EU KLEMS

ICT, Labour Services and Productivity in the EU and US: Evidence from EUKLEMS

Mary O'Mahony

University of Birmingham and NIESR

Presentation to 6th ZEW Conference: The Economics of ICT
July 05 2008

The EU KLEMS project is funded by the European Commission, Research Directorate General as part of the 6th Framework Programme, Priority 8, "Policy Support and Anticipating Scientific and Technological Needs".

EU KLEMS

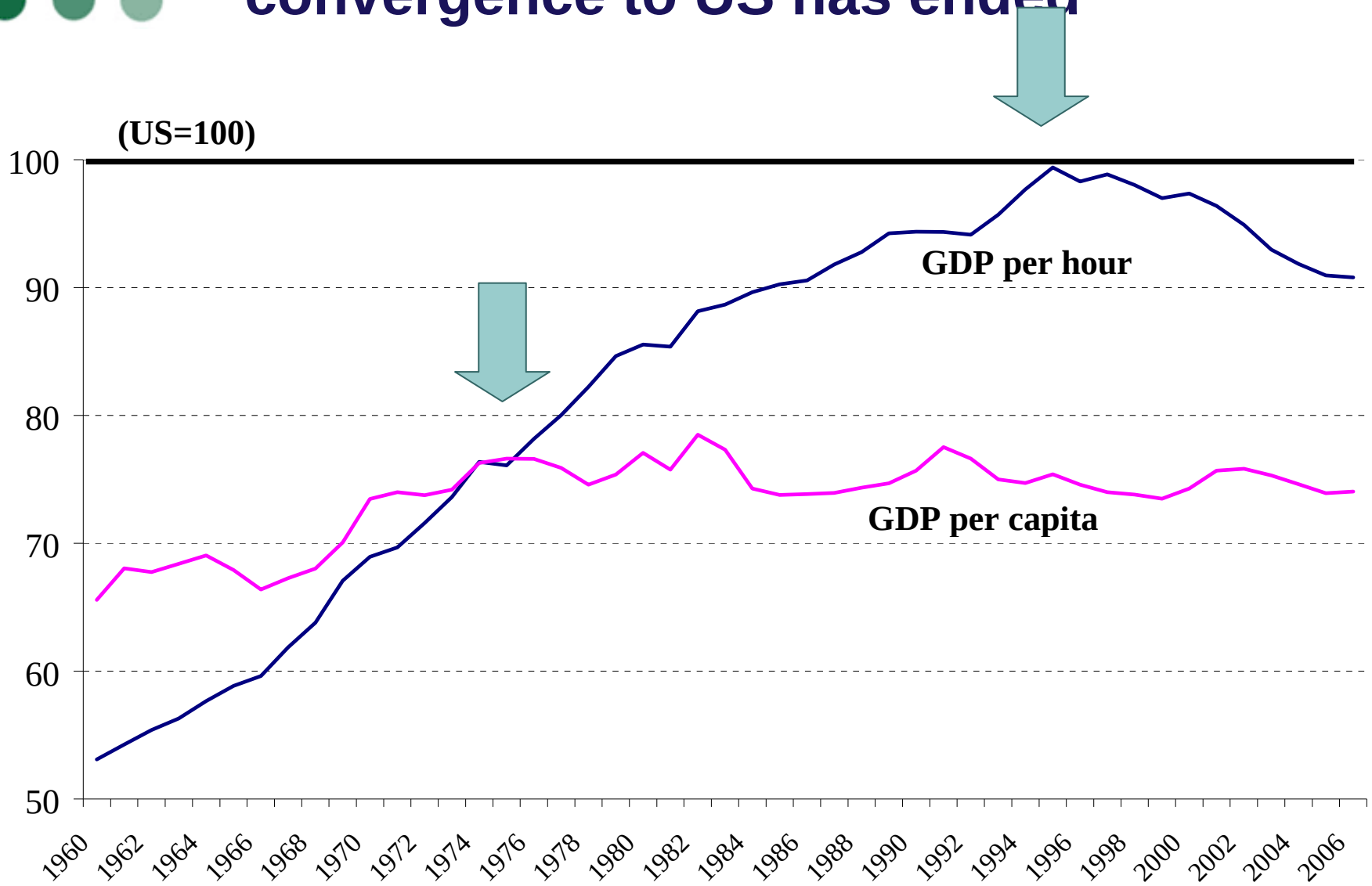
Overview

- **Consider trends in productivity growth and ICT comparing EU countries and the US.**
  - The Productivity Gap between Europe and the US: Trends and Causes, Bart van Ark, Mary O'Mahony and Marcel P. Timmer *Journal of Economic Perspectives, Feb 2008*
- **Preliminary results in estimating levels of productivity and ICT capital (Timmer and Inklaar)**
- **Working with EUKLEMS**
  - Intangibles and returns to ICT
  - Micro data linked to EUKLEMS
    - Plant level data
    - Individual level data
- **Start with brief summary of EUKLEMS**

What is EUKLEMS

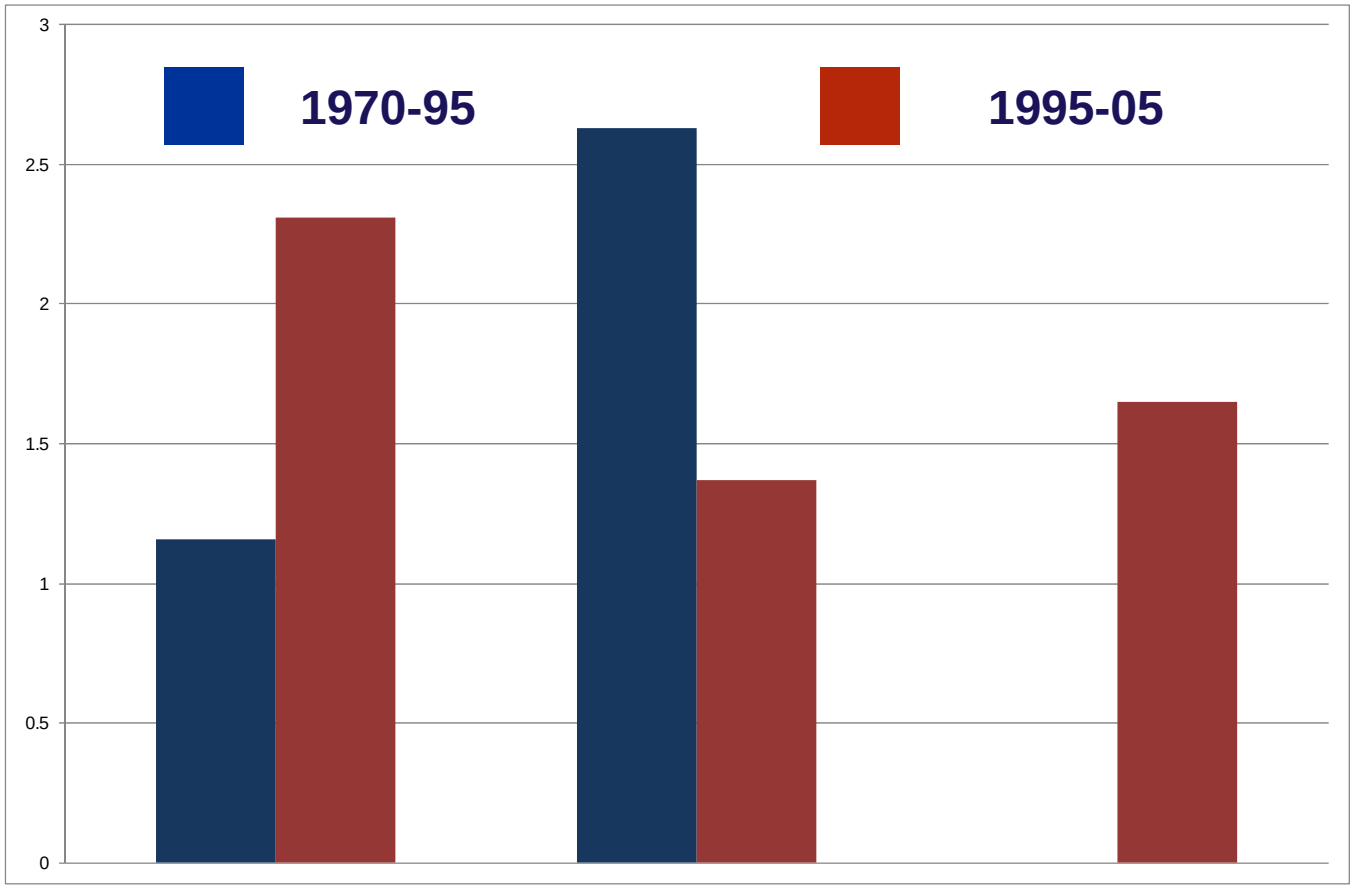
- **Consortium of 16 universities and research institutes in Europe with a link to other countries**
- **Aim to construct detailed industry estimates of output and inputs for all EU countries, linking to other countries such as US, Canada and Japan and Korea**
  - KLEMS (Capital, Labour, Energy, Materials, Services)
  - 30 -70 industries, depending on variable
  - Annual series, 1970-2005 (1995-05 some countries)
- **Describe differences in productivity growth (and levels) across countries/industries, using growth accounting method**
- **Growth accounts – organising principle – data useful for range of purposes**
- **March 2008 release of publicly available datasets, June 2008 – additional levels estimates and linked data, end of project**
- **Web-site www.euklems.net**

Context: EU-15 Labour productivity convergence to US has ended



EU KLEMS

EU versus US: Growth in value added per hour worked
Total Economy, % per annum



EU KLEMS

Why did US forge ahead and why did EU slowdown.

- **Proximate causes: slower emergence of knowledge economy**
  - Small ICT-producing sector
  - Limited role of ICT-investment
  - Reduction in average skill level
  - Less innovation (product and process)
- **Ultimate causes: institutions**
  - Role of labour markets
  - Product market regulations
  - R&D investment, Higher education system
- **Euklems most useful in delineating proximate sources, but links with other data might also allow examination of ultimate sources**

Proximate sources: EU KLEMS Growth Accounts

Gross output Production Function: Y = output, K = capital, L = labour, X = Intermediates

$$Y_j = f_j(K_j, L_j, X_j, T)$$

Growth accounting equation:

$$\Delta \ln Y_{jt} = \bar{v}_{jt}^{X} \Delta \ln X_{jt} + \bar{v}_{jt}^{K} \Delta \ln K_{jt} + \bar{v}_{jt}^{L} \Delta \ln L_{jt} + \Delta \ln A_{jt}^{Y}$$

v's shares of inputs in the value of output, A is MFP

Depends on assumptions of neoclassical production model, market clearing and constant returns to scale

EU KLEMS Growth Accounts

Capital services based on 8 asset types

$$\Delta \ln K_t = \sum_k \bar{v}_{k,t} \Delta \ln S_{k,t}$$

Weights based on user cost of capital rather than asset acquisition prices

Takes account of rates of return, depreciation and capital gains

ICT assets: high depreciation rates and capital losses so user costs imply greater weight.

Main data base shows division into ICT and non-ICT (greater detail for some countries)

EU KLEMS Growth Accounts

Labour services index: takes account of different marginal productivities of types of workers

EUKLEMS estimates based on hours worked by 18 types (skill group, age, gender)

$$\Delta \ln L_t = \sum_l \bar{v}_{l,t} \Delta \ln H_{l,t}$$

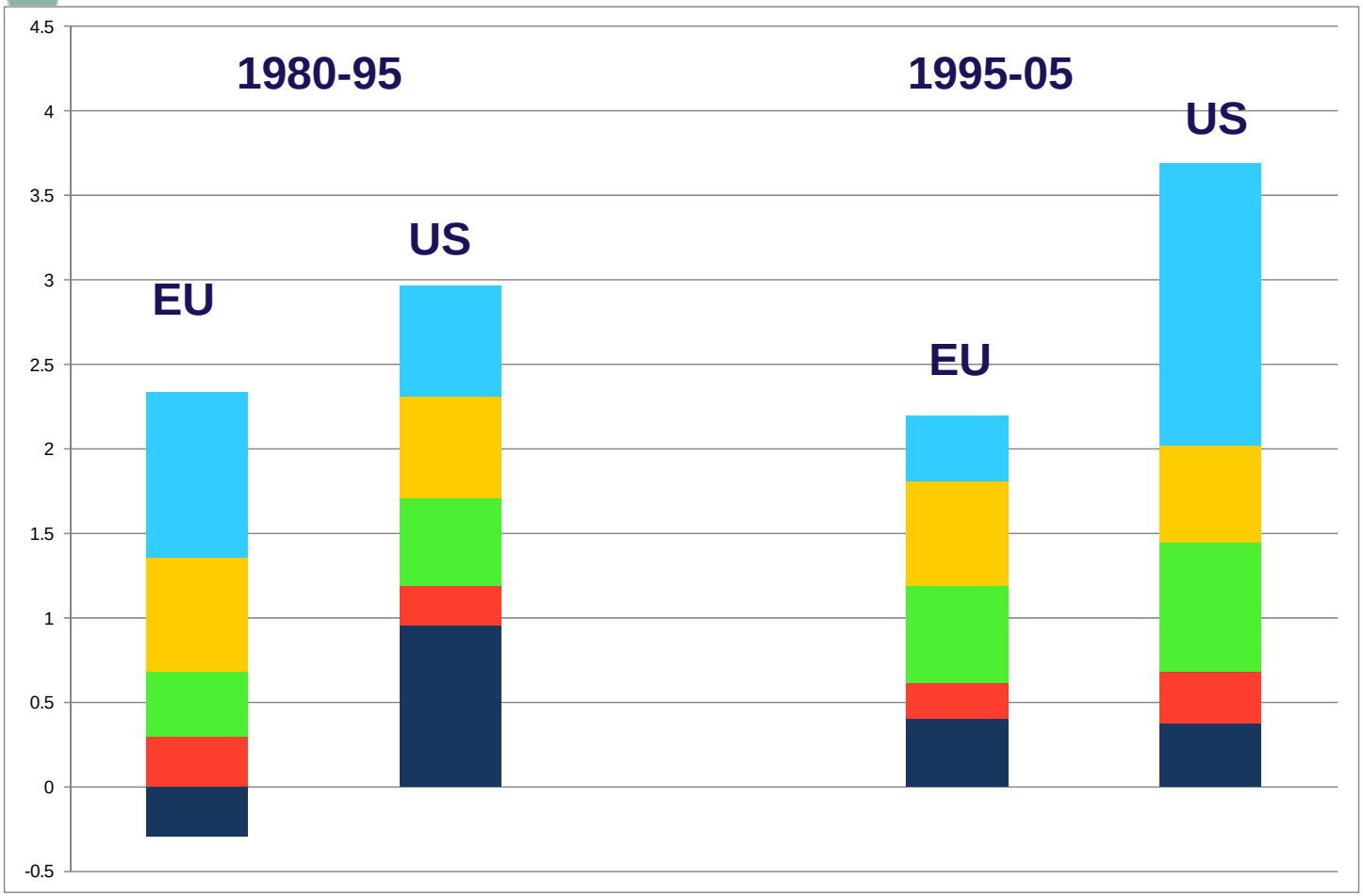
Weights: Wage bill shares. If hours worked growing faster for higher productivity workers then positive labour composition impact on growth

Main data base shows division of hours and wage bills by gender, by skill group and by age

Full 18 type cross classification available for some countries

EU KLEMS

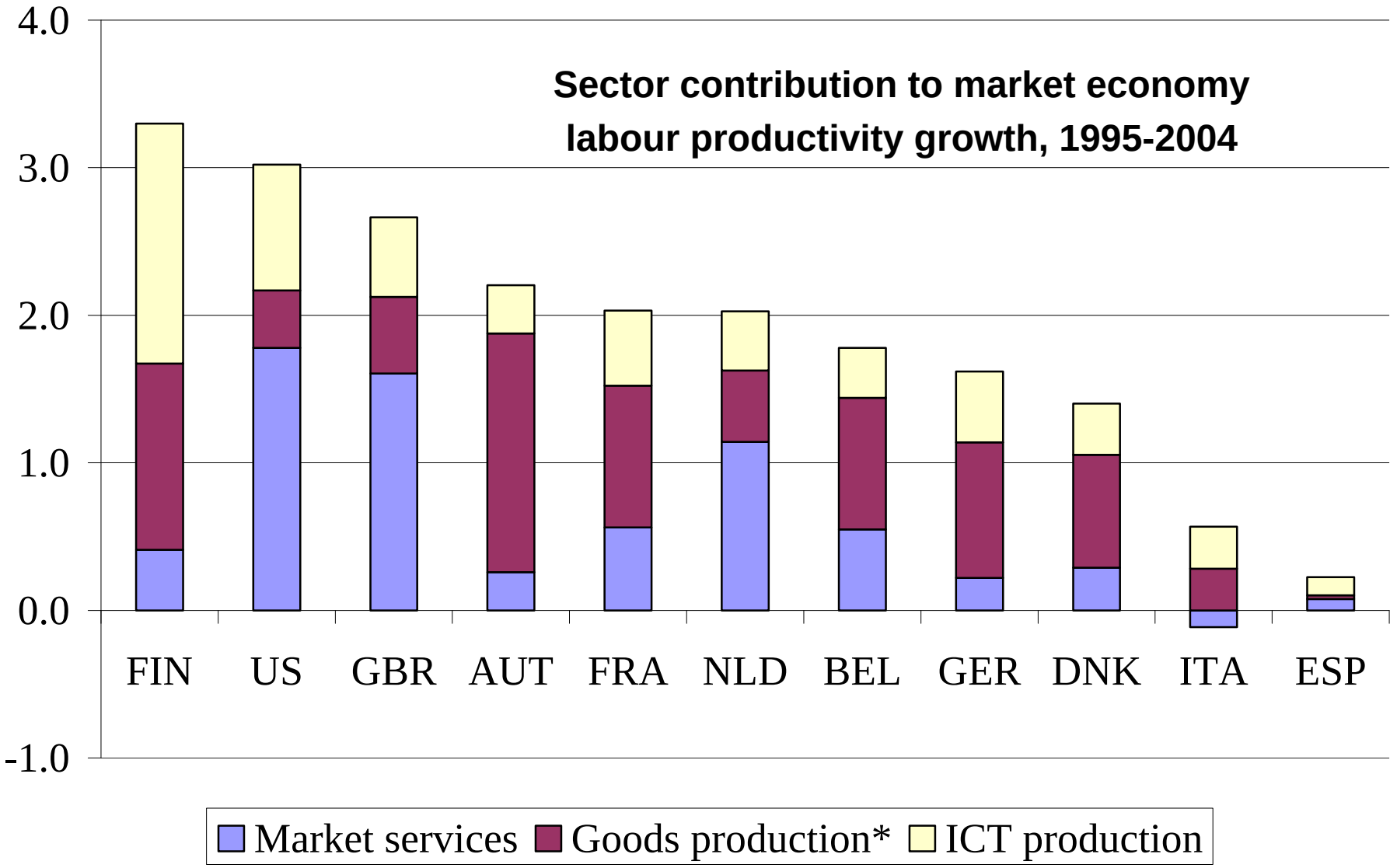
Decomposition of GDP growth in market economy, 1980-2004, EU and US



Contributions of the knowledge economy to labour productivity

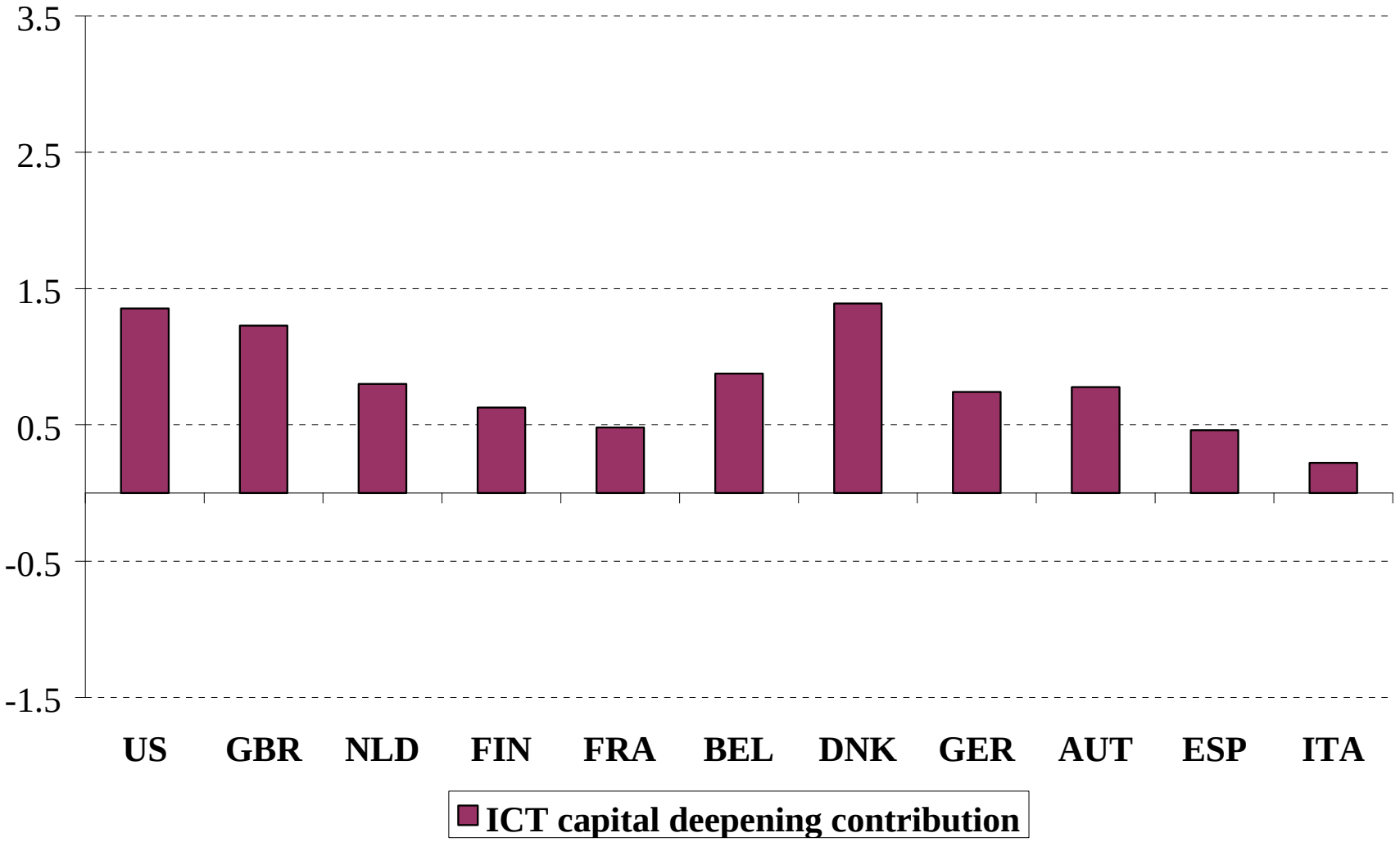
	European Union		United States	
	1980-95	1995-2005	1980-95	1995-2005
1 Growth rate of market economy output	2.1	2.2	3.0	3.7
2 Hours worked	-0.5	0.7	1.4	0.7
3 Labour productivity	2.6	1.5	1.5	3.0
contributions from				
4 Labour composition	0.3	0.2	0.2	0.3
5 Capital services per hour	1.2	1.0	0.7	1.1
6 ICT capital per hour	0.4	0.5	0.5	0.7
7 Non-ICT capital per hour	0.8	0.5	0.2	0.4
8 Multifactor productivity	1.1	0.3	0.6	1.6
Contribution of the knowledge economy to productivity (4)+(6)+(8)	1.8	1.0	1.3	2.6

Market services important source of growth differences across Europe & US

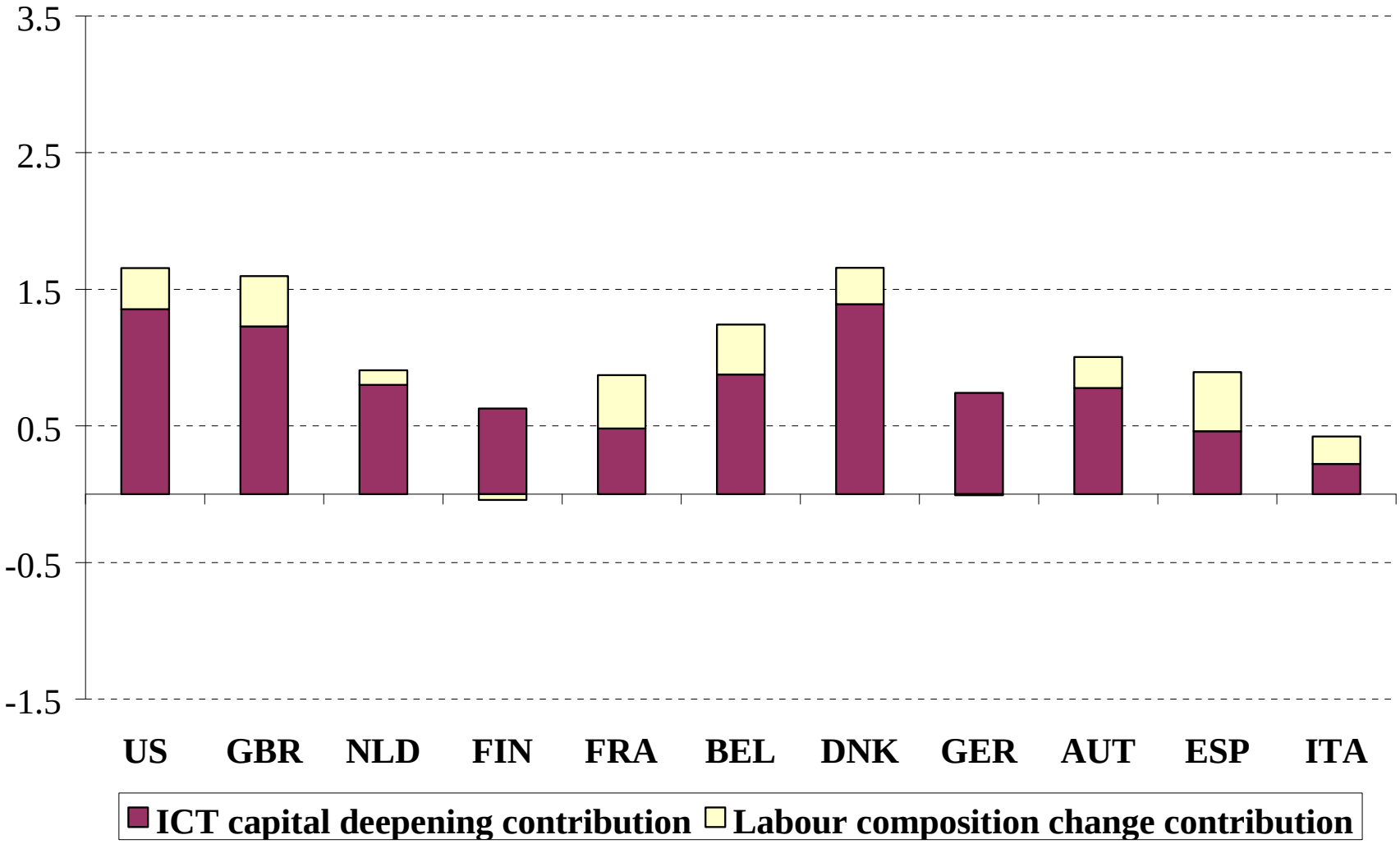


ICT investment contributes to market services growth in all countries since 1995

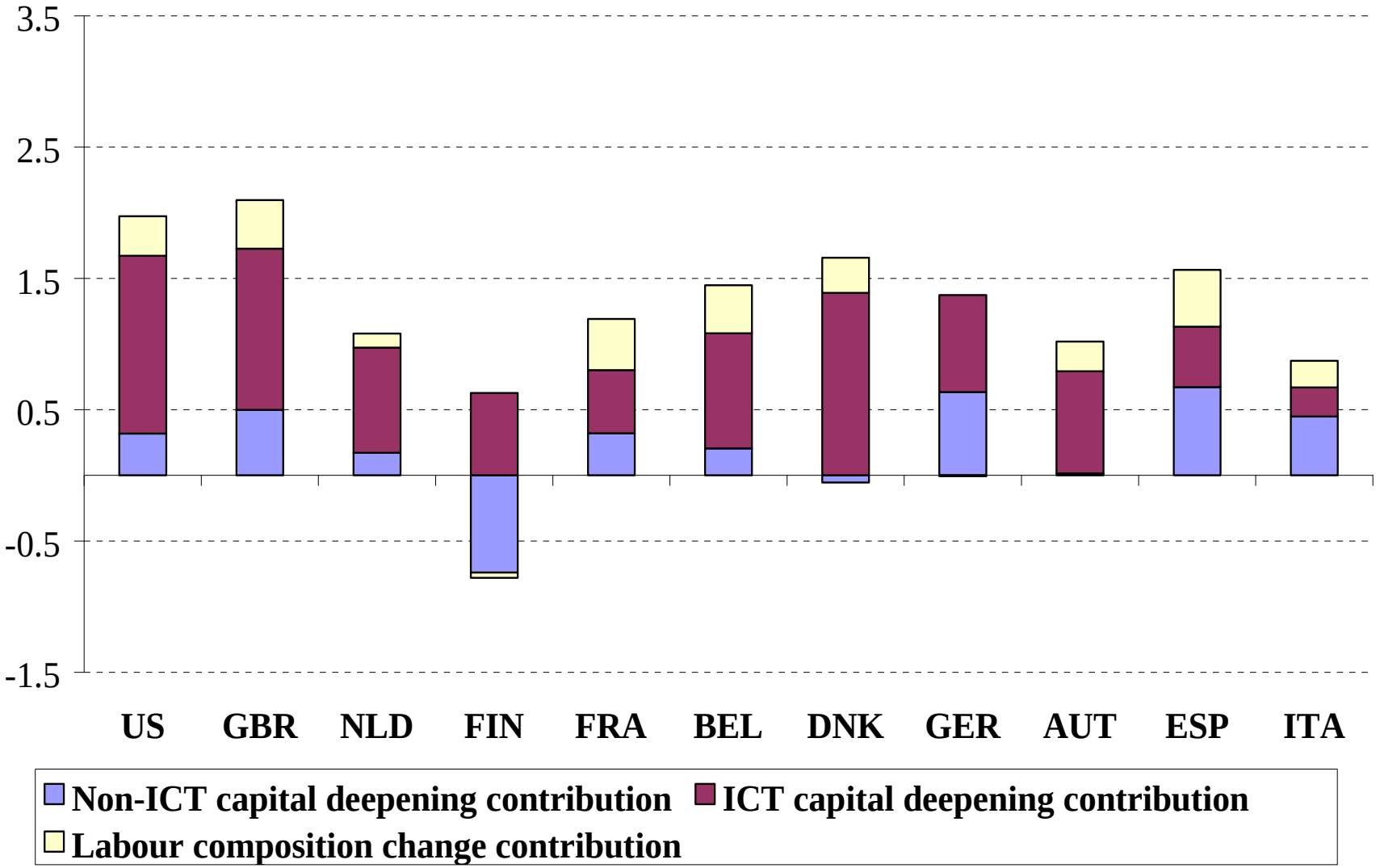
EU KLEMS



PLUS Improvement in labour composition

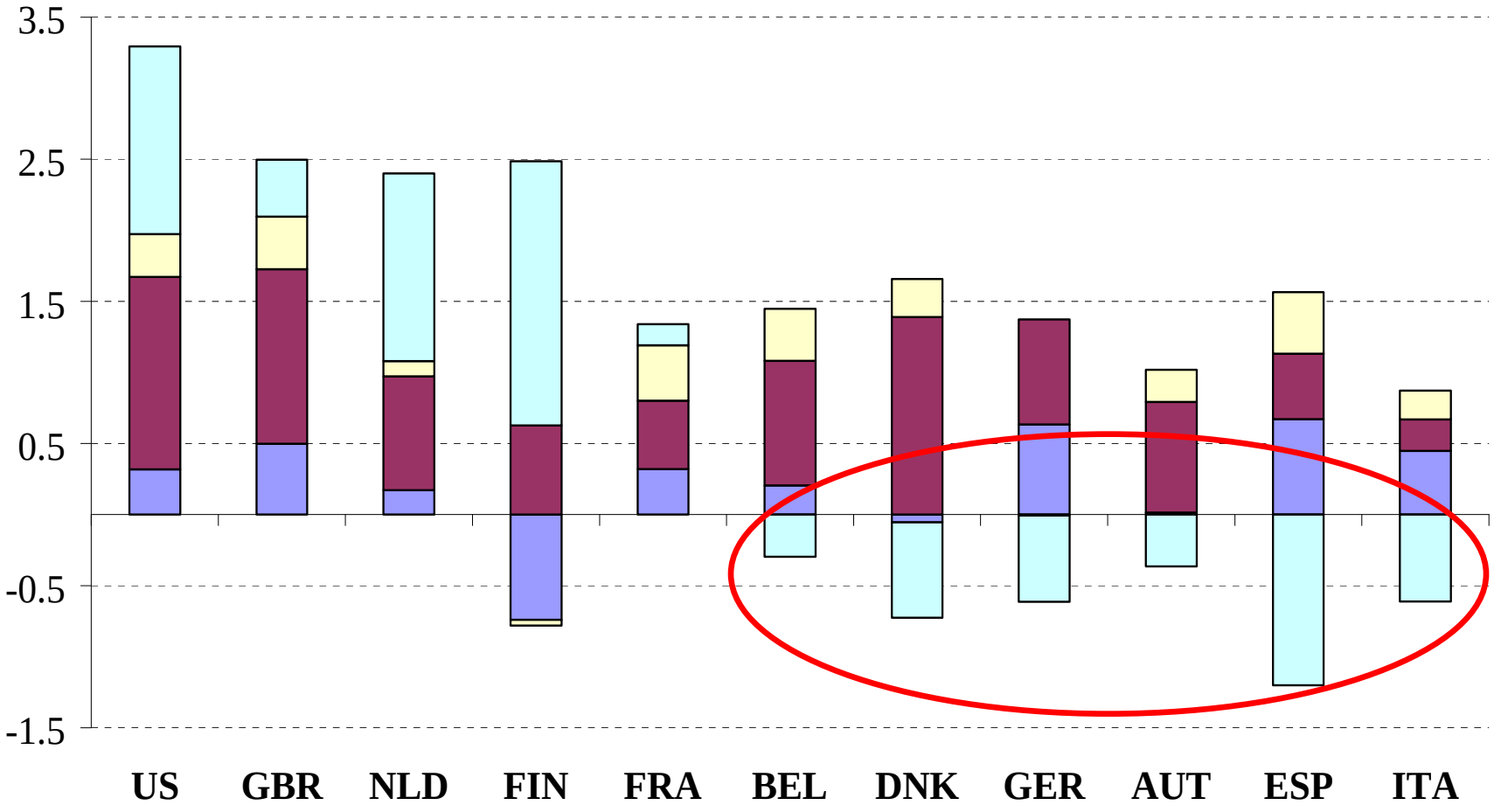


PLUS Non-ICT deepening



EU KLEMS

… but MFP contribution makes the big difference between fast and slow growth

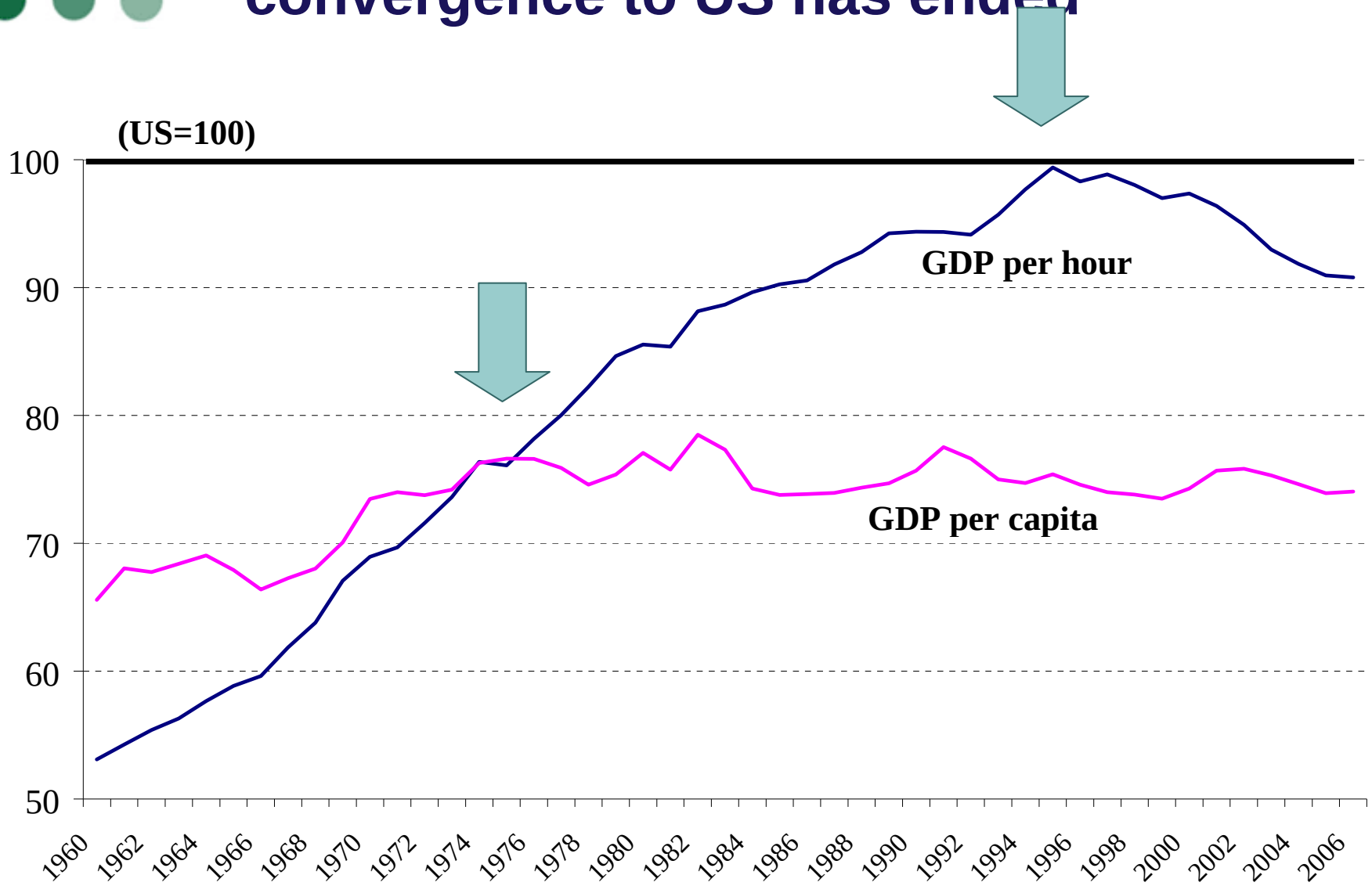


EU KLEMS

Main findings

- **Divergence in productivity growth across Europe and the US, mainly driven by differences in MFP growth in market services**
- **Market regulation, competition and scale and/or lagged adjustment to ICT in Europe?**
- **Or end of catch-up growth – if EU close to or above frontier by 1995 might expect slowdown of the growth rate.**
- **Understanding growth needs estimates of relative levels across countries**

Context: EU-15 Labour productivity convergence to US has ended

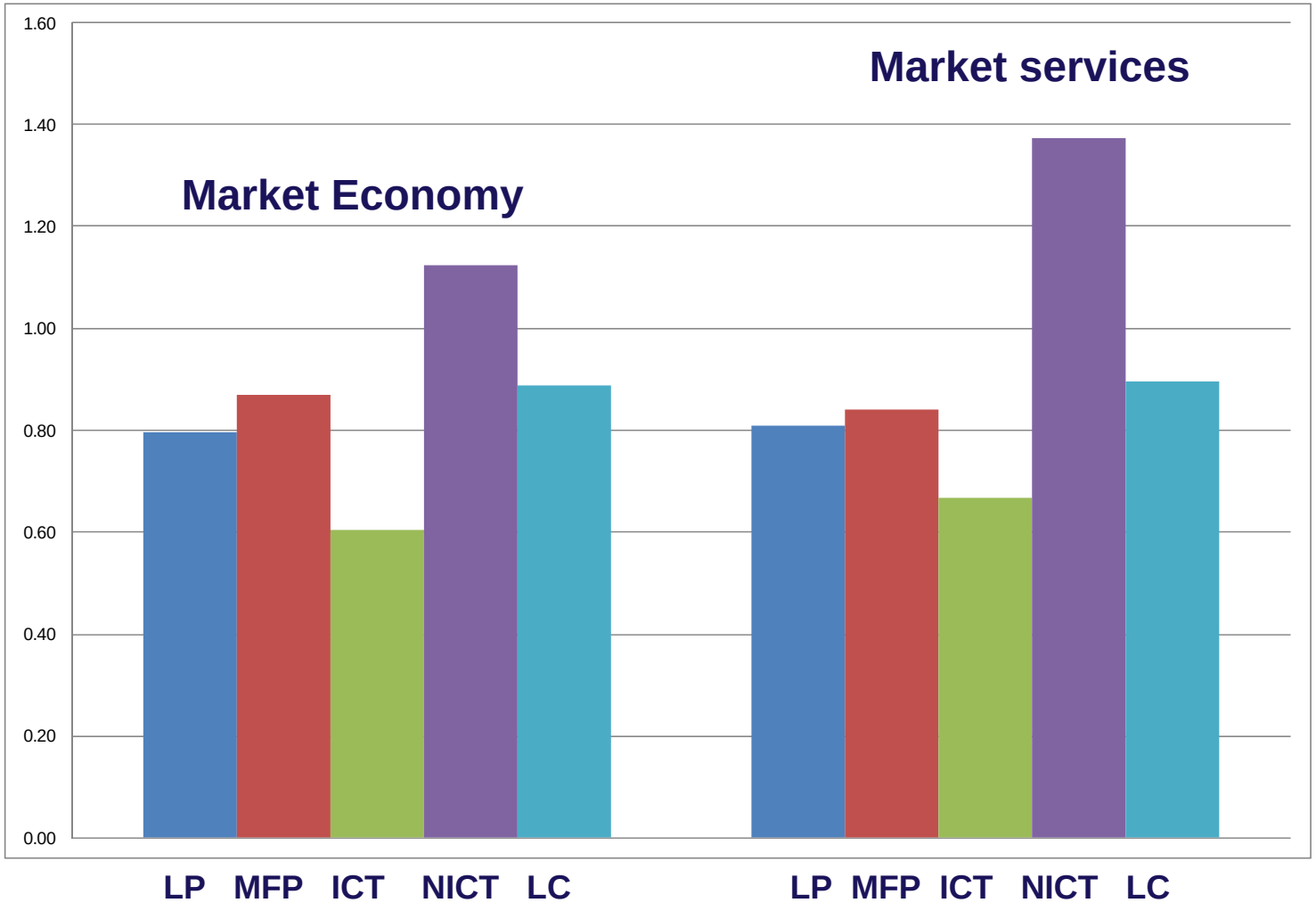


EU KLEMS

Productivity Levels: Inklaar and Timmer, University of Groningen

- **Methodology – estimates of relative prices applied to nominal values**
  - GDP or industry prices for output - Sectoral vs. gross output: differences in vertical integration.
  - Comparison over time: current vs. constant PPPs
  - Aggregation
  - Levels of capital input Capital PPPs and weights: ex-ante or ex-post
  - Levels of labour services – how many types?
- **Industry output PPPs and input PPPs**
- **Symmetric IO table based on Supply-Use tables**
- **Distinguish 30 types of labour – disaggregation important for levels**
  - 5 education classes x 3 age groups x gender
- **Distinguish 8 types of capital**
  - 3 ICT assets, 5 non-ICT assets
- **PPP for each input (exchange rate for imports)**

Productivity and input levels in the EU15, 1997 US=1. US uses more ICT capital and has more skilled labour; EU more non-ICT capital

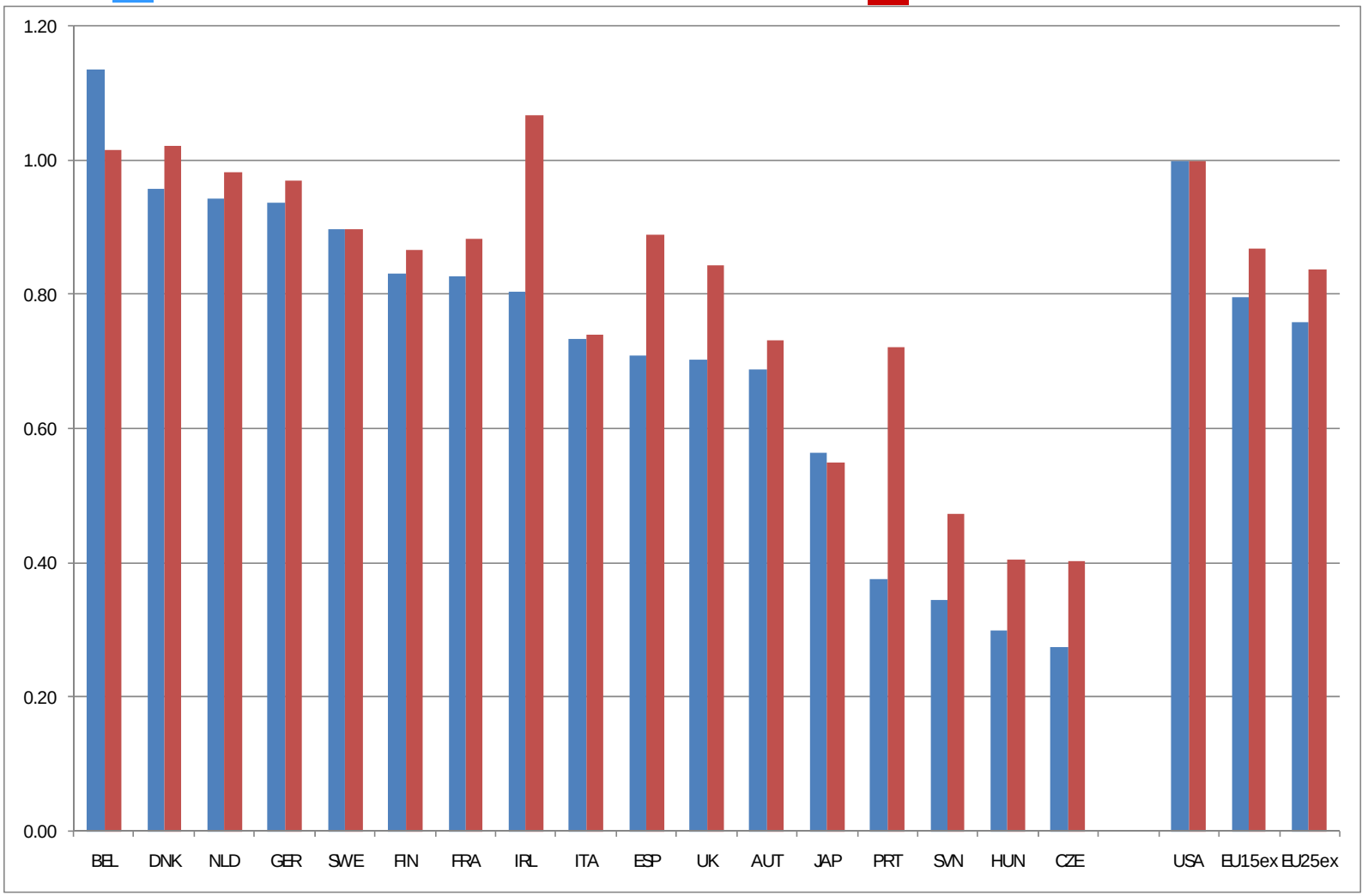


Relative levels of LP and MFP by country: US = 1

EU KLEMS

Market Economy Labour productivity

Market Economy MFP



EU KLEMS

Productivity Levels

- **In market economy US large lead in LP levels**
- **Estimates show US also has large lead over EU countries in MFP**
- **US higher levels of ICT capital and complementary inputs such as skilled labour per hour worked**
- **Against this EU higher levels of traditional capital per hour worked**
- **Conclude inputs cannot explain gaps**
  - need to look to other forms of investments (intangibles)
  - And other factors that might impact on these investments, e.g. regulation

EU KLEMS

Unmeasured inputs

- **Direct measures of intangibles difficult**
  - But considered in FP7 projects COINVEST and INNODRIVE
- **An indirect method is to see if there is evidence of high returns to ICT or elasticities of output w.r.t. ICT, greater than those implied in growth accounting model.**
- **Mixed results – O'Mahony and Vecchi (Economica 2005) found above normal returns in US, UK industry panel (pooled mean group estimator)**
- **Inklaar, Timmer and van Ark (Economic Policy 2007) found no evidence of high returns in market services**

Returns to ICT: O'Mahony and Zubanov

- **EUKLEMS dynamic panel data – long T, relatively short N**
- **Standard fixed effects models appear to imply strongly decreasing returns to scale and often negative coefficients on ICT when time dummies included - Suggests the need to model dynamics**
- **Panel is country, not industry – do not impose similar elasticities across industries**
- **Experimented with many econometric specifications, best results using method that includes fixed effects with country specific AR1 and within group heteroscedasticity**

EU KLEMS

Results suggest higher elasticities of ICT (and relative returns to ICT versus non_ICT capital) than implied by growth accounting

	Market economy	
	Regression	Growth accounting
Materials	0.529	0.505
Labour services	0.189	0.334
ICT capital	0.058	0.015
Non-ICT capital	0.106	0.145

Results above suggest role for intangible investments.

EUKLEMS includes some measures of R&D expenditures and patents

Linking microdata to EUKLEMS

- EUKLEMS has rich data on outputs and inputs but need more than this to consider drivers of MFP gaps and divergence
- Solution is to attempt to link data from other sources
- A useful way forward is to aggregate variables from microdata (plant, company, individuals) to industry levels
- Some data already linked – entry/exit from plant data (Bartlesman) and concentration ratios and average age of firms from company accounts

Research using linked microdata: plant level

- **Bartlesman, Perotti and Scarpetta**
  - Link data on distribution of firms' distance from frontier to EUKLEMS and measures of employment protection legislation (EPL) from OECD
  - Argue that high exit costs more important near frontier where firms are experimenting with new products/processes
  - Use confidential microdata to calculate indicators such as the productivity of the best performing quartile relative to the mean
  - Construct ordinal ranking of industries (distance) – higher rank where quartile further removed from mean
  - Shows significant negative coefficient when 'distance' measure is interacted with EPL
  - Other work considers direct indicators of ICT – broadband use, e-commerce - for 13 EU countries

EU KLEMS

Research using linked microdata: Individual level

- Most useful is Labour Force Surveys - rich data sources and available for many countries
- To date consider only UK data, but plan to look at micro data for some other countries and use Eurostata European Labour Force Survey
- Papers to date consider measures that proxy for organisational change such as on the job training, home working, flexible working arrangements.
- Construct Principal Components based indicator by industry and link to EUKLEMS
- Using two stage estimator (Black and Lynch, 2001) and GMM in first stage, results show organisational change variable has positive impact on UK productivity

Skill biased technical progress

- **Consider standard biased technical change equation relating wage bill shares to capital output ratios and technology indicator.**

$$\left(\frac{W_{jit}}{WT_{it}}\right) = \beta_i + \beta_K \ln\left(\frac{K_{it}}{Y_{it}}\right) + \beta_{IT} \ln\left(\frac{ICT_{it}}{K_{it}}\right) + \eta_t D_t + \varepsilon_{it}$$

Where W_j is wage bill of type j worker, WT = total wage bill in industry i, K is capital, Y is output, ICT is ICT capital and D are time dummies

Results using basic EUKLEMS data for 9 EU countries suggest Skill Capital complementarity is only apparent for females while ICT appears to decrease demand for older men, especially those with degree level qualifications

Pooled Regression results, 9 EU countries, 11 industries, 1970-2005

C	Aged 50+					
	Male			Female		
	High	Intermediate	Low	High	Intermediate	Low
K/Y	-0.0025**	-0.0009	0.0033**	0.0012**	-0.0005	0.0011*
	(0.0006)	(0.0011)	(0.0010)	(0.0002)	(0.0004)	(0.0005)
ICTK/K	-0.0007*	0.0026**	-0.0045**	0.0003**	0.0008**	0.0020**
	(0.0003)	(0.0007)	(0.0006)	(0.0001)	(0.0002)	(0.0003)

Notes: Standard errors are in parentheses. ** and * denote significance at 1% and 5% levels, respectively.

EU KLEMS

Skill biased technical progress

- To examine the ‘age bias’ in more detail extract data from UK LFS on training
- Construct industry measures linked to EUKLEMS
- Regressions show that training interacted with ICT has significant impact on wage rates
- A lower proportion of older workers receive lower training on average than other age groups
- Shows large impact on predicted earnings
- Also older workers are more likely to refuse offers of training

EU KLEMS

Conclusions

- **EUKLEMS is a rich resource useful in analysing various aspects of links between ICT, productivity and relative earnings**
  - In producing ‘stylised facts’ using growth accounting
  - And when linked to other data sources
- **Macrodata have advantages in measurement**
  - Linked to Systems of National Accounts, internationally comparable
- **Microdata have advantages in detail**
- **Combining both leads to more complete and convincing picture**