# Innovation-driven productivity growth: the role of ICT capital and effective labour

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# Our contribution

- We assess the importance of information and communication technology (ICT), research and development (R&D) and organizational capital (OC) for labour productivity growth.

- To operationalize the concepts of R&D capital and OC, we apply novel GLOBALINTO measures of investments in R&D and OC that are based on firm-level wage costs related to specific skills and occupations.

- We use a rich employer–employee panel data set of Norwegian firms covering the period 2008–2019, including detailed occupational data.

- We further explore the interactions between ICT capital and labour skills by incorporating innovation-biased technical change (IBTC) – a concept originally proposed by Hannu – as a factor in a neo-classical production function.

- The analysis is provided for select industries in manufacturing and services.

- Overall, all three types of intangible capital seem to be important for productivity, with ICT having clearly the highest impact.

# Background

- Firms invest in a wide range of intangible assets, such as information technologies, software, patents, designs, trademarks, new organisational processes and firm-specific skills.

- Together, these non-physical assets are sometimes referred to as a firm's *knowledge-based capital*, KBC (see OECD, 2013).

- According to Corrado et al. (2018), the growth rate of investments in intangibles has been greater than that of tangible capital during 2000-2013 in the countries that they analyse (17 EU countries and the US).

# The great productivity slowdown

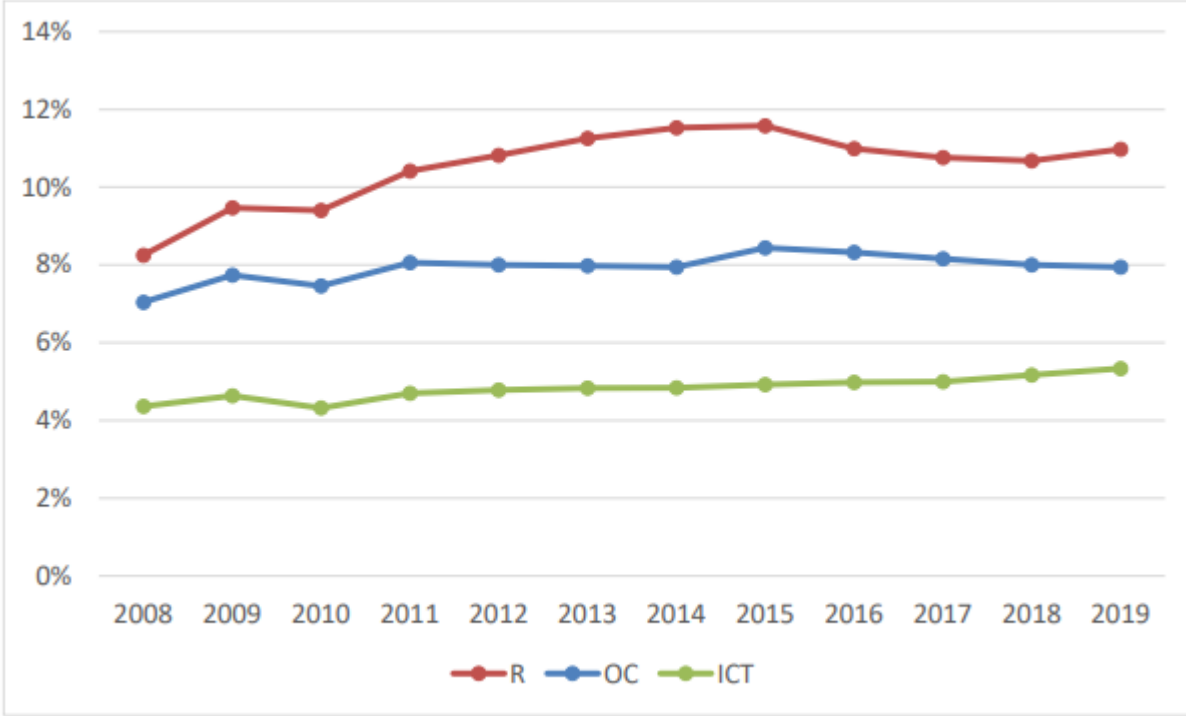
It is a paradox that this development has been accompanies by a slowing of labour productivity growth in the most OECD economies during the last 10-15 years. This phenomenon is sometimes referred to as the great productivity slowdown.

# Some explainaitons of the paradox: unmeasured “output”

- Brynjolfsson and Oh (2012) and Brynjolfson et al. (2018) make the case that welfare is growing faster than (measured) economic output due to free digital services, such as payment services and social media networks.
- Brasch and Raknerud (2022) estimate that new intermediate goods through net entry of firms contribute about 0.5 percentage point annually to labour productivity growth in Norwegian manufacturing.

# The data: Labour categories related to intangible assets

**Figure 3.1. Employment shares within each intangible type for Norway. 2008-2019**



# Empirical results

- Our estimates indicate that the overall elasticity of output with respect to ICT capital lie in the range of 0.10-0.15 across a wide range of high-tech and low-tech manufacturing and service industries.
- These estimates are generally higher than the estimated elasticity of output with respect to tangible capital, which lie in the range of 0.07 to 0.12 across the same industries.

- Positive interaction effects between ICT capital and specific labour skills contribute considerably to the overall impact of ICT on output and productivity.

- If we do not account for such interactions effects, the estimated elasticity with respect to ICT lie in the range of 0.03 to 0.05 across the same industries. We estimate positive interaction effects of similar magnitude between (high) ICT capital and (high) shares of workers engaged in either R&D-, organizational- or ICT-related activities at the firm level.