

fondazione RODOLFO DEBENEDETTI

**The information economy: Productivity Gains and
the Digital Divide**

Catania, June 15th, 2002

**THE SPREAD OF ICT AND PRODUCTIVITY
GROWTH
IS EUROPE REALLY LAGGING BEHIND IN
THE NEW ECONOMY?**

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Motivation of the study

- ✓ Recent evidence suggests growing disparities in growth performance, and challenges some stylised facts
- ✓ The acceleration in growth in some countries has been attributed to the spread of ICT
- ✓ Europe appears to be lagging behind in the adoption of ICT. Can this help explain why growth in Europe has been slow?
- ✓ The slowdown and mild recovery have offered new elements in this debate,

but, behind cyclical fluctuations, the issue is whether there has been any structural shift in some countries and whether this shift has been encouraged (or discouraged) by policy and institutions

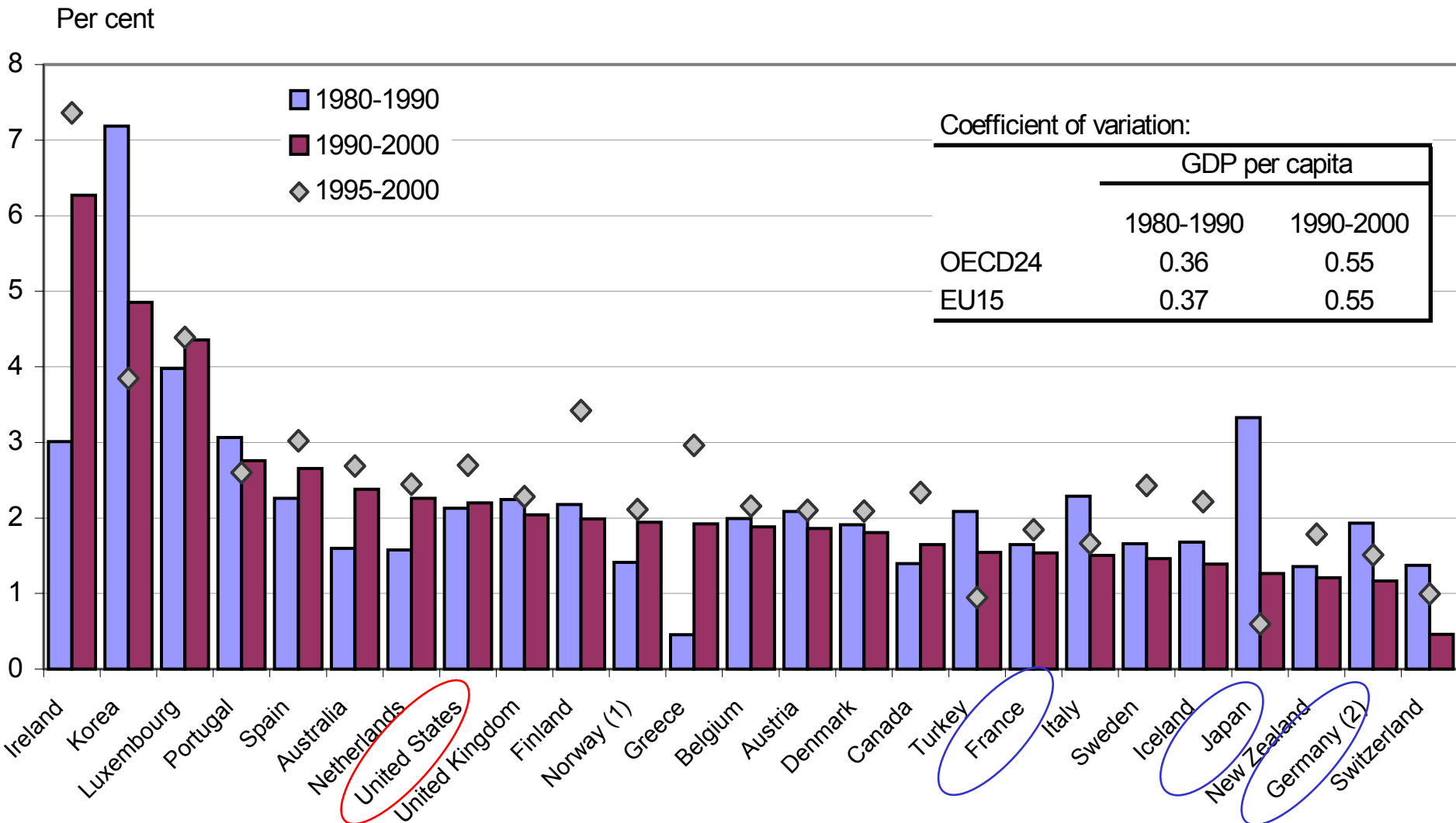
- ✓ We use harmonized macro, sectoral and micro data to shed light on these issues for the OECD countries

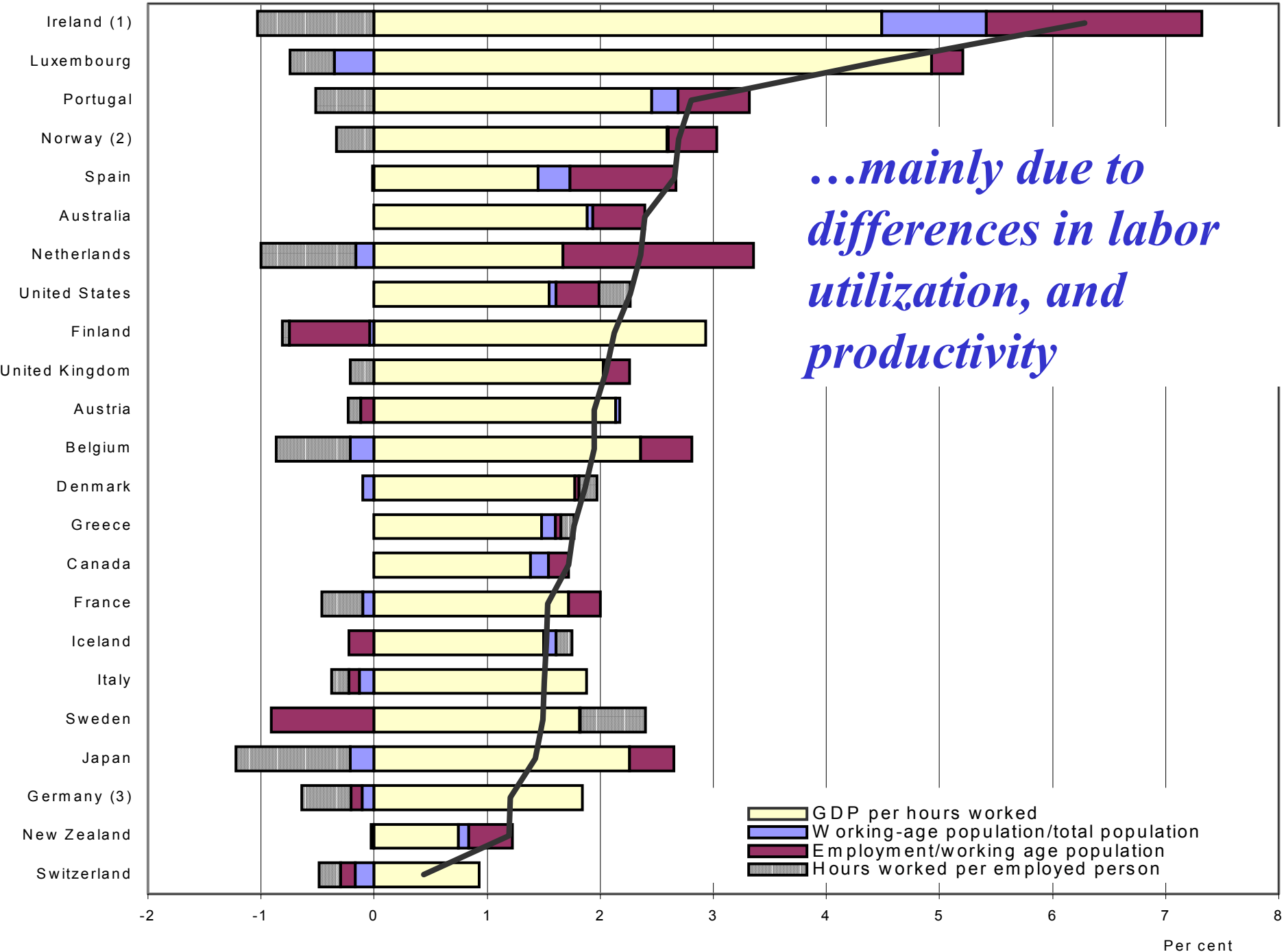
Plan of the presentation

- ❶ What do aggregate data tell us about the main drivers of growth in OECD countries? *Evidence from aggregate growth accounting*
- ❷ What is the role of reallocation of resources across sectors, and across firms, within each sector? *A productivity decomposition approach*
- ❸ What is the role of firm dynamics and investment in high tech for innovation, adoption and growth? *Evidence from micro data*
- ❹ What theory tells us about the possible policy factors that may influence adoption and innovation?
- ❺ Is there any empirical evidence on the links between these factors and performance? *Regression analysis*

...large differences in GDP per capita growth

Growth of GDP per capita in the OECD area over the past two decades
 Average annual rates of change, cyclically-adjusted series





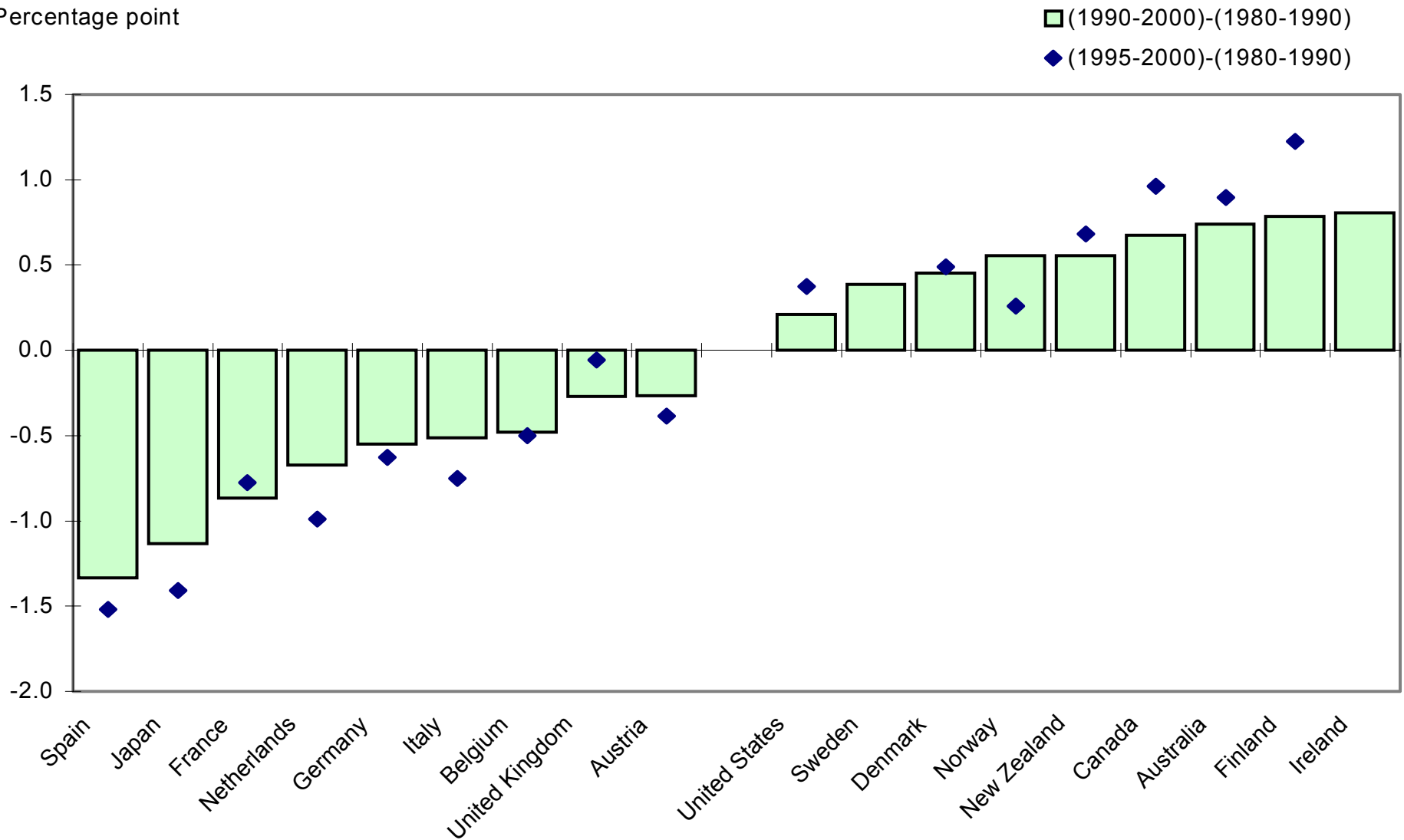
...mainly due to differences in labor utilization, and productivity

GDP per hours worked
 Working-age population/total population
 Employment/working age population
 Hours worked per employed person

...but also because MFP has accelerated in some countries

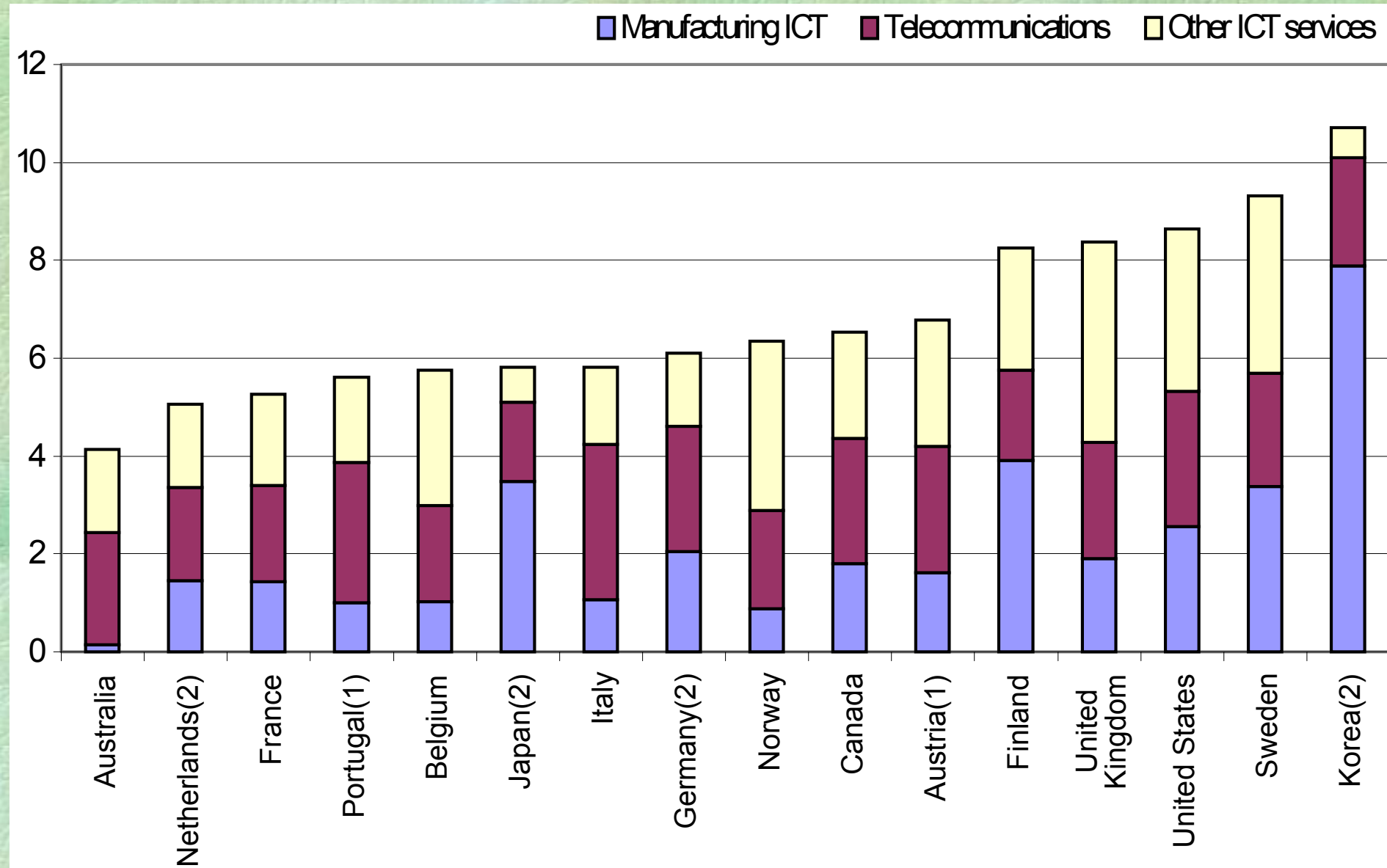
Changes in MFP growth rates, (1990s¹ vs.1980s²)

Percentage point

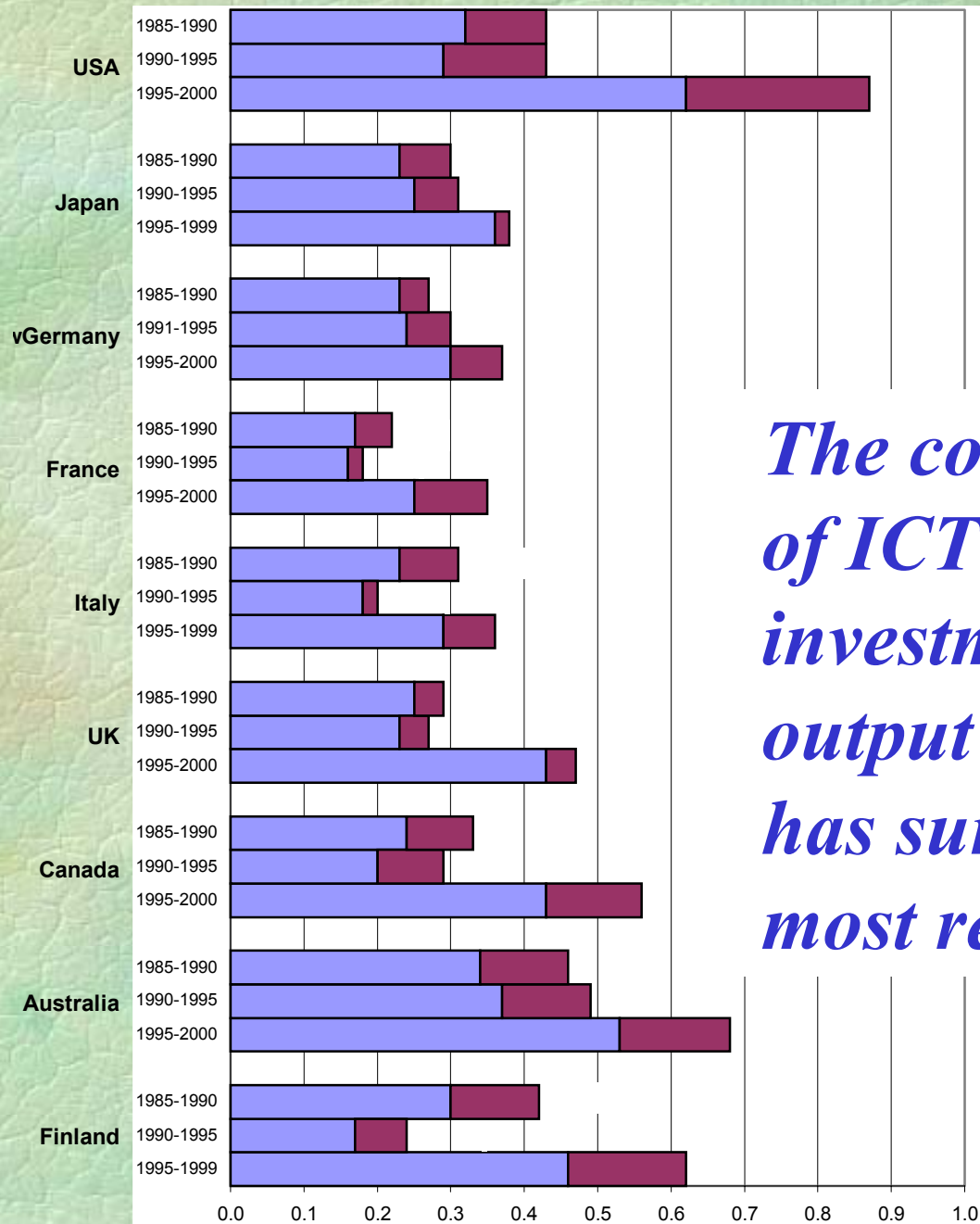


The size of the ICT industry varies across countries

Share of ICT in total business sector, Value added



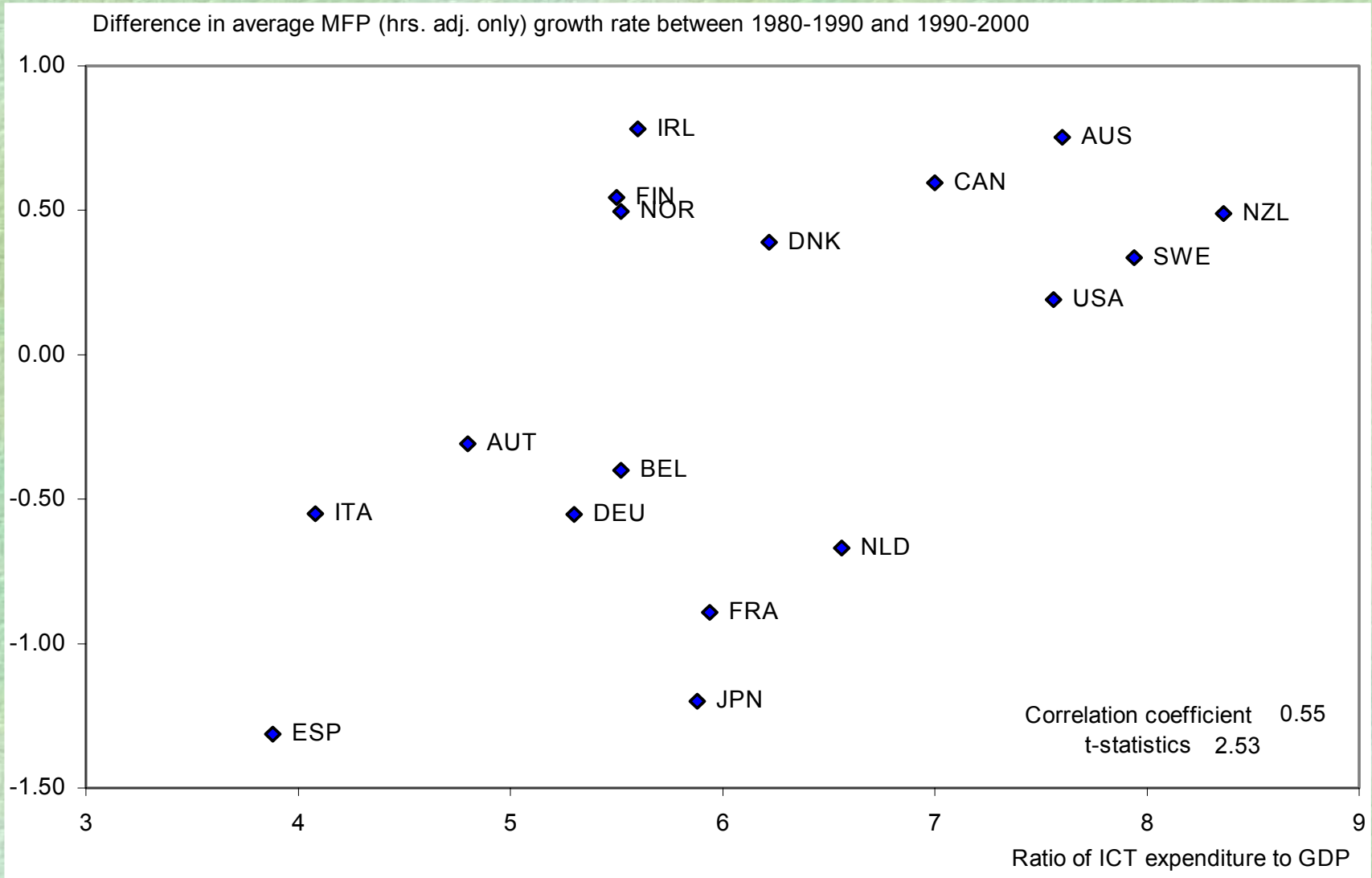
The contribution of ICT capital to output growth
Total industries, based on harmonised ICT price index



The contribution of ICT investment to output growth has surged in most recent years

more difficult to detect spillover effects of ICT (e.g. in MFP growth), but some indirect evidence

ICT expenditure and changes in MFP growth rates



Summing up the macro evidence

- **Growing disparities in GDP per capita growth are largely due to a widening of labour utilisation patterns**
- **...also large differences in the pace of MFP, with some countries accelerating (US, CA, AUS, IRL), but most large European countries further decelerating**
- **The size of the ICT-producing industry varies significantly and its rapid productivity pace can help explain some of the cross-country differences**
- **ICT-driven capital deepening also very different**
- **The acceleration in MFP in some countries appears to be a combination of embodied and disembodied components**
- **...and there is some indirect evidence that ICT may also be producing spillover effects in the whole economy (via Internet, e-commerce etc.)**

Scraping the surface: the role of sectoral shifts

- **Sectoral shifts in resources have played a minor role in shaping aggregate productivity patterns, most of the effects are *within***
- **However, ICT producing industries experienced a major boost in productivity and, depending on their size, contributed to overall growth**
- **More interestingly, the contribution of ICT-using industries to overall productivity growth varies greatly across OECD countries; higher than average in U.S., especially in services**

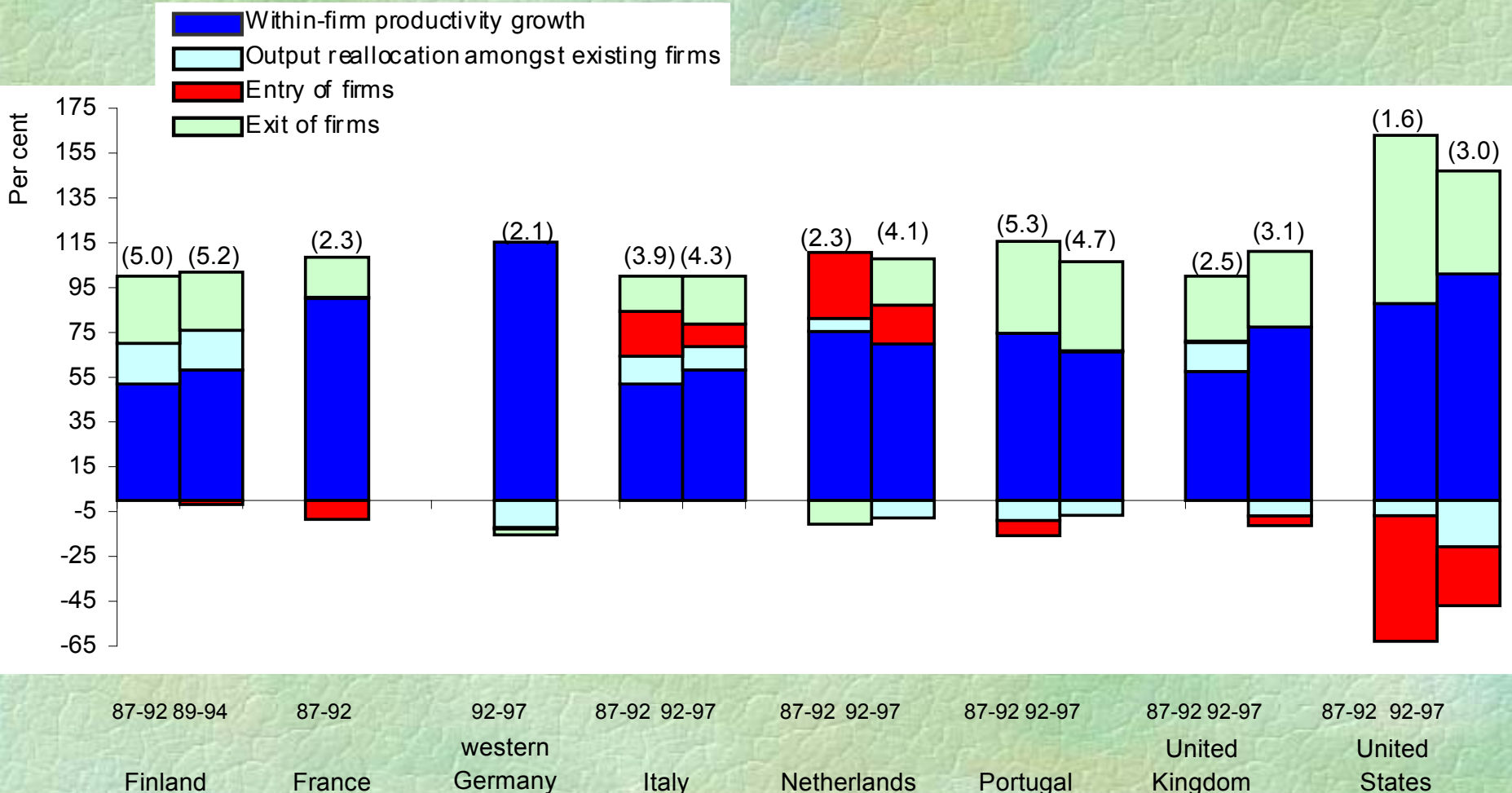
This evidence raises a number of questions, including:

- ✓ *Why have some countries (e.g. US) developed a larger ICT industry than others (e.g. Continental Europe)?*
- ✓ *Why have some countries invested more than others in ICT equipment and exploited its potential?*

Firm-level evidence for 10 countries

contribution of within, reallocation, entry and exit

Manufacturing industries, 1989-94

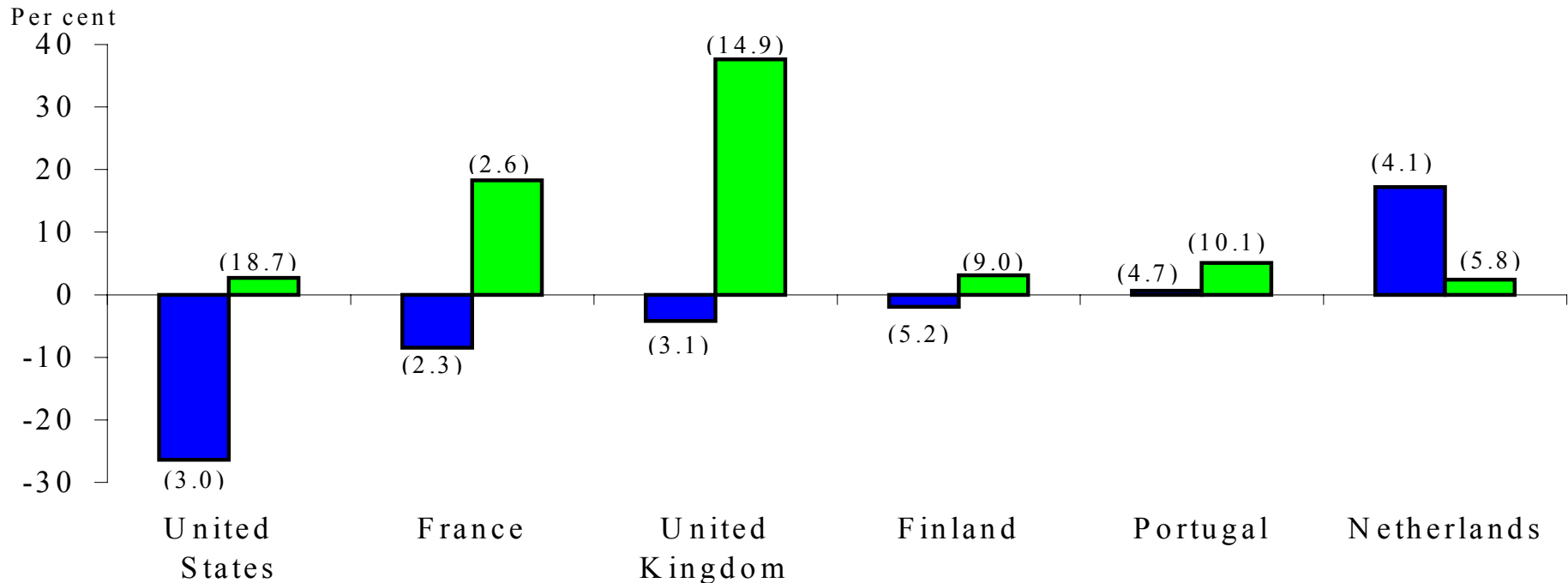


...but in high-tech industries entry boosts productivity even in the US

Contribution of new entry to labour productivity growth in manufacturing and selected ICT industries

Percentage share of total productivity growth¹

■ Total manufacturing ■ Office accounting and computing machinery (2)



1. Total productivity growth in parenthesis.

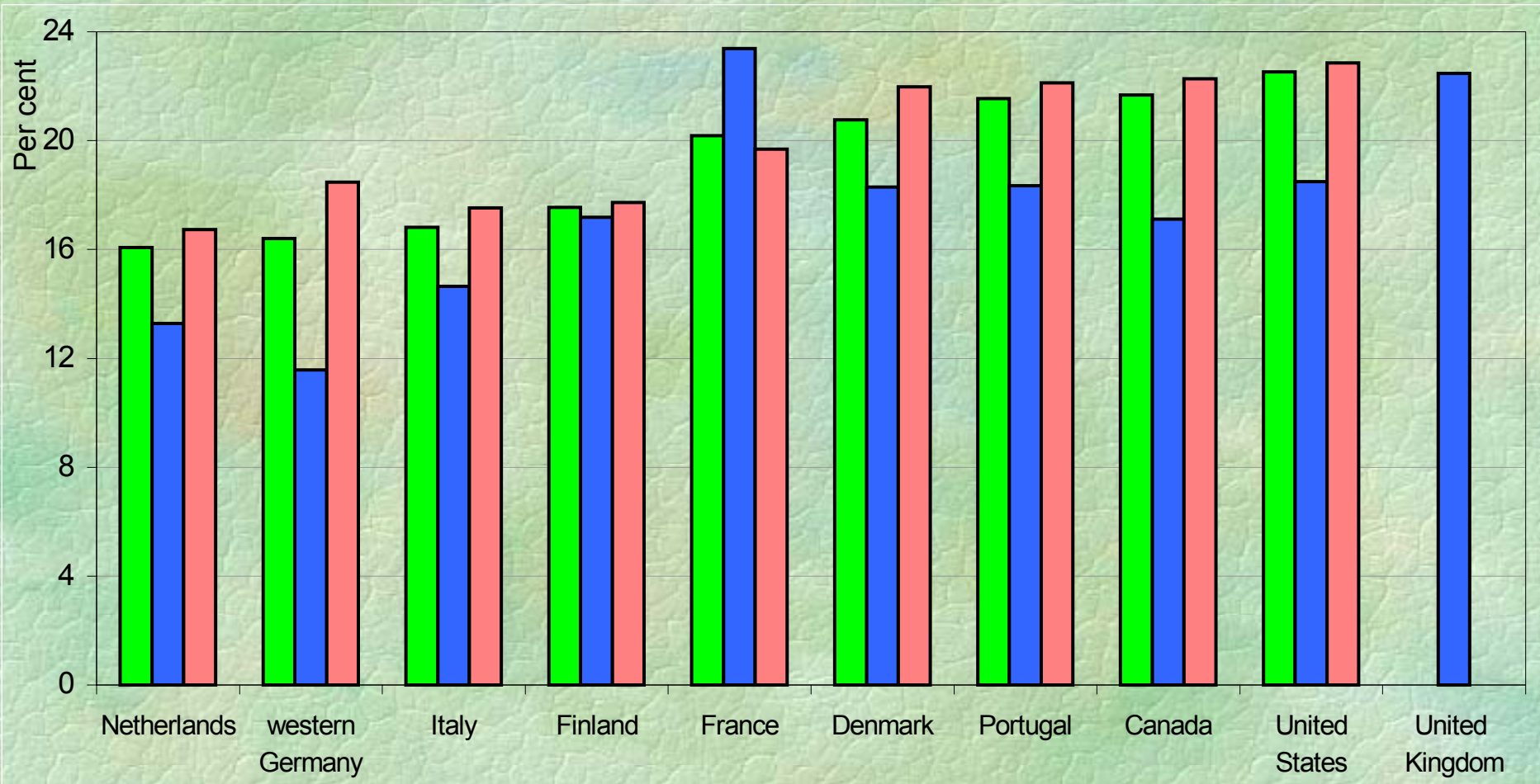
2. Electrical machinery and apparatus n.e.c. for France, Netherlands and Portugal.

Source : OECD.

Firm turnover (entry + exit rates) is significant...

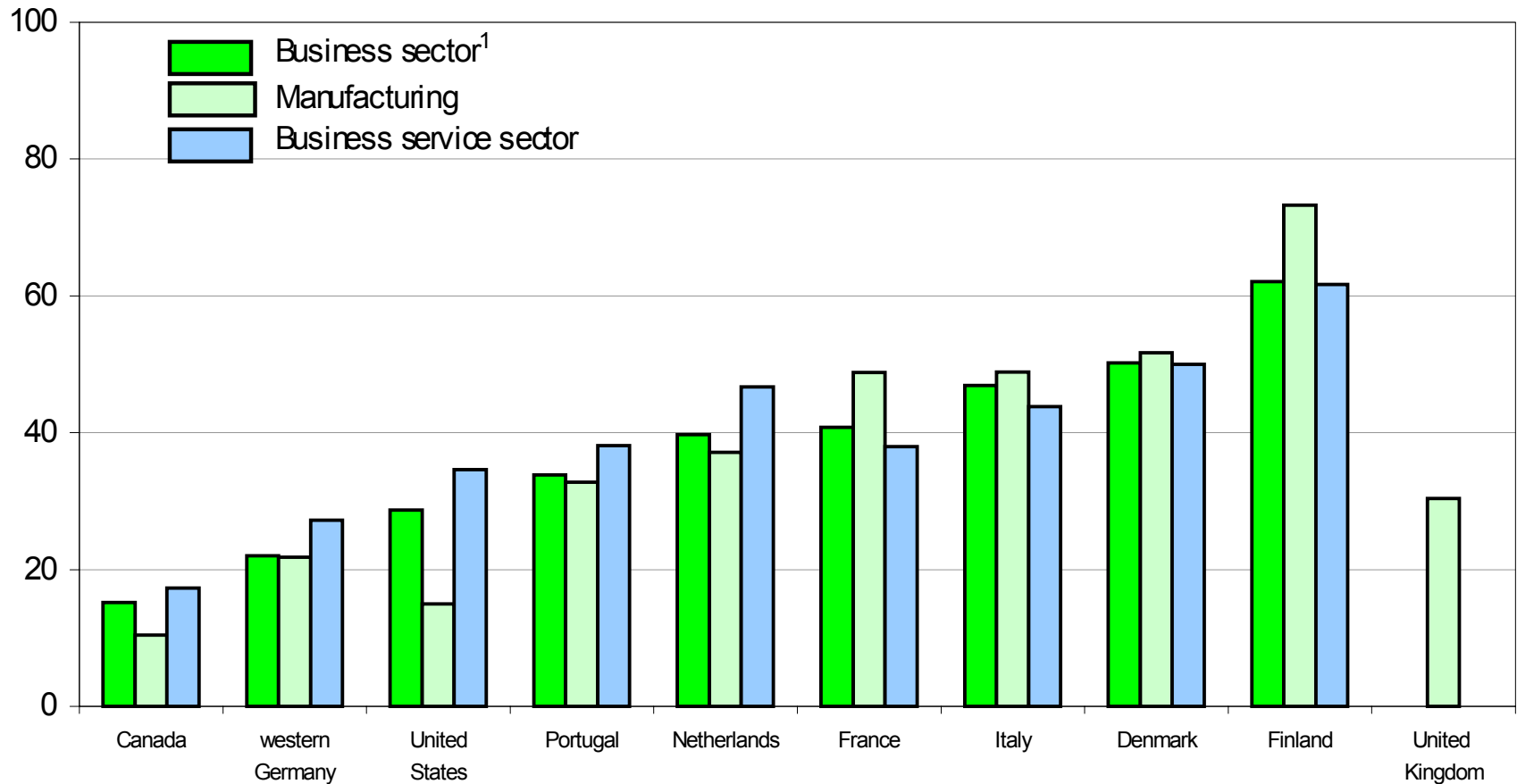
- Business sector²
- Manufacturing
- Business service sector

Overall firm turnover in broad sectors



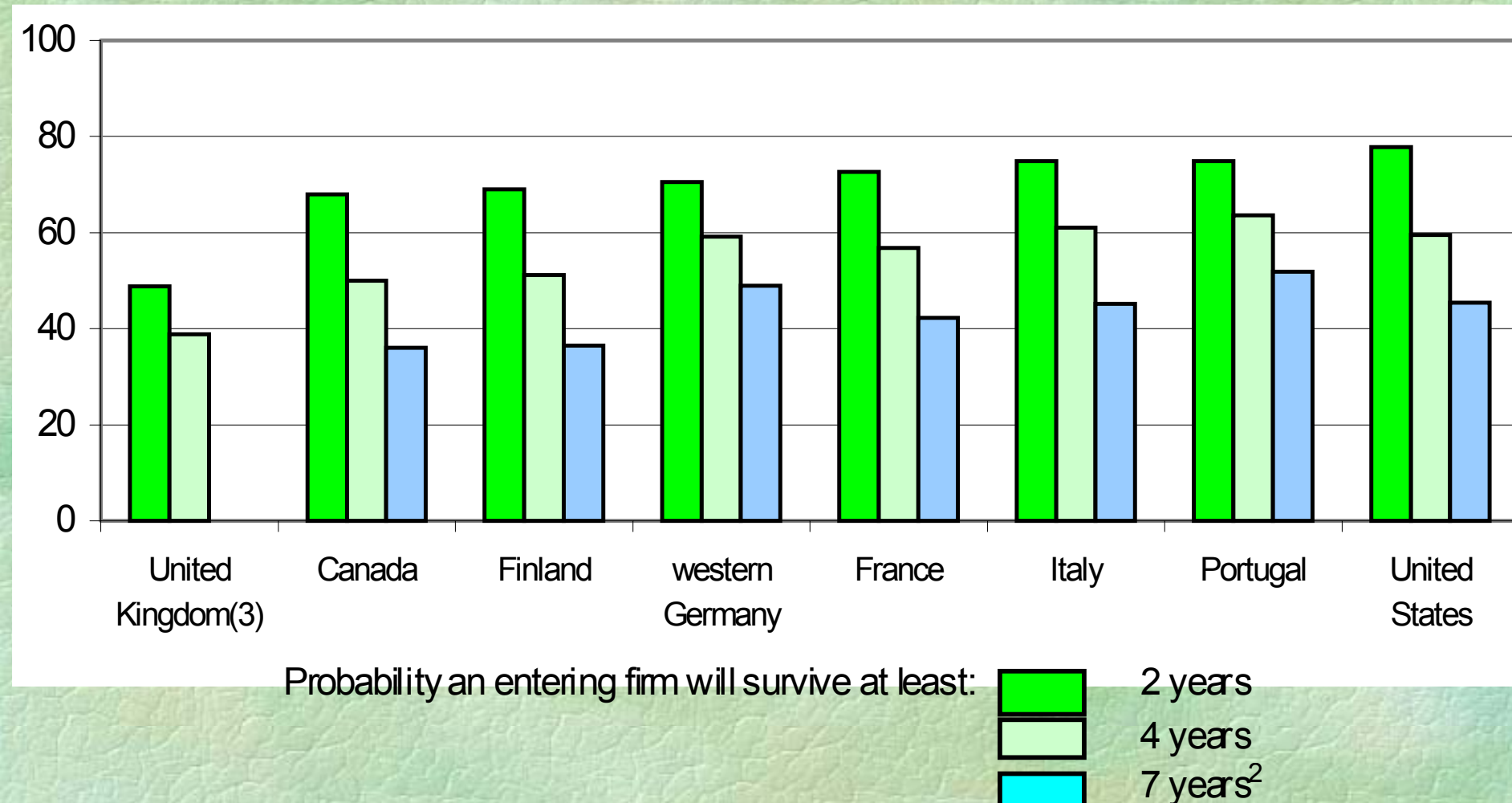
*...but involves a modest fraction of employment,
because entrants are relatively small...*

Relative size of entering firms with respect to incumbents (in per cent)



Survivor rates suggest high failure in the initial years, but no major difference across countries




Total manufacturing



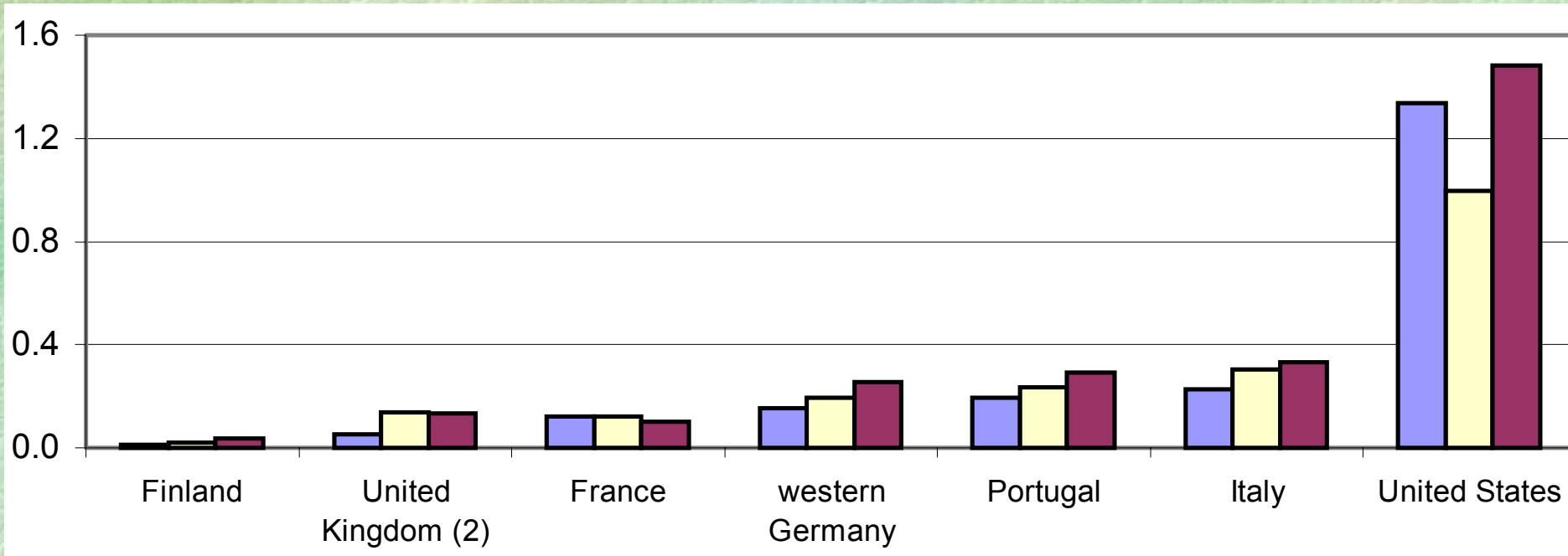
...although there are strong differences in the expansion of successful firms

Net employment gains among surviving firms at different lifetimes, 1990s

(net gains as a ratio of initial employment)

Average employment gains of surviving firms:  after 2 years
 after 4 years
 after 7 years¹

Total manufacturing



Summing up the sectoral and micro evidence

- **US have been better in gaining comparative advantage in rapidly growing ICT market segments. The U.S. also experienced a more widespread productivity acceleration of ICT-user industries**
- **Firms' behaviour in the US markets also differs compared with that of firms in EU. In particular,**
 - **In the US, *entrant firms tend to be more heterogeneous* in terms of both size and productivity than in Europe;**
 - ***Selection effects work quickly* so that weak recent entrants exit the market and this is associated with a stronger contribution of exits to total labour productivity in the US compared with Europe;**
 - **Moreover, selection and learning effects imply that successful, *surviving entrants expand rapidly*, generating stronger post-entry growth.**
- **All in all, there seems to be more market experimentation in the US than in Europe**

Further evidence on micro data - U.S. vs. Germany

➤ Exploit harmonized micro data in U.S. and Germany for 2000

➤ Measure:

➤ Labour Productivity, Payroll Per Worker, ICT investment, Skill Mix, Establishment Age and Size

➤ Objectives:

➤ What is the relationship between ICT and outcomes like productivity and payroll per worker?

➤ Is there evidence of greater market experimentation in U.S.?

➤ Findings:

➤ Greater impact of ICT investment on differences in productivity and payroll per worker across businesses in U.S.

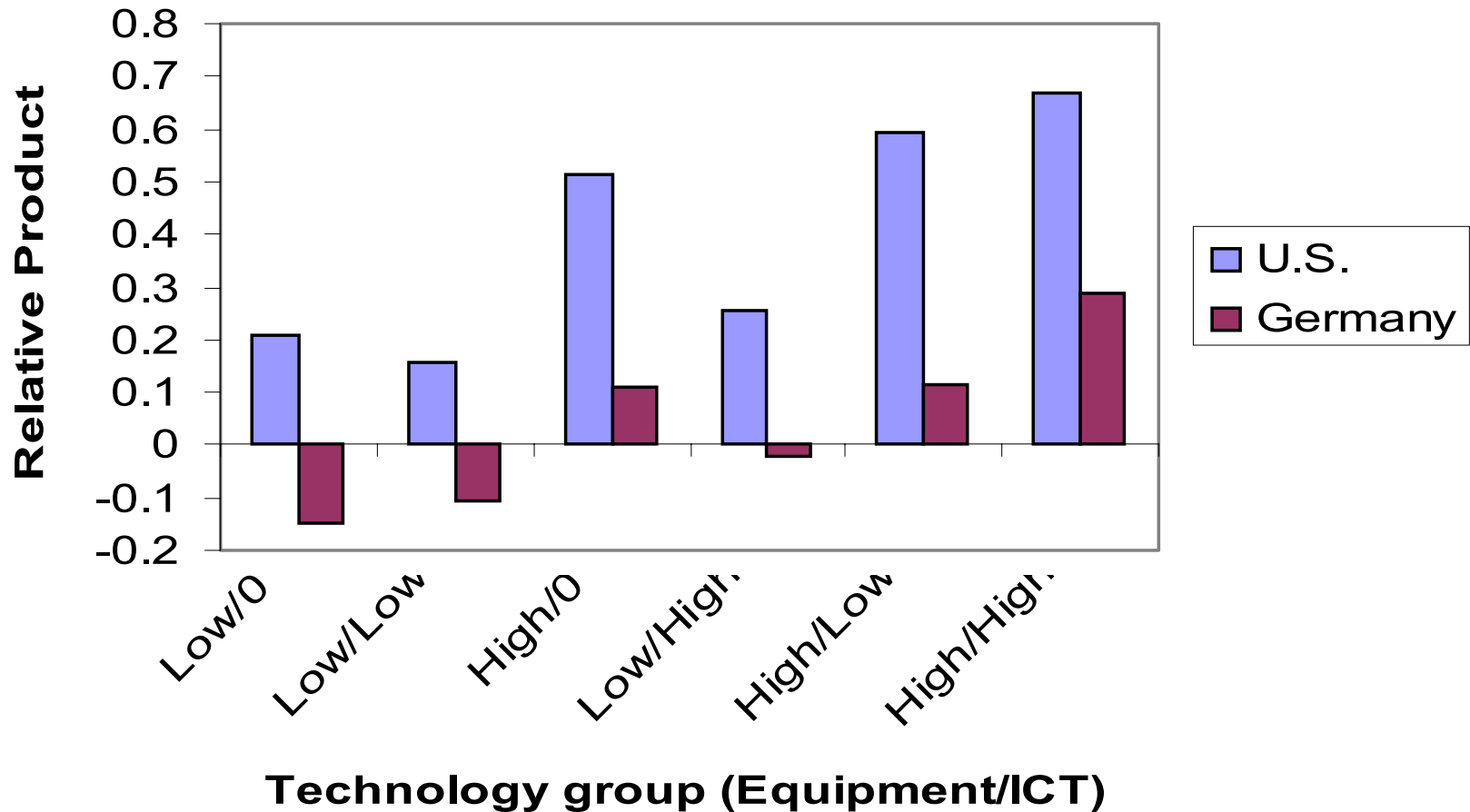
➤ Evidence of greater market experimentation in U.S. (i.e., greater dispersion in outcomes and choices) especially for businesses most actively changing technology.

➤ Interpretation:

➤ U.S. firms choose higher mean, higher variance strategy

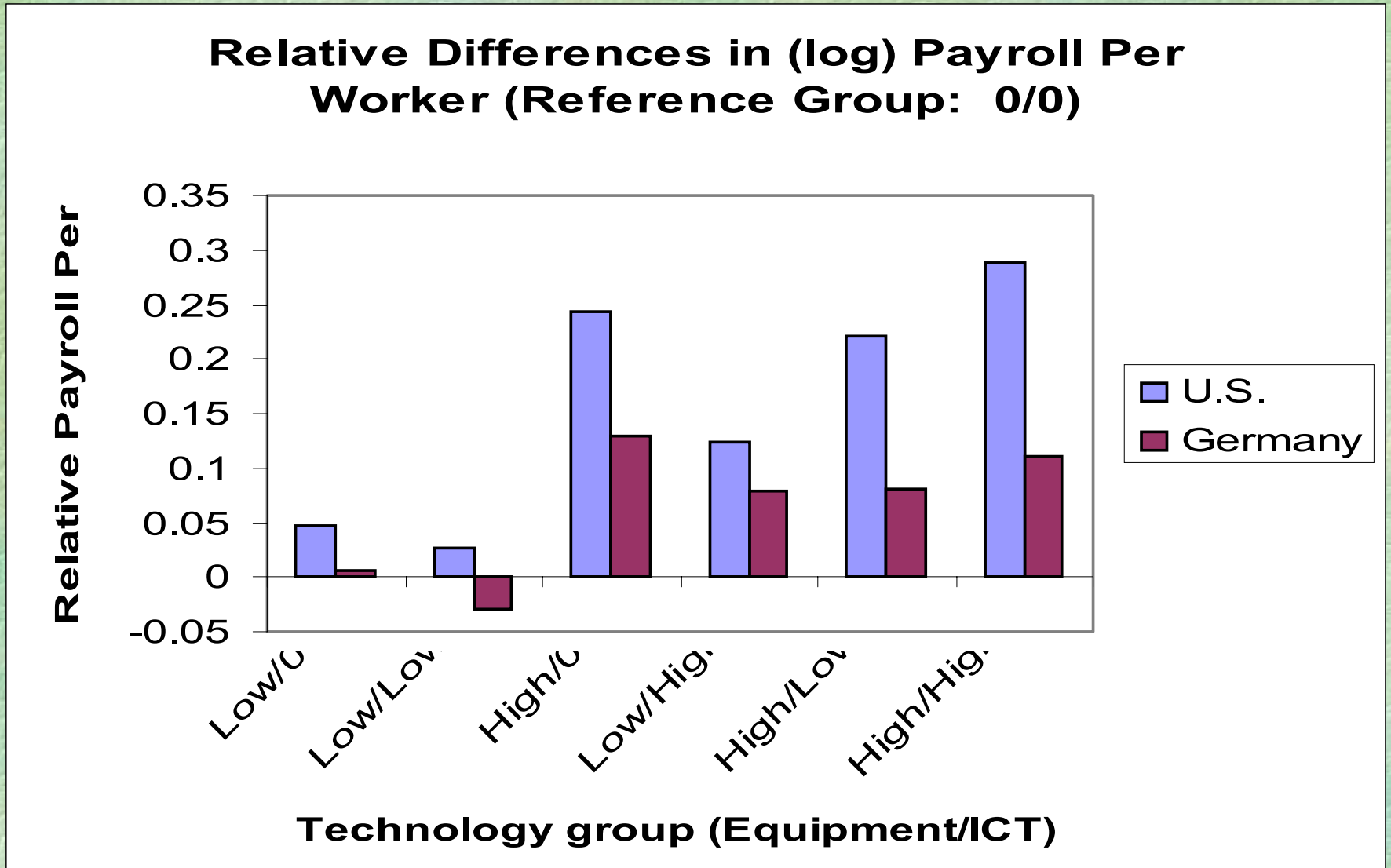
Greater impact on productivity differentials across technology groups:

Relative Differences in (log) Labor Productivity (Reference Group: 0/0)



Controls include size, age, industry, skill mix, internet access

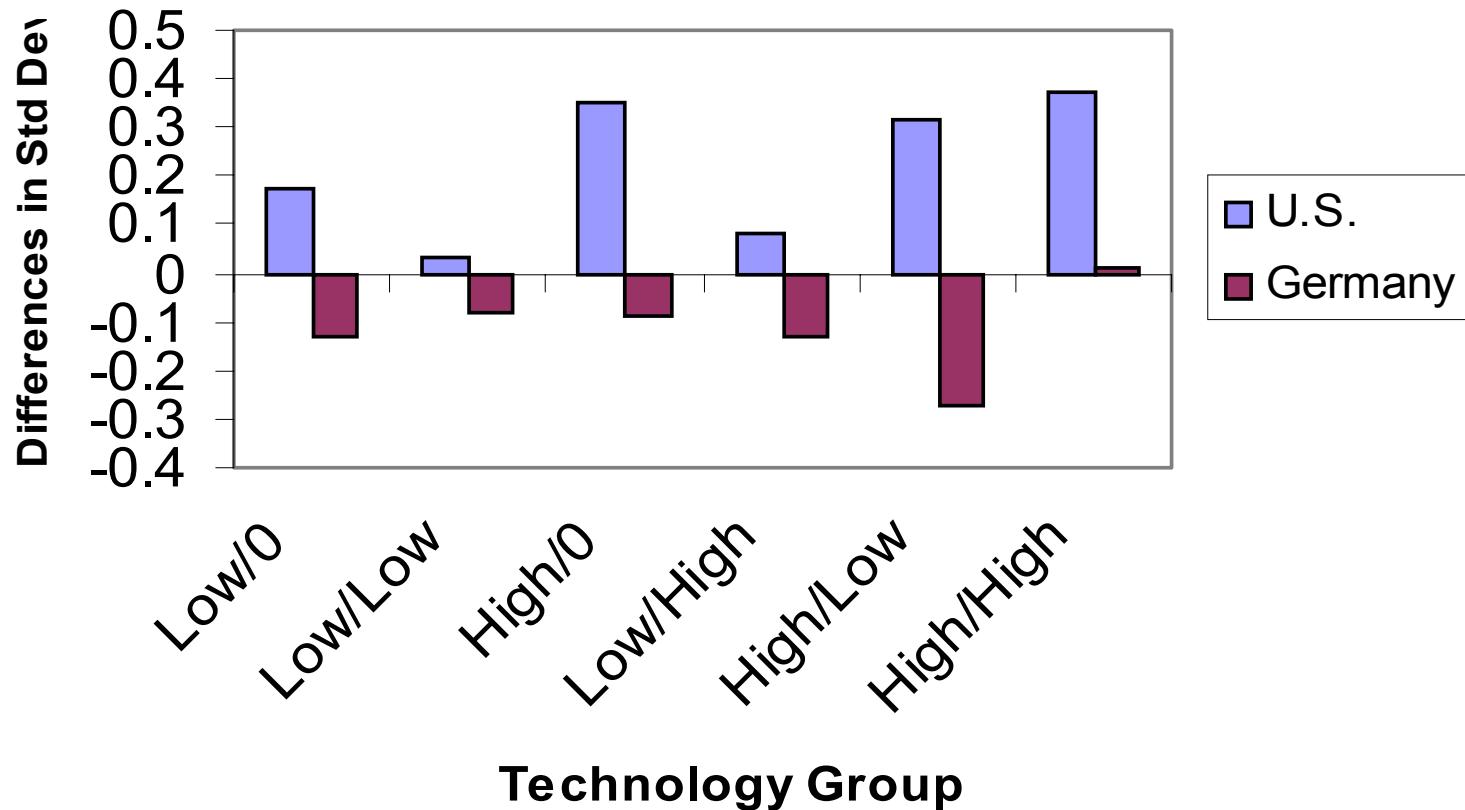
Greater impact on payroll per worker differences :



Controls include size, age, industry, skill mix, internet access

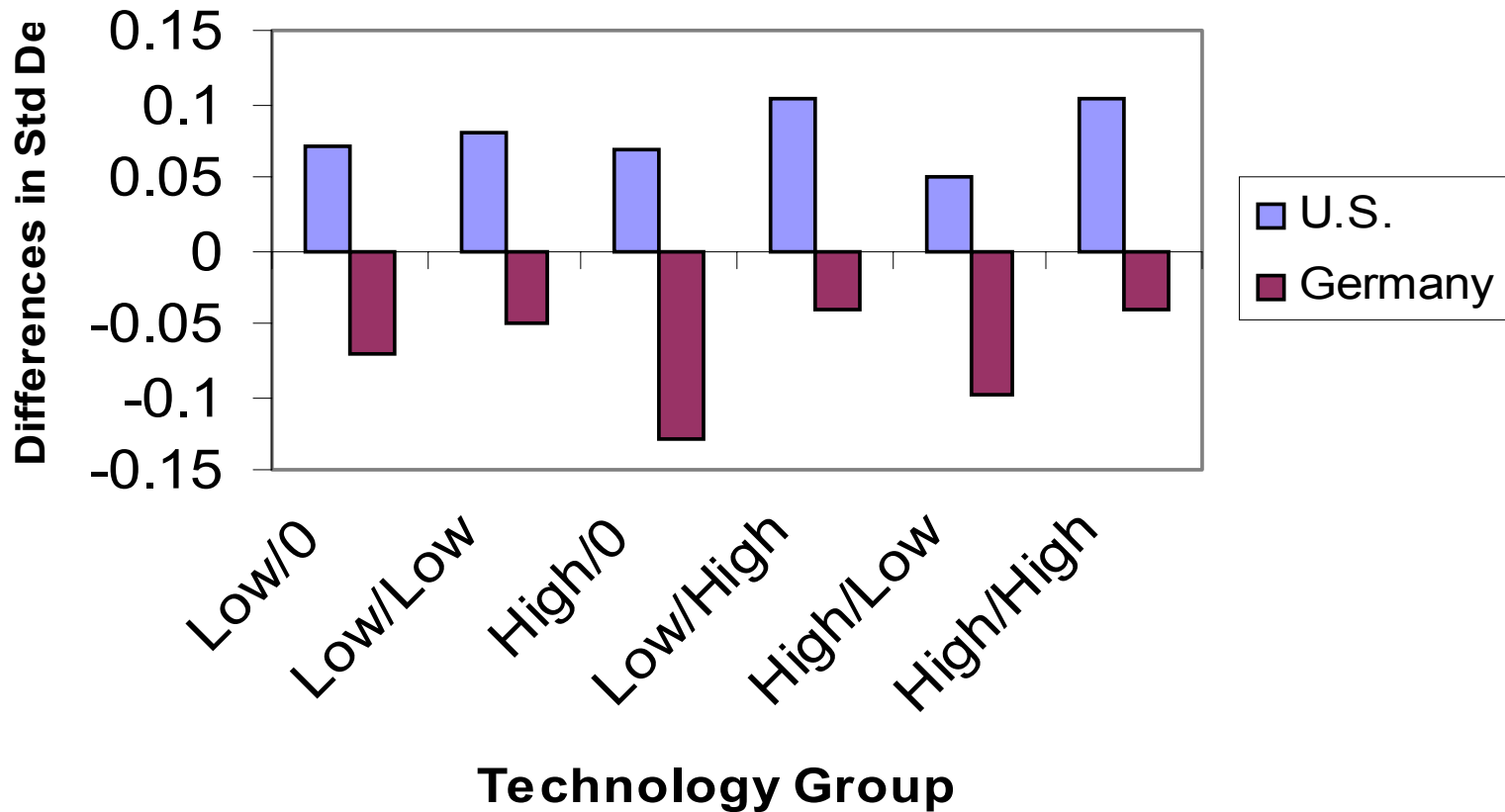
Higher variance in labor productivity for those most actively changing their technology:

**Relative Dispersion of (log) Labor Productivity
(Reference Group: 0/0)**



Higher variance in ways of doing business for those most actively changing their technology:

Relative Dispersion of Skill Mix (Reference Group: 0/0)



More on experimentation:

- ✓ Finding of greater dispersion for U.S. firms most actively changing technology also holds for:
 - Payroll Per Worker
 - Equipment Investment Per Worker
 - Computer Investment Per Worker
 - Internet Access Per Worker
- ✓ Differences in productivity dispersion across technology groups in U.S. accounted for by observable and unobservable factors.

Guidance from Theory Before Considering Policy Differences...

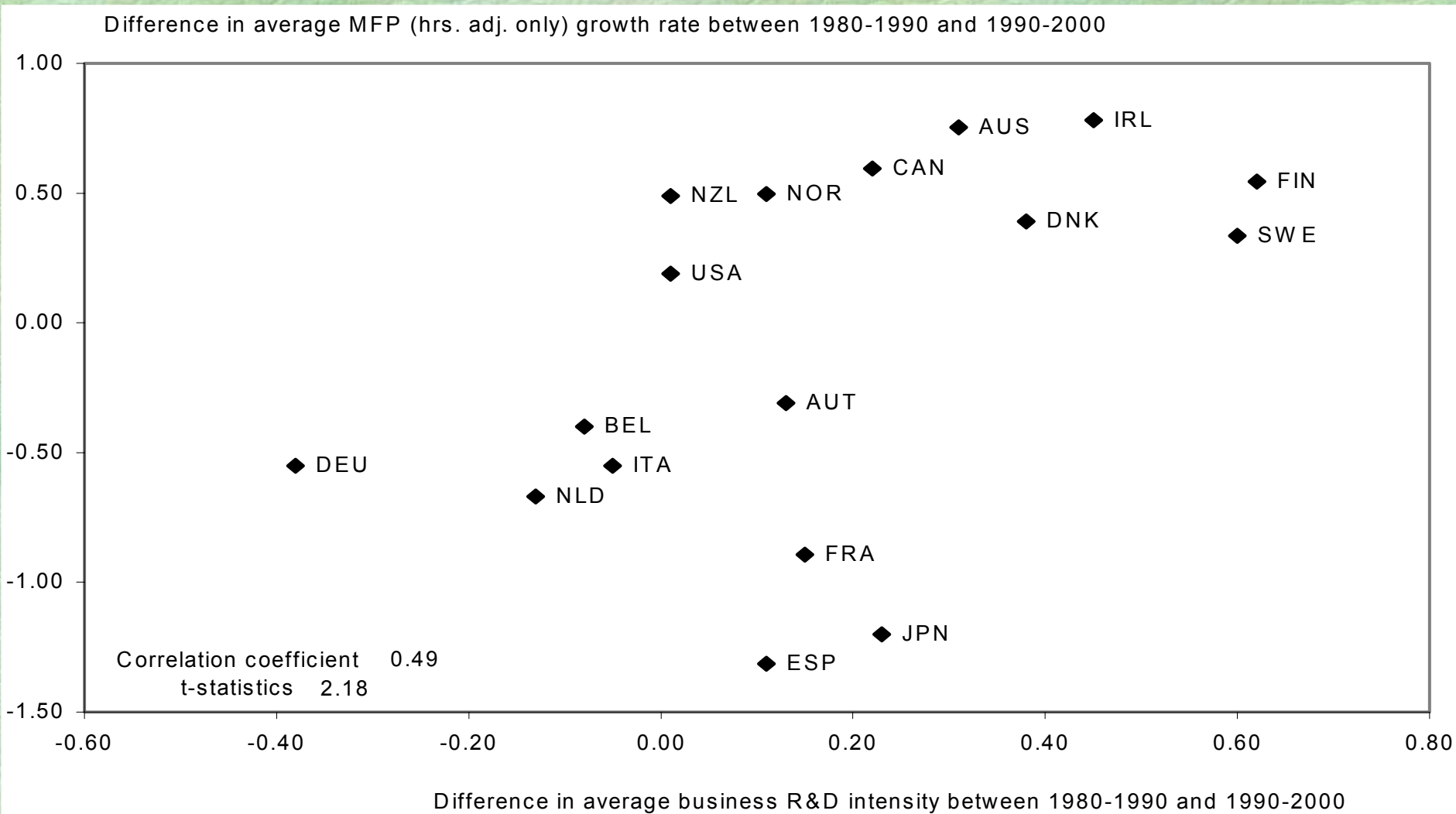
- ✓ **Channels for ICT to impact growth:**
 - ✓ Traditional capital deepening
 - ✓ ICT as innovative activity
 - ✓ Contribution of ICT producing sector
- ✓ **Development, adoption, diffusion of ICT is costly and uncertain – market experimentation inherent on both development and adoption margins...**
- ✓ **“Appropriate Market Institutions”:**
 - ✓ Complex relationship between market structure and innovative activity
 - ✓ Market institutions should take into account selection and learning effects associated with market experimentation
 - ✓ Policies that act as barrier to reallocation of outputs and inputs across businesses can adversely impact successful adoption and diffusion of innovative activities like ICT.

Policy, regulations and industry performance

- ✓ Ideally we would like to link data on policy & institutions with data on investment in ICT and productivity
- ✓ ...but policy and institutions vary mainly across countries and data are lacking for some variables, e.g. ICT investment by industry and country
- ✓ Thus, we look at the link between policy & institutions and either productivity or innovation (R&D) across all manufacturing industries using pooled data (country, industry and time):
 - ✓ the period (early 80s - 90s) covers the spread of ICT
 - ✓ we distinguish technology trajectories and identify ICT-intensive industries

Some bivariate relations: there is a link between the acceleration of MFP and change in R&D

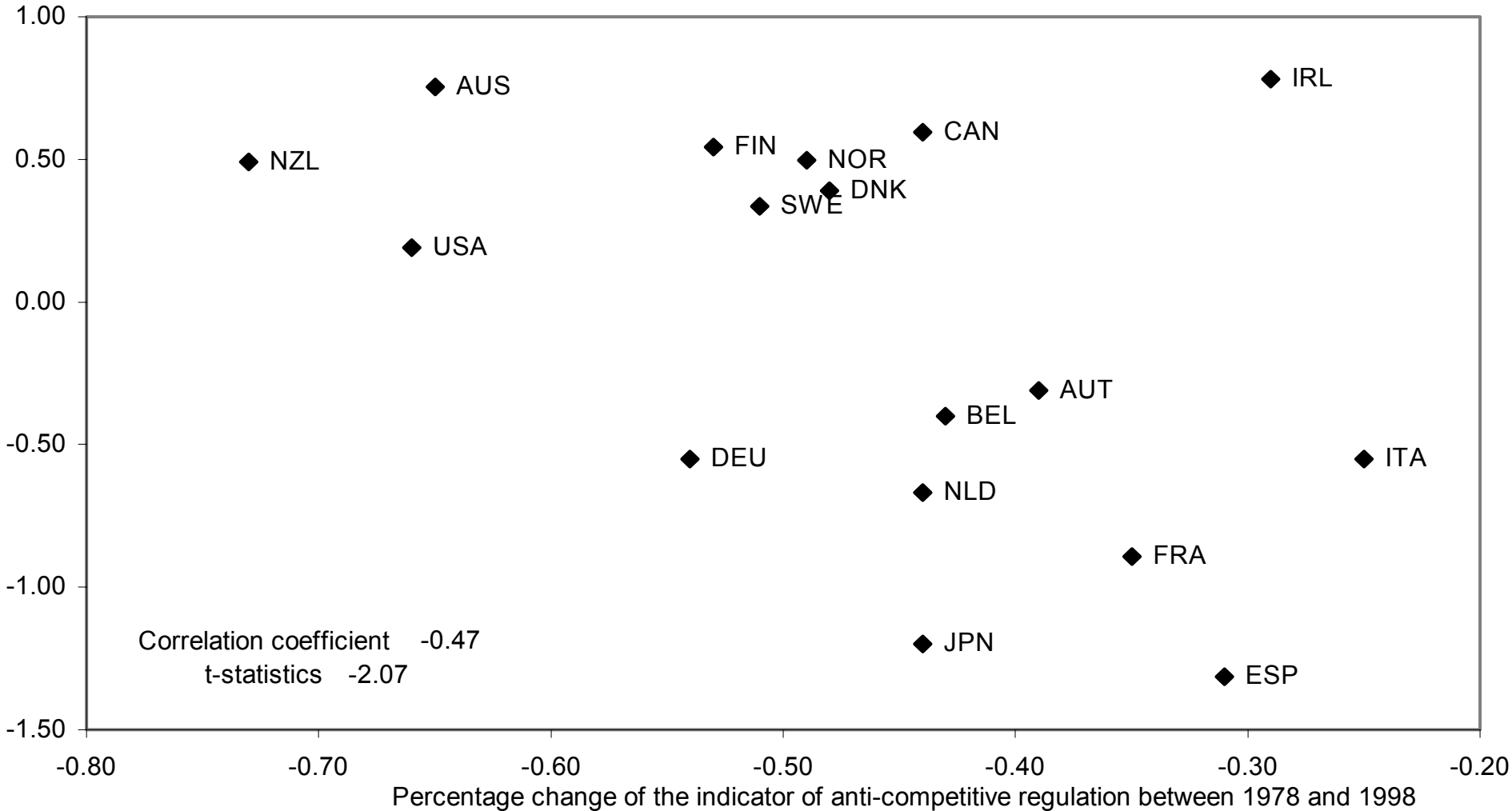
Changes in R&D intensity and MFP growth rates (1990s vs. 1980s)



...and there is a link between acceleration of MFP and change in product market regulations

Product market regulation and MFP growth ¹

Difference in average MFP (hrs. adj. only) growth rate between 1980-1990 and 1990-2000



Assessing MFP performance

- ✓ We assume that MFP growth in each industry/country is a function of technological progress in the industry and of the technology gap with the frontier country
- ✓ We allow R&D, policy and regulations to affect MFP both directly and indirectly by speeding up the adoption of frontier technology
- ✓ Strict product market regulations (PMR) are assumed to affect the degree of competition in the market and, *via* this channel, to reduce ‘dynamic’ efficiency, e.g.
 - directly: managerial efficiency, workers’ effort etc.
 - indirectly: incentives to switch to frontier technologies
- ✓ Moreover, we look at whether certain labour market regulations (EPL) also affect MFP:
 - ✓ but distinguish the effect depending on industrial relations systems and technological trajectories

Results from MFP equation (manufacturing):

- **Technological convergence takes place mainly in low-tech industries**
- **R&D boosts MFP in low-tech industries and in high-tech industries with cumulative technology (e.g. motor vehicles); however, in the latter, technology leaders enjoy higher returns by investing in R&D than followers**
- **There is a weak *direct* effect of strict PMR on MFP, but a strong *indirect* effect (i.e. PMR mainly discourage adoption)**
- **Strict EPL has a negative effect on MFP in countries with predominantly sectoral wage bargaining and where lack of coordination reduces the expected returns from investing in training, which is needed in order to shift to a new technology**

Results from R&D equation (manufacturing):

- **Protection of IPRs has a positive effect on R&D intensity**
- **Trade restrictions (especially non-tariff barriers) reduce technology spillovers and incentives to invest in R&D**
- **Strict inward-oriented product market regulations (but not administrative ones) curb R&D intensity**
- **Strict EPL adds to the negative effects of PMR in unco-ordinated countries**
- **In co-ordinated countries, strict EPL tilts the patterns of specialisation of innovative activity towards stable and cumulative technologies and away from activities with large turnover of technologies (e.g. certain ICT industries).**

Summing up

➤ **Strict PM regulations have a negative impact on innovation and adoption of new technologies, including ICT:**

- **The effect is stronger in those industries where countries have accumulated significant technology gaps (possibly including ICT industries).**
- **Technology gaps are also explained by the negative effects of anti-competitive regulations on innovation, which is stronger in high-tech industries with multiple technological trajectories.**

➤ **Since the ICT industry includes domains where leading technology changes frequently, these results help explain why Europe, while enjoying leading positions in some mature industries with cumulative technologies, has been slow in moving into the ICT industry.**

➤ **Certain institutional and regulatory settings may reduce the degree of *market experimentation* of new firms, reducing the speed with which a country shifts to a new technology; this offers an interpretation to the differences in innovation and adoption across the Atlantic.**