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The Aggregate Contribution of ICT to Output and Labour Productivity in Transition Economies

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Agenda

☞ Motivation for research

☞ Research hypotheses

☞ Impact of ICT on output and labour growth

- ICT production

- ICT use

- Increase in TFP in the ICT sector

- Spillover effects of ICT production and use

☞ Determinants of the productive use of ICT

☞ Future impact of ICT – contribution to growth in Poland until 2025

☞ Conclusions and policy recommendations

Motivation for research

- ☞ Lack of quantitative estimates of the impact of ICT on growth in transition economies
- ☞ Lack of analyses of the potential of ICT for faster convergence with developed countries
- ☞ Insufficient understanding of the economic, institutional and regulatory determinants of diffusion and productive use of ICT

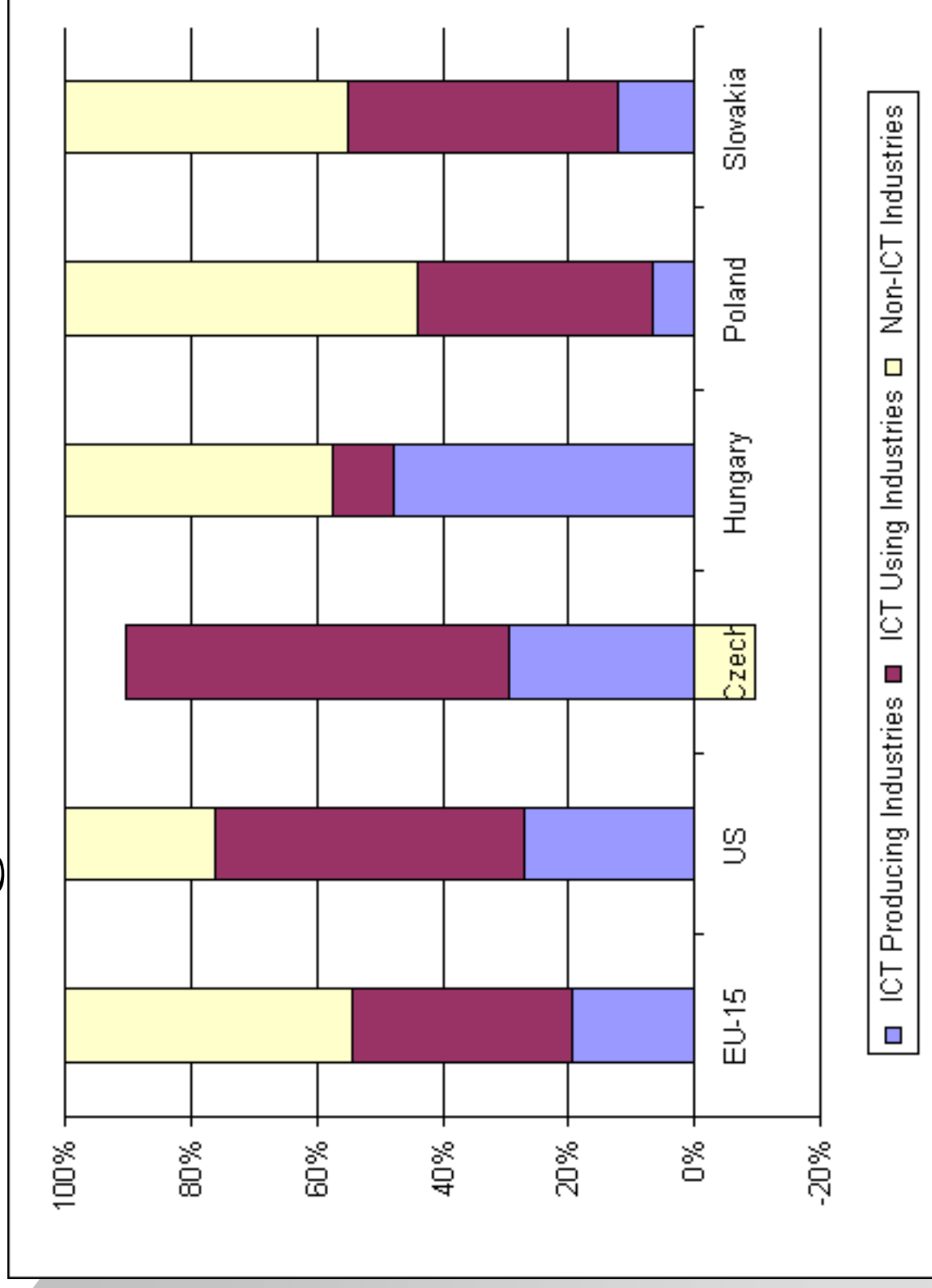
Research hypotheses

- ☛ ICT contributed to acceleration in output and labour productivity growth in selected transition economies during 1995-2001 and hence to catching-up on the EU-15 countries
- ☛ ICT are likely to be one of the drivers of income convergence until 2025 through stimulation of restructuring on the macro, industry and micro level
- ☛ High level of development of the economic, insitutional and regulatory framework is prerequisite to wide diffusion and productive use of ICT in the transition economies

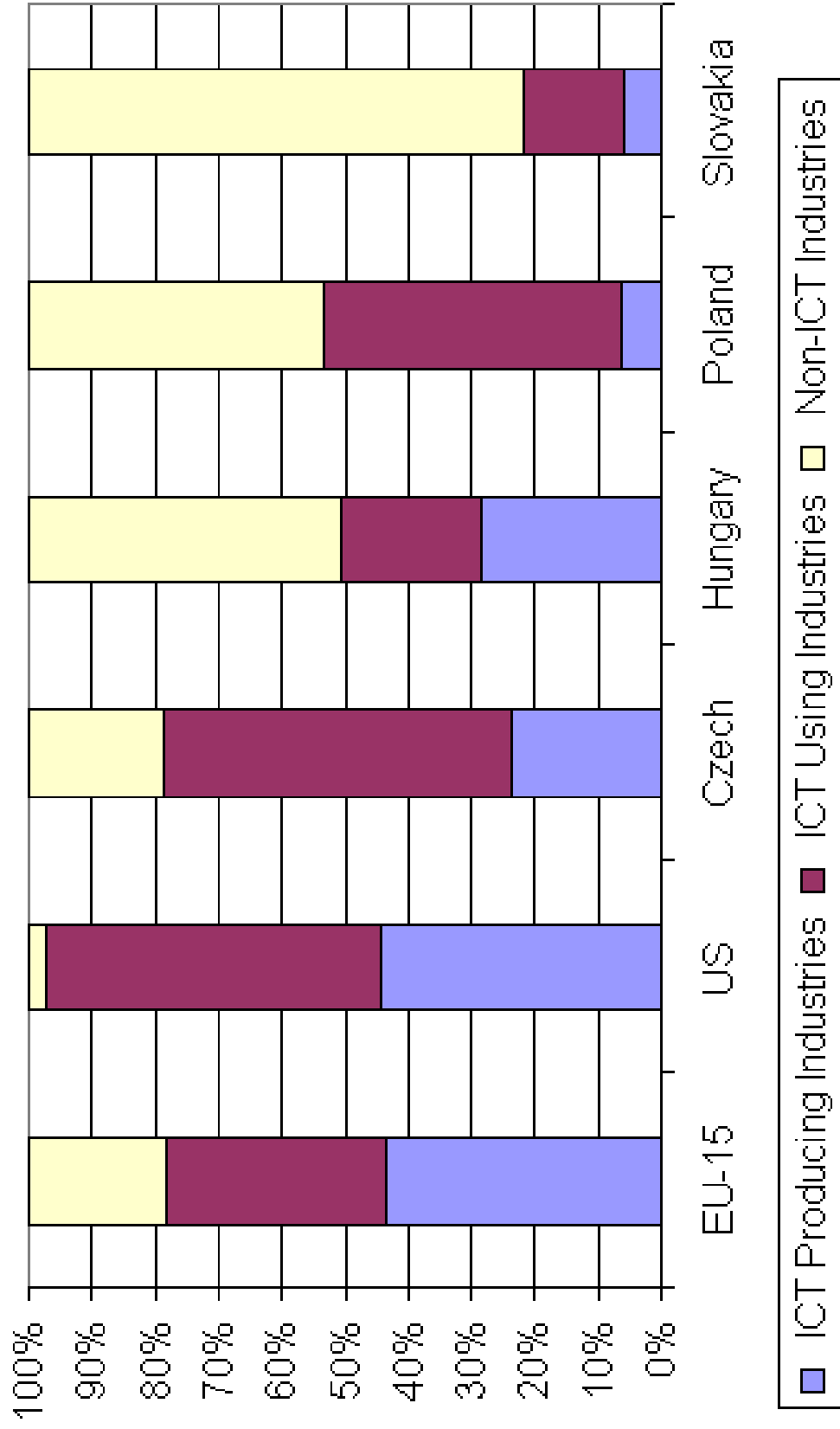
Impact of ICT on growth

- Four channels:
 - I. ICT production, which directly contributes to an increase in the aggregate valued added generated in an economy;
 - II. Increase in total factor productivity (TFP) in the ICT sector, which contributes to growth in aggregate TFP in the whole economy;
 - III. The effect of ICT investment on growth through capital deepening or substitution
 - IV. Increase in TFP in non-ICT producing sectors due to spillover effects of ICT production and use

I. Contribution of ICT production to GDP growth 1995-2001



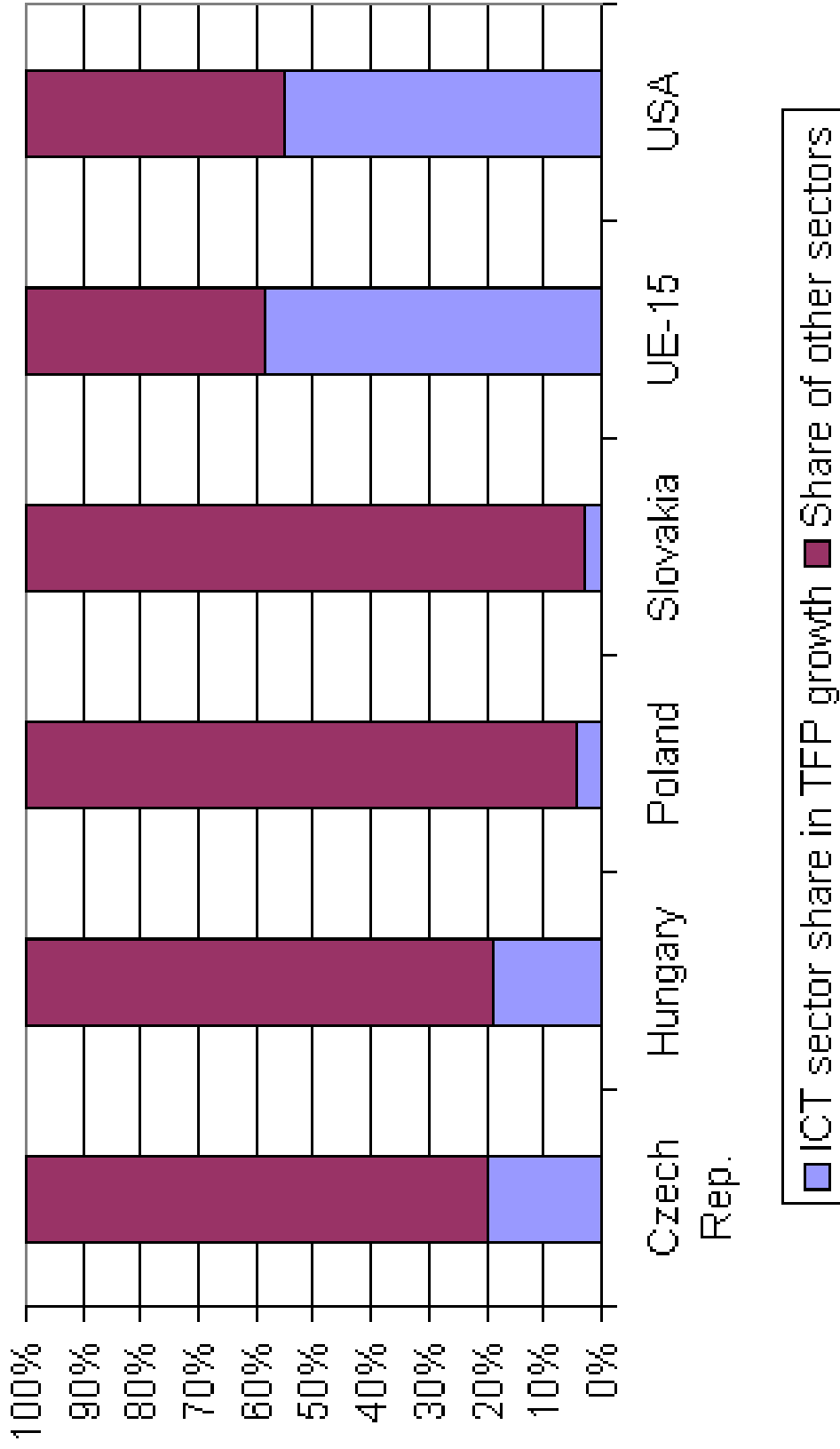
And labour productivity...



II. Methodology - ICT sector contribution to TFP growth

- Based on gross output and Domar weights methodology:
- Insufficient data on industry-level capital service input measures and deflators for both input and output=> TFP sector growth rates in CEE and EU countries are based on data for the US ICT industries (Jorgenson et al. 2002, Timmer et al. 2003).
- Data from I/O tables for the CEE countries is not sufficient to calculate Domar weights. Hence, it is assumed that the ratio between ICT sector value added and Domar weights for the EU-15 is the same for the four CEE countries: Czech Republic, Hungary, Poland and Slovakia
- Since none of the CEE countries produces semiconductors and microprocessors, TFP growth rates in CEE countries in “electronic components” (mostly semiconductors and microprocessors) assumed to equal the TFP growth rate for “telecommunications equipment”.

II. ICT sector contribution to aggregate TFP growth



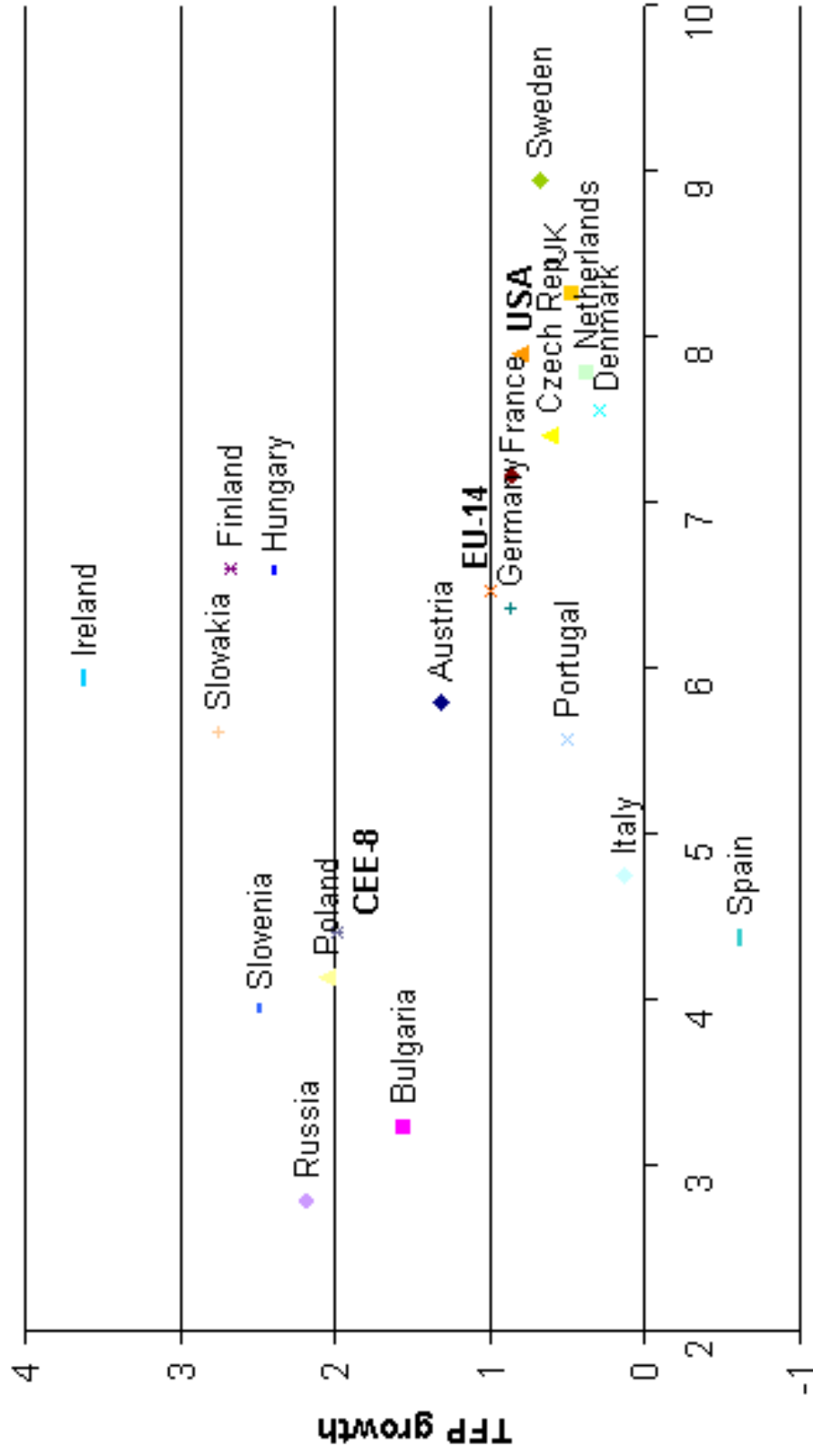
III. Methodology - contribution of ICT capital to growth ...

- Growth accounting methodology (Piatkowski, 2003b):
 1. investment series for ICT based on WITSA; for total investment from World Bank WDI (2000, 2003) and complementary sources
 2. Harmonized price index for ICT investment based on ICT deflators for the US (Jorgenson et al.. 2003)
 3. Labour compensation shares based on data from national statistical offices plus sensitivity analysis

III. Contribution of ICT capital to GDP growth

| | GDP growth | Non-ICT capital | ICT capital | Labour force | TFP | Share of ICT capital in GDP growth |
|----------------|-------------|-----------------|-------------|--------------|-------------|------------------------------------|
| CEE-8 | 2,67 | 0,47 | 0,48 | -0,27 | 1,98 | 18,0% |
| Bulgaria | 0,51 | -0,89 | 0,45 | -0,60 | 1,55 | 88,4% |
| Czech Republic | 2,27 | 1,20 | 0,73 | -0,28 | 0,62 | 32,2% |
| Hungary | 3,64 | 0,37 | 0,71 | 0,18 | 2,38 | 19,4% |
| Poland | 4,81 | 1,98 | 0,55 | 0,23 | 2,05 | 11,5% |
| Romania | 0,79 | 0,08 | 0,22 | -1,35 | 1,84 | 28,3% |
| Russia | 1,12 | -0,97 | 0,09 | -0,17 | 2,17 | 8,3% |
| Slovakia | 4,10 | 1,15 | 0,55 | -0,35 | 2,75 | 13,5% |
| Slovenia | 4,10 | 0,87 | 0,54 | 0,20 | 2,49 | 13,1% |
| USA | 3,52 | 0,75 | 0,82 | 0,90 | 0,82 | 23,2% |
| EU-15 | 2,42 | 0,81 | 0,46 | 0,84 | 0,46 | 18,8% |

IV. ICT spillover effects

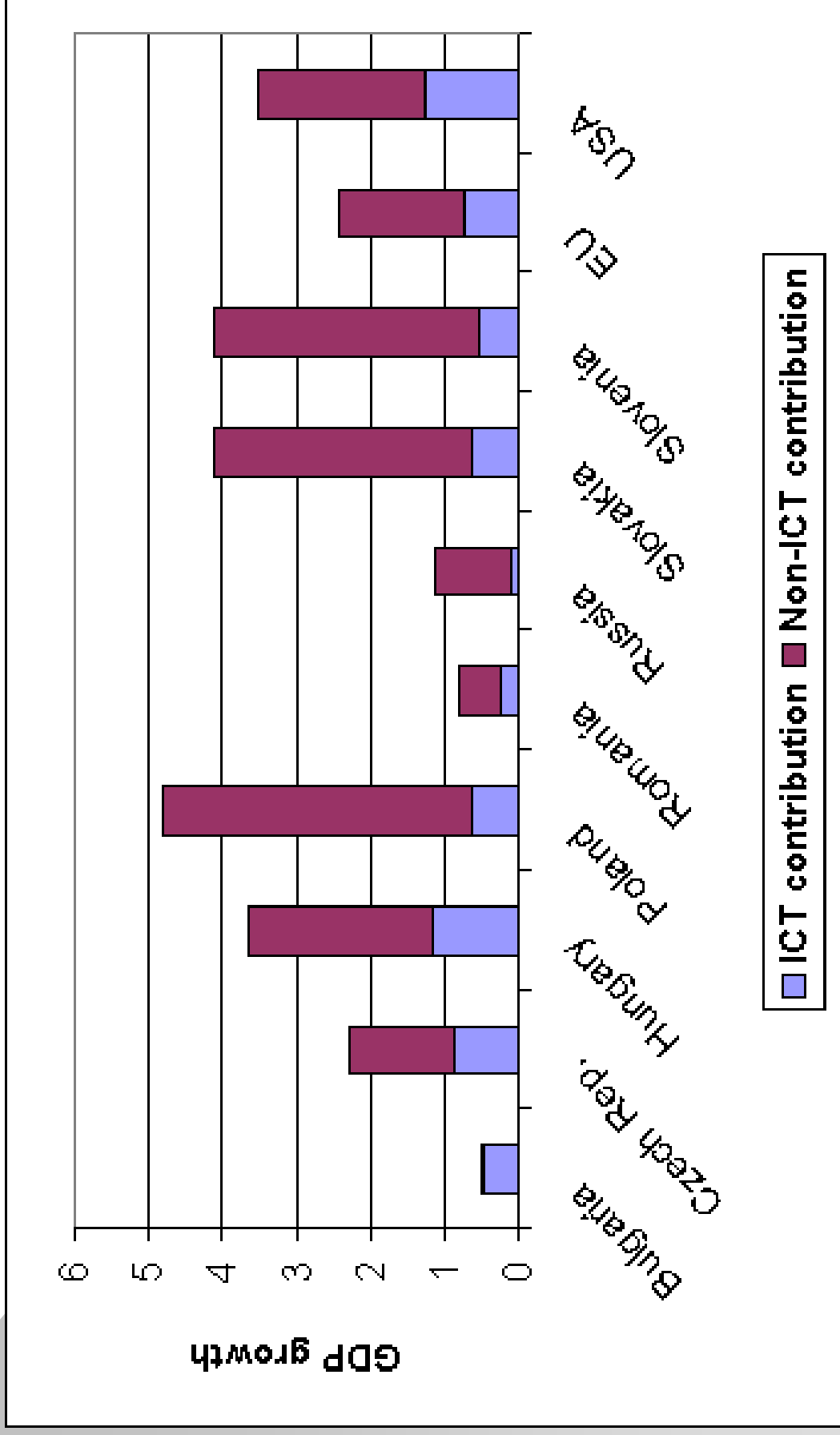


ICT spending as share in GDP

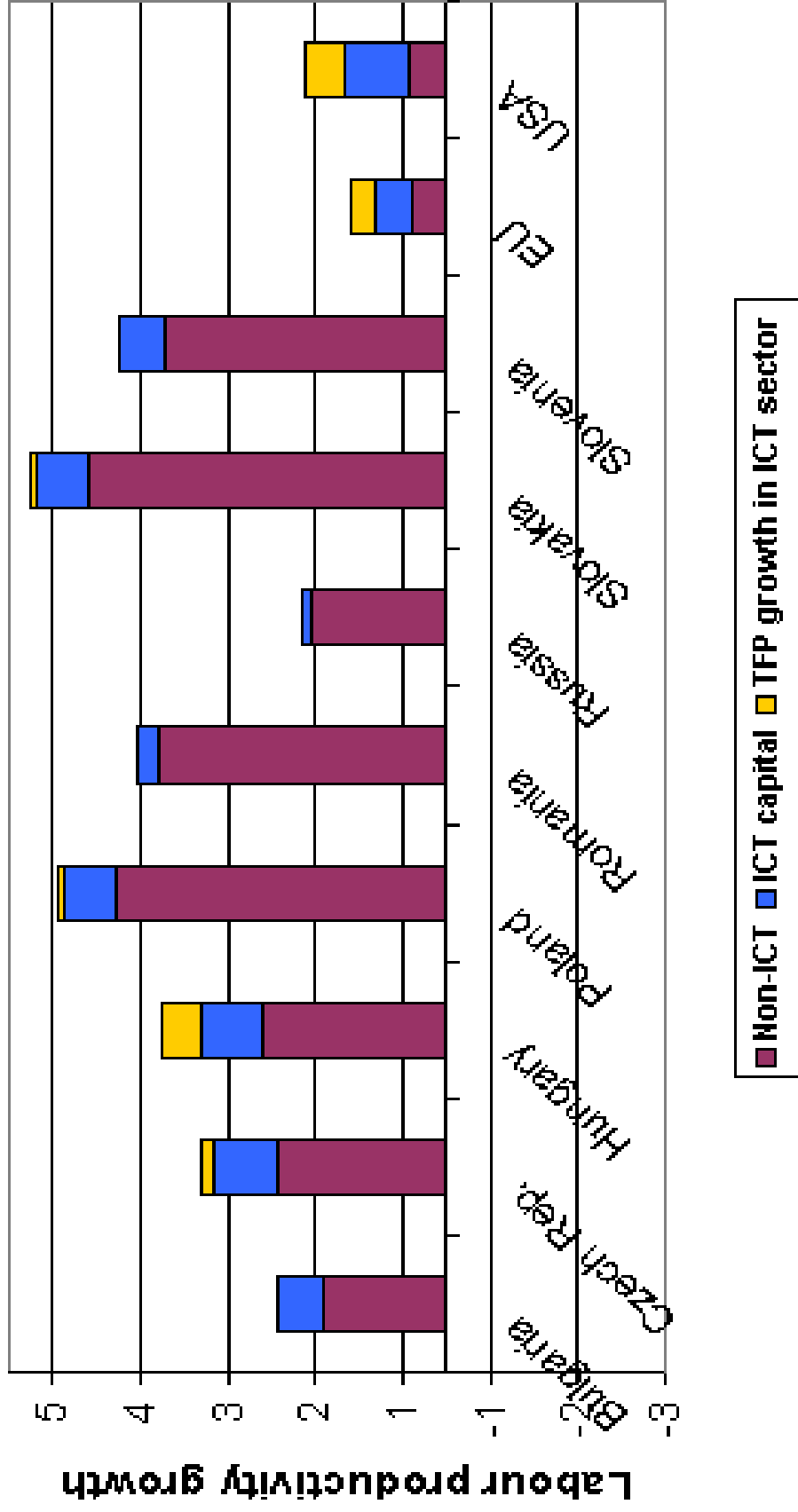
Potential for ICT spillovers...

- ICT (Internet) => faster production, diffusion, and sharing of knowledge => faster pace of innovation => increase in productivity growth rates;
- ICT accelerate diffusion of existing knowledge through imitation, adoption and diffusion of business models, ideas and through improving access to information;
- ICT tend to stimulate changes in business models and increased investments in human capital at the firm level. These positively contribute to increase in productivity;
- ICT – similarly to earlier technological revolutions based on general-purpose technologies (electricity, combustion engine) – may in future find yet unknown applications, which could enhance overall productivity growth.

Aggregate contribution of ICT to GDP growth, 1995-2001



And labour productivity...



Determinants of ICT use

Appendix Table B.1: Variables and data sources for the New Economy Indicator

| Factor | Variable | Source |
|--|---|------------------------|
| 1. Quality of regulations and contract enforcement | Sum of World Bank Regulatory Quality and Rule of Law Indicator* | Kaufmann et al. (2003) |
| 2. Infrastructure | Sum of total number of telephone lines (main and cellular) and PCs per 1000 persons | WDI 2003 |
| 3. Trade openness | Share of trade in GDP | WDI 2003 |
| 4. Development of financial markets | Domestic credit to private sector (% of GDP) | WDI 2003 |
| 5. R&D spending | Annual R&D spending (% of GDP) | Eurostat 2003 |
| 6. Quality of human capital | Public spending on education (% of GDP) | Eurostat 2003 |
| 7. Labour market flexibility | Unemployment rate | WDI 2003 |
| 8. Product market flexibility | Product market regulation indicator (Nicoletti et al. 2000)** | EBRD 2003 |
| 9. Openness to foreign investment | FDI (% of GDP) | WDI 2003 |
| 10. Macroeconomic stability | Inflation (CPI) | WDI 2003 |

„New Economy Indicator” ranking...

| Country | Rank | Value 1995-2001 |
|-------------------|------|-----------------|
| Sweden | 1 | 9.882 |
| Netherlands | 2 | 8.001 |
| Denmark | 3 | 7.331 |
| Ireland | 5 | 6.210 |
| UK | 4 | 6.343 |
| Belgium | 6 | 5.624 |
| Finland | 9 | 4.857 |
| Austria | 8 | 5.021 |
| USA | 7 | 5.162 |
| Germany | 10 | 3.105 |
| Portugal | 11 | 2.076 |
| France | 12 | 1.340 |
| <i>Slovenia</i> | 13 | -0.180 |
| <i>Czech Rep.</i> | 14 | -1.060 |
| Hungary | 15 | -2.163 |
| Italy | 17 | -3.141 |
| Spain | 16 | -3.102 |
| Greece | 18 | -5.399 |
| <i>Slovakia</i> | 19 | -5.670 |
| Poland | 20 | -7.042 |
| Bulgaria | 21 | -10.372 |
| Romania | 22 | -12.063 |
| Russia | 23 | -13.375 |

Potential of ICT investments for GDP growth in Poland until 2025

- Assumptions:
 1. Employment will grow by 0.5% annually until 2025. This would translate – *ceteris paribus* – into the unemployment level of 7% at the end of the period.
 2. Depreciation rate for non-ICT capital: 7.5% annually; for IT hardware, software and communications equipment: 29.5%, 31.5% and 11.5%, respectively.
 3. Labor compensation share in total income to amount to 65% throughout the period
 4. TFP growth: 1.5% annually (versus 2,05% on average during 1995-2001).
 5. ICT hedonic price deflator: prices of IT hardware, software and communications equipment until 2025 will decrease at an average hedonic rate equal to the 1990-2001 average rate for the US, that is, respectively, 20.7%, 1.3% and 3.2% annually.
 6. Non-ICT deflator: 3% annual growth.
 7. Increase in real investments in ICT (before deflation with hedonic price index): 5, 10% and 15% annually.
 8. Increase in real non-ICT investments: 5% annually.

Contribution to GDP growth...

| Real rate of growth in ICT investments* | GDP growth | Total capital | Non-ICT capital | ICT capital | Labour force | TFP | Share of ICT in GDP growth |
|---|------------|---------------|-----------------|-------------|--------------|------|----------------------------|
| 5% | 3,76 | 1,94 | 1,59 | 0,35 | 0,32 | 1,50 | 9,3% |
| 10% | 4,01 | 2,19 | 1,59 | 0,60 | 0,32 | 1,50 | 15,0% |
| 15% | 4,26 | 2,43 | 1,59 | 0,85 | 0,32 | 1,50 | 20,0% |

ICT is key to future growth...

- Simple, post-transition growth reserves are by now almost exhausted.
- In future, fast output and LP growth will have to rely mostly on growth in TFP, which will not be possible without sustained progress in economic restructuring (in particular of the service sector) based on the use of ICT
- Investments in ICT have to be complemented with changes in organizational structures and increase in ICT skills of the labour force

ICT provide additional opportunities..

- Implementation of ICT is likely to stimulate faster productivity growth on the firm level (spillover effects)
- New, yet unknown applications of ICT can in future contribute to increase in productivity
- Yet, more time is needed for firms to learn to productively use ICT – CEE countries to fully benefit after 2010

Policy recommendations

- Conducive overall business environment – macroeconomic stability, low administrative barriers, transparent and effective regulations
- Competition, competition, competition!
- Development of public e-services (push strategy)
- Implementation of public e-procurement systems
- Political priority for ICT
- Promotion of benefits of ICT use among businesses and individuals
- Increased outlays on ICT training (ICT „driving licences”, lifelong learning)