AND NON-INFORMATION CAPITAL

REPLICATION ALSO REQUIRES GROWTH OF THE LABOR FORCE AND INVESTMENT IN HUMAN CAPITAL

INNOVATION IS MUCH RISKIER, MORE DIFFICULT, AND LESS LIKELY TO SUCCEED

CAPITAL INPUT AND THE COST OF CAPITAL

PERPETUAL INVENTORY METHOD

$$K_{i,t} = (1-\delta_i)K_{i,t-1} + I_{i,t}$$

where:

K - capital stock
I – investment
δ - depreciation rate

RENTAL PRICE OF CAPITAL INPUT

$$c_{i,t} = [r_t - \pi_{i,t} + (1+\pi_{i,t})\delta_i]P_{i,t-1}$$

where:

c - price of capital input
P - price of investment
r - rate of return
π - asset-specific inflation rate


Measuring Capital
OECD Manual
SECOND EDITION
OECD
2009

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.

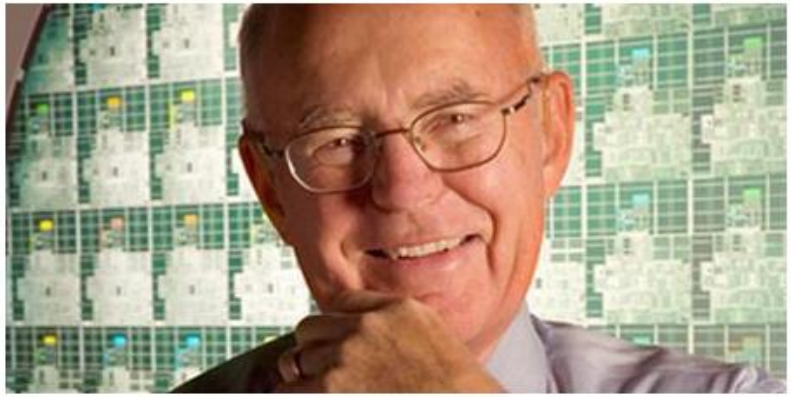
MOORE'S LAW: The number of transistors on a chip doubles every 18-24 months (Itanium processor 9300, formerly code-named Tukwila, was released on February 8, 2010, and has four cores and two billion transistors).

If transistors were people

If the transistors in a microprocessor were represented by people, the following timeline gives an idea of the pace of Moore's Law.

Now imagine that those 1.3 billion people could fit onstage in the original music hall. That's the scale of Moore's Law.

Moore's Law: What it means to you



Moore's Law is the foundation for exciting new technological capabilities and improved energy efficiency.

Advances in process technology and subsequent reductions in cost make computing devices accessible to an ever-increasing number of people worldwide, empowering innovations across the computing continuum—from the smallest handheld devices to the most powerful cloud-based servers.

You can see the results of Moore's Law all around you, in devices millions of people use every day, including personal computers and laptops, mobile phones, and consumer electronics.

The tenets of Moore's Law enable improved functionality at an increasingly rapid pace in everything from common household appliances to important innovations in automobiles, life-saving medical devices, and even spacecrafts.

Moore's Law also inspires energy efficiency and green manufacturing. As the number of transistors placed on chips continues to increase exponentially, fewer resources are used to produce each chip.

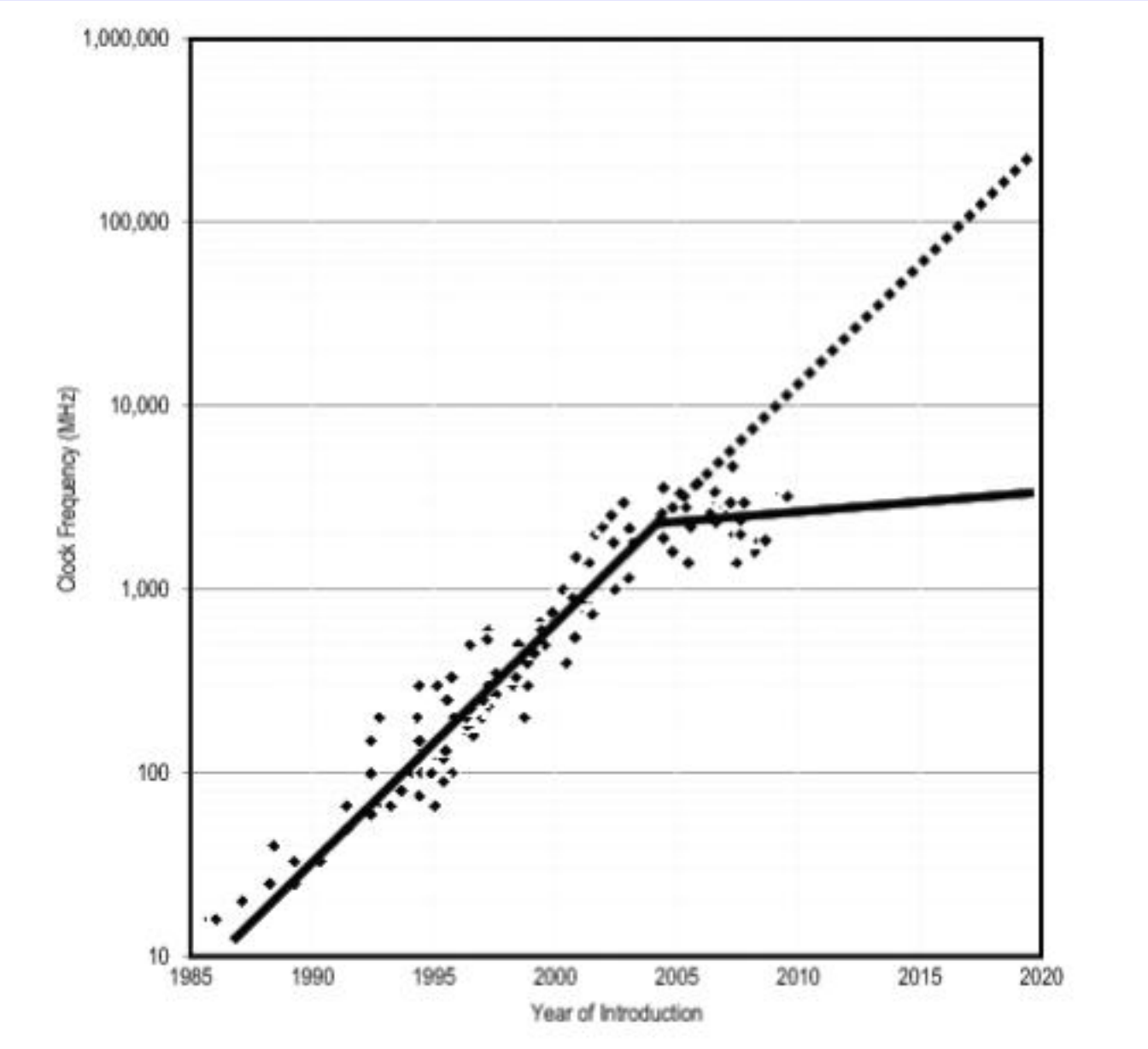
THE YELLOW BRICK WALL:
MOORE'S LAW AND THE FUTURE OF COMPUTING

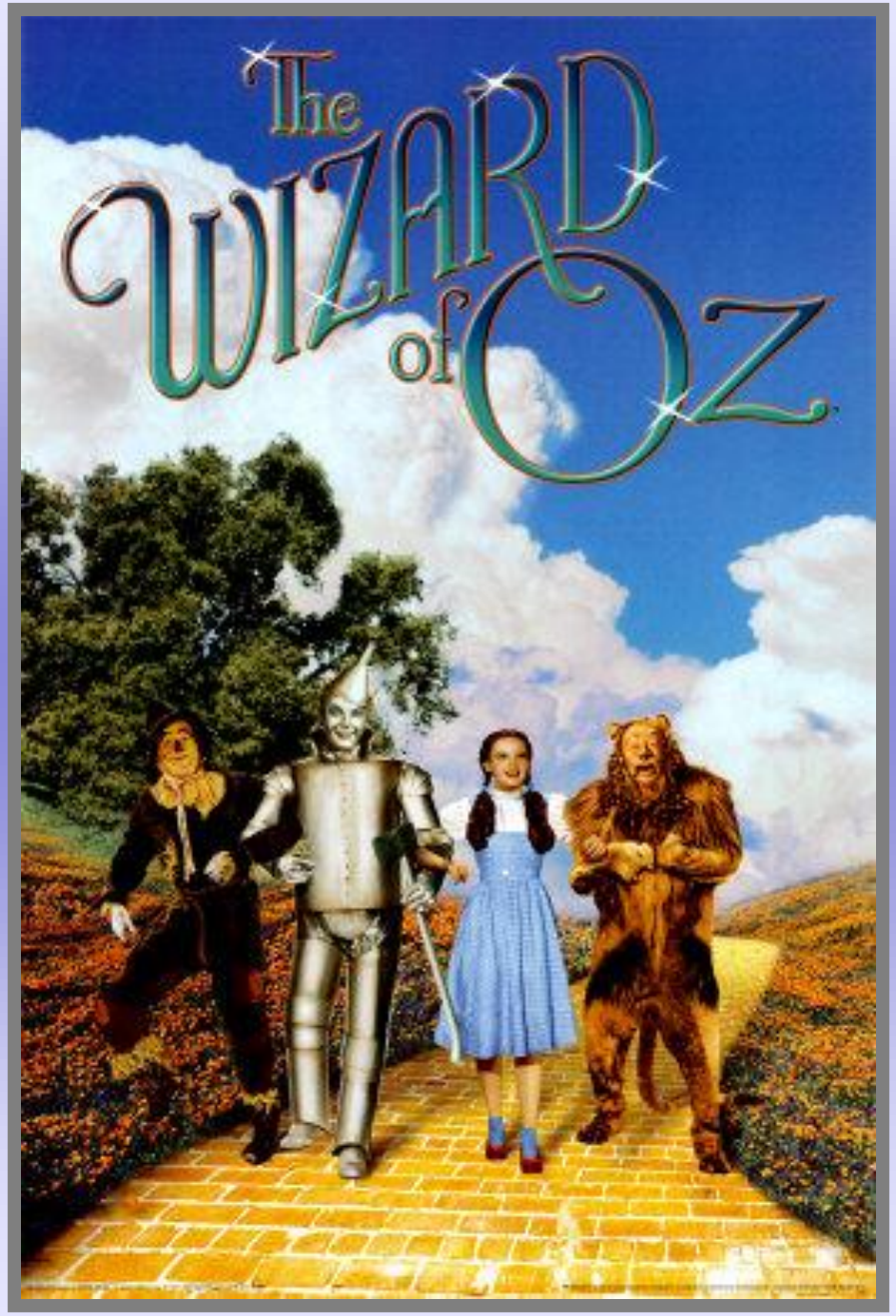
Optional reading:

Martin Giles (2011), "After the PC," Special Report: Personal Technology, *The Economist*, October 8-14.

Samuel H. Fuller and Lynette I. Millette (2011), eds., "Summary," *The Future of Computing Performance: Game Over or Next Level?,* Washington, DC, National Academy of Sciences Press, pp. 5-20.
http://www.nap.edu/openbook/12980/png/9.png

"Before 2004, processor performance was growing by a factor of about 100 per decade; since 2004, processor performance has been growing and is forecasted to grow by a factor of only about 2 per decade." p. 9.


1,000,000
100,000
10,000
1,000
100
10
Clock Frequency (MHz)
1985
1990
1995
2000
2005
2010
2015
2020
Year of Introduction


The
WIZARD
of
Oz

INVESTMENT IN INFORMATION TECHNOLOGY: Conclusions

Information Technology Has Developed Very Rapidly Since the Invention of the Transistor in 1947, the Integrated Circuit in 1958, and the Microprocessor in 1971. This is Captured by Moore's Law, Doubling the Number of Transistors on a Chip Every 18-24 Months.

The Economics of Information Technology is Captured by IT Prices, Which Have Declined Very Rapidly Since the Commercialization of the Electronic Computer in 1959 (18 Percent Per Year for Computers; 40 Percent Per Year for Logic Chips).

The Impact of Information Technology Depends on the Growth of Capital Stocks and Their Rental Prices. Until Recently Economists Have Used Asset Prices to Try to Represent This, But This Underestimates the Impact of IT Investment by a Factor of 7.5!

The Improvement of Computing Performance has Slowed Drastically Since 2004.

LABOR QUANTITY AND PRICE

Labor Input is the Flow of the Services of Human Capital into the Labor Market

The Starting Point: Employed Labor Force

Employment, Hours Worked and Market Labor Compensation

Separation into Quantity (Hours) and Price (Wages Plus Fringe Payments) Components

LABOR QUANTITY AND PRICE

Growth Rate of Labor Input

$$\Delta \ln L_{jt} = \sum_{l} \bar{v}_{ljt} \Delta \ln L_{ljt}$$

Labor Compensation Weights

$$v_{lj} = \frac{P_{L,lj} L_{lj}}{\sum_{l} P_{L,lj} L_{lj}} \quad l = 1 \ldots 168$$

Two-Period Average Value Shares

$$\bar{v}_{ljt} = \tfrac{1}{2}[v_{ljt} + v_{lj,t-1}],$$

Price of Labor Input

$$P_{L,j} L_j = \sum_{l} P_{L,lj} H_{l,j}$$

Productivity and U.S. Economic Growth

Dale W. Jorgenson
Frank M. Gollop
Barbara M. Fraumeni

Table 6.1
Classification of civilian labor force for each industry

	No.	Categories
Gender	2	Male; Female
Class	2	Employees; Self-employed and unpaid
Age	7	16–17; 18–24; 25–34; 35–44; 45–54; 55–64; 65+
Education		
1977–92	6	0–8 years grade school
		1–3 years High School
		4 years High School
		1–3 years College
		4 years College
		5+ years College
1992+	6	0–8 years grade school
		grade 9–12 no diploma
		High School graduate
		some College no Bachelors degree
		Bachelors degree
		more than BA degree

LABOR QUALITY AND ITS DECOMPOSITION

Labor Quality is the Ratio of Labor Input to Hours Worked.

$$Q_{jt}^{L} = \frac{L_{jt}}{H_{jt}}$$

Decomposition of Labor Quality

$$\begin{aligned}\Delta \ln Q_L &= \Delta \ln Q^{saec} + \Delta \ln Q^{sae} + \Delta \ln Q^{sac} + ... \\ &+ \Delta \ln Q^{sa} + \Delta \ln Q^{se} + ... \\ &+ \Delta \ln Q^{s} + \Delta \ln Q^{a} + \Delta \ln Q^{e} + \Delta \ln Q^{c} \\ &= \Delta \ln L - \Delta \ln H\end{aligned}$$

Labor Input Sub-Indexes

$$\Delta \ln L_{CO,j} = \sum_{s,a,c,e \in \{5,6\}} \bar{v}_{SKsaecj} \Delta \ln H_{saecj}$$

$$\Delta \ln L_{NC,j} = \sum_{s,a,c,e \notin \{5,6\}} \bar{v}_{UNsaecj} \Delta \ln H_{saecj}$$

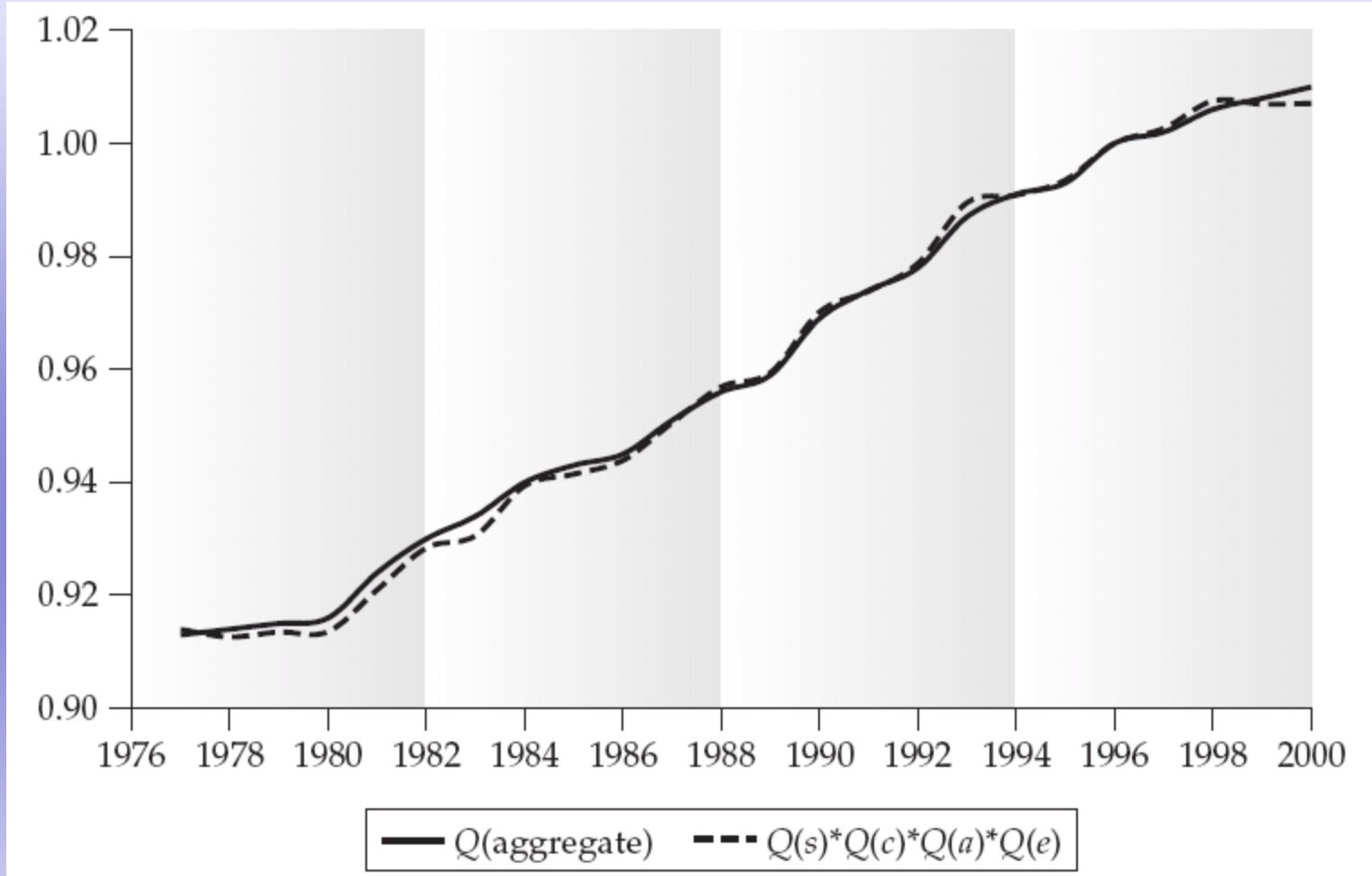


Figure 6.2
Aggregate quality and first order approximation, $Q(s)^{*}Q(c)^{*}Q(a)^{*}Q(e)$.

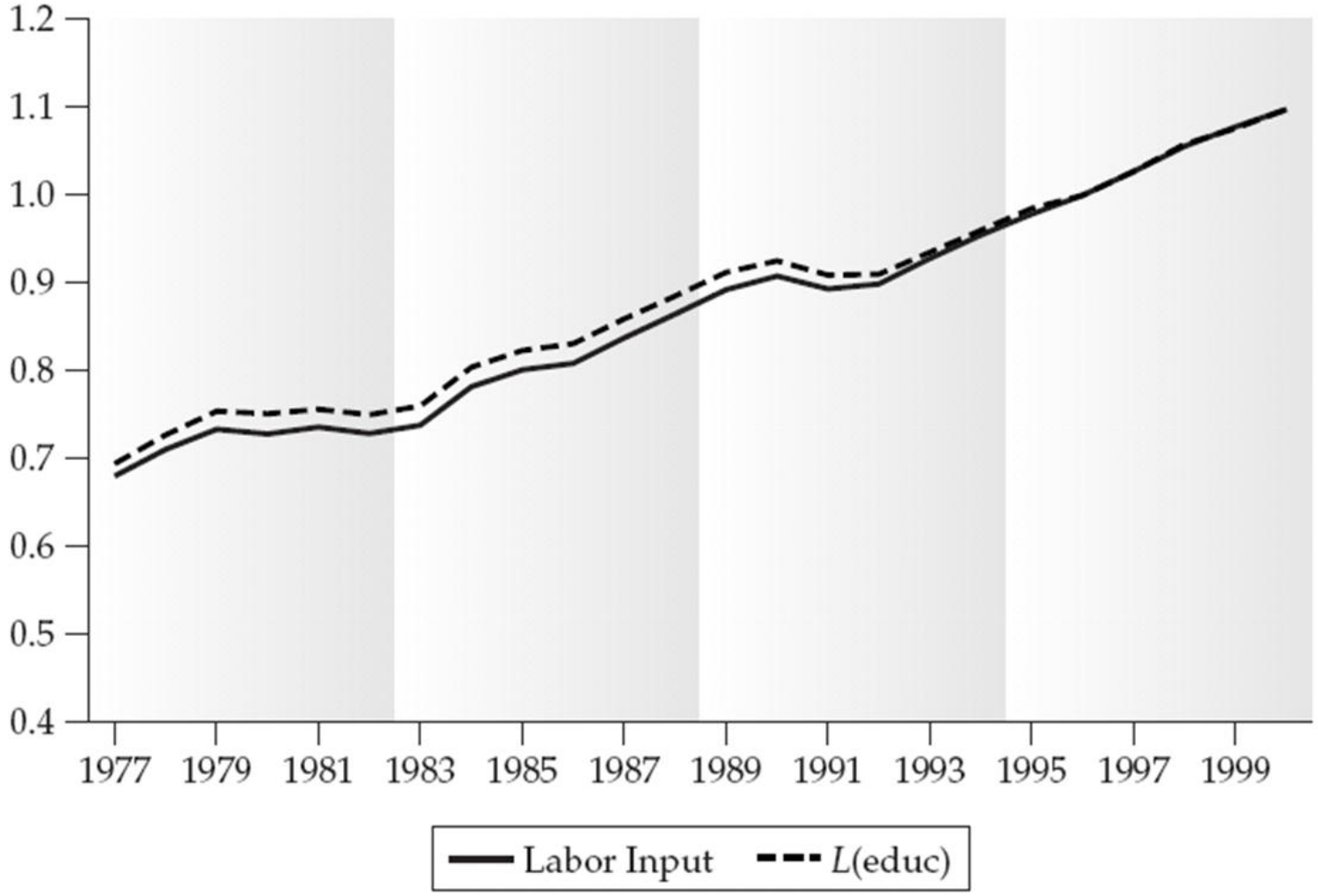


Figure 6.4
Labor volume (all worker characteristics) vs. education alone.

OPTIONAL READINGS ON HUMAN CAPITAL:

Li, Haizheng, Yunling Liang, Barbara M. Fraumeni, Zhiqiang Liu, and Xiaojun Wang (2010), “Human Capital in China,” Beijing, Central University of Finance and Economics.

Christian, Michael (2011), “Human Capital Accounting in the United States: Context, Measurement, and Application,” Madison, Wisconsin Center for Economic Research, July.

Liu, Gang (2011), “Measuring the Stock of Human Capital for Comparative Analysis: An Application of the Lifetime Income Approach for Selected Countries, OECD, Paris, June.

THE CONCEPT OF HUMAN CAPITAL

Investment in Physical Capital vs.
Investment in Human Beings

Human Wealth vs. Nonhuman Wealth

Market and Nonmarket Labor Incomes

Lifetime Labor Incomes and Asset Values

IS HUMAN CAPITAL IMPORTANT?

Nonmarket Compensation Includes Leisure Time, Household Production, Investment in Education and Investment in Child-Rearing

Nonmarket Labor Compensation is Four Times the Value of Market Compensation

The Value of Human Investment Is Four Times the Value of Nonhuman Investment

Human Wealth is Ten Times the Value of Nonhuman Wealth

Source: Jorgenson and Fraumeni (1989, 1992)

INVESTMENT IN HUMAN CAPITAL: Conclusions

Measuring Investment in Human Capital

Measuring Labor Input

Labor Quantity and Price

Labor Quality and Its Decomposition

Increased Educational Attainment is the Primary Source of Labor Quality Growth

BARRIERS TO RESUMPTION OF ECONOMIC GROWTH

THE LISBON AGENDA

THE EU KLEMS PROJECT

THE BOLKESTEIN DIRECTIVE ON SERVICES

THE SERVICES SECTOR DIRECTIVE OF 2006

A NEW STRATEGY FOR A SINGLE MARKET

THE LISBON AGENDA

The starting point for our discussion of European innovation policy is the Lisbon Agenda, adopted by Lisbon European Council in March 2000. This was a ten-year program *to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.*

This strategic goal was to be achieved by a three-pronged program:

- preparing the transition to a knowledge-based economy and society by better policies for the information society and R&D, as well as by stepping up the process of structural reform for competitiveness and innovation and by completing the internal market;

- modernizing the European social model, investing in people and combating social exclusion;

- sustaining the healthy economic outlook and favorable growth prospects by applying an appropriate macro-economic policy mix.

EUROPEAN INNOVATION POLICY

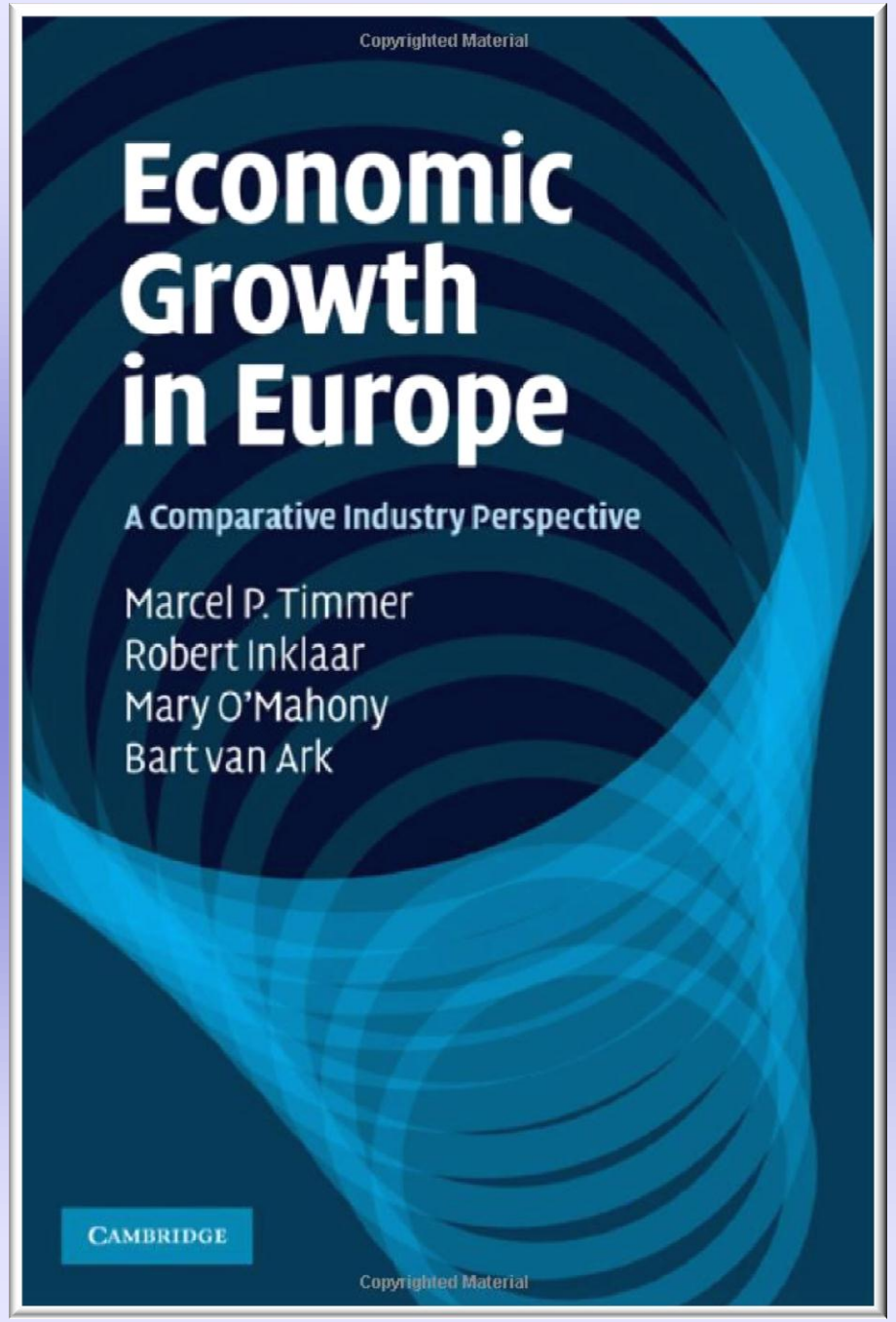
The EU KLEMS Project was launched in 2003 with support from the European Commission, Research Directorate General, and was completed in 2008.

By 2004 it had become apparent that the Lisbon Agenda was not working. This led to three initiatives at the European level:

1. The Kok Report of 2004. This was a report to the European Commission by a High Level Group chaired by Wim Kok, Prime Minister of The Netherlands from 1994 to 2002 and leader of the Labour Party in The Netherlands from 1986.

2. The Bolkestein Directive on Services in the Internal Market. This was proposed to the European Commission in 2004 by Frits Bolkestein, a liberal-conservative politician who led the People's Party in The Netherlands and served as Secretary of Defense under Kok in a coalition government. In 1999 Bolkestein joined the European Commission and served as European Commissioner for the Internal Market and Services until 2004.

3. The Monti Report, *A New Strategy for the Single Market.* This was prepared in 2010 for Juan Manuel Barroso, President of the European Commission, by Mario Monti, an economist who had preceded Bolkestein as European Commissioner for the Internal Market from 1995 to 1999. Monti is now the Prime Minister of Italy.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Economic Growth in Europe
A Comparative Industry Perspective
Marcel P. Timmer
Robert Inklaar
Mary O'Mahony
Bart van Ark
CAMBRIDGE
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Table 2.1 Decomposition of output growth, market economy, EU and US, 1980–2005.

	European Union		United States	
	1980-1995	1995-2005	1980-1995	1995-2005
1 Market economy output (2) + (3)	2.1	2.2	3.2	3.6
2 Hours worked	-0.5	0.7	1.3	0.7
3 Labour productivity	2.5	1.5	1.9	2.9
Contributions from (4) + (5) + (8)				
4 Labour composition	0.3	0.2	0.2	0.3
5 Capital services per hour (6) + (7)	1.2	1.0	1.0	1.3
6 ICT capital per hour	0.4	0.5	0.7	1.0
7 Non-ICT capital per hour	0.8	0.4	0.3	0.3
8 Multi-factor productivity	1.0	0.3	0.7	1.3
Contribution of the knowledge economy to labour productivity (4) + (6) + (8)	1.7	1.1	1.6	2.6

Notes: Contributions to growth of output volume in the market economy (annual average growth rates, in percentage points). Data for European Union refers to ten countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain and the United Kingdom. 'ICT' is information and communications technology.

Source: Calculations based on EU KLEMS database, March 2008, see Chapter 3.

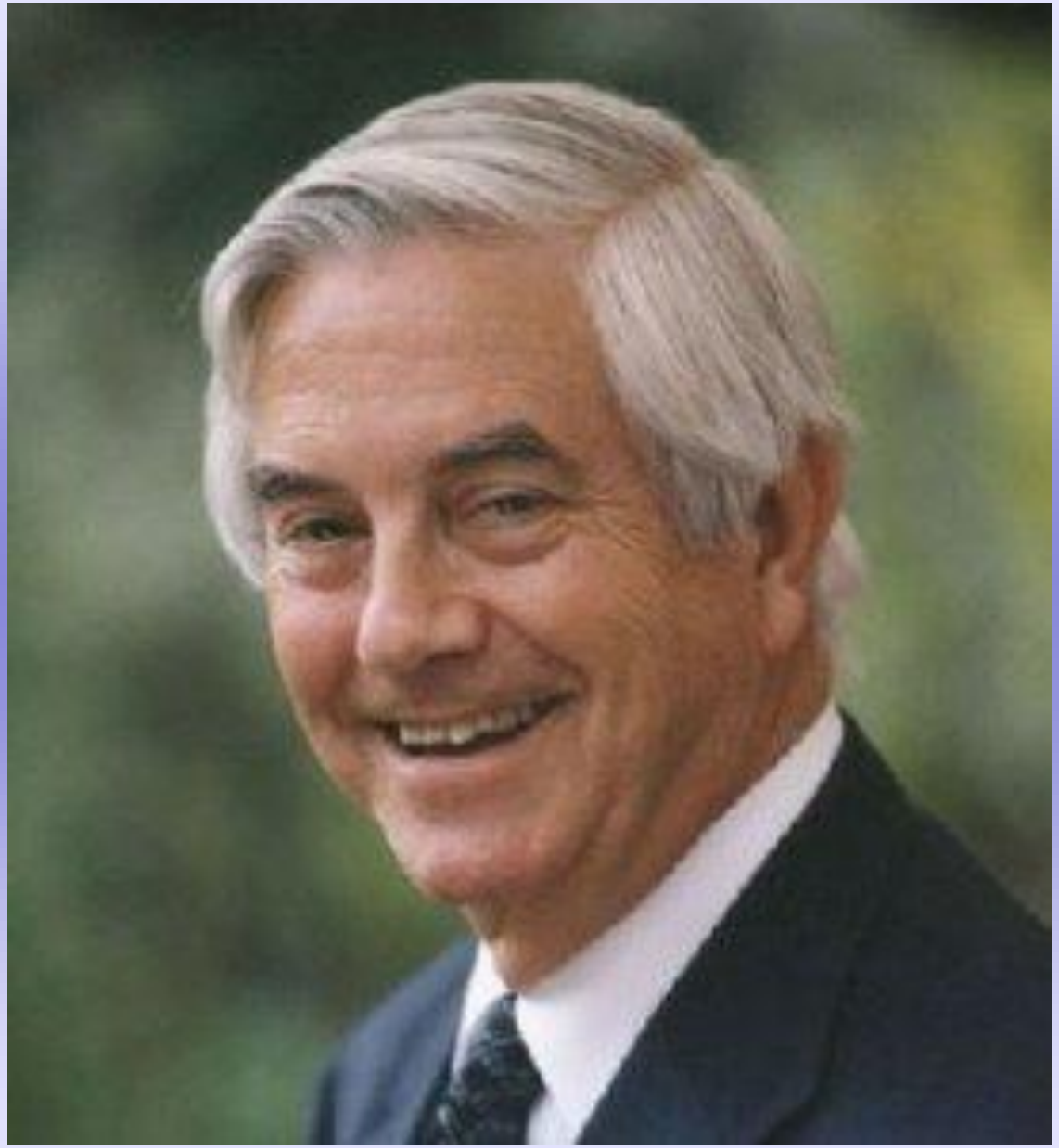
THE ROLE OF MARKET SERVICES

The Share of Market Services in the GDP Averaged Around 40 Percent in 1995, But Has Been Steadily Growing

The Contribution of IT Capital Input in the U.S. Is Higher Than in Europe; the Contribution of Non-IT Capital Input Is About the Same

The Share of College-Educated (High-Skilled) Workers in Market Services Is Much Higher in the U.S. than in Europe (Except for Finland)

More Rapid Growth of Labor Productivity in U.S. Market Services Is Due To the Contribution of Investment in IT Capital, Growth in High-Skilled Workers, and Increases in Multi-Factor Productivity



THE BOLKESTEIN DIRECTIVE ON SERVICES IN THE SINGLE MARKET

This proposal for a directive is part of the process of economic reform launched by the Lisbon European Council with a view to making the EU the most competitive and dynamic knowledge-based economy in the world by 2010.

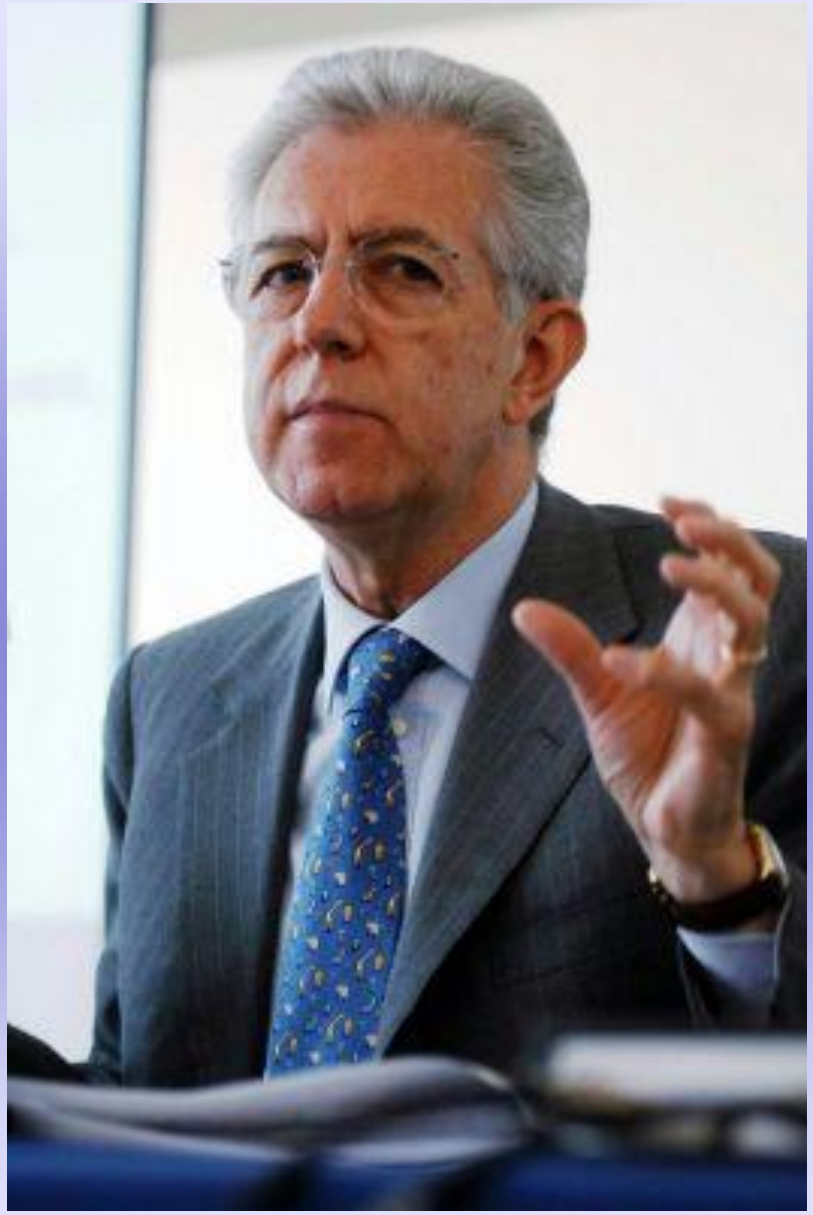
Achieving this goal means that the establishment of a genuine internal market in services is indispensable. It has not hitherto been possible to exploit the considerable potential for economic growth and job creation afforded by the services sector because of the many obstacles hampering the development of service activities in the internal market. This proposal forms part of the strategy adopted by the Commission to eliminate these obstacles and follows on from the Report on the State of the Internal Market for Services, which revealed their extent and significance.

With a view to taking full effect by 2010, the proposal is based on a dynamic approach involving phased implementation of some of its provisions, a commitment to additional harmonisation on certain specific matters (cash-in-transit services, gambling and judicial recovery of debts), the guarantee that it will evolve and that any need for new initiatives can be identified. Moreover, this proposal is without prejudice to any legislative or other Community initiatives in the field of consumer protection.

THE SERVICES DIRECTIVE OF 2006

In the Commission's initial 2004 draft, service providers would, temporarily, have been subject to the laws of their country of origin rather than those of the country where the service is provided. They could thus test a new market without having to register with the authorities. This principle was the most controversial part of the proposal as many of Europe's older member states worried that cheaper workers from the eastern EU countries would flock massively to the West, pulling down social standards.

Instead, the article was renamed 'freedom to provide services' and holds that member states must "ensure free access to and free exercise of a service activity within [their] territory," while allowing them to continue applying their own rules on conditions of employment, including those laid down through collective bargaining agreements.



"The services sectors are crucially important for our economies. They account for 70% of GDP, they are the most important source of foreign direct investment, and they are the only sector of net job creation in the EU. Nevertheless, services markets remain strongly fragmented with only 20% of the services provided in the EU having a cross-border dimension. As a result, the productivity gap between the US and the Euro area remains much wider than acceptable (about 30%)."

Mario Monti

A NEW STRATEGY FOR THE SINGLE MARKET, 2010

UNDERSTANDING THE KNOWLEDGE ECONOMY: CONCLUSIONS

REPLICATION VS. INNOVATION: Replication Greatly Predominates and Requires a Policy Framework for Investment in Information Technology and Human Capital.

INVESTMENT IN INFORMATION TECHNOLOGY: The Yellow Brick Wall and the Future of Information Technology.

INVESTMENT IN HUMAN CAPITAL: The Lifetime Income Approach and the Most Important Form of Investment.

BARRIERS TO THE RESUMPTION OF ECONOMIC GROWTH: The Service Sectors and the Completion of the Single Market.

THE LISBON AGENDA AND THE SERVICES DIRECTIVE: SUMMARY

The Lisbon agenda failed. As the Kok Report of 2004 points out, all five of the objectives had to be achieved simultaneously – the knowledge-based economy, reduced regulatory barriers to entry, a single market in services, including financial services, and fiscal consolidation.

In 2004 Single Market Commissioner Bolkestein proposed creation of a single market in services through free entry into service markets, the country of origin principle, and harmonization of the legal framework for service businesses. Free entry and harmonization were made voluntary and the country of origin principle was rejected.

Europe 2020 has replaced the Lisbon Agenda. This focuses on public financing of research, enhanced educational performance, support for broadband, reduction of natural resource use, modernization of labor markets, and elimination of poverty. The single market in services has disappeared as an objective and fiscal consolidation is not mentioned.

In a 2010 report to Jose Manuel Barroso, President of the European Commission, Mario Monti has pointed out that the service sector constitutes most of the European economy and is highly fragmented. He calls for a single market in services.