



Productivity Symposium  
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Oslo, Norway

NORWAY'S PRODUCTIVITY PERFORMANCE  
-AN OECD PERSPECTIVE

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# Outline of presentation

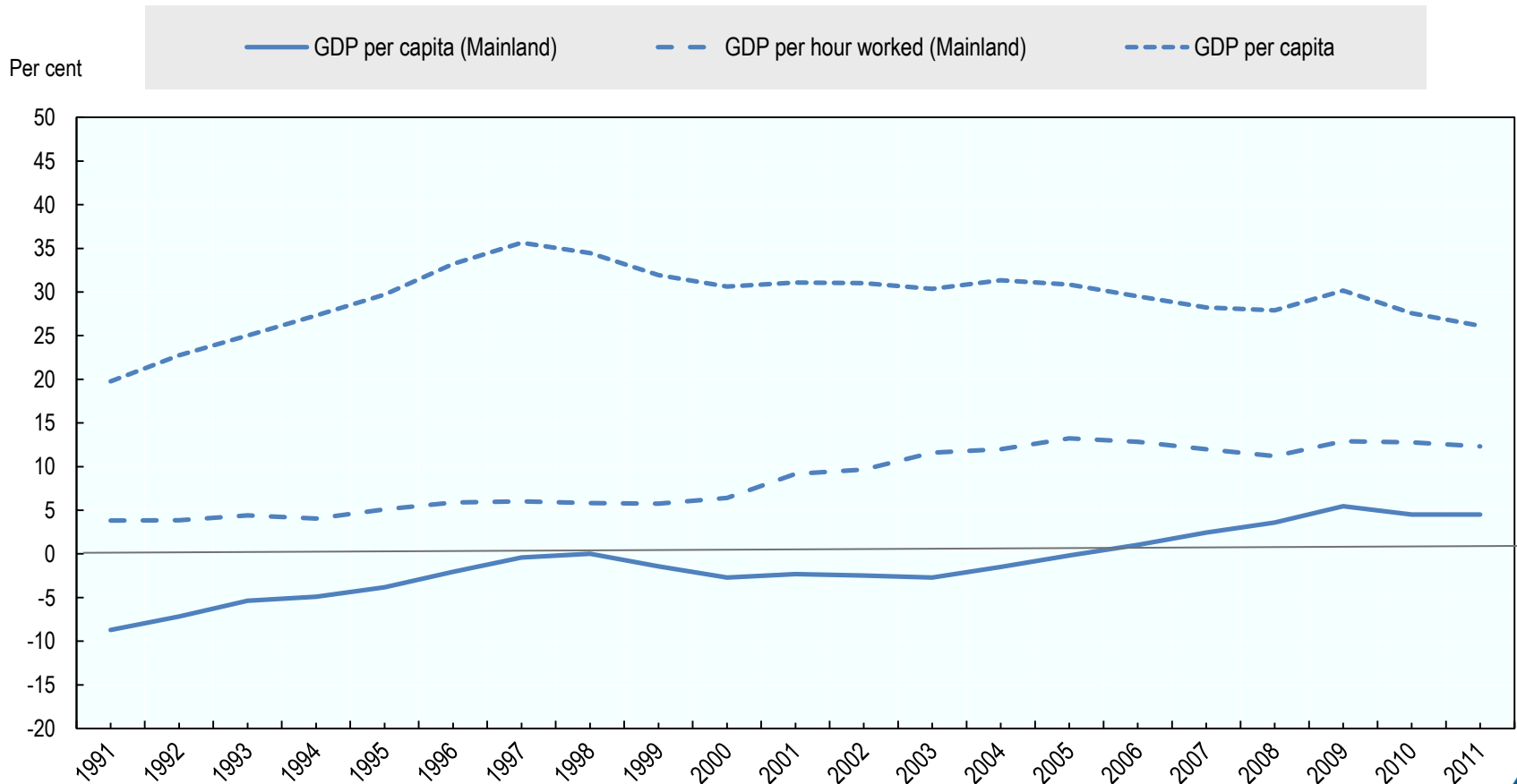
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- Productivity performance in a cross-country perspective: controlling for the contribution of natural resources
- The direct contribution of physical and human capital
- The role of knowledge-based capital and its growing importance as a source of productivity
- The role of resource reallocation within and across firms
- Summing-up



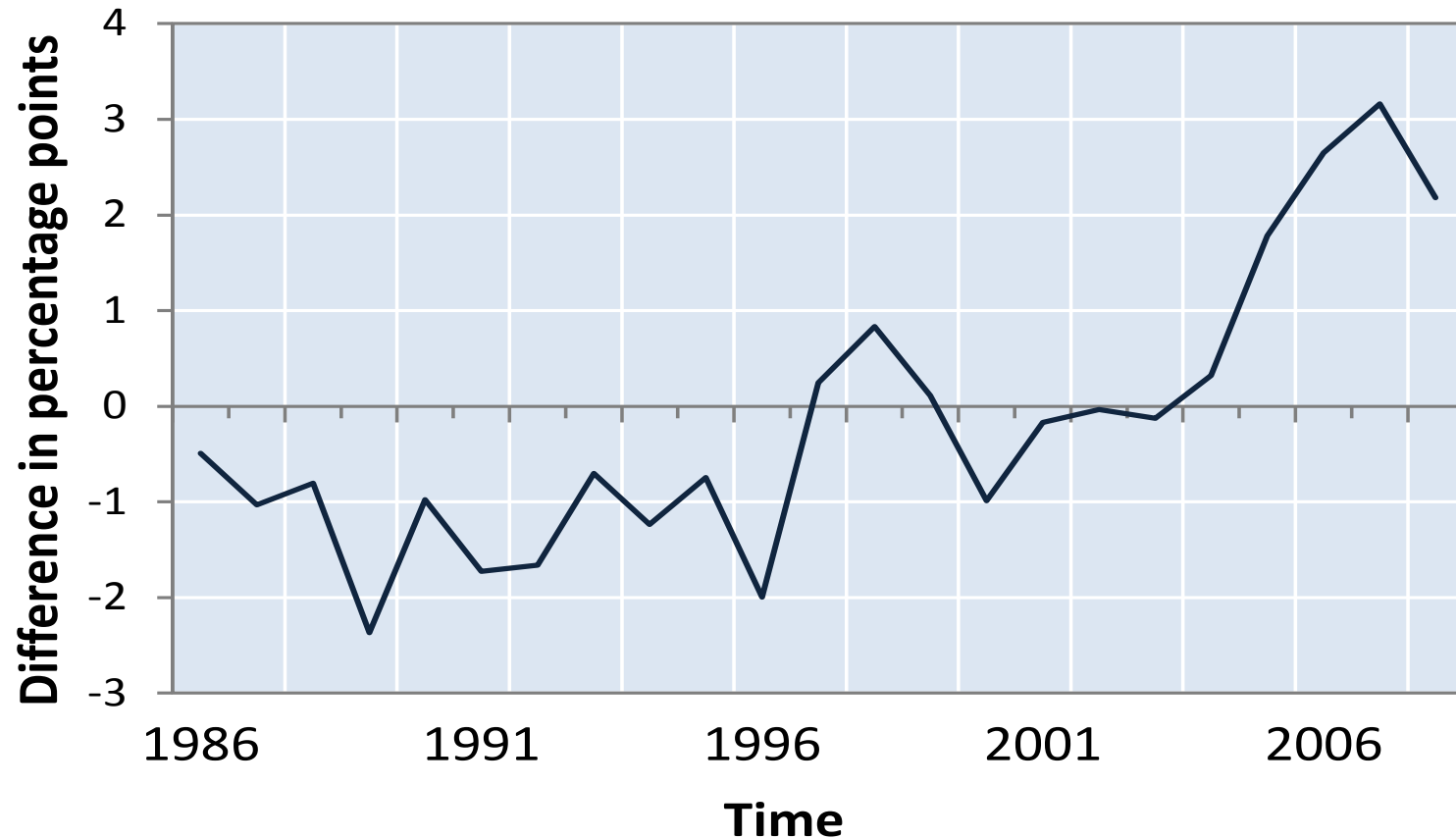
# Norway's advantage in per capita income is less pronounced when export value of petroleum production is excluded

Growth performance indicators for Norway  
Gap to upper half of OECD countries





## Differences in MFP growth rates from including natural resources as a production factor

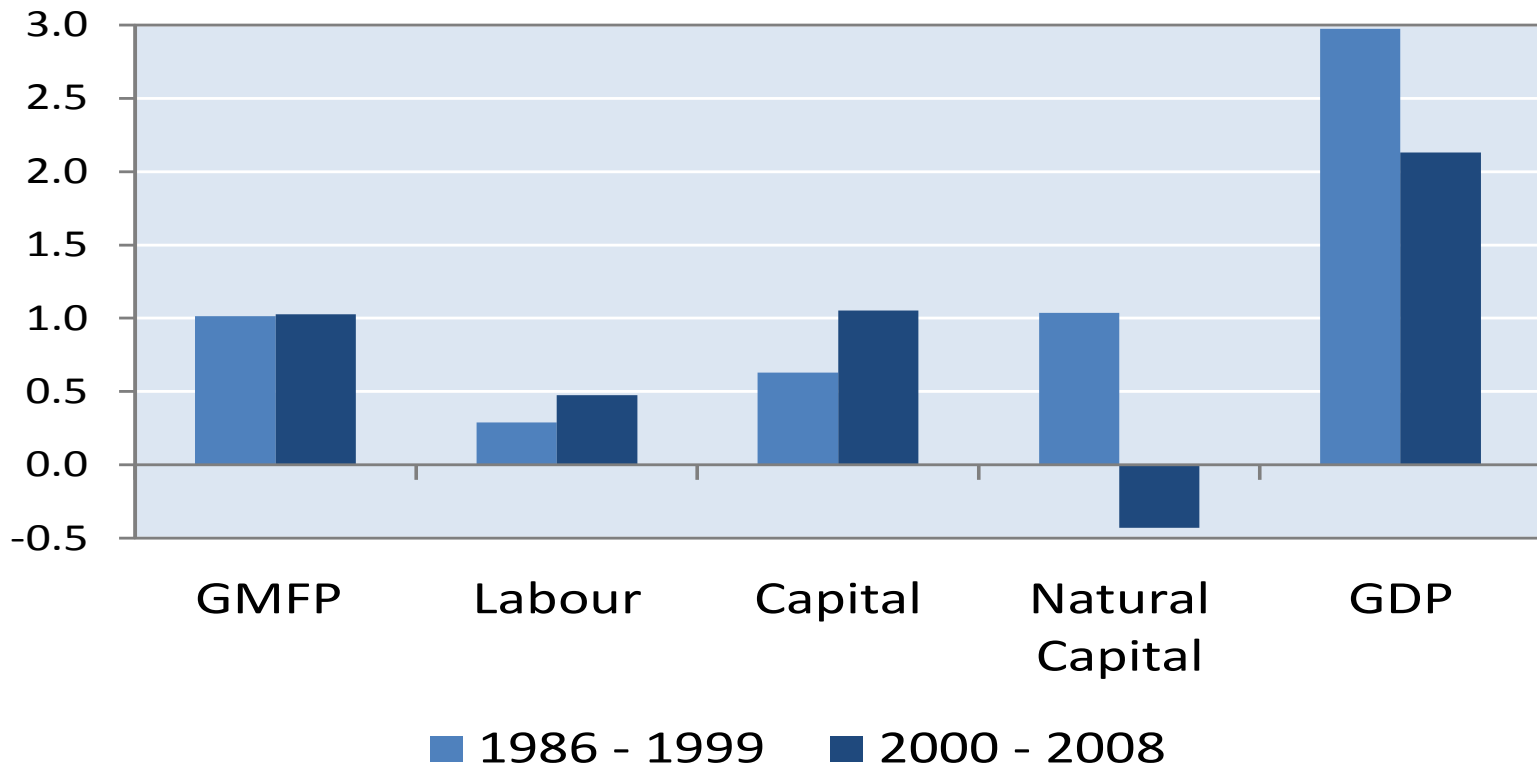


Brandt, N., P. Schreyer and V. Zipperer (2013), “Productivity Measurement with Natural Capital”, *OECD Economics Department Working Papers*, No. 1092, OECD Publishing.



## The decline in GDP growth is more than accounted for by the reduction in the contribution from natural resource

### Norway



*The Norwegian economy appears to have successfully (so far) substituted produced capital for natural capital*



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- Productivity performance in a cross-country perspective: controlling for the contribution of natural resources
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## Using a simple framework to shed light on the sources of Norway's performance

- A simple econometric analysis based on the Solow framework as developed by Mankiw, Romer and Weil (1992) and which considers physical and human capital.
- Per capita income level is a function of investments rate in physical capital, level of human capital and the rate of population growth:

$$\ln y_{it} = \frac{\alpha}{1-\alpha} \ln s_{Kit} + \frac{\beta}{1-\alpha} \ln h_{it} - \frac{\alpha}{1-\alpha} \ln(n_{it} + g + \delta) + f_i + f_t + e_{it}$$

- This function is estimated from a panel of 20 OECD countries between 1980-2010. Estimation includes country and time fixed effects and controls for first-order serial correlation.
- GDP per capita for Norway corresponds to mainland GDP



## Both human and physical capital contributes significantly to per capita income.

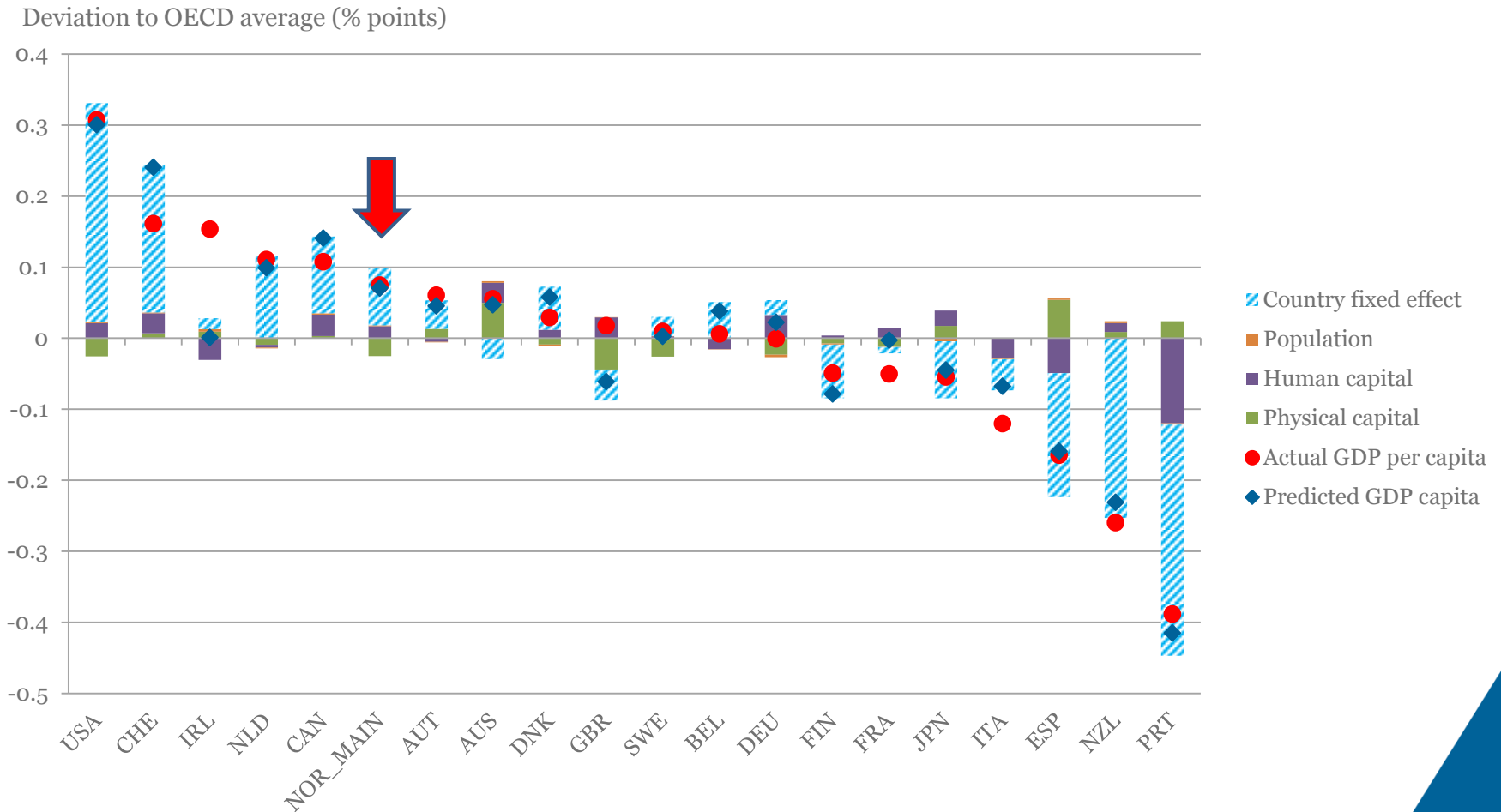
Dependent variable: log of per capita GDP	(1)	(2)	(3)	(4)
Physical capital	0.1951*** (0.0173)	0.2004*** (0.0184)	0.1997*** (0.0184)	0.1895*** (0.0202)
Human capital	0.2304*** (0.0658)	0.1857*** (0.0680)	0.2031*** (0.0657)	0.1932*** (0.0660)
Population growth	0.0131 (0.0193)	0.0193 (0.0212)	0.0228 (0.0206)	0.0186 (0.0229)
R&D intensity		0.0234*** (0.0084)	0.0211*** (0.0081)	0.0204** (0.0084)
Trade intensity			0.0350** (0.0169)	
Index of market and supplier access				0.0848*** (0.0157)
R Squared	0.9994	0.9995	0.9995	0.9995
Number of observation	599	561	561	546





# A large portion of per capita income gap is found in the country fixed effect

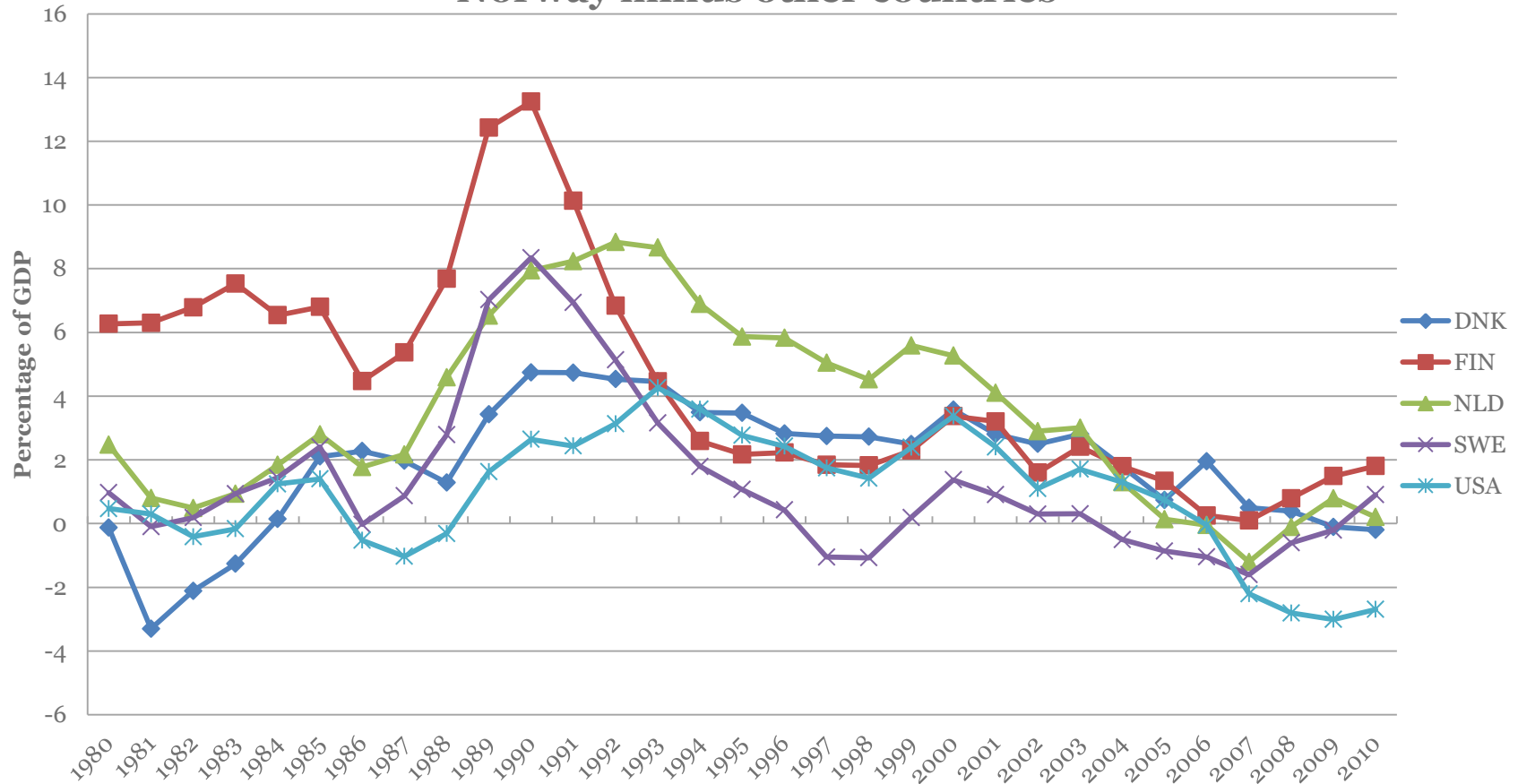
Contribution to deviation of GDP per capita against 20 OECD country average (2000-2010)





# Norway's advantage in physical capital has been declining since the mid-1990s

## Norway's advantage in investment rate Norway minus other countries

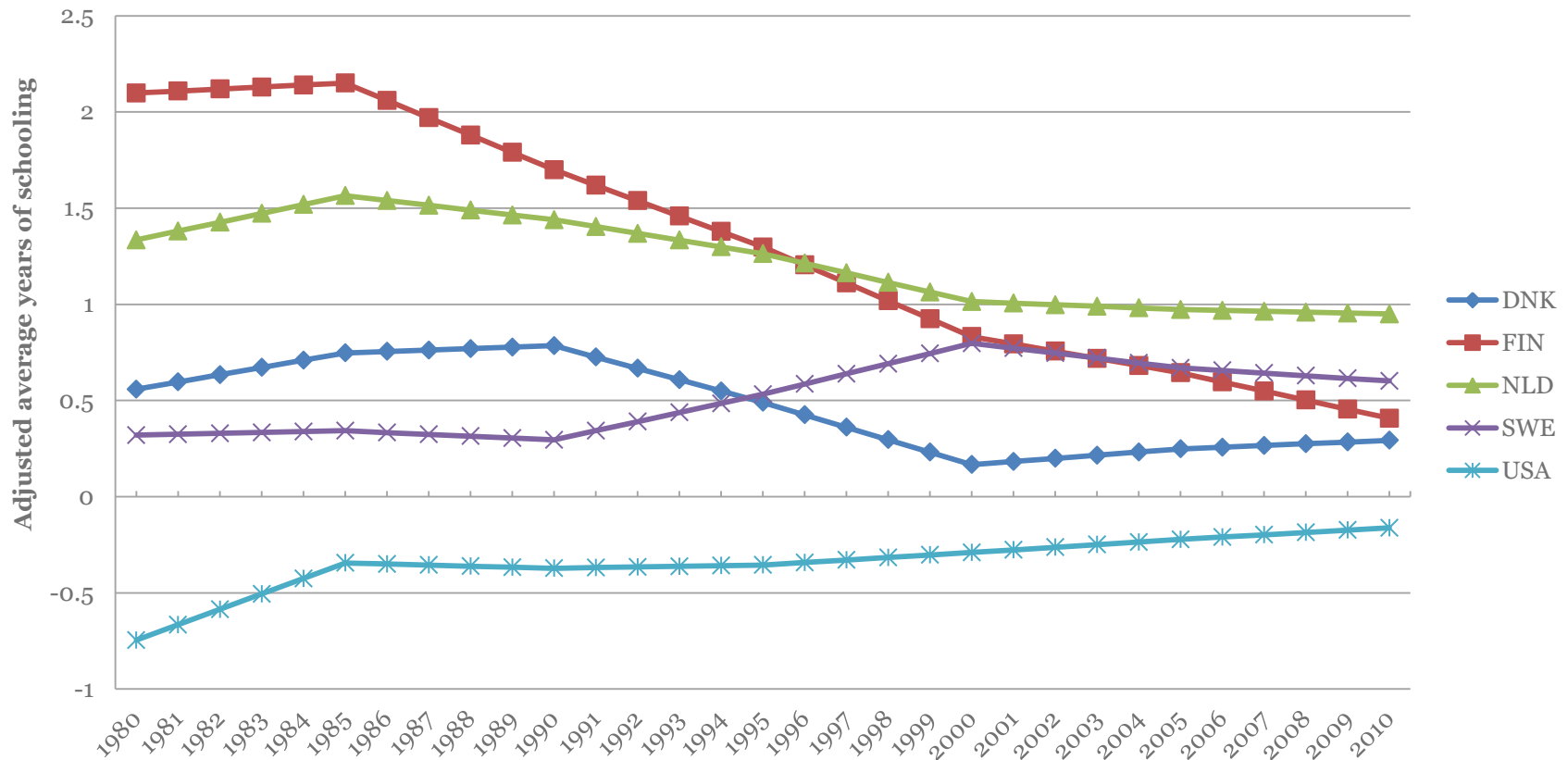


*Norway's investment rate covers only non-oil sector*



## The advantage in human capital has remained stable

### Norway's advantage in Human Capital Norway minus other countries

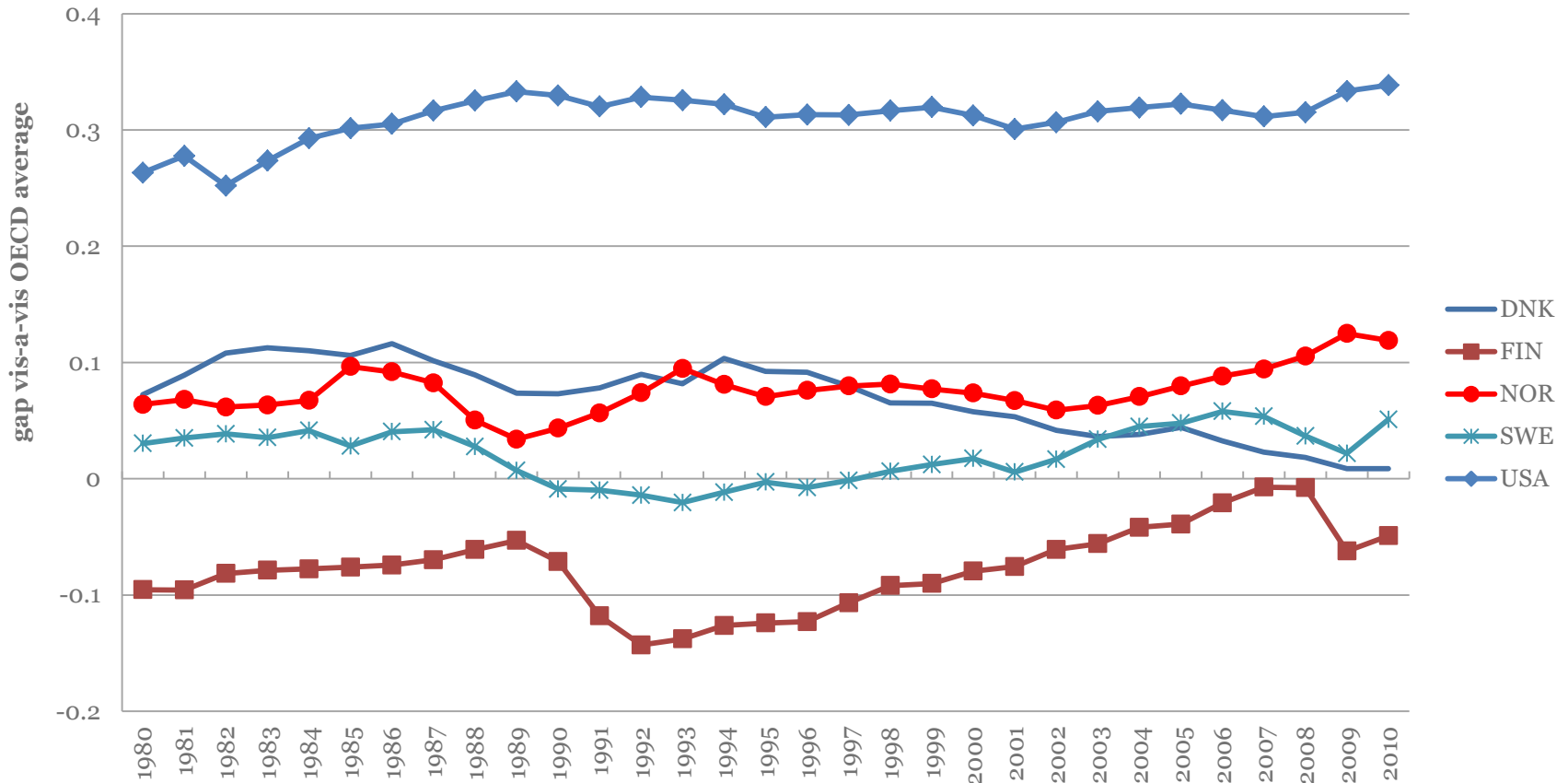


*Based on mean years of schooling without adjustment for quality or compositional effect of labour force*



# Norway is out-performing other Nordic countries in what can be loosely interpreted as MFP

## Country Fixed effects and residuals of standard Solow regression



*Even on the basis of mainland GDP (i.e. excluding the export value of oil)*



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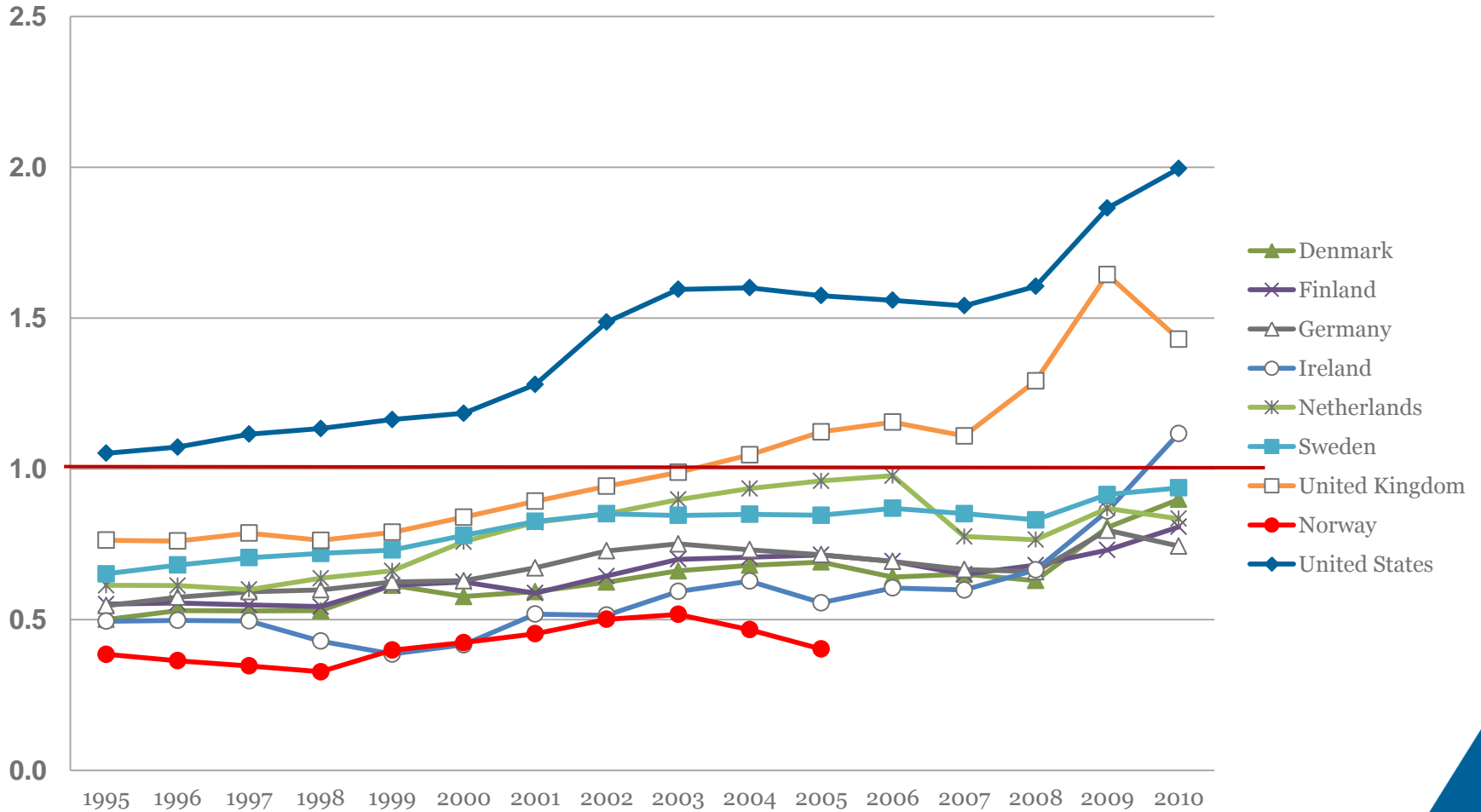
# An important factor missing from the basic Solow framework: Knowledge-based capital

Type of KBC asset	Mechanisms of output growth for the investor in the asset
<b>Computerised information</b>	
Software	Improved process efficiency, ability to spread process innovation more quickly, and improved vertical and horizontal integration.
Databases	Better understanding of consumer needs and increased ability to tailor products and services to meet them. Optimised vertical and horizontal integration.
<b>Innovative property</b>	
Research & Development	New products, services and processes, and quality improvements to existing ones. New technologies.
Mineral explorations	Information to locate and access new resource inputs - possibly at lower cost - for future exploitation.
Copyright and creative assets	Artistic originals, designs and other creative assets for future licensing, reproduction or performance. Diffusion of inventions and innovative methods.
New product development in financial services	More accessible capital markets. Reduced information asymmetry and monitoring costs.
New architectural and engineering designs	New designs leading to output in future periods. Product and service quality improvements, novel designs and enhanced processes.
<b>Economic competencies</b>	
Brand-building advertisement	Improved consumer trust, enabling innovation, price premia, increased market share and communication of quality.
Market research	Better understanding of specific consumer needs and ability to tailor products and services.
Worker training	Improved production capability and skill levels.
Management consulting	Externally acquired improvement in decision making and business processes.
Own organisational investment	Internal improvement in decision making and business processes.



# Investment in KBC is becoming increasingly important in rich OECD countries

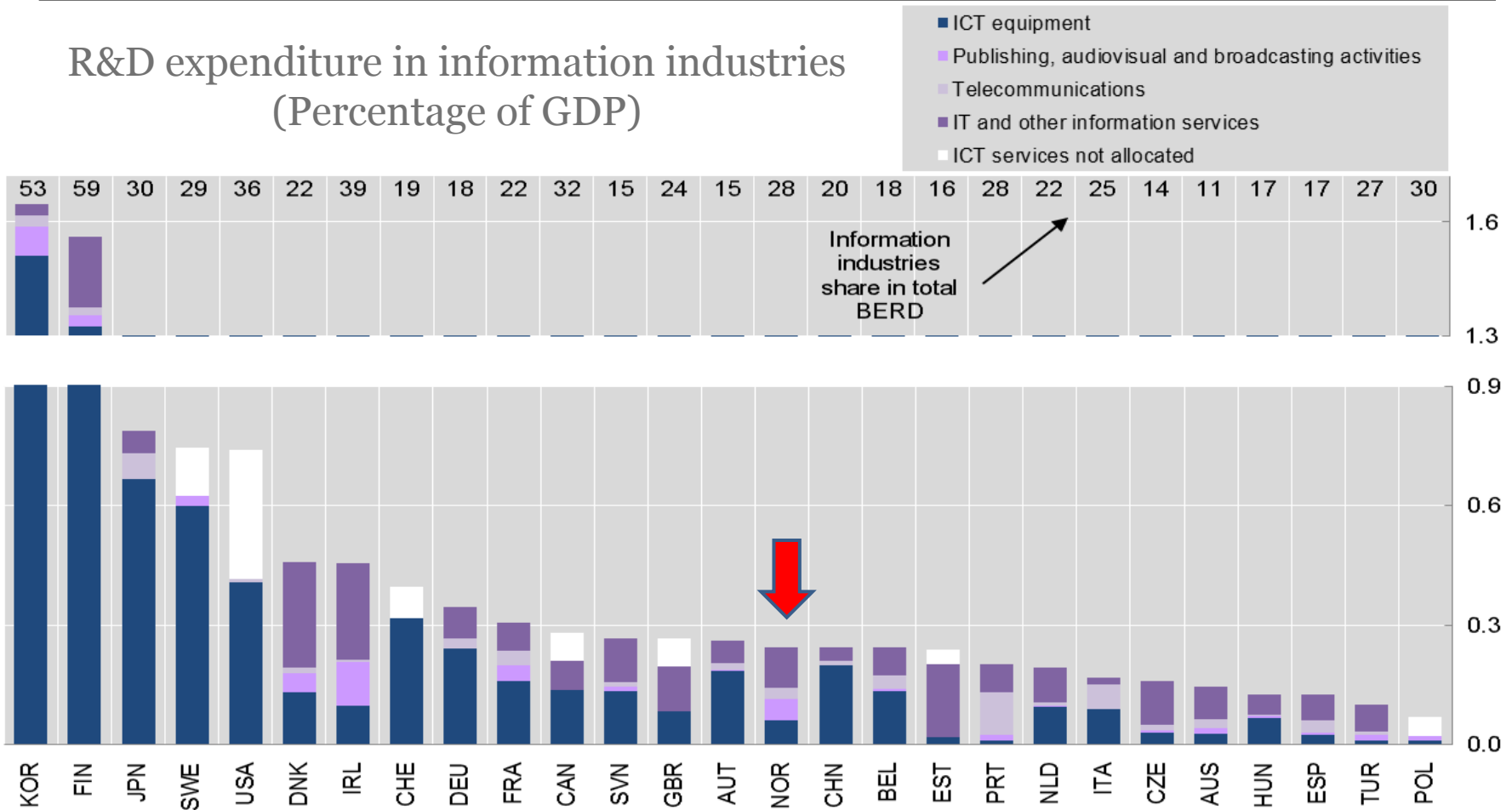
## The ratio of KBC to Physical capital investments





# Norway's ICT related R&D is small compared to other Nordic countries

R&D expenditure in information industries  
(Percentage of GDP)



Information industries includes ISIC Rev.4 Division 26 (Manufacture of computer, electronic and optical products) and Section J (Information and communication), consisting of Divisions 58-60 (Publishing and broadcasting industries), 61 (Telecommunications) and 62-63 (Computer programming and information service activities).





## The augmented Solow regression indicates a significant and positive contribution by R&D to per capita income

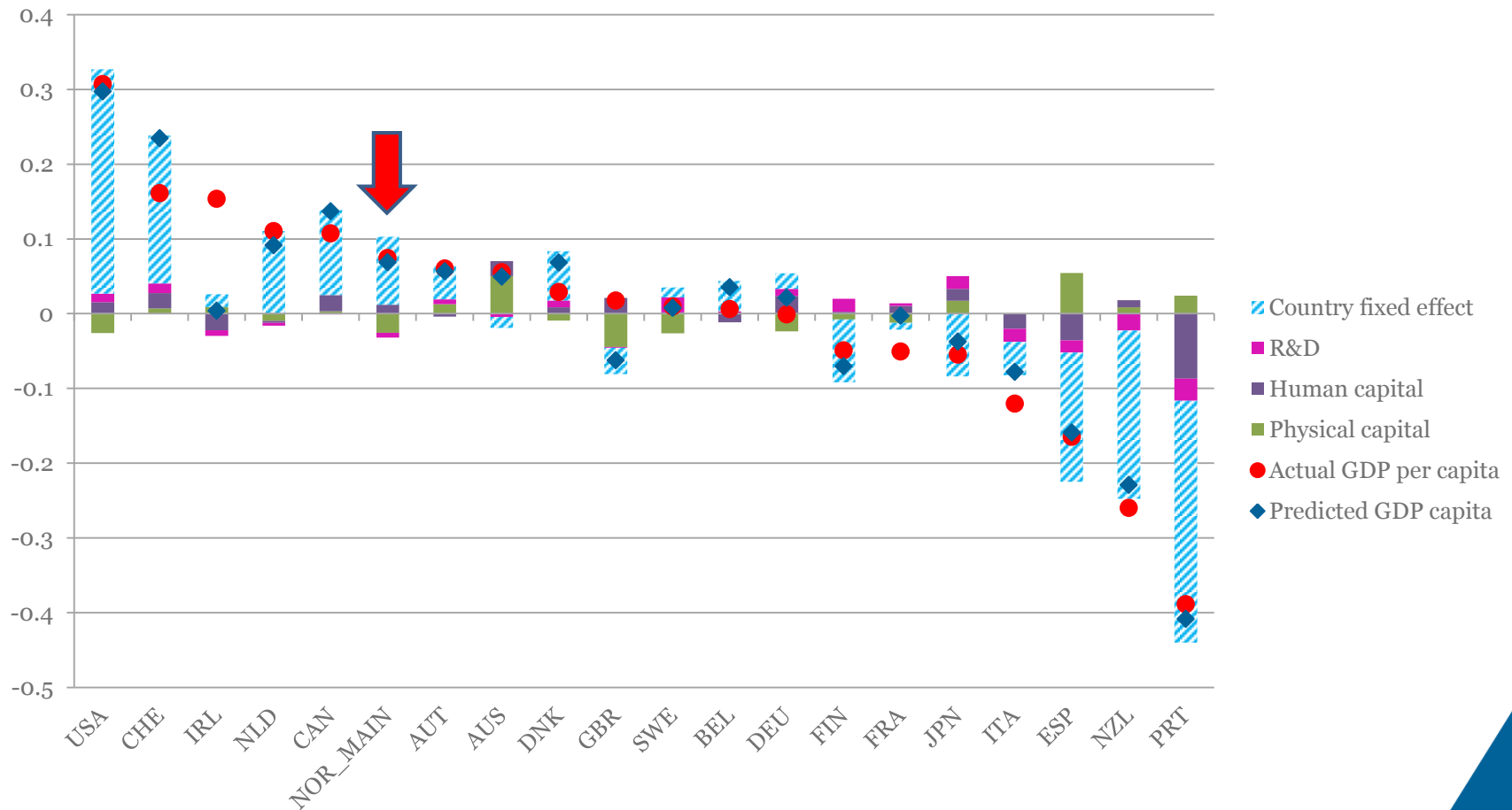
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# Country fixed effects remains the dominant explanatory factor even after R&D is added

Contribution to deviation of GDP per capita against 20 OECD country average (2000-2010)

Deviation to OECD average (% points)

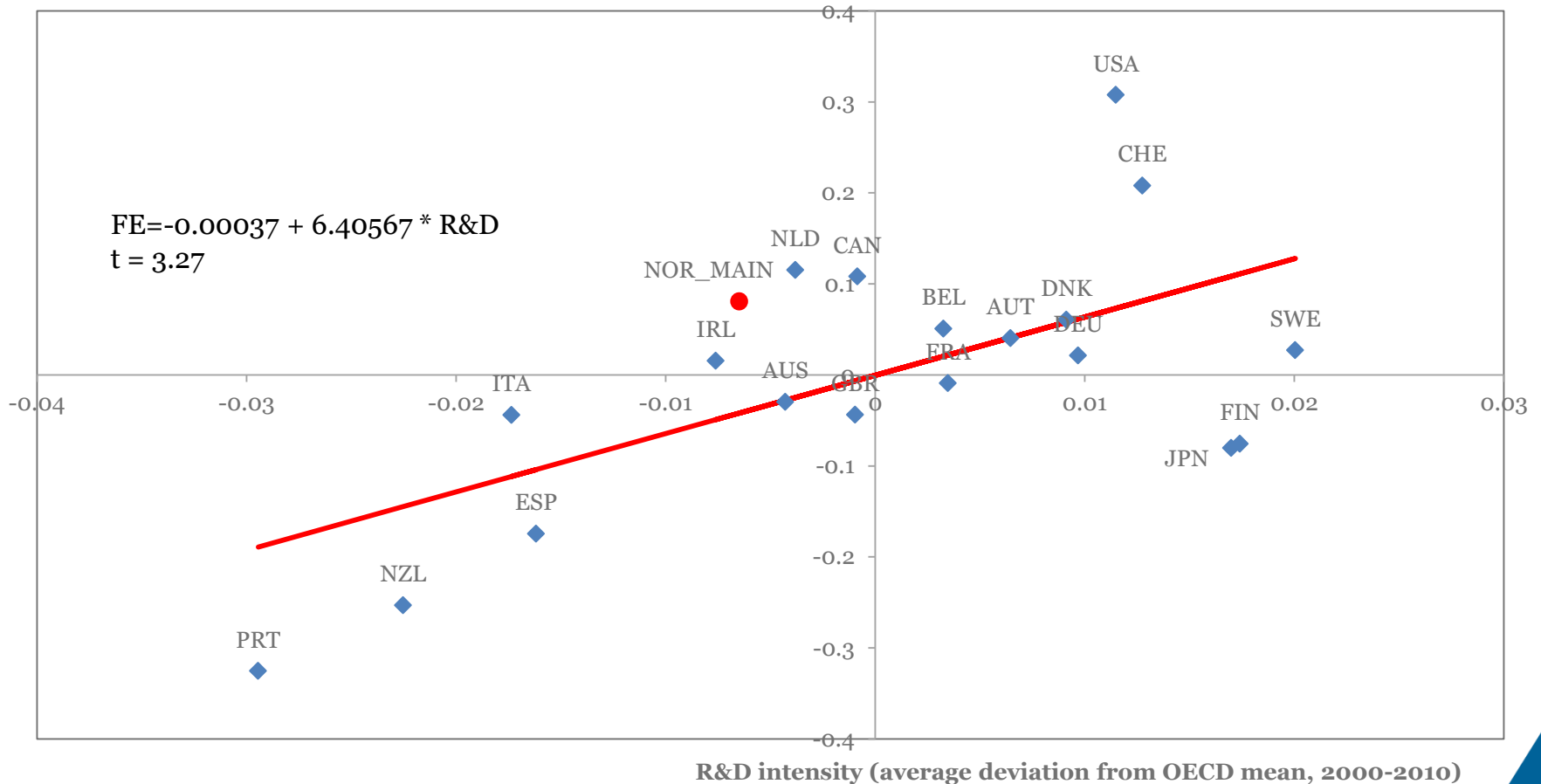




# Some contribution of R&D is embodied in country fixed effects due to its low time variance

Country fixed effects in the Solow regression

## Country fixed effect and R&D intensity

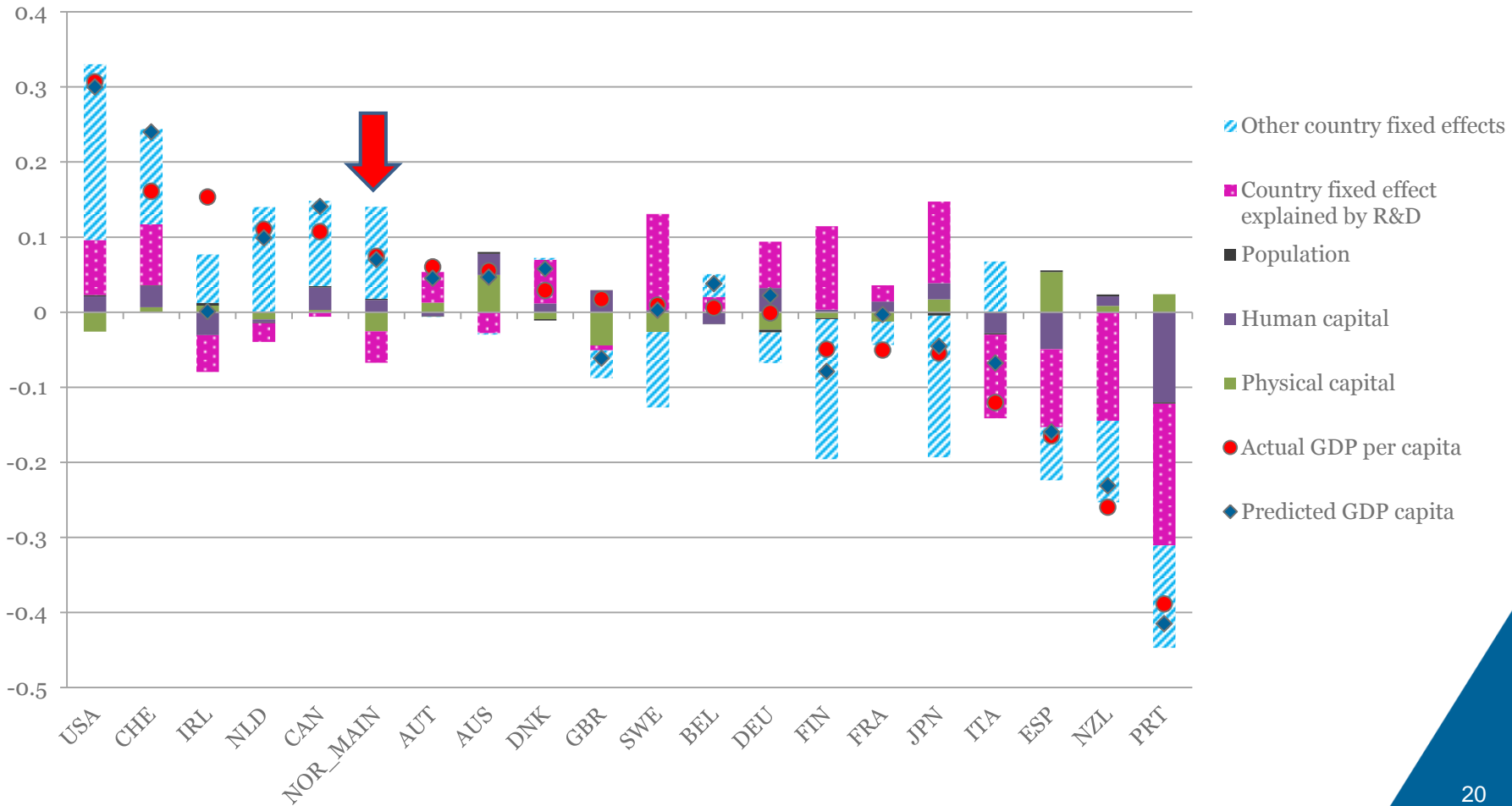




# The R&D component in country fixed effects reveals the sizable contribution by R&D in income gap

Contribution to deviation of GDP per capita against 20 OECD country average (2000-2010)

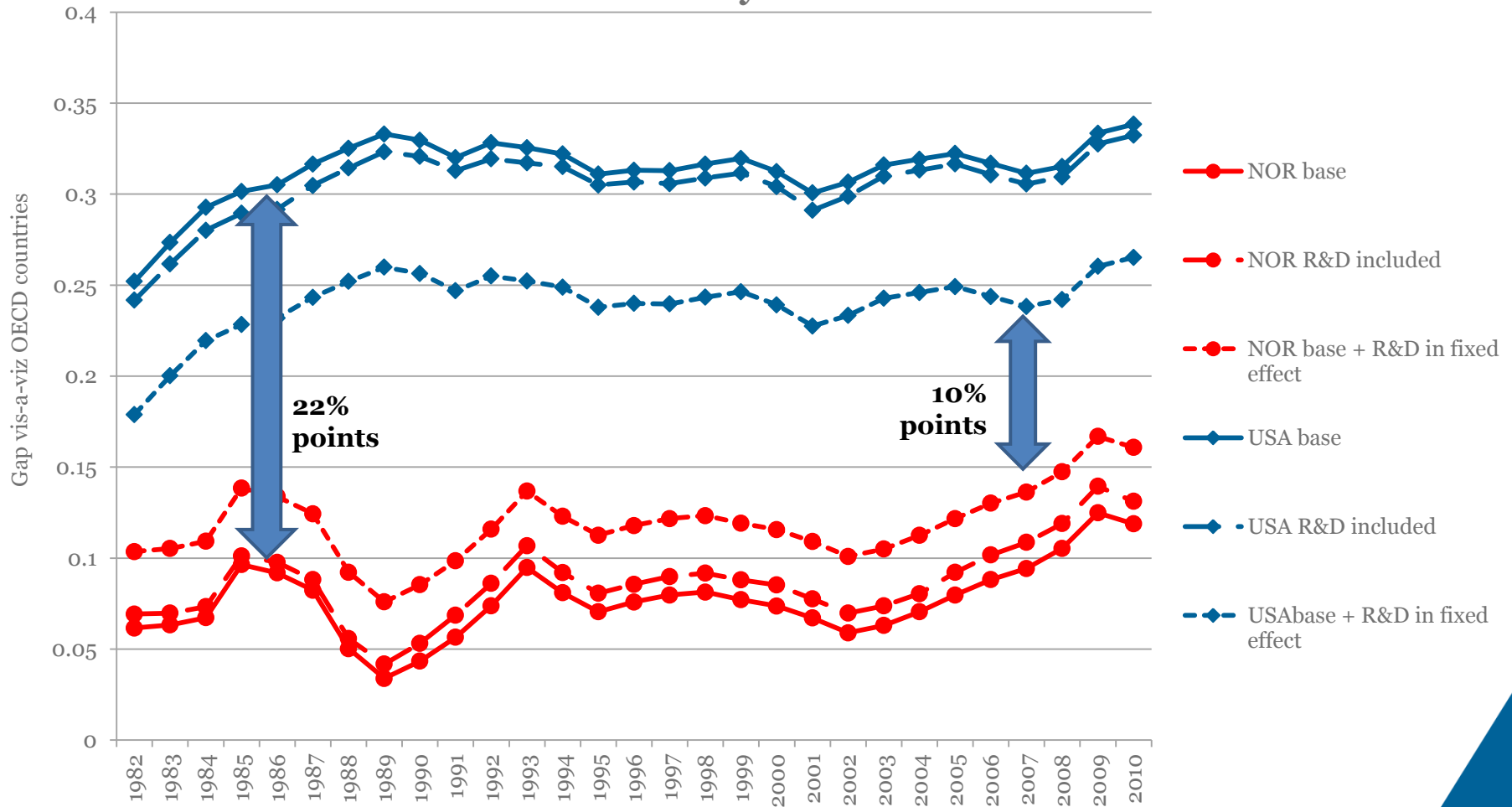
Deviation to OECD average (% points)





# The difference in R&D intensity can explain up to half of Norway's productivity gap vis-à-vis the United States

## Country Fixed effects and residuals of Solow models Norway vs the U.S.





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## Making the most out of ICT investment requires changes in business practices within firms

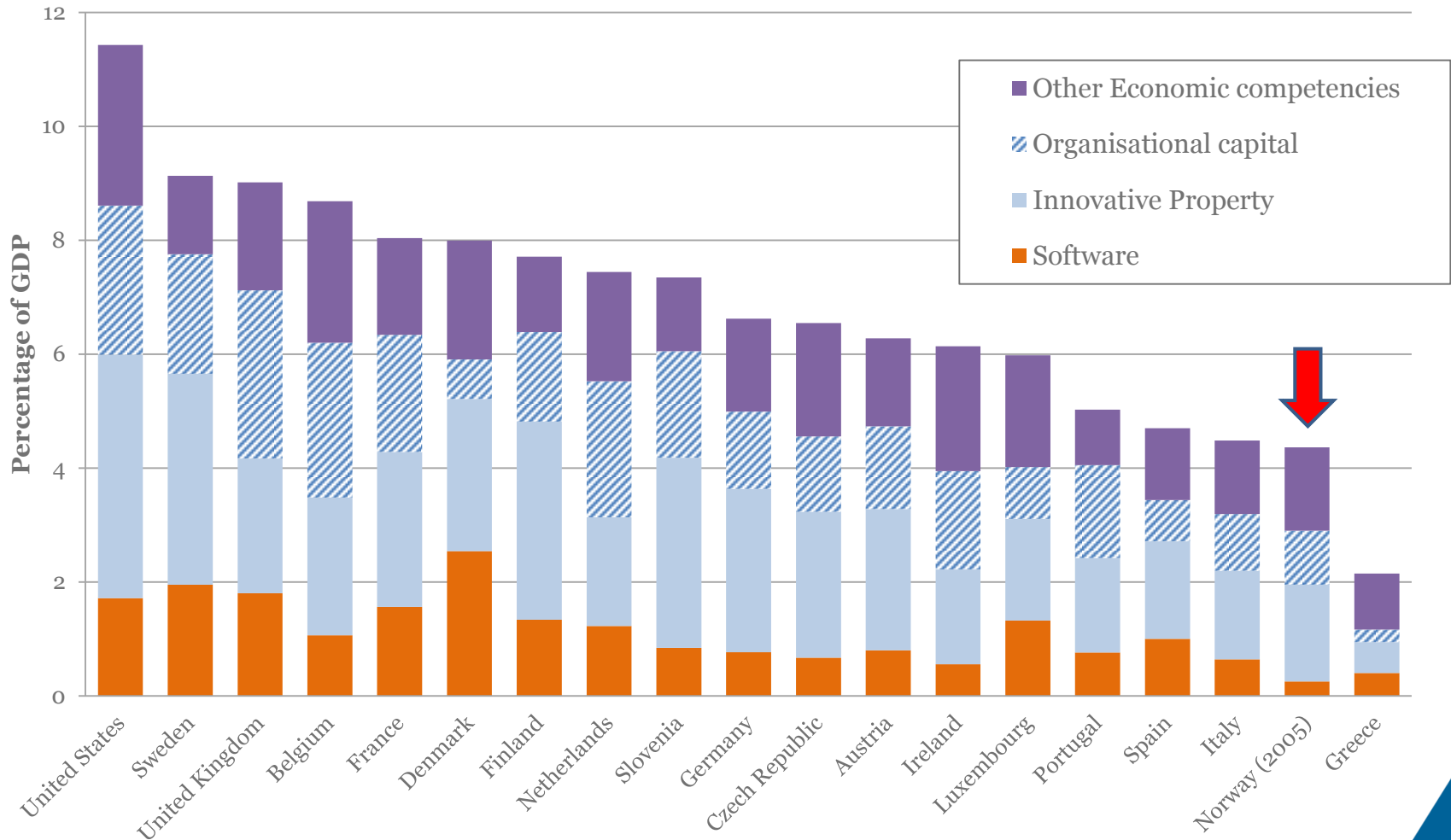
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- Vast body of research has underscored the importance of investment in ICT for innovation in services
  - ICT-using services made a significant contribution to productivity gains in the 2000s (Jorgensen, Ho and Stiroh, 2008) ...
  - ...and account for a good portion of the gaps in productivity and growth performance between US and Europe (Van Ark, O'Mahoney and Timmer, 2008)
  
- Conditions for ICT to generate efficiency gains within firms:
  - Adapting business practices and providing workforce training is required to get most of ICT investment: Organisational capital (Brynjolfsson and Hitt, 2003)
  - Studies comparing US and UK firms (operating in the UK) have attributed better performance of US firms to higher tendency to undertake organisational changes (Crespi, Criscuolo and Haskell, 2007)



## Norway's KBC investment is relatively less intensive and is less oriented toward ICT and organisational capital

Investment in KBC as percentage of GDP (Year 2010, except Norway)

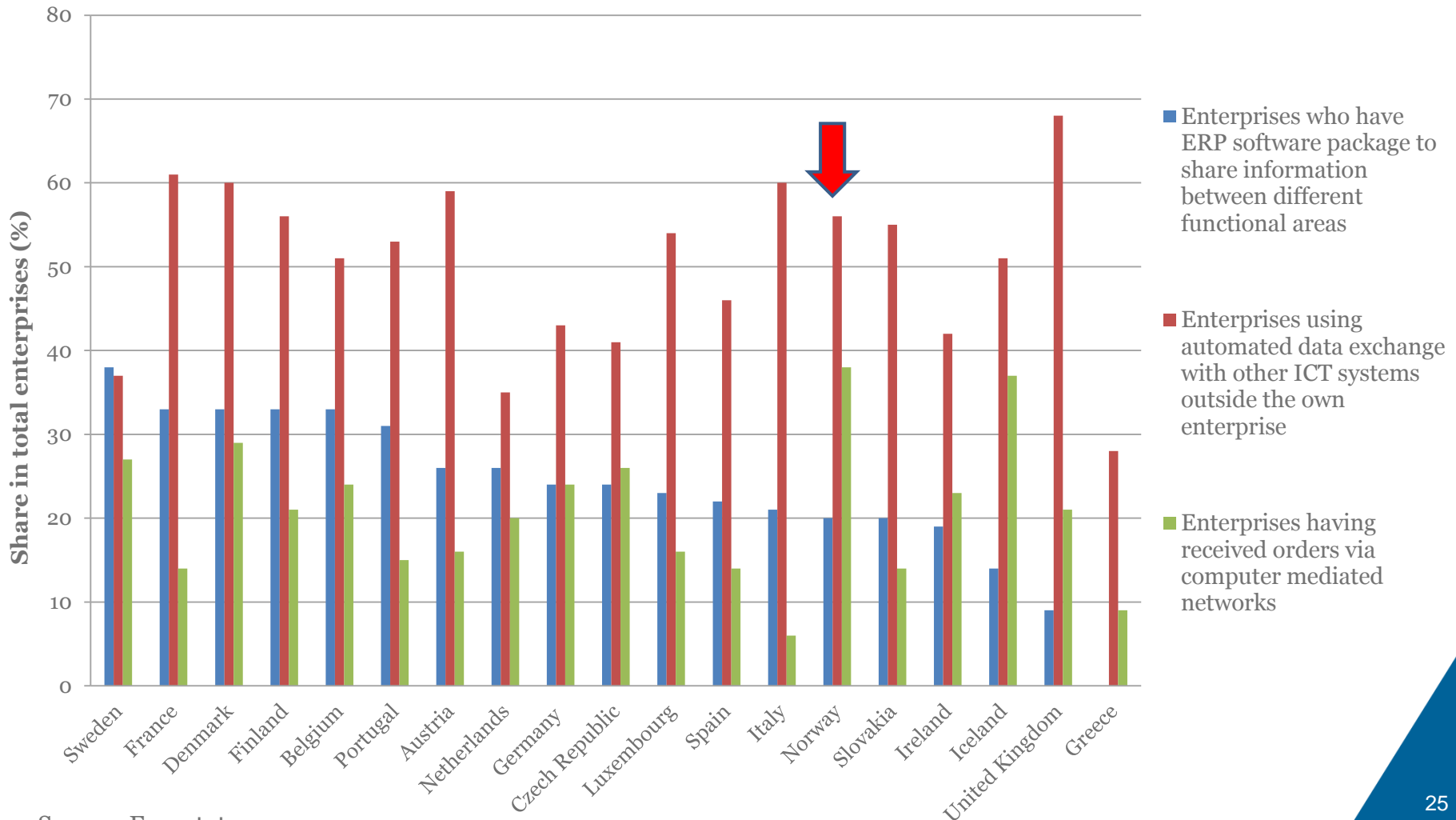






# Norway businesses appear to be overall well connected but may not invest much to adapt practices

## The use of ICT in enterprises





# Making the most out of KBC requires efficient reallocation of resources across firms

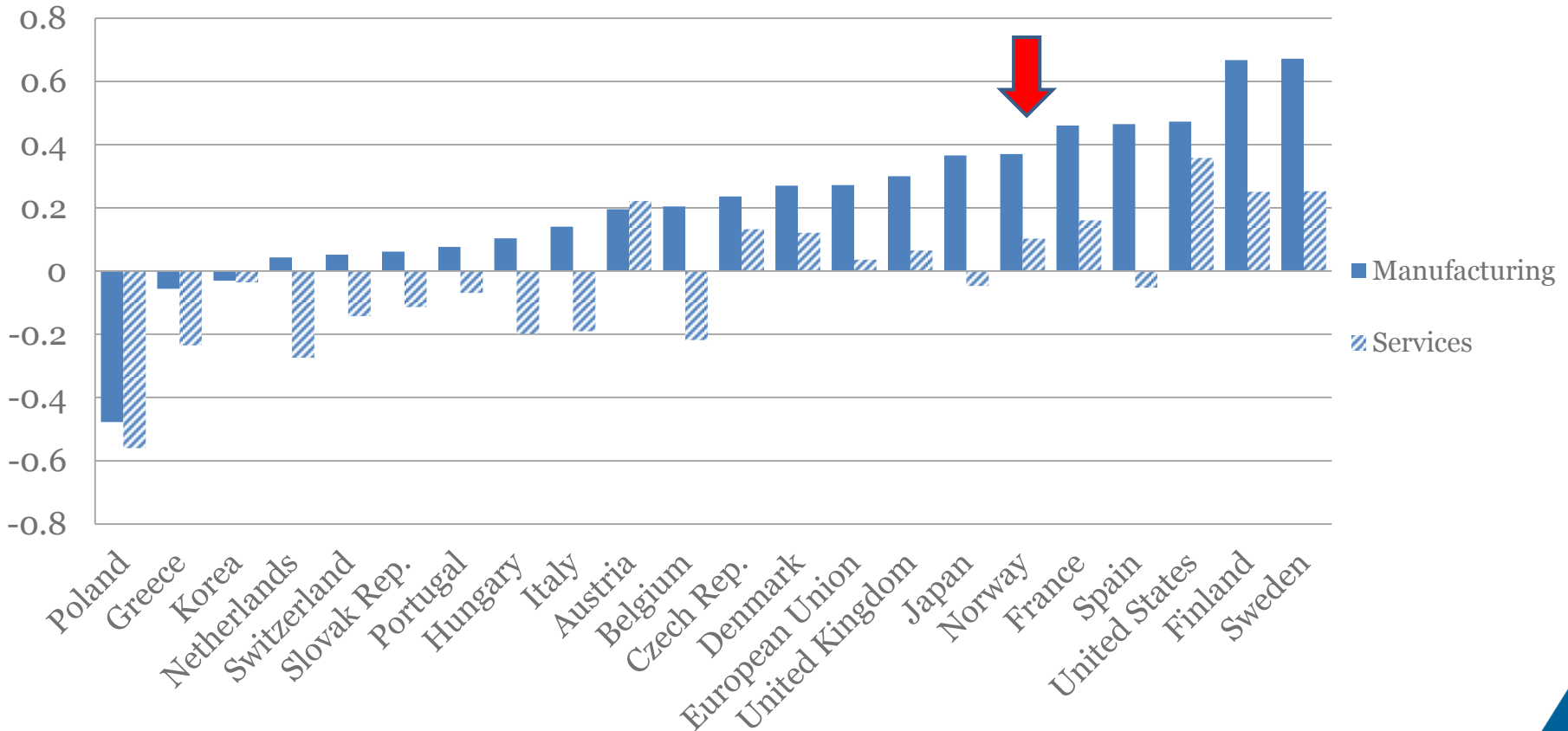
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- Varying use of intangible assets at the firm level is reflected in heterogeneity in productivity
- Investment in new ideas entails large fixed costs, low marginal costs:
  - Source of increasing returns to scale
  - To fully reap scale effect new firms or firms with new ideas need to be able to raise production rapidly and hence attract tangible resources (capital and labour)
- Resources must flow from low-productivity to high-productivity firms
- Static and dynamic allocative efficiency



# OECD countries differ in their ability to allocate labour to the most productive firms

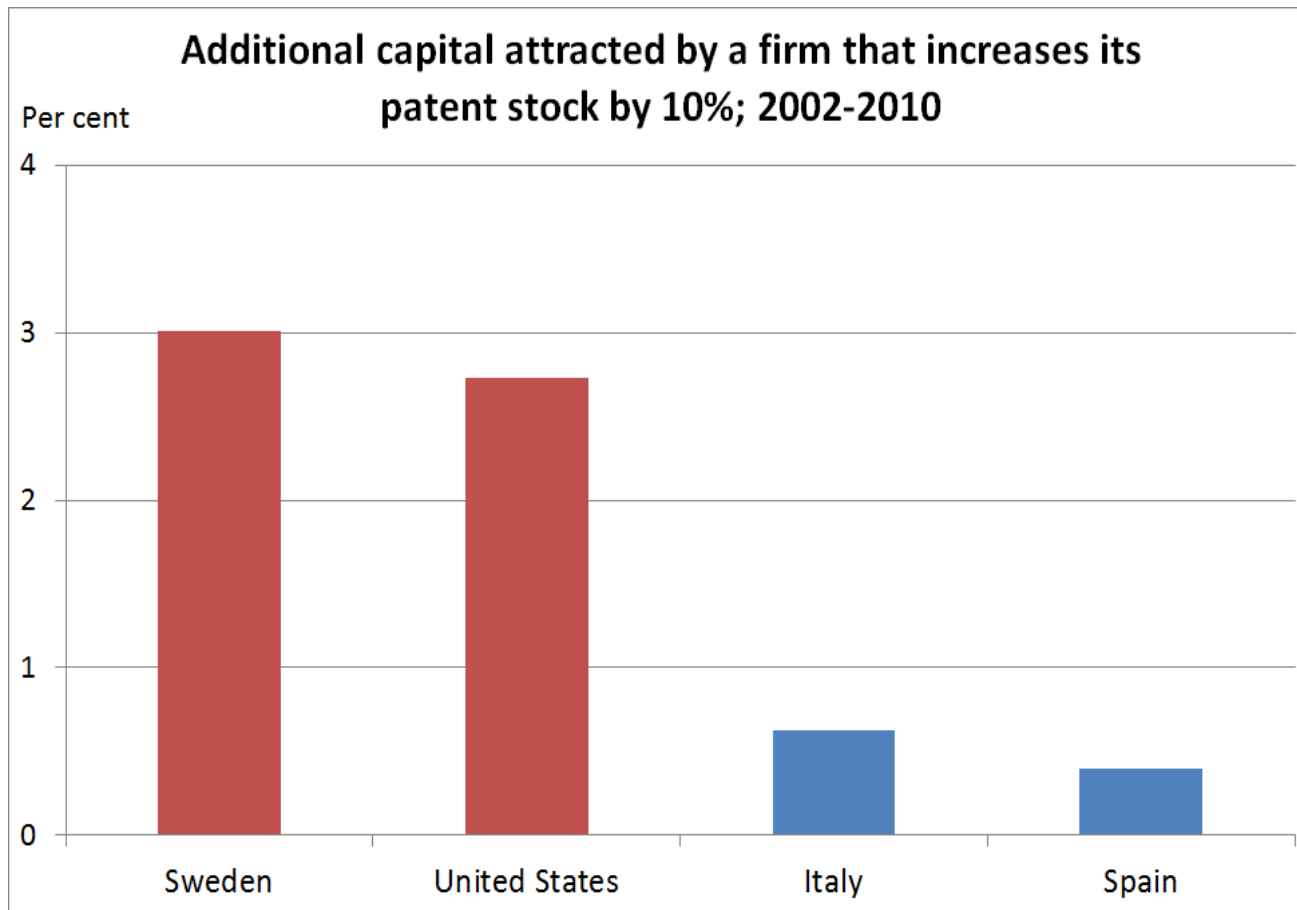
Covariance across firms between firm size and labour productivity  
Log points; selected OECD Countries, 2005



*Policy factors include product market regulation, the cost of bankruptcy legislation employment protection legislation and barriers to competition in financial markets.*



# Dynamic allocative efficiency: do resources flow to innovative firms?



Efficient reallocation mechanism underpin the implementation and commercialisation of new ideas in SWE and the US.

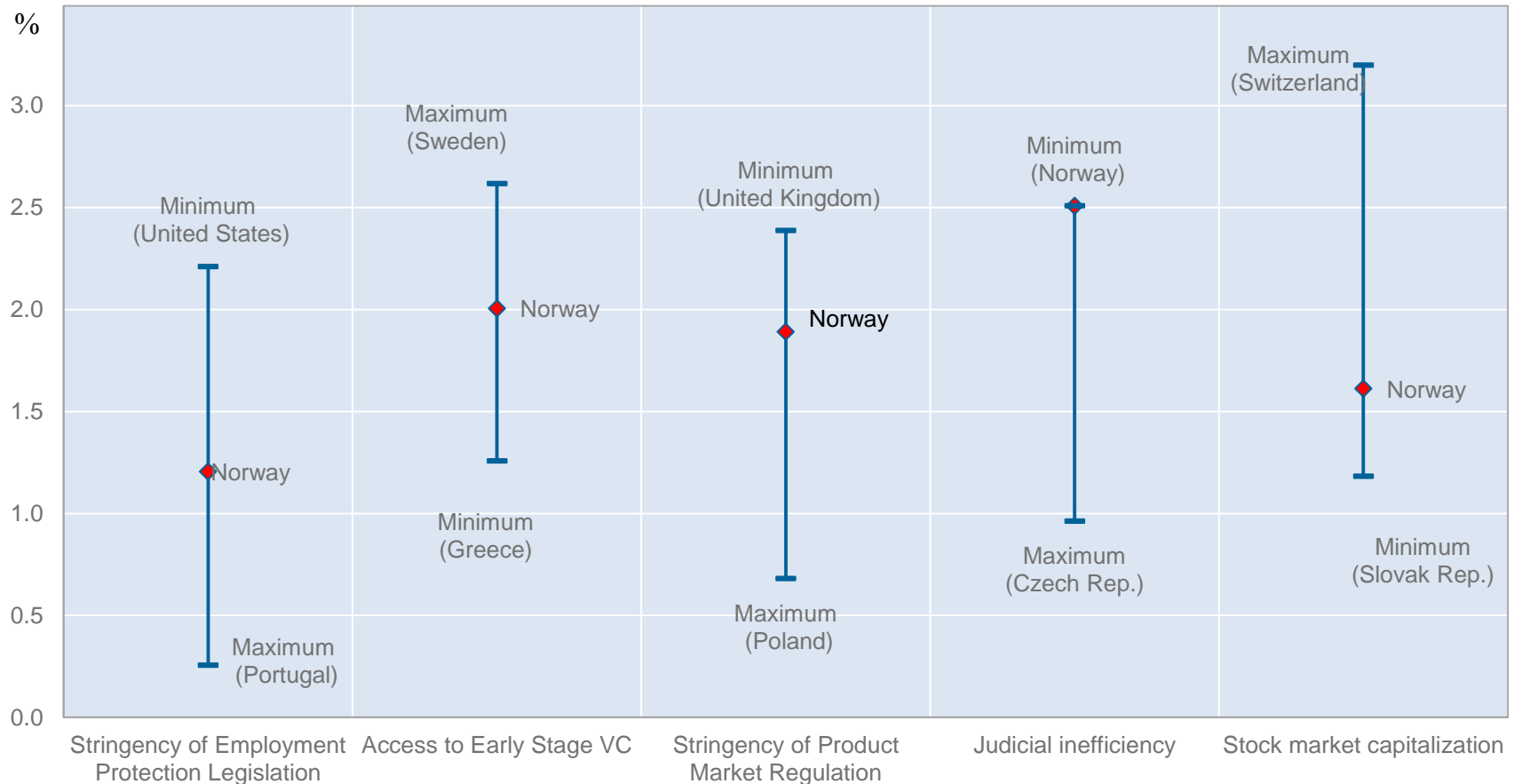
But it is much more difficult for innovative firms to attract capital in ITA and ESP.

*Source:* Andrews, Criscuolo and Menon (2013). The chart shows the estimated coefficient from a firm level regression of  $\log(\text{capital stock})$  on the  $\log(\text{patent stock})$ , controlling from firm fixed effects and country\*sector\*time fixed effects. The difference between the coefficients for SWE & USA and ITA & ESP is statistically significant .



# The ability of innovative firms to attract tangible resources is influenced by policy environment I

*Additional labour attracted by a firm that raises its patent stock by 10%*

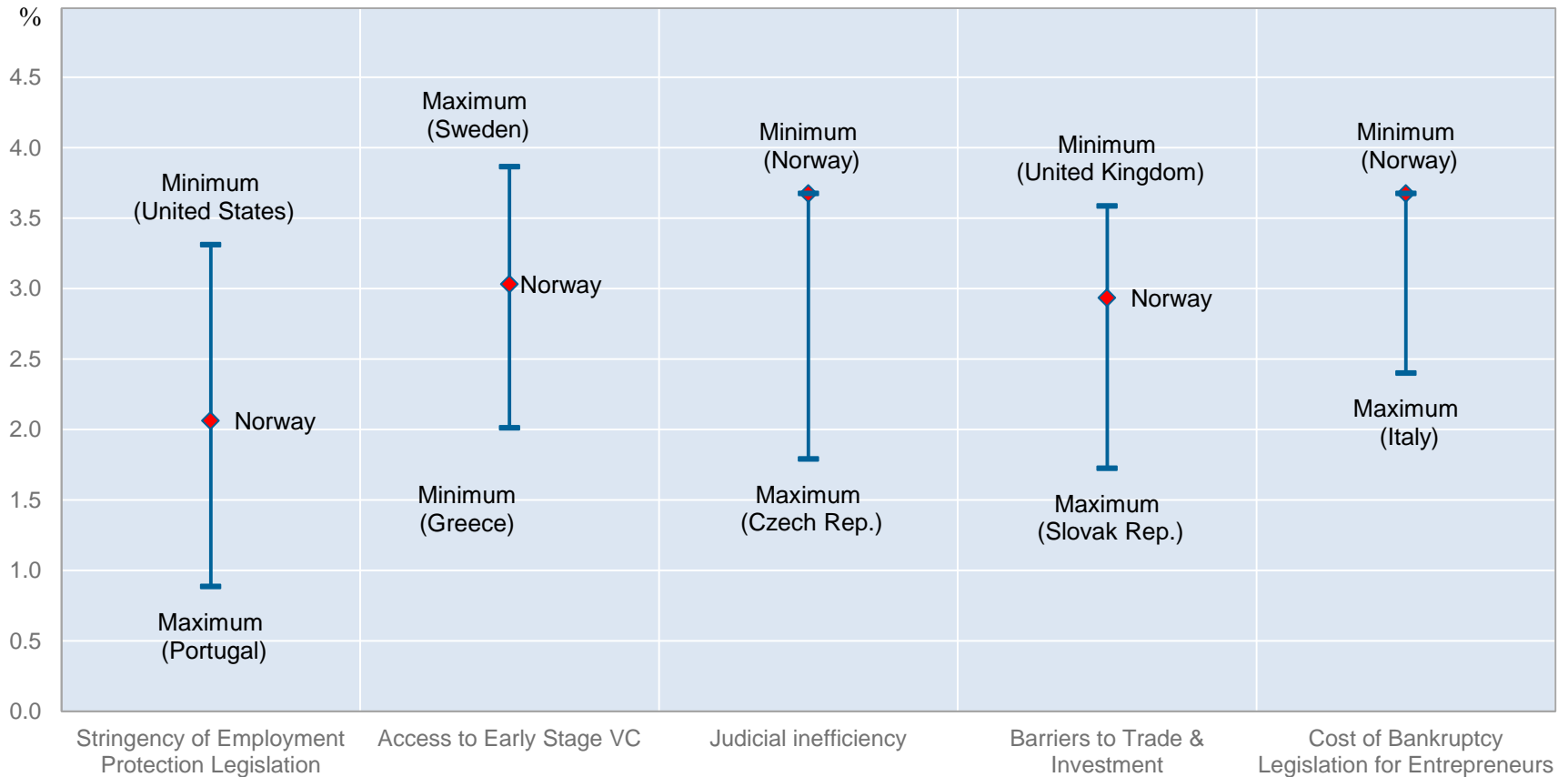


The estimated impact of various policies on the responsiveness of the firm employment to patenting



# The ability of innovative firms to attract tangible resources is influenced by policy environment II

*Additional capital attracted by a firm that raises its patent stock by 10%*



The estimated impact of various policies on the responsiveness of the firm investment to patenting



## Summing up

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- *Relatively good productivity performance, even after controlling for oil production/exports*
  - MFP growth has been maintained in the face of slowing GDP
  - Comparable MFP levels to other Nordics but a 20 per cent gap vis-à-vis US levels
  - Gap in innovation – as proxied by R&D – may account for between one-fifth to one-half of this gap
- *Boosting innovation – especially in services -- may require stronger investment in KBC:*
  - Norway appears to be lagging in particular in ICT investment, but also organisational capital
  - Regulatory barriers to competition in telecom and energy (gas) sectors are high by OECD standards
  - Improving skills level to facilitate adapting to changes in technology



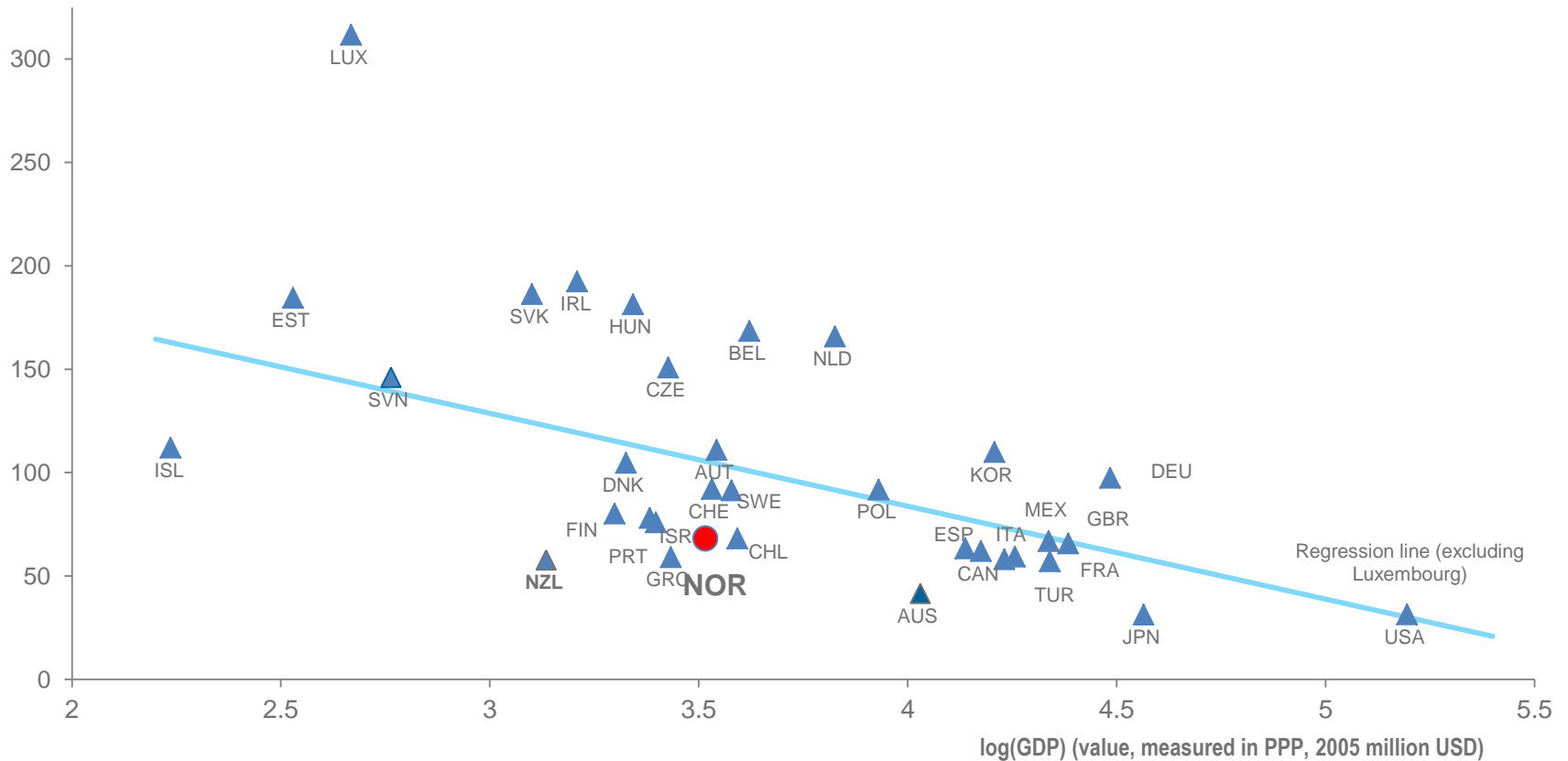
- 
- *Thank you*
  - *Additional material*





# Norway's trade intensity (adjusted for size) is relatively low by international standards

goods and services trade as a share of GDP (%)



*Norway is no more disadvantaged than Sweden in terms of distance and access to markets.*