Christopher Lennartz (Hrsg.)

Fachtagung „Berufsbildung, Fachkräfte und Transformation in einer Internationalen Perspektive“

Eine Sammlung der Veranstaltungsbeiträge

Bundesinstitut für Berufsbildung

Inhaltsverzeichnis

Keynote Speech prepared for the BIBB Annual Conference (December 1, 2023)

Skills Policy to Address Digital Transformation and Social Inequality in Korea

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Key Takeaways

01 Digital transformation and labor market inequality

02 Key Facts of Digital Transformation

03 Modelling Socioeconomic impact of digital transformation

04 Policy suggestions

Chapter 1.

Digital transformation and labor market inequality

Digital transformation and labor market inequality

Digital transformation is changing labor market entry opportunities, skill formation, wages and earnings distributions, and son on.

- concerns arise for growing social inequality

Existing research mainly discusses the impact of **digital transformation on the world of work and the labor market** as a whole, and emphasizes the need for job/task change and vocational training (OECD, 2020; ILO, 2021; Autor et al., 2020)

Active labor **market policies** including **job training, and social security** to **protect vocational skills are of great importance**

- Need a comprehensive approach to skills policy to **make full use of vocational skills**

Digital transformation and labor market inequality

How does technological change, epitomized by **digital transformation, affects** labor markets and economic growth?

1) Automates tasks and creates new jobs
2) Desynchronization of productivity and labor income(Autor et al., 2020; OECD, 2018) has continued
3) The democratization of manufacturing and the rise of a zero marginal cost society.

Debate is still ongoing over whether a new employment relationship(e.g., platform labor) has emerged, or there is a shift in in the existing capital-labor relationship or a new form of instability (Rifkin, 2014; Chang et al., 2017)

Digital transformation and labor market inequality

The nature of **technological change** and **labor market polarization**

The overlap of skill-biased technological progress, **routine and task-biased technological progress**, and **offshoring of** jobs affect how job polarization unfolds across different countries (Ryu and Choi, 2018)

Despite the surge in productivity driven by technological change and innovation, labor income has not kept pace with productivity growth and the desynchronization and increasing inequality within the workforce has sustained (Autor et al., 2019; Autor et al., 2020)

Key concepts in digital transformation

Meta-studies on digital transformation keeps an eye on the disruptive impact of **digital technologies (Vial, 2019)**

Business organizations reshape their **value creation chains** to create a **strategic response, and to deal with structural changes** and **organizational barriers**

On the other hand, the combination of ICT and connectivity technologies has led to significant changes in organizational attributes: DT is understood as a process of improving organizational capabilities (Vial, 2019: 8)

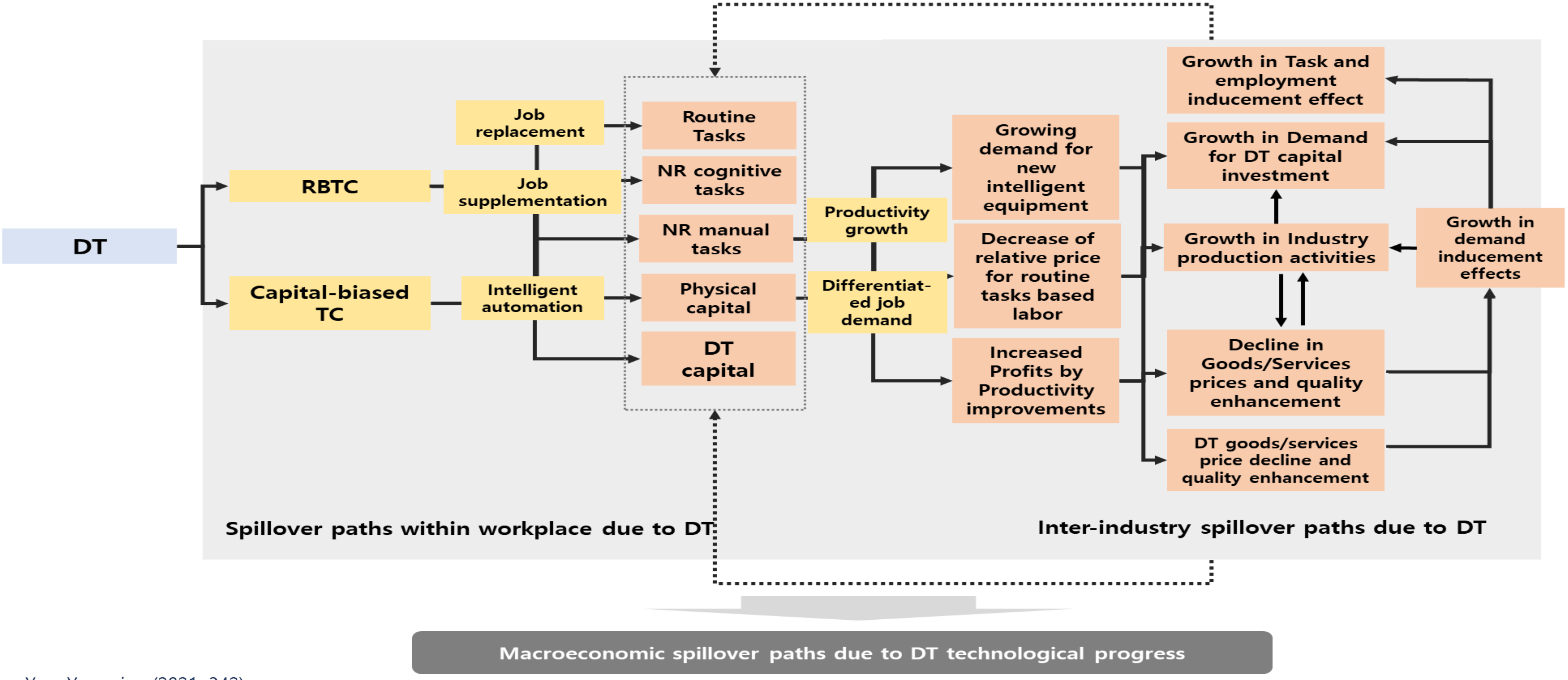
Two approaches to digital transformation

1) Macro-economic approach considers **DT as a symptom of** technological change, emphasizing macroeconomic and social impacts in a comprehensive sense, which is closely related with international organizations' discussions on the **"future of work (OECD, ILO, EU)**

2) Organization-centric approach views **DT** as the creation of a new organization based on **digital technologies**, paying attention to the **proliferation of business models.**

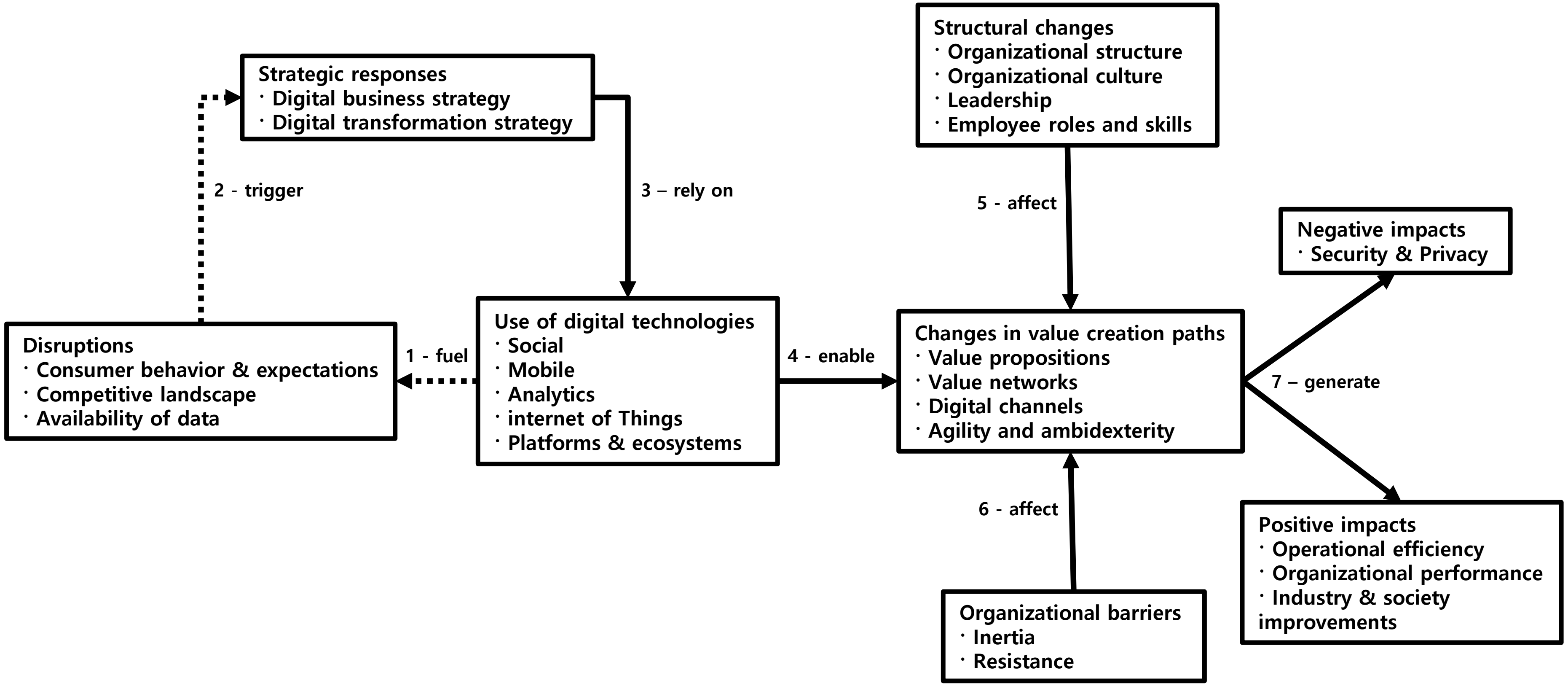
Often closely related to the strategies of platform companies, which emphasizes **the ability of companies to respond to digital transformation**

Two approaches to digital transformation: the macro approach



Source: Yeo, Youngjun (2021: 342)

Two approaches to digital transformation: the organization-centric approach

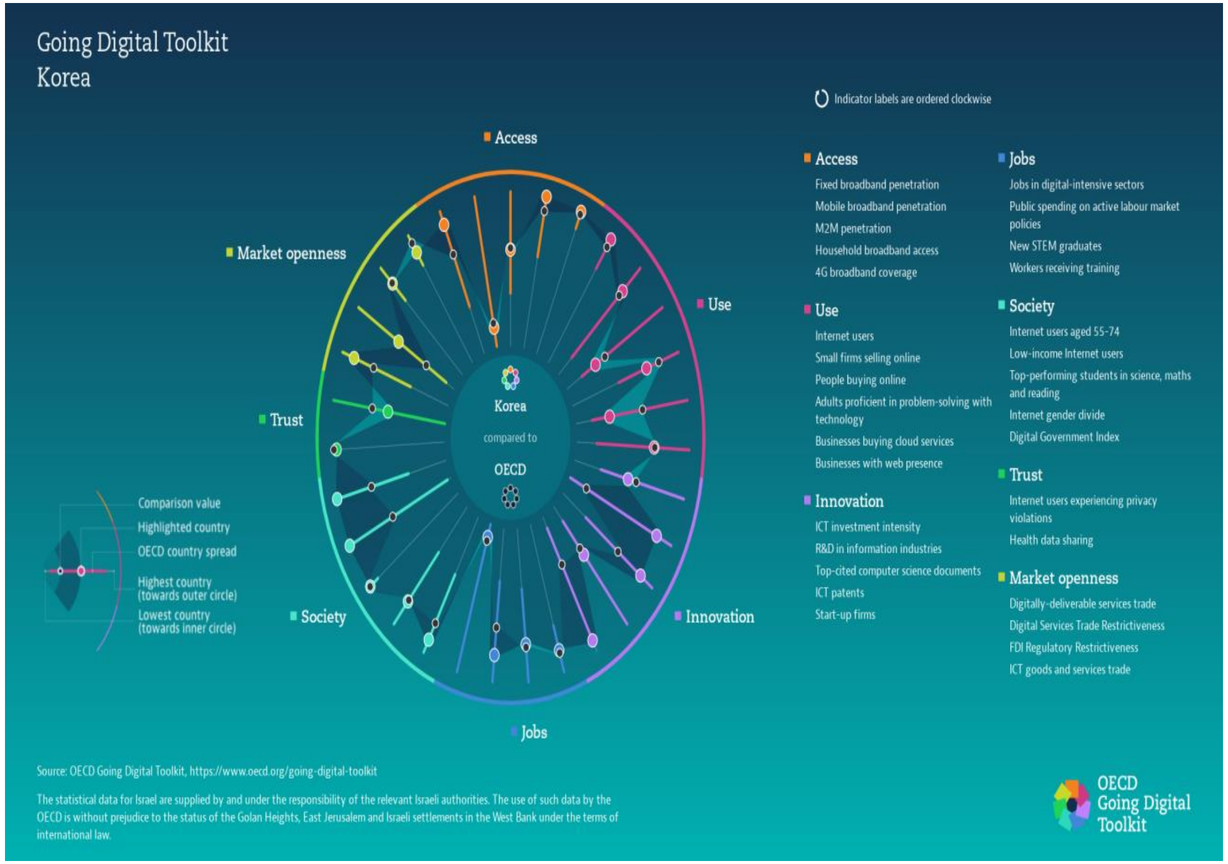


Source: Vial (2019: 122)

Chapter 2.

Key Facts of Digital Transformation

OECD Going Digital Toolkit



OECD Going Digital Toolkit:

Overview of the state of digital transformation in member states and policies to address it

Present a unified policy framework:

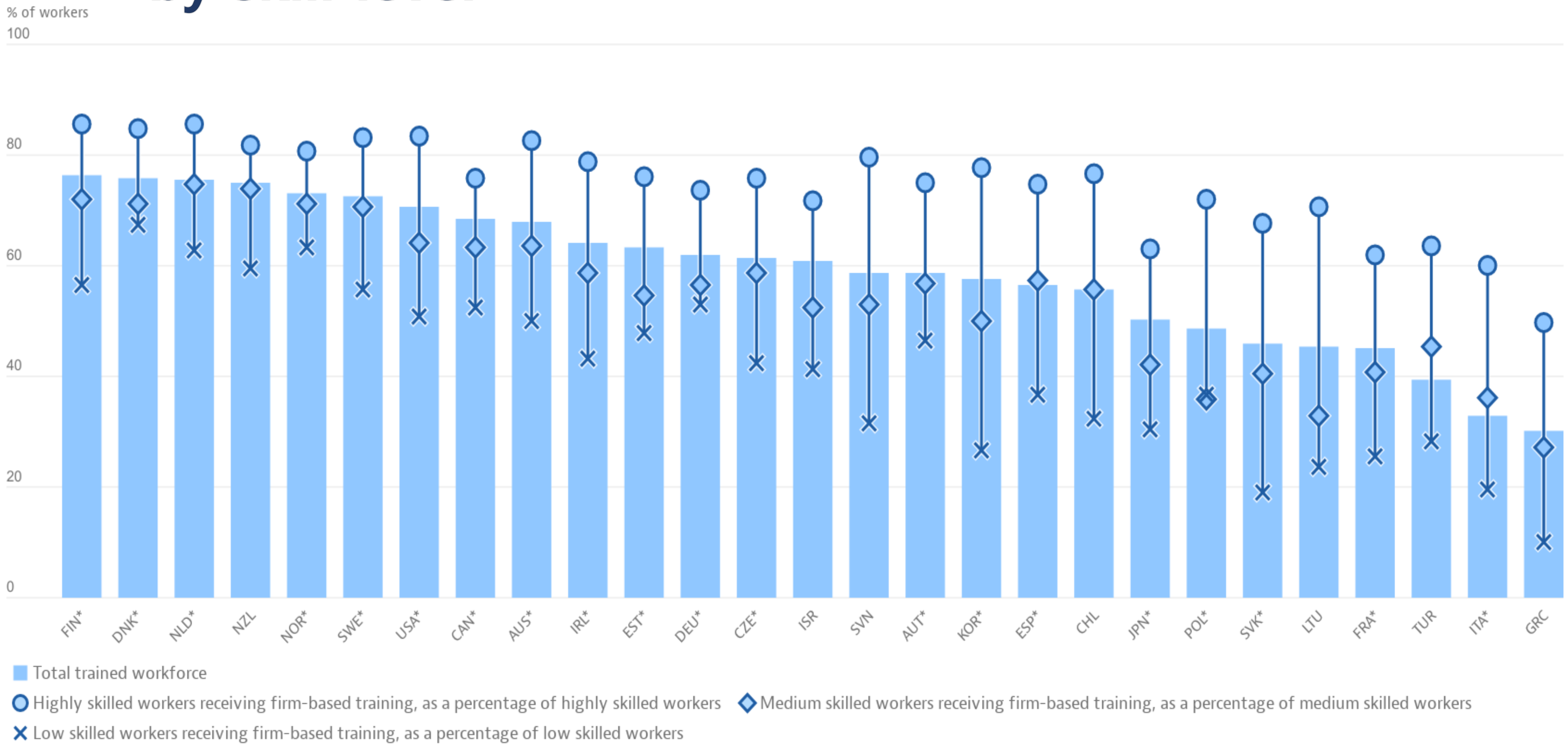
- too help materialize the potential of **digital transformation,** which helps discover consistent and resilient policies

7 Pillars: access, use, innovation, jobs, society, trust, market openness

- Each pillar consists of 5-7 metrics, which aims to foster growth and well-being

Source: https://goingdigital.oecd.org/countries/kor
Note: Low scores (closer to the center of the circle), high scores (closer to the circumference) (last accessed 22.10.11)

Job training participation rates by skill level



Source: OECD Going Digital Toolkit (based on PIAAC data)
Source: https://goingdigital.oecd.org/indicator/44 (last accessed '22.10.11')

Job training participation rates by skill level

The Matthew effect in learning(Blossfeld et al., 2019) : better educated workers are more likely to participate in vocational training in all countries

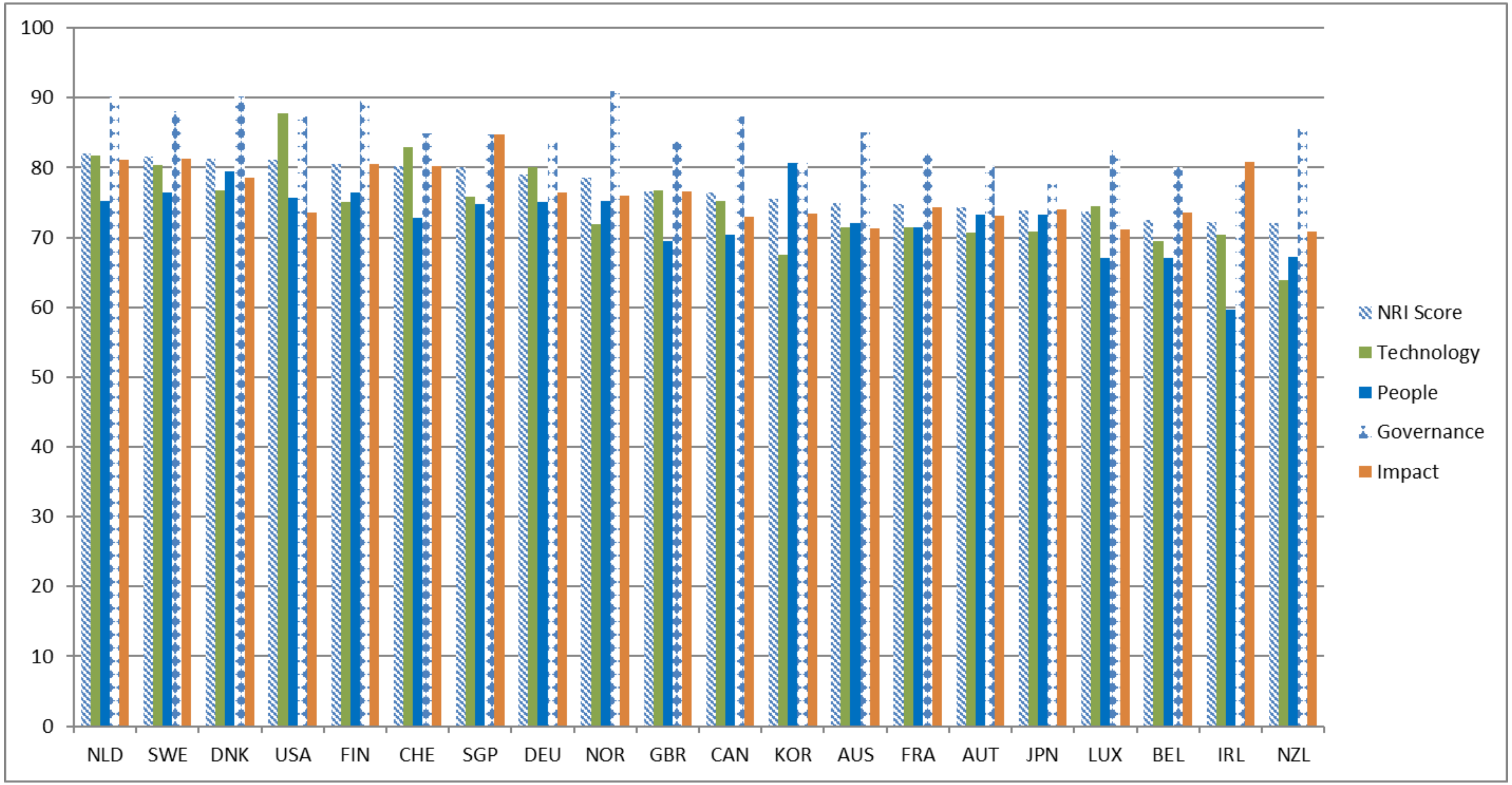
Countries with the highest overall rates of worker participation in vocational training include Finland, Denmark, the Netherlands, and New Zealand, Nordic **and continental European** countries, such as Norway and Sweden, as well as the United States and Canada, Austria and Ireland in **Anglo-American countries**

Korea has an overall worker training participation rate of **57.7 percent**

- found large gaps in job training participation rates by level of education and skill-level

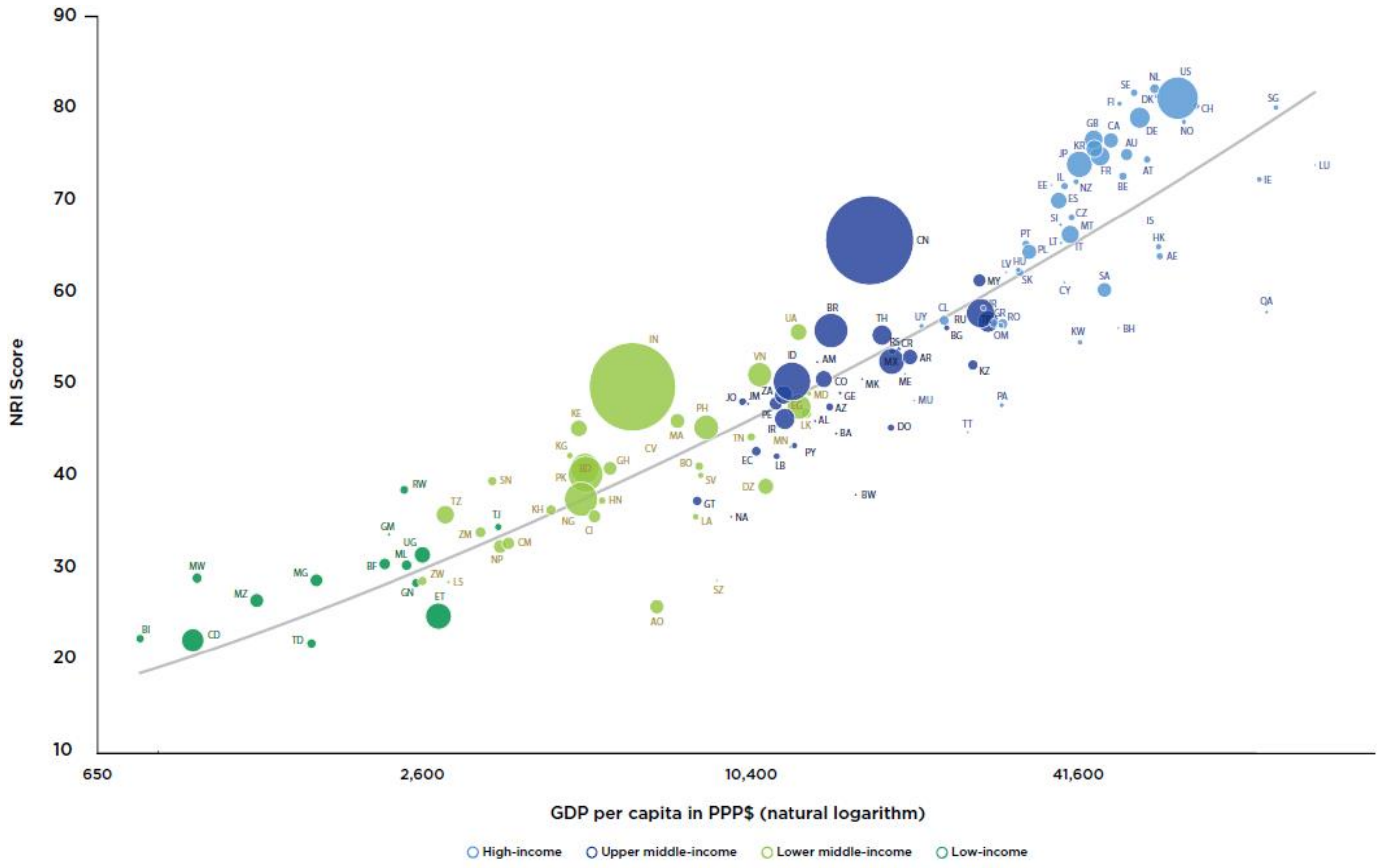
The rate of participation in job training in the past year for the **low-skilled** group is **about 26.**7%, **50.0% in the medium-**skilled group, and **77.6% in the** highly-skilled **group**

Network Readiness Index and its distribution by sub-pillars



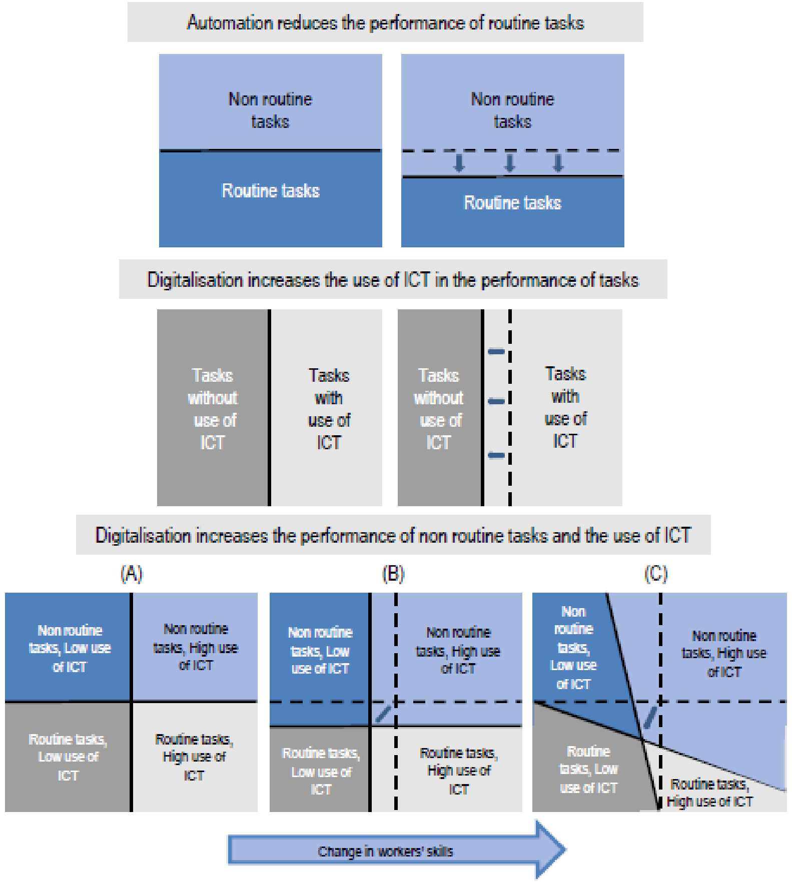
Note: Country order sorts the top 20 countries in order, starting with the country with the highest NRI rank (NLD).
Source: Authored by researchers from the Portulas Institute (2021) Network Readiness Index 2021

Network Readiness Index and GDP per capita (in PPP)



Note: Note: GDP per capita is in PPP$ (natural logarithms). Both GDP per capita and population data (represented by the size of the bubbles) are for 2019 or the latest year available. The data are drawn from the World Bank's World Development Indicators database. The general trend line is a polynomial of degree two (R2 = 0.85). Countries are grouped according to the World Bank Income Classifications (July 2021).
Source: Network Readiness Index Database, Portulas Institute, 2021 (NRI Report 2021: 49)

How digitalization is impacting job configurations: automation - tasks – the use of ICT



substitution and complementarity effects on the demand for jobs and tasks

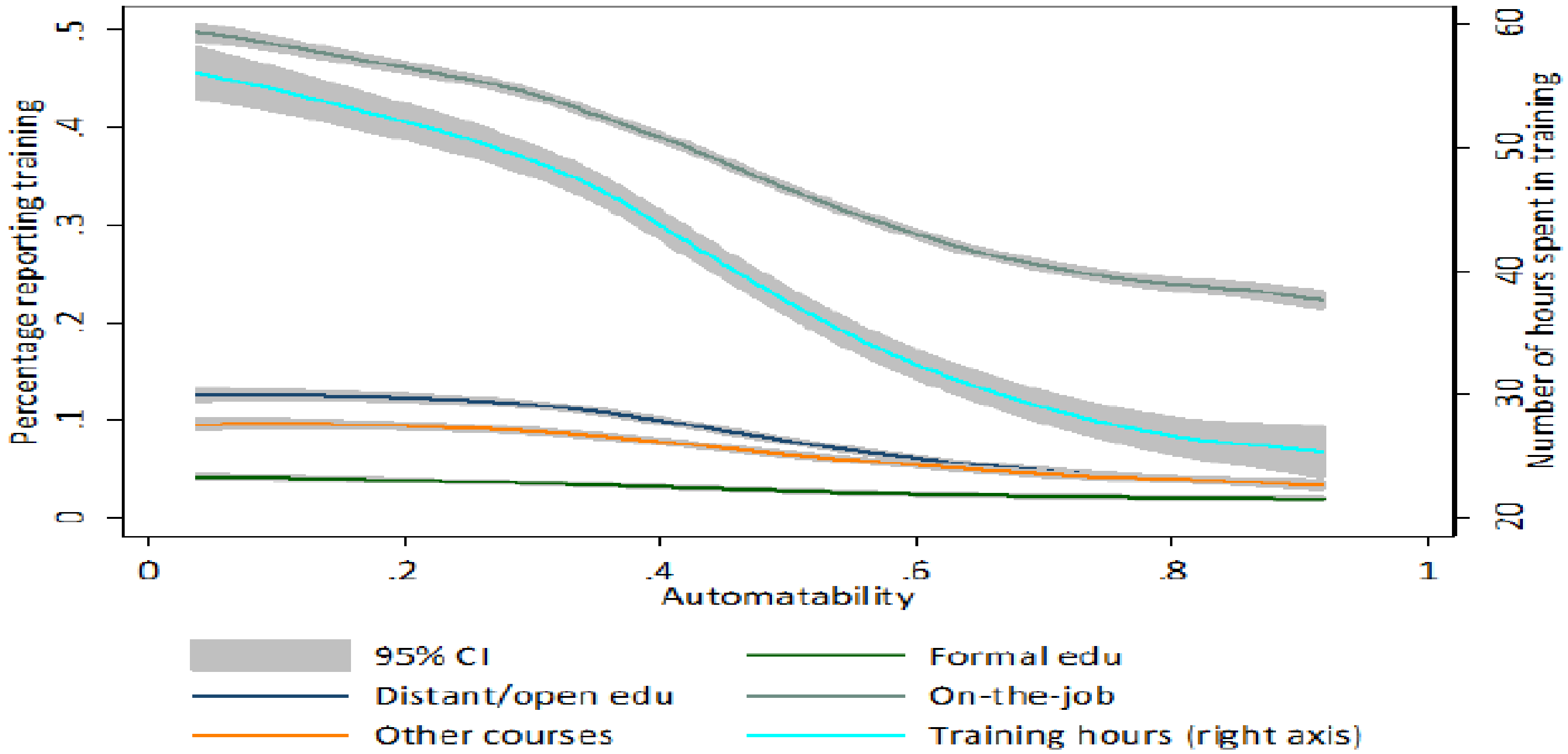
Digitalization derives differential demand for labor by type of skills needed

There is less demand for routine tasks, more demand for non-routine tasks

ICT utilization increases demand for non-routine tasks, which accelerates digital transformation

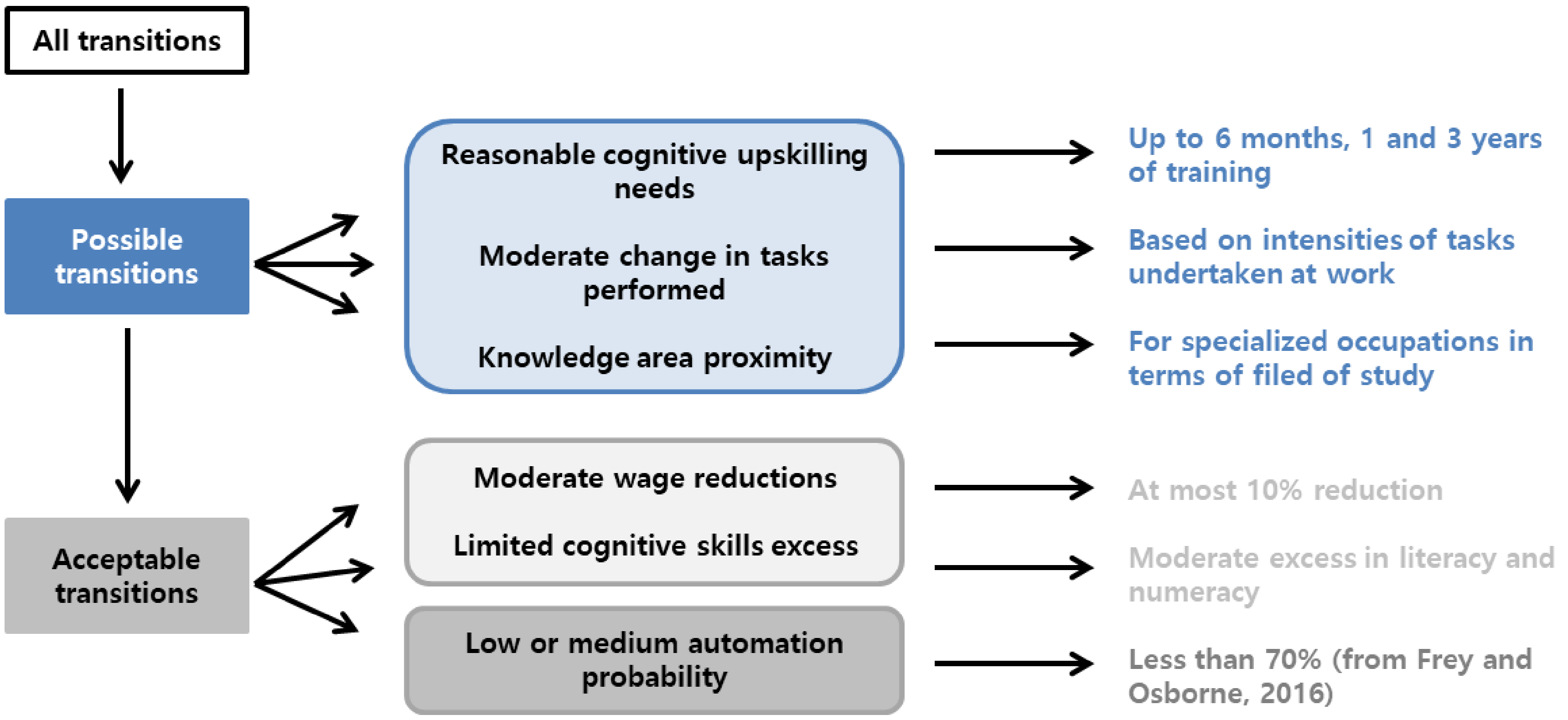
Source: OECD (2019a: 44)

Automation risk and training participation over the past year



Source: Nedelkoska & Quintini (2018: 49)

Transition, skills, and job training: possible and acceptable transitions



Source: OECD (2019: 93)

Chapter 3.

Modelling Socio-economic impact of digital transformation in Korea

Computable General Equilibrium (CGE) Models

The Models consider the changes in major institutional attributes related to technological change and vocational skill development in the era of DT, analysis scenarios were designed to conduct policy experiments

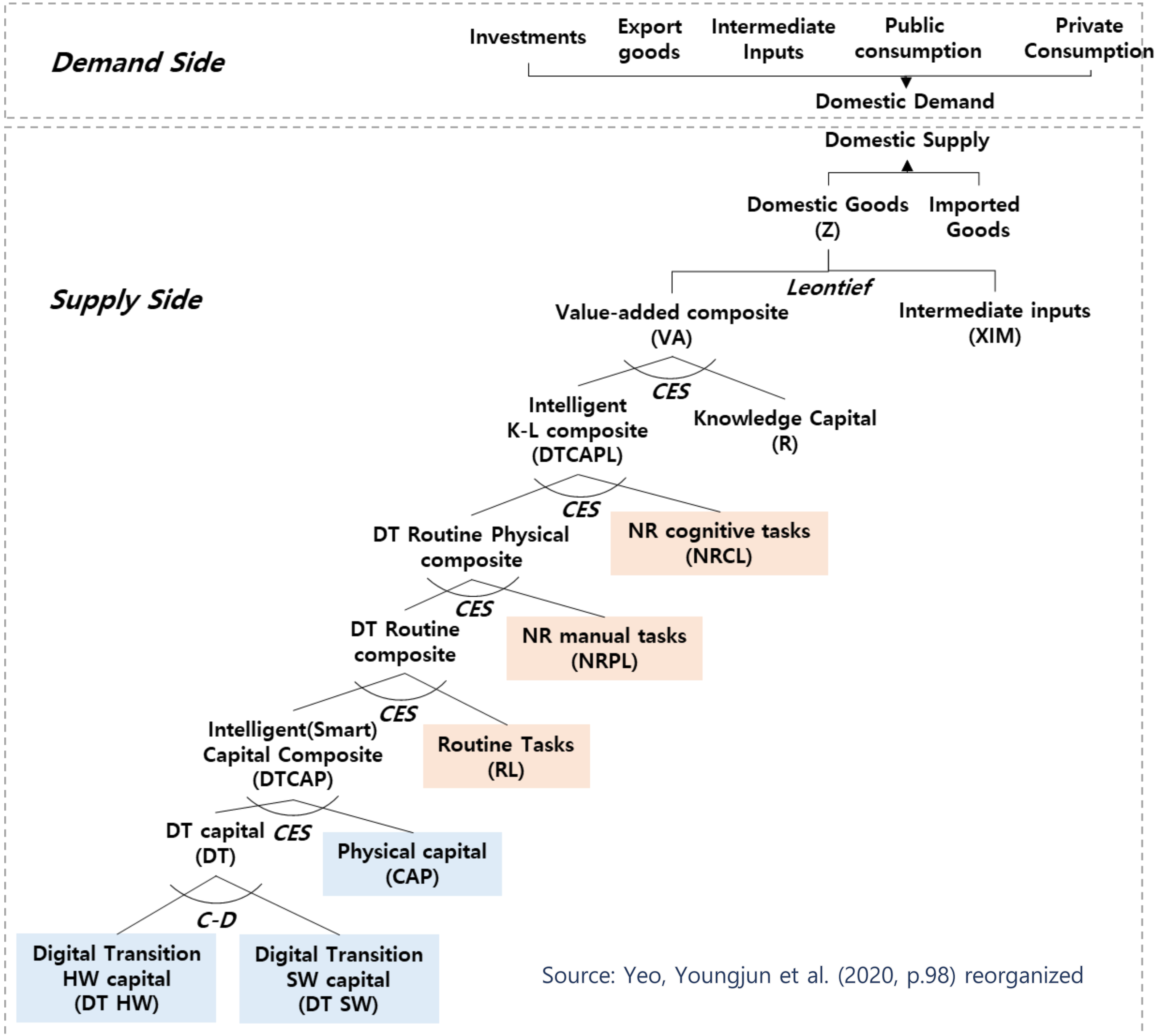
DT capital accumulation and capital-augmented technological progress by digital transformation by industry were include in the model

Dynamic changes in the labor market: consider changing task distribution across industries as well as a mix of routine/non-routine, cognitive/physical tasks

Endogenous determination of employee learning: the relative wages of routine physical tasks as opposed to non-routine cognitive tasks were taken into account

In other words, depending on the nature of the relationship with the digital transformation technology (complementarity and substitution effects), the allocation of labor income by task may be different.

Designing industry-specific production functions



Source: Yeo, Youngjun et al. (2020, p.98) reorganized

$$\Pi_i^Z = LT(P_i^{XIM}, P_i^{VA}) - P_i^Z \geq 0 \perp Z_i$$ equation (3.1)

$$P_i^{VA} = SPILL_i \cdot CES(P_i^{DTCAPL}, PR_i^R; \sigma_i^{VA})$$ equation (3.2)

$$P_i^{DTCAPL} = CES(P_i^{DTRNLP}, P_{NRCL}; \sigma_i^{DTCAPL})$$ equation (3.3)

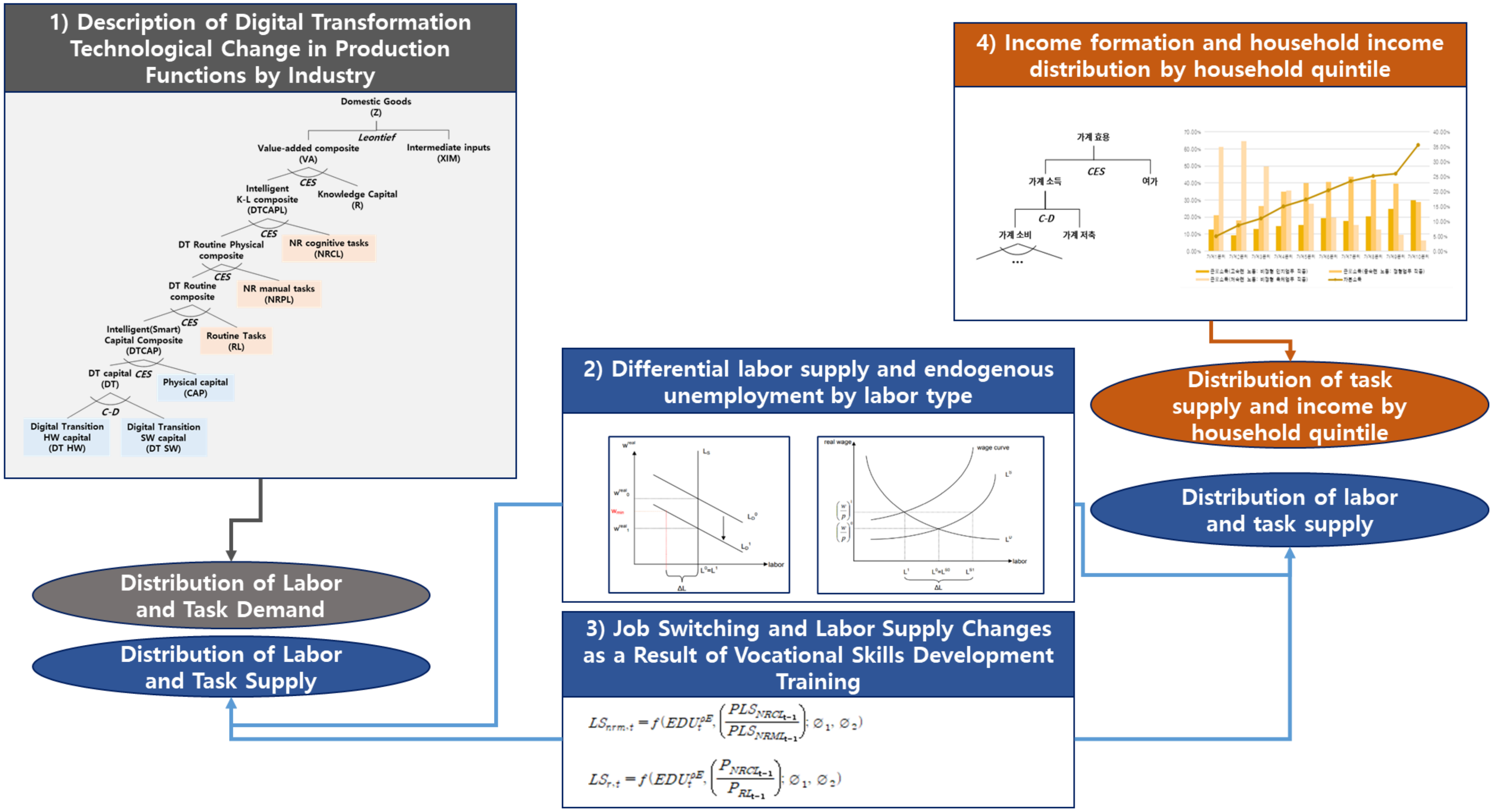
$$P_i^{DTRNP} = CES(P_i^{DTR}, P_{NRPL}; \sigma_i^{DTRNP})$$ equation (3.4)

$$P_i^{DTR} = CES(P_i^{DTCAP}, P_{RL}; \sigma_i^{DTR})$$ equation (3.5)

$$P_i^{DTCAP} = CES(P_i^{DT}, P_{CAP}; \sigma_i^{DTCAP})$$ equation (3.6)

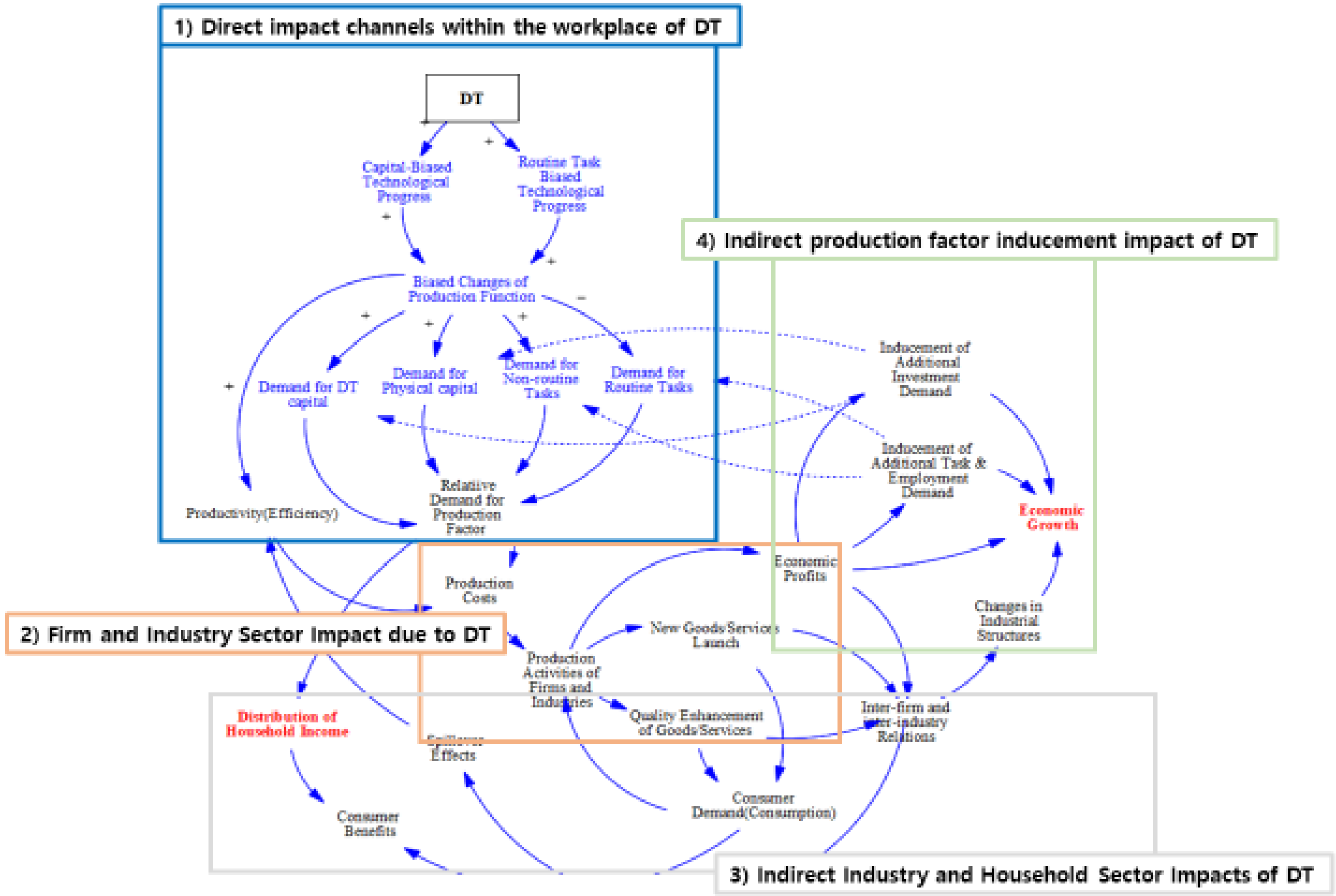
$$P_i^{DTCAP} = CD(P_{DTHW}, P_{DTSW})$$ equation (3.7)

Relationships between key components in a CGE model



Source: Ryu et al. (2022: 106)

Key macroeconomic spillovers from digital transformation



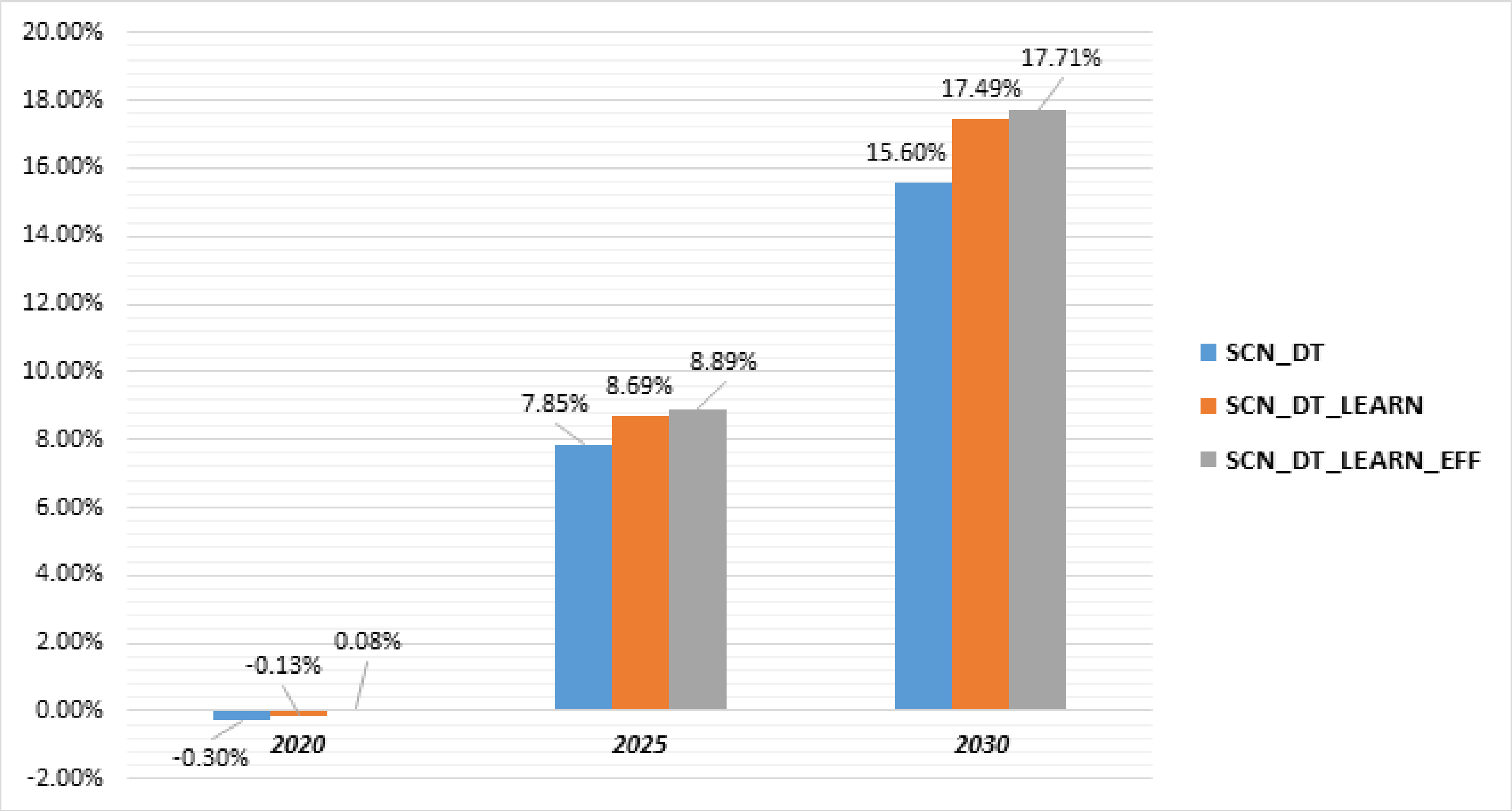
Source: Ryu et al. (2022: 107)

Designing analysis scenarios

Scenario name	Scenario description	Modeling approach
Business as usual (BAU) scenarios	Korean economy in '18-'30 without exogenous shocks	-.
DT Scenarios	Increased DT technology change compared to BAU scenarios	Increased investment in DT (1%p increase in investment in DT technology
DT_LEARN Scenario	- Increased DT technology change compared to BAU scenarios - Progress in improving workers' access to skills development and vocational training	- Take into account increased investment in lifelong learning and job training (1%p increase in investment in job training) - Reflect endogenous learning decisions
DT_LEARN_EFF Scenario	- Increased DT technology change compared to BAU scenarios - Increased access to skills development and vocational training for workers - Increased specialization and adaptability of education and training institutions	Improvement on worker skill obsolescence rates (1%p decrease in depreciation rate of human capital stock accumulation)

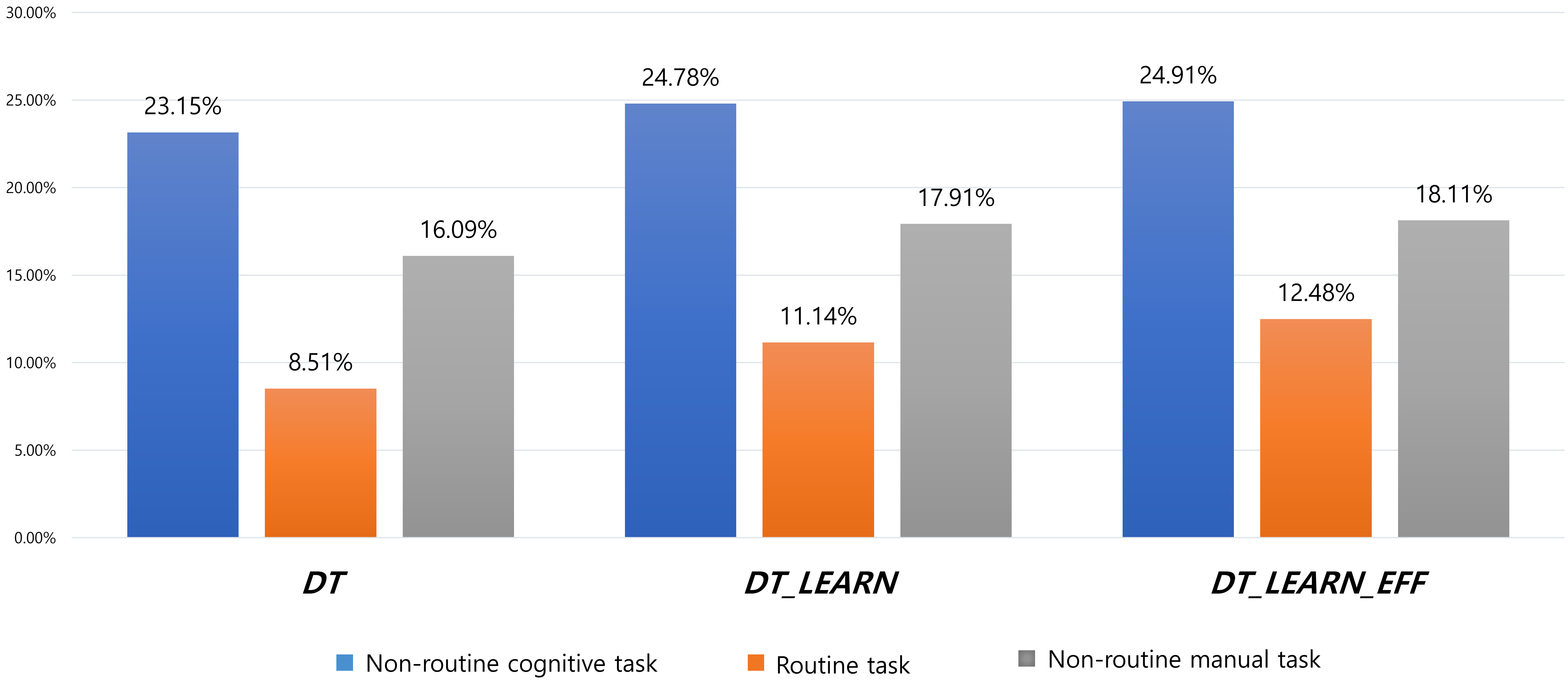
Source: Ryu et al. (2022: 108)

Change in GDP as opposed to the BAU by scenario



Source: Ryu et al.,(2022: 110)

Change in employment rates as opposed to the BAU by scenario in 2030



Source: Ryu et al. (2022: 115)

Changes in income share by household quintile as opposed to the BAU scenario in 2030

Source: Ryu et al. (2022: 119)

DT Scenario: The share of high-income households increases, while the share of households in the middle income quintile decreases.

- As individuals in the low-income quintile are more likely to be employed in non-routine physical task-based jobs, the household income distribution is expected to polarize

DT_LEARN Scenario

/DT_LEARN_EFF Scenario

- The moderation of income growth for high-income households contributes to an improvement in income distribution.
- Additionally, increased economic growth leads to an enhancing income distribution

Chapter 4.

Policy suggestions

Policy implications

Digital transformation increases labor market/household income inequality (**DT Scenario)**

Increased investment in lifelong skills development(**DT_LEARN Scenario**) can partially mitigate the widening inequality effects of digital transformation

- necessary to promote the motivation to help switch jobs and accumulate competencies through learning, and to establish a supply system that fully reflects the learning needs of workers as technology changes.

→ This will lead to increased scale effects across the economic system, creating a virtuous cycle of spillovers that can expand employment rates

Support for a strategic transition to jobs and tasks that are highly complementary to digital transformation skills is needed.

- Supporting labor transition leads to economic growth and inequality reduction.

Policy implications

Promote a virtuous cycle between the demand for learning in the labor market and the supply of knowledge, skills, and competencies by training institutions to meet the demand

Vertical, hierarchical organizational cultures and supplier-centric learning environments are neither conducive to autonomous and proactive decision-making nor to improving task competency and skill levels.

There is a need for organizational culture and workplace innovation to provide autonomy and discretion for the development of competencies and vocational training.

Recognize the autonomy of various training programs to prepare a supply system that faithfully reflects the training demand.

Policy implications

Establish a training system led by companies and learners and give them autonomy in determining training contents and methods.

- Ensure that the learning incentive system contributes to the accumulation of workers' capabilities according to environmental changes such as technological changes in the market.

Promote the professionalism of training institutions by enhancing their practices and reforming revenue and evaluation structures.

- This will enable them to respond flexibly to learning needs.

To improve the effectiveness of education and training, trust in education and training institutions can be enhanced when they have high utility value in tasks and jobs due to DT, and participation in learning and vocational training can be further increased.

Policy implications

Operate programs that respond to learners' needs and the changing technological environment, and increase contact with industrial sites.

Training institutions form partnerships with various innovators in the industry to continuously update, develop, and operate continuing vocational education and training programs.

In terms of teaching and learning methods, educational contents, and management of teacher and instructor operations, it is necessary to expand efforts to increase the connection with industry

Policy recommendations

- Key policy implications

: Active social policies and vocational skills policies in response to digital transformation must establish policy instruments and infrastructure to preemptively respond to the risks of informatization and job displacement.

- Reshaping vocational skills policy to combine multi-layered governance and policy instruments in terms of protection and utilization as well as development of vocational skills.
- K-Digital Training (KDT: the Korean Digital Key Talent Training): needs further improvement to avoid inequalities in access to services based on market position, geography, education, etc.

Key policy proposals

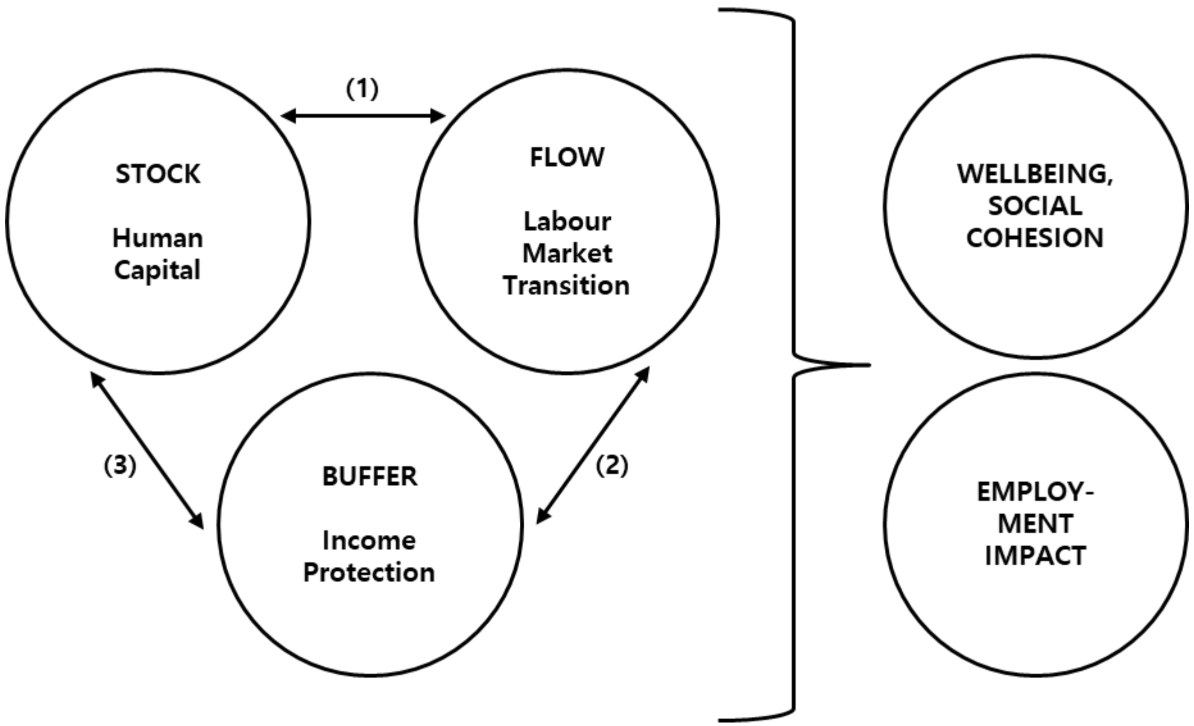
- Digital transformation is a powerful driver of structural social inequality as it brings radical structural changes to the world of work.
- While existing skills policies have focused on the development of job skills, they are limited in responding to the growing labor market instability caused by digital transformation
- To actively respond to social inequality at a time of accelerating digital transformation, skills policies need to be reorganized to organically link the development, protection, and utilization of vocational skills.
- Propose to restructure skills policy from a stock-buffer-flow linkages of the social investment state theory.

Key policy proposals

- Social investment state theory: identifies the linkage of flows-stock-buffers as the core of the social investment state, which provides income security and opportunities for human capital investment during the critical transition phase of the life course (Hemerijck, 2014; 215).

→ Contribute to building a flexible and stable labor market by reorganizing occupational policies

Linking Stock-Flow-Buffer in Social Investment Policies



Source: Adapted with some modifications from Orlandini (2016: 26)

Linkages of Stock-Flow-Buffer Functions

Policy Linkages	Backgrounds	Goals	Key policy instruments	Related policy examples
(1) Stock-Flow linkages	- Reduce training investments in tasks and roles that are at high risk of job displacement due to automation and intelligence technology(e.g, AI). - Long-term training opportunities and labor market transition support based on individual training rights	- Increase opportunities for participation in lifelong learning and vocational training in response to technological change and organizational restructuring in the wake of digital transformation. - Ensure social citizenship-based training opportunities	- Expand Paid Training Leave and reshape National Daily Learning Card into Individual Training Accounts	- K-Digital Training - Expanding the scope of the National Daily Learning Card Program and strengthening support levels
(2) Flow-Buffer linkages	- Increased need to link human capital accumulation with enabling measures that strengthen incentives to participate in the labor market	- Strengthening the automatic stabilizer function of skills policies - Generous (short-term) unemployment benefits provide income and motivation while preparing for job search and labor market entry	Enabling policies to facilitate labor market entry for young people and women with career breaks, and help middle-aged employees to upskill and reskill their skillsets.	- Monitor job displacement risk and labor market inequality by labor market intelligence system

Linkages of Stock-Flow-Buffer Functions

Policy linkages	Backgrounds	Goals	Key policy instruments	Related policy examples
(3) Stock-Buffer linkages	- Work-life balance: Increased delay and instability in family formation due to caregiving, parenting, and work-life pressures, and the rise of flexible family forms.	Support the development and maintenance of human capital stocks during critical transitions in the lifecycle. - Reducing income inequality through lifelong learning and professional development (refer to results of CGE Model Analysis)	Promoting work-life balance and employability policies based on the universal breadwinner-caregiver model (Ryu et al., 2019)	Design a system that allows people to combine work and training: introduce partial unemployment, Empowering mid-career workers to upskill - Activate Paid Training Leave
(4) Enhancing human capital Stock	- Increased risk of skill attrition due to technology convergence and organizational change - Digital transformation and technological advancements are driving demand for high-skill/atypical task labor.	Improve the quality of your human capital (DT_LEARN_EFF scenario	Transforming the workplace for digital transformation readiness Build a layered network	- European Commission's Local-Regional Medium-Tier Network

4. Policy suggestions

Linkages of Stock-Flow-Buffer Functions

分类	Backgrounds	Goals	Key policy instruments	Related policy examples
(5) Promoting Flow	Labor market entry mismatches are growing due to changes in recruiting methods - Increased labor market instability and rapidly changing job structures have led to delays and incomplete transitions.	Facilitate labor market transitions	Job placement and employment services to support young adults' transition into the labor market.	- Vocational training and employment services to help people move from job to job within the labor market. - Create pathways for higher-level vocational education and strengthen industry-university collaboration
(6) Preparing Buffer	Facing the limitations of skills policies based on standard employment relationships (SER) and the need to position skills policies as a universal social safety net	Maintain a minimum income security safety net with income security and economic stabilization	Strengthening Employment Insurance Scheme (EIS) by expanding eligibility for benefit entitlements - Enhancing support for Personal Training Accounts	- Introducing the National Employment Support System

Source: Ryu et al., (2022: 225-226)

THANK YOU

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TU Dortmund

BIBB project „Vocational tasks in international Comparison“. A short introduction to the workshop „Organizational aspects of Transformation“

Vocational Tasks in international Comparison

- Comparative research project
- In co-operation with colleagues from Korea and Spain
- Based on the experience from past projects that there is great variation in tasks mixes in occupations and that this influences training decisions
- Objective: To map these differences in quantitative data as a basis for further analyses

- Selected Occupations
- Based on existing databases (e.g. PIAAC) and national datasets (e.g. Employment Surveys)

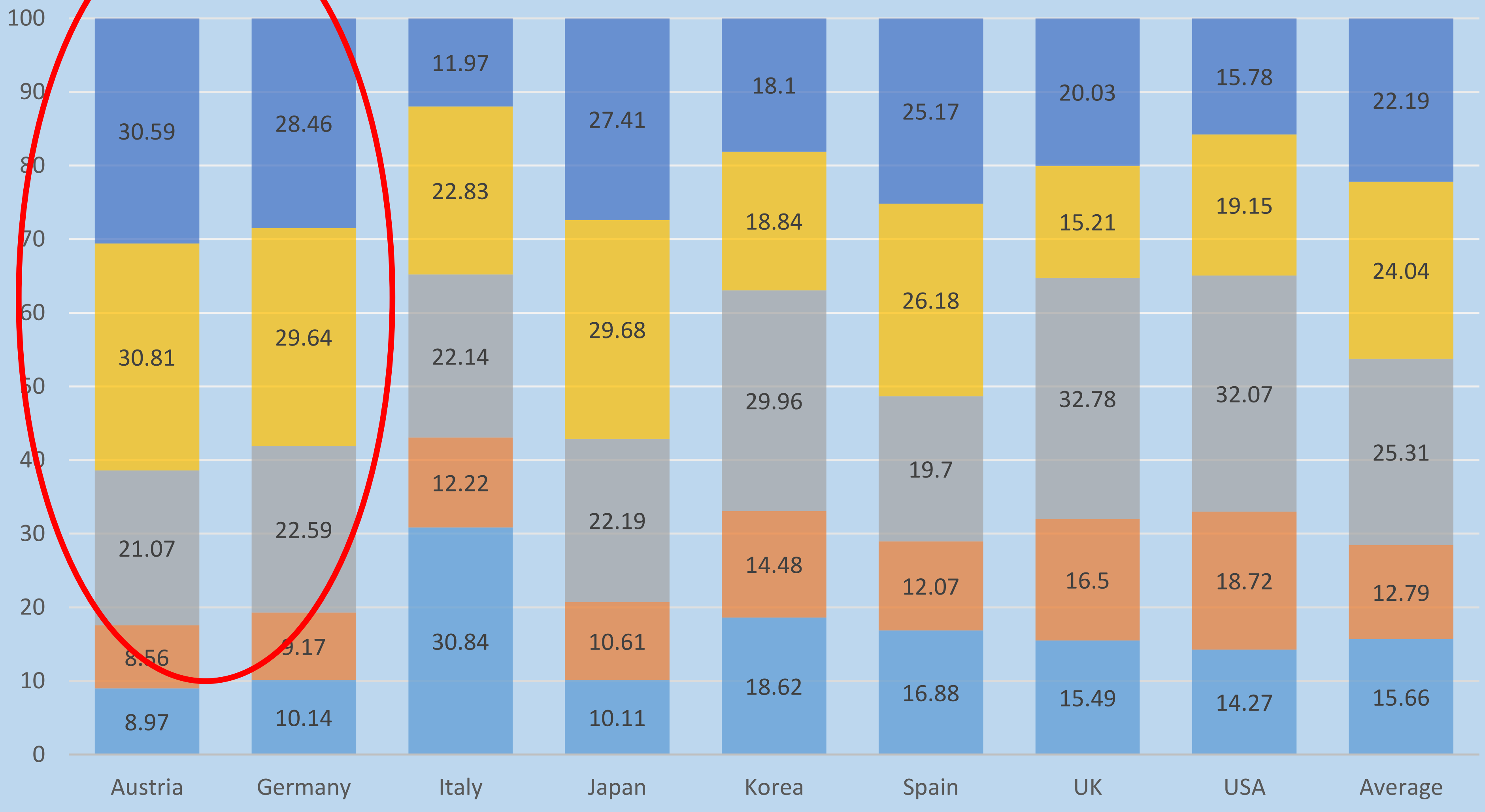
Bundesinstitut für Berufsbildung

- Parallel project: A Comparative national tasks database

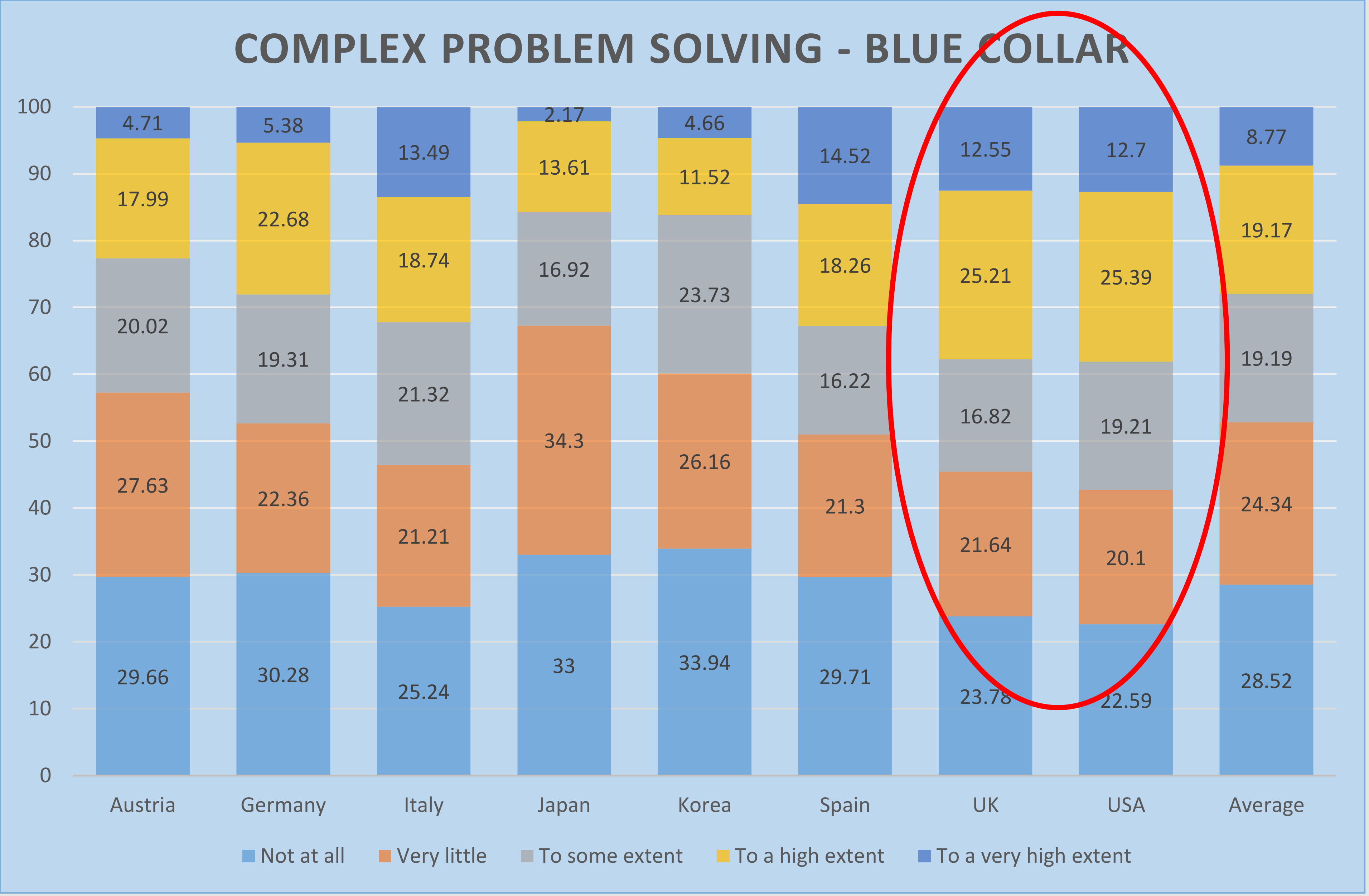
JRC EUROPEAN COMMISSION

Great Variation, Challenges of disaggregation

FLEXIBILITY, HOW TO DO WORK - BLUE COLLAR



Sample size (n) = 5.983
OECD PIAAC 2012


COMPLEX PROBLEM SOLVING - BLUE COLLAR
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Spain
UK
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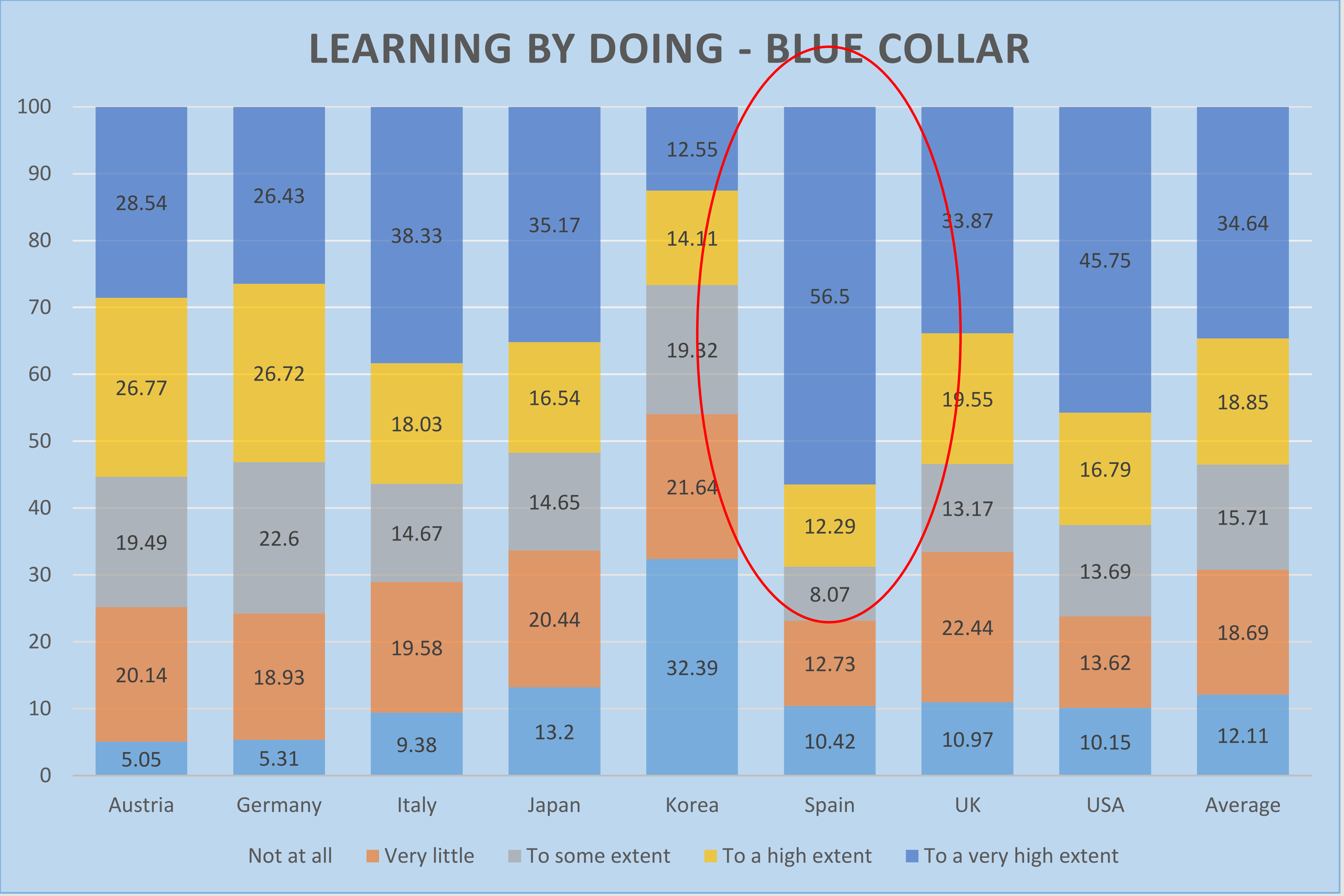
Not at all
Very little
To some extent
To a high extent
To a very high extent


problem-solver


LEARNING BY DOING - BLUE COLLAR
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18.85
15.71
18.69
12.11
Austria
Germany
Italy
Japan
Korea
Spain
UK
USA
Average
Not at all
Very little
To some extent
To a high extent
To a very high extent


informal learner

- How do transformative firms and organisations look like?
- What type of apprenticeship is suited?
- Is there a universal model or will there be different patterns?
- What is the role of individual workers?
- …

Vocational Tasks in international Comparison – Questions

- Workforce skills, on-the-job training and firms' propensity to invest in new technologies
  Irene Brunetti & Marco Biagetti, INAPP

- Who is listening to guarantors of good VET? The role of trainers.
  Marco Blank, University of Erlangen

- How do skilled workers contribute to innovation?
  Torgeir Nyen & Johan Røed Steen, Fafo Institute

- Vocational education and training as a driver of innovation: a long-neglected field of research
  Patrick Lehnert, University of Zurich

- Conclusions from the Working Group
  Jörg Markowitsch, 3s Research & Consulting

Programme

INAPP
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DELLE POLITICHE PUBBLICHE

ANNO EUROPEO
DELLE
COMPETENZE

WORKFORCE SKILLS, ON-THE-JOB TRAINING, AND FIRMS' PROPENSITY TO INVEST IN NEW TECHNOLOGIES

Marco Biagetti – Irene Brunetti

Inapp

Bibb conference on ''*Vocational Education, Skilled Workers and Transformation in an International Perspective*''

1 december 2023 – Bonn

MOTIVATIONS AND AIMS

- In today's digital age, a **skilled workforce** is crucial for effectively leveraging **technology**. Skilled employees are in fact better able to adapt to and harness the power of new technologies, improving overall efficiency.
- **Skilled workers** are integral to a **firm's decision to invest in new technology**. Their expertise enables a more successful and efficient integration of technology into the organization, ensuring that the firm can leverage the full benefits of its technological investments.
- The presence of skilled workers influences strategic decision-making and **contributes to a culture of innovation** and continuous improvement within the organization.
- Different channels through which improve the skills and education of workforce: formal education and **firm-provided training**
- **Technology investments** require **training** for successful implementation, and training programs are more effective when aligned with the firm's technological goals
- Finally, **investing in new technology** often necessitates **strategic workforce planning**. The firm may need to assess its current workforce, identify skill gaps, and plan for future staffing needs. This process can lead to the creation of vacancies as the firm aims to align its workforce with its technological goals

MOTIVATIONS AND AIMS

- Analyze the **relationship between firm's investments in new technologies** and the **decision to provide specific training programs**
- Analyze the **relationship between firm's investments in new technologies and firm's vacancies**
- Analyze the **relationship between the share of high educated workforce and firm's investments in new technologies** (which we name "bidirectionalism" henceforth)

- By the ***Rilevazione Imprese e Lavoro*** (RIL-INAPP) survey, we provide you an overview of the behavior of Italian firms with respect to the issues under discussion today

LITERATURE AND DEFINITIONS (1)

ANNO EUROPEO DELLE COMPETENZE

- Skills: productive assets of the workforce acquired through learning activities. Very difficult to define this elusive concept though. Usually they are considered to be some combination of education, training and experience (OECD, 2011)
- Anglosaxon definition of vocational skills: physical or manual dexterity, qualifications untied to wage levels
- Germanic definition (berufsbildung): includes general education helpful to production (considered a social activity). Theoretical knowledge in a practical context. Linked to wage increases
- Differences originating from the formation of European Nation States (Clarke and Winch, 2007)

LITERATURE AND DEFINITIONS (2)

- Innovation: The implementation of a new or significantly improved product, process, marketing method, organizational method in business practises, workplace organization or external relations (Oslo Manual, third edition, OECD and Eurostat 2005: 46)

RELATIONSHIP BETWEEN SKILLS AND INNOVATION (1)

- Link between innovation and skills also difficult to assess:
  1. Many differences in the propensity of firms to innovate and the intensity of innovation activity
  2. Surveys only collect data on skills at a very aggregate level, therefore a direct link between innovation activity, innovation expenditure by an industry and the employment of people and skills between the industry is not always found.

For instance, innovation activity (such as patenting) may be funded by an industry but its undertaking may be outsourced to another. These input-ouput relations make it difficult to infer which skills are involved.

RELATIONSHIP BETWEEN SKILLS AND INNOVATION (2)

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- Innovation intensity **measured as the ratio of the proportion of total innovation expenditures undertaken in an industry to the industry share over GDP** varied widely across industries according to 2003 Australian data (Australian Bureau of Statistics, 2005)

- Similar variations are also found in the R&D (basic and applied research plus experimental development) intensity

- This intensity is unsurprisingly higher for bigger (often foreign-owned) firms, which usually exploit higher economies of scale from the innovation activity.

RELATIONSHIP BETWEEN SKILLS AND INNOVATION (2)

- Differences are also huge in composition thus demand for skills also is varied.

Industry	Main innovation	Skills required
Communication	**Acquisition of telecommunication equipment**	**Electronic, software engineering**
Retail	**Marketing**	**Customer liaison and advertising**
Finance, insurance	**Organizational restructuring**	**Human resources, adult education**

THE SO CALLED "BIDIRECTIONALISM"

ANNO EUROPEO DELLE COMPETENZE

- With no technical change, training and skill upgrading or recruitment only in production.
- With technical change, training occurs also in innovation. Innovation, training and production should be considered a joint product of a single process. Structural imbalances are unlikely to appear in the job market (Piore, 1968)
- From innovation to skills.
- High-tech spurs complexity, mental work, CVET. Technology needs to be mastered. Self and time management is crucial for further career development (Beer, Mulder 2020)
- Industry 4.0 entails continuous reskilling through LLL which is destined to become a fundamental component for both organizational strategies and personal careers (Li, 2022).
- Digital technologies enhance upskilling and training but more time spent on those technologies make workers more experienced thus reducing training. Workers who work on complex tasks more often receive training regardless of their job's skill requirements (Lukowski et al., 2020).
- Technology increases make more likely to use high-ability workers and less so high-experienced workers (Abowd et al., 2007).

THE SO CALLED "BIDIRECTIONALISM" (2)

- "Pure bidirectionalism"
- High share of STEM graduates is associated with a higher digital investment, but also more digital spending tends to make transition to a higher share of STEM graduates easier for an enterprise.
- Hierarchical structure of a firm is flattened as well due to a younger, junior workforce and significant reorganization (Babina et al., 2023).
- From (management) skills to innovation.
- Managerial skills spur innovation because they acquire knowledge beyond the firm's current technological domain. Those skills can be applied elsewhere should innovation projects fail (Custódio et al., 2017, Zhao et al. 2021).

ECONOMIC ISSUES "STAY VIGILANT"

- **Growing inequality?**
  1. Based on HC theory. SBTC
  2. Increasing demand for skills outpacing supply
- **Further setbacks?**
  1. Skills shortage and/or mismatch
  2. What if the educational system is not fit (educational failure)?
  3. Knowledge society and post-industrial theories. Will it be really inclusive?
- **Is the demand side being overlooked?** It could be interesting to analyze it when it is the economic structure of a country rather than the molding of workers' characteristics the basic ingredient of technology to be exploited in a productive manner?

THE DATASET (1)

- We use "***Rilevazione Imprese e Lavoro*** (RIL)" survey conducted by INAPP for 2018 and 2021
- RIL is a representative sample of partnerships and limited liability firms. Each waves: over 30.000 firms operating in non-agricultural private sector. A subsample of the included firms (around 30%) are followed over time
- Information on composition of the workforce, including the **share of graduate and tertiary educated workers**, the decision about **on-the-job training**, the firm's vacancies, the asset of the industrial relations, managerial and corporate governance characteristics, productive specialization and other firm strategies such as innovation and export.
- RIL-INAPP 2018 and 2021 collects information on **digital investments**, both in tangible and intangible assets, and RIL-INAPP 2021 reports information about the topic of training

THE DATASET (2)

Three main RIL-2021 questions

“In the period 2019-2021 did the firm invest in these new technologies?”

- i) Internet of Things and augmented reality (IoT),
- ii) 3D printers,
- iii) Robotics,
- iv) Cloud Computing and Big data analytics,
- v) Web applications and devices for online selling,
- vi) Cybersecurity and technological updates of existing devices
- vii) Artificial Intelligence
- viii) others

“During 2021 did the firm train their employees in I4.0 enabling technologies?” If yes, “**Which Industry 4.0 enabling technologies have you trained on?”**

i) Internet of things ii) cloud manufacturing and big data iii) Collaborative Robotics iv) human-machine advanced interface, v) additive manufacturing, vi) augmented reality, vi) Artificial Intelligence, vii) Blockchain

THE DATASET (3)

“Is the firm currently looking for staff to be employed under an employment contract?” If Yes, “**Which of the following job profiles is the company looking for?”**

- Management
- Scientific and highly specialized profiles

High skill professions

- Technical profiles
- Executive profiles in office work
- Skilled profiles in commercial and service activities
- Skilled workers (construction, repair or maintenance of artefacts, objects and machines)

Medium skill professions

- Unskilled workers (operation and control of industrial machines and automated or robotic systems)
- Unskilled workers (simple and repetitive activities for which no particular qualification is required)

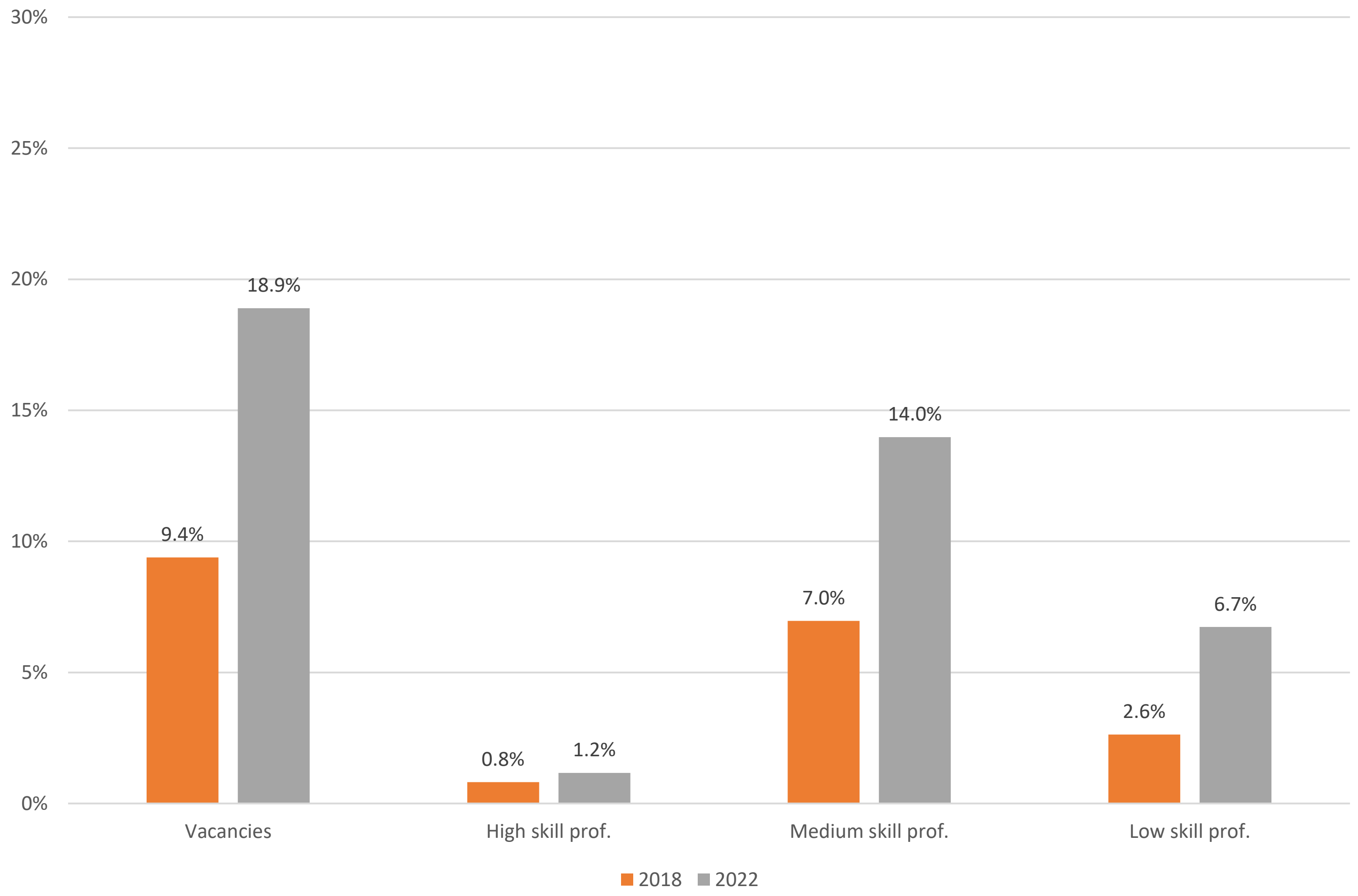
Low skill professions

Sample selection

- We select firms with at least 1 employee
- After excluding observations with missing values for the main variables, **the final cross-sectional sample** for 2021 is equal to around **24,000 firms** while the longitudinal sample is given by around **3,000** firms observed both in 2018 and 2021

SOME DESCRIPTIVE EVIDENCES ON VACANCIES

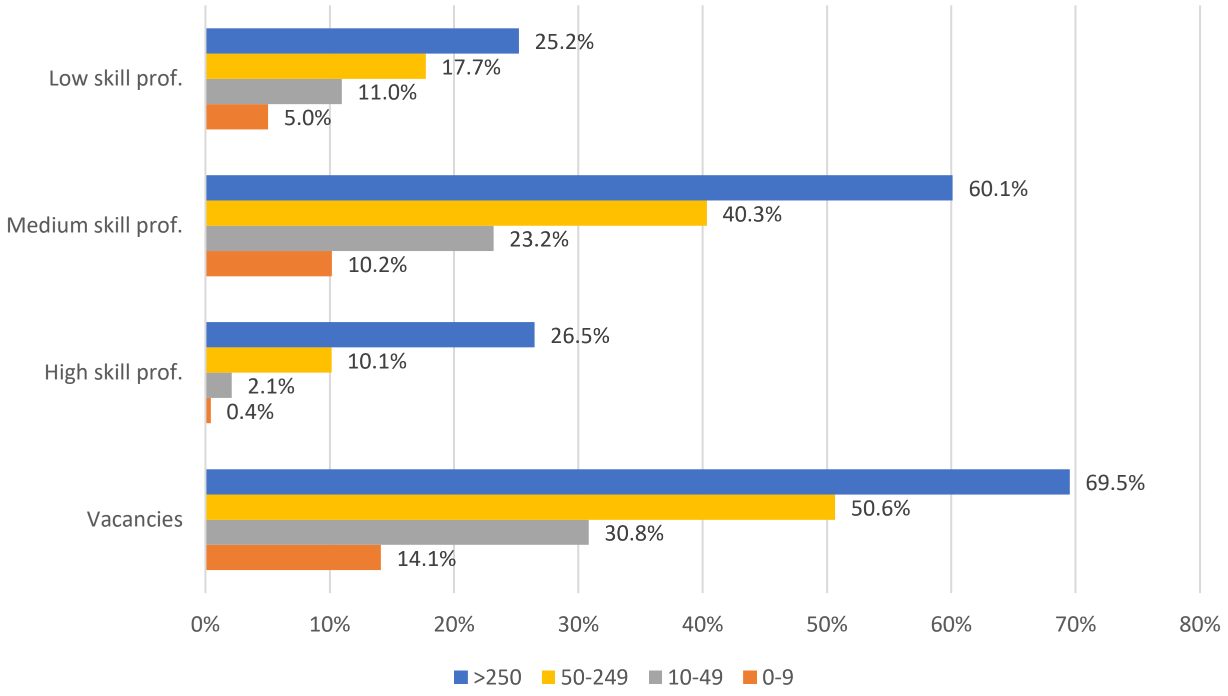
The share of firms that are looking for new employees and for different types of professions

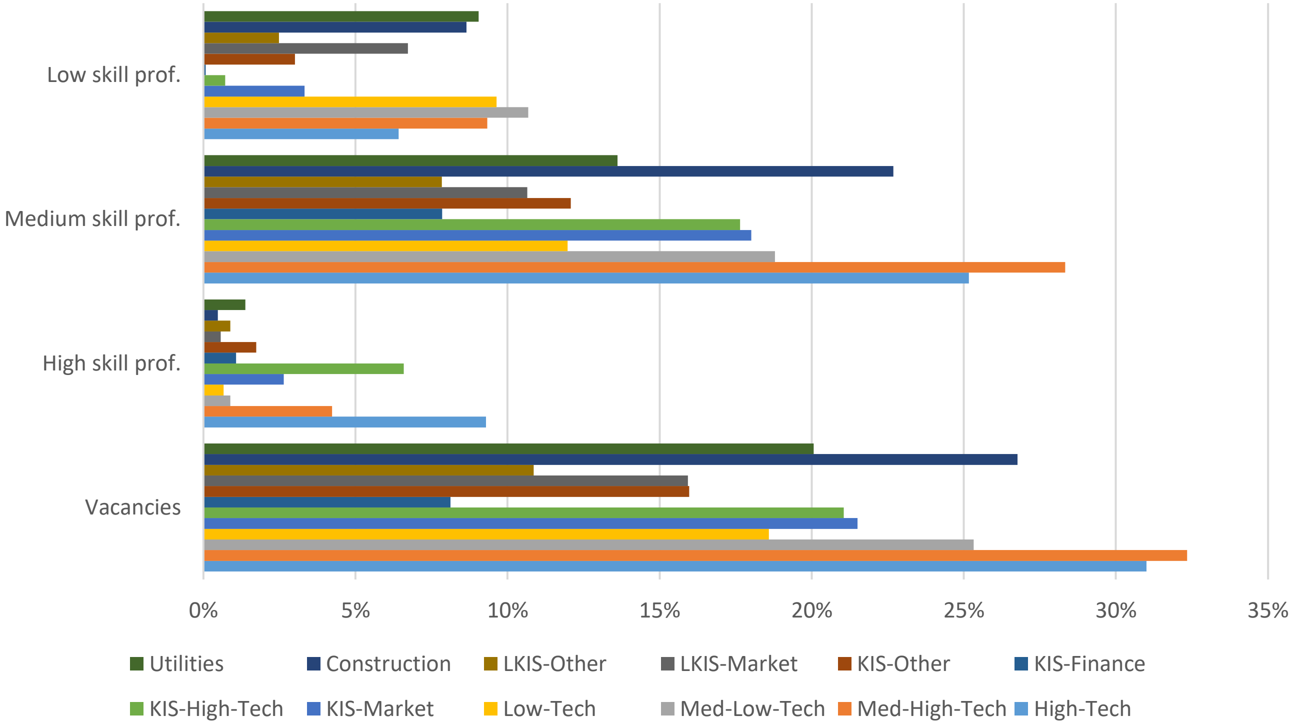


Source: Author's elaboration on RIL 2018 and 2021 data.

SOME DESCRIPTIVE EVIDENCES ON VACANCIES BY SIZE AND SECTOR

The share of firms that are looking for new employees for different types of professions, by size and sector of activity





Source: Author's elaboration on RIL 2021 data.

SOME DESCRIPTIVE EVIDENCES ON INVESTMENTS IN DIGITAL TECHNOLOGIES

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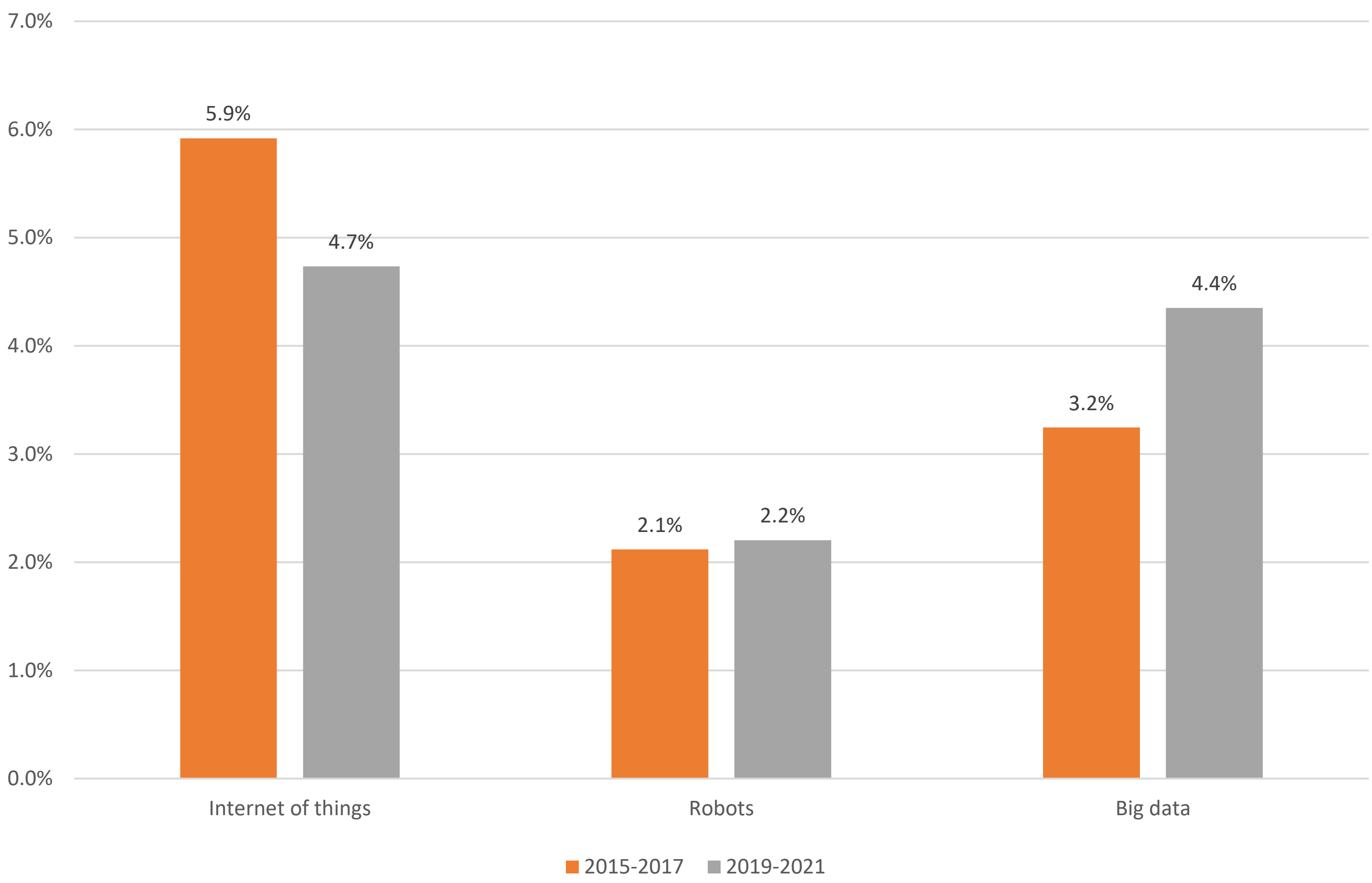
The share of firms that invest in digital technologies

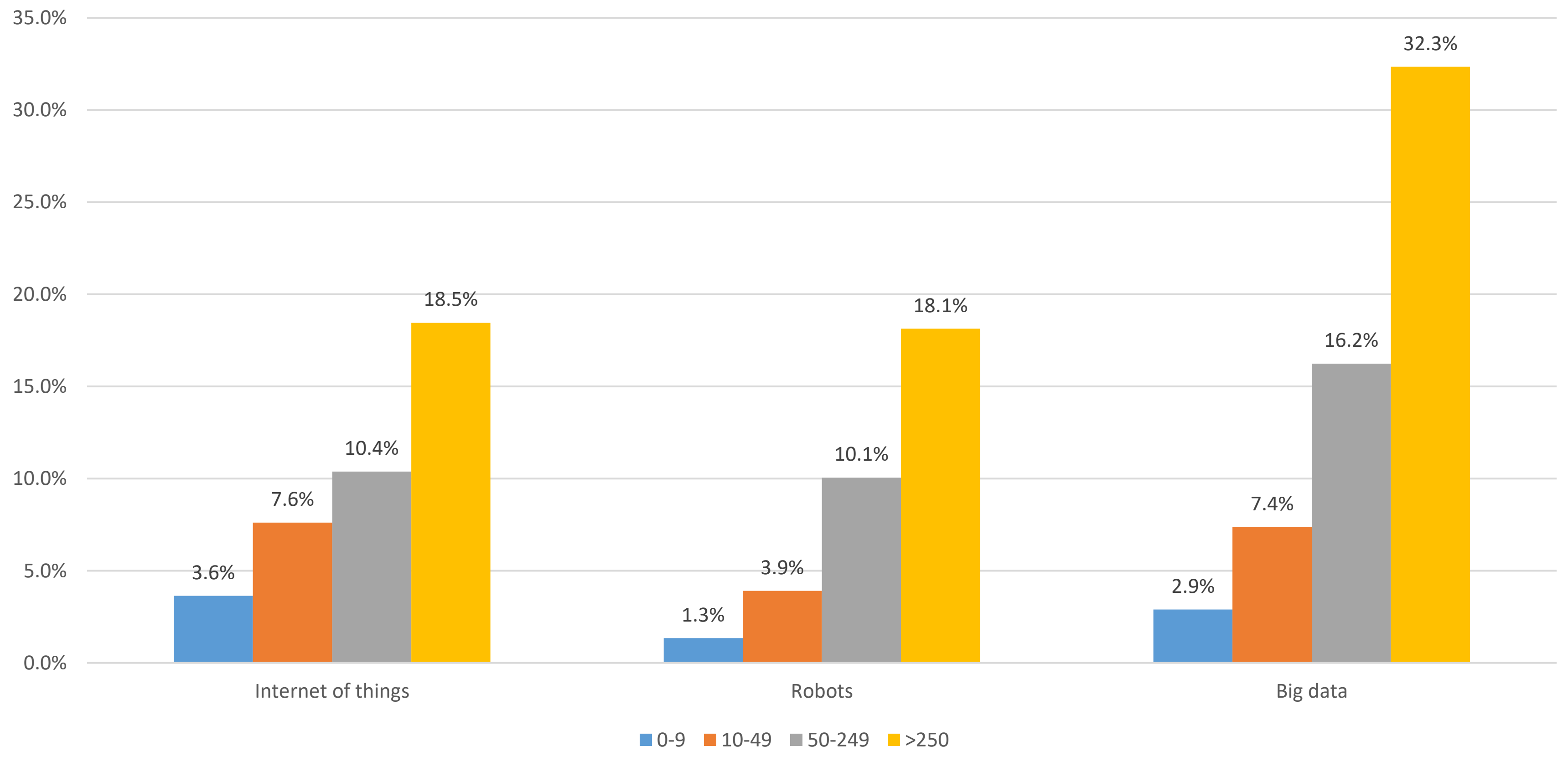


Source: Author's elaboration on RIL 2021 data.

SOME DESCRIPTIVE EVIDENCES ON INVESTMENTS IN DIGITAL TECHNOLOGIES

ANNO EUROPEO DELLE COMPETENZE

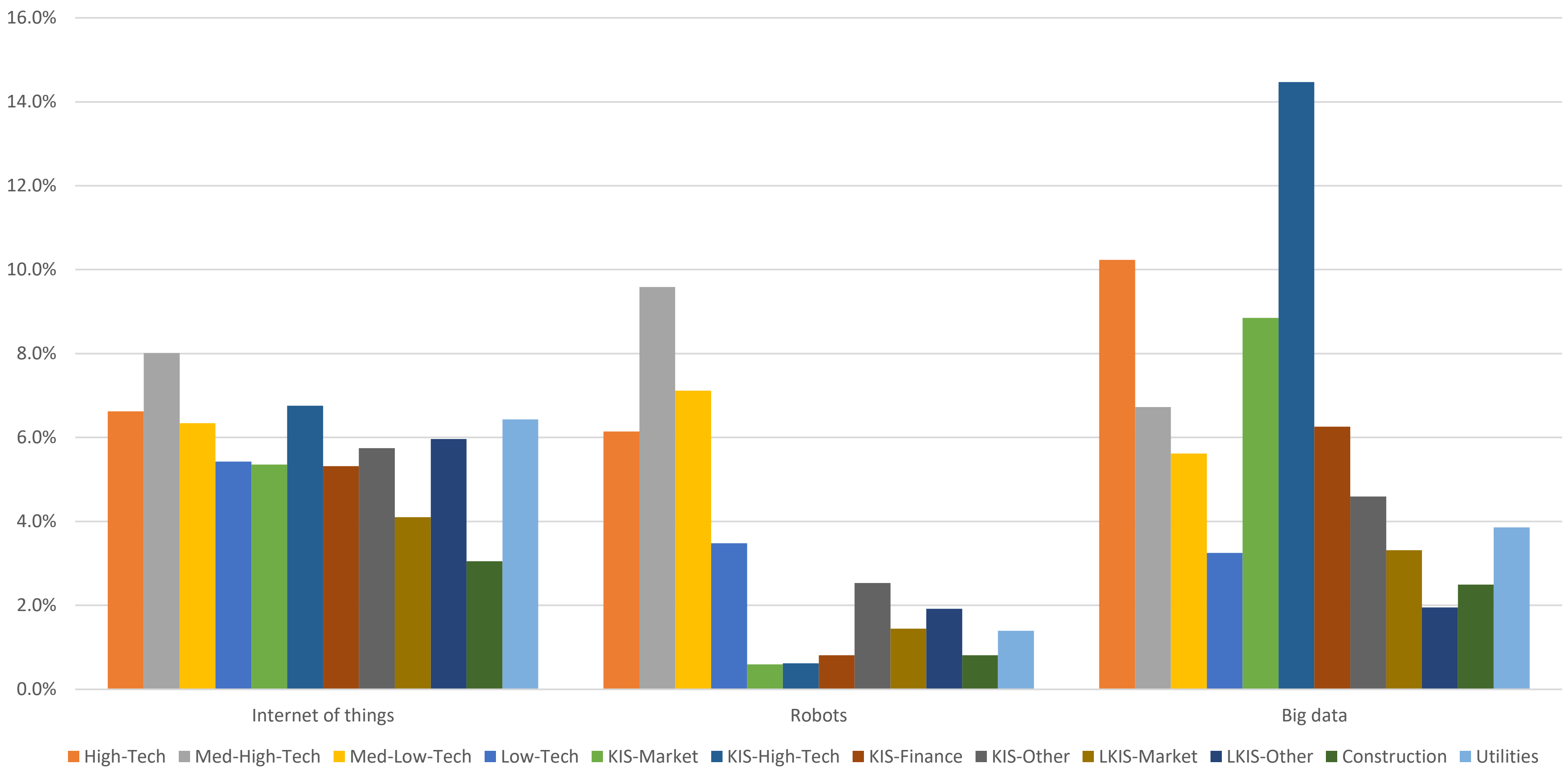
The share of firms that invest in digital technologies, by size



Source: Author's elaboration on RIL 2021 data.

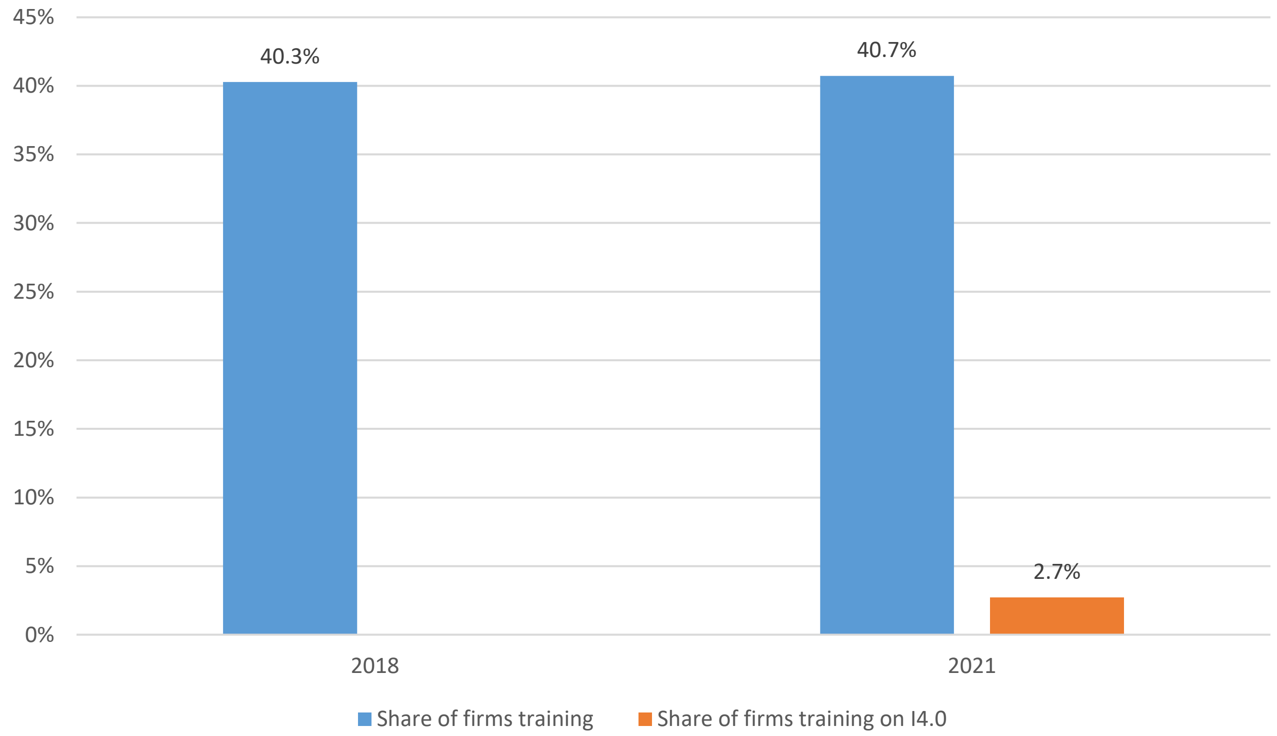
SOME DESCRIPTIVE EVIDENCES ON INVESTMENTS IN DIGITAL TECHNOLOGIES

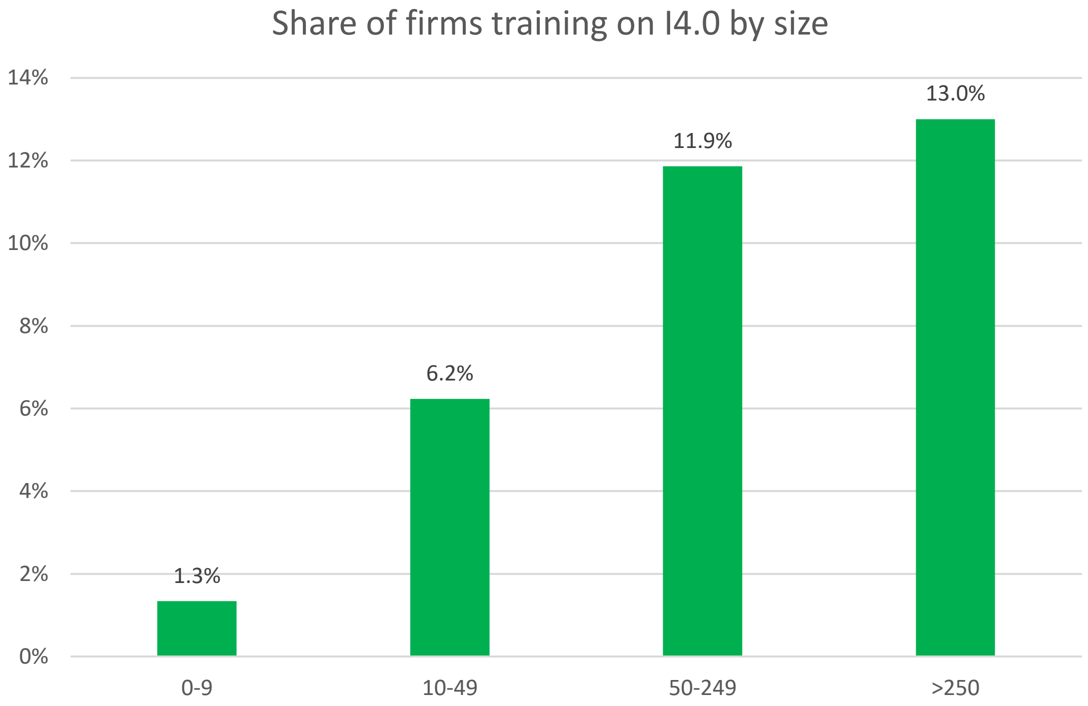
The share of firms that invest in digital technologies, by sector of activity



Source: Author's elaboration on RIL 2021 data.

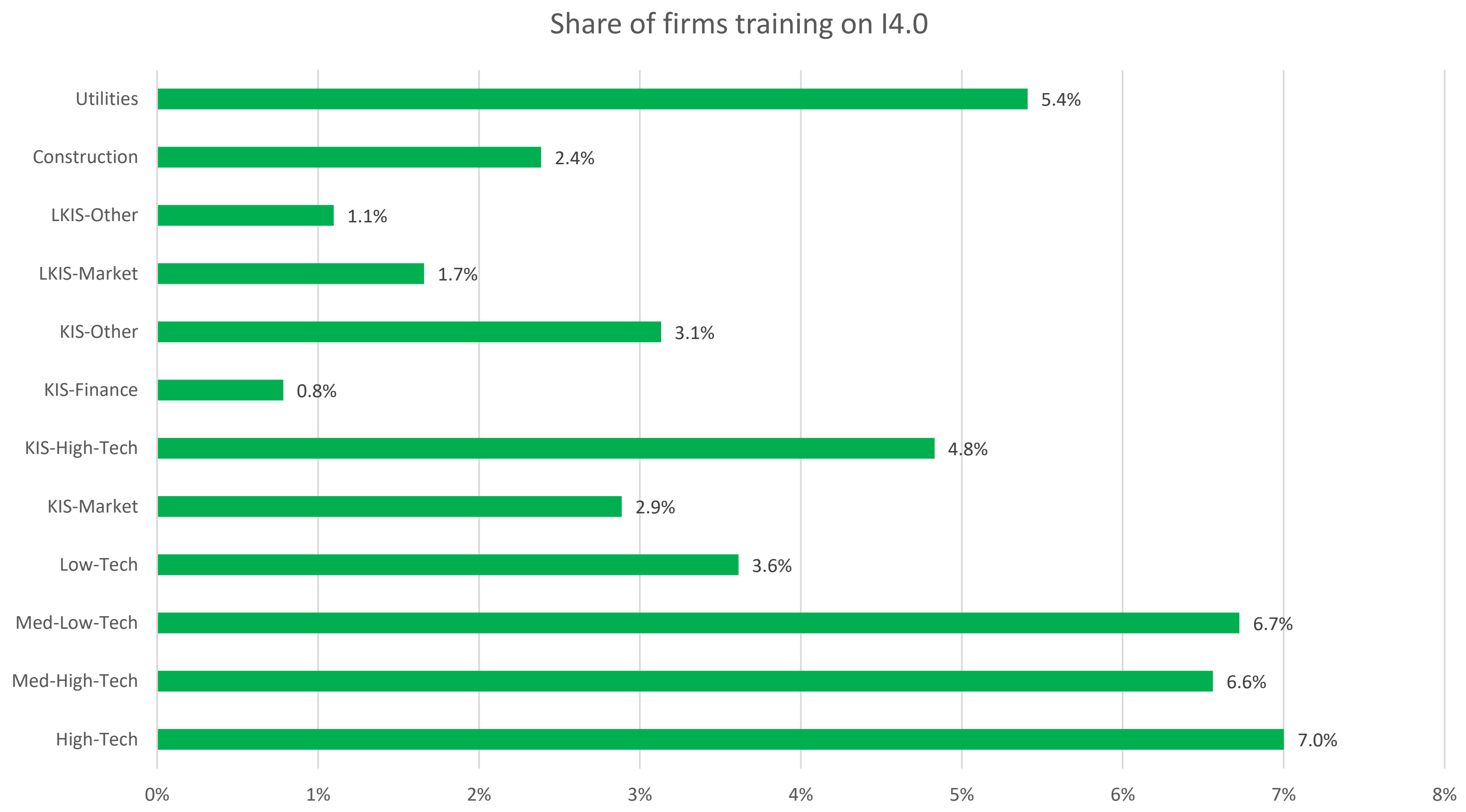
SOME DESCRIPTIVE EVIDENCES ON TRAINING





Source: Author's elaboration on RIL 2021 data.

SOME DESCRIPTIVE EVIDENCES ON TRAINING BY SECTOR OF ACTIVITY



Source: Author's elaboration on RIL 2021 data.

MAIN RESULTS ON PROBABILITY TO: TRAIN, TRAIN ON I4.0, VACANCIES AND VACANCIES OF HIGH SKILL PROFESSIONS

$$Prob(Y_i = 1|X_i) = \alpha + \beta X_i + \varepsilon_i$$

Where Y represents alternatively: the probability to train, to train on I4.0, to demand new employees, and to demand new employees with high skills at time 2022, and X_i represents the investments in different digital tecnologies at time 2019-2021 plus other characteristics

	Training	Training on I4.0	Vacancies	Vacancies of high skill professions
Robots	0.054***	0.035***	0.014	-0.007*
Big data	0.069***	0.037***	0.043***	0.019***
Internet of things	0.068***	0.037***	0.055***	0.010***
Firm's Characteristics	YES	YES	YES	YES
Workforce's Characteristics	YES	YES	YES	YES
Number of observations	24,027	24,027	24,027	24,027

Source: Author's elaboration on RIL 2021 data.

MAIN RESULTS ON RELATIONSHIP BETWEEN HIGH SKILL WORKERS AND INVESTMENTS ON I4.0

$$Y_{i,t+1} = \beta_0 + \beta_1 \cdot TW_{it} + \gamma \cdot M_{i,t} + \lambda \cdot F_{i,t} + \lambda_i + \mu_i + \varepsilon_{i,t}$$

where $Y_{i,t+1}$ represents the investment in digital (I4.0) technologies between 2019 and 2021 of firms *i*, and TW_{it} is the share of workers with tertiary education at time 2018.

	Robot	**Internet of Things**	**Big data**
Share of workers with tertiary education	0.071*	0.082*	0.017
Share of degreed workers	0.023	0.083***	-0.016
Firm's Characteristics	YES	YES	YES
Workforce's Characteristics	YES	YES	YES
Number of observations	2,945	2,945	2,945

Source: Author's elaboration on RIL 2018-2021 data.

CONCLUSIONS

- Italian RIL data show that the higher the digital investment the higher the odds of providing training programs.
- A feebler but significant acceleration factor is also found for training program in Industry 4.0
- A positive and statistically significant correlation between skilled workers and firm's future digital investment is evident
- Conversely, **the economic structure of a country still plays the lion's part**
- Italian firms seem to look for middle skilled workers, a notable number of SMEs invest little in high-tech. This hampers Industry 4.0 from being widely spread. But to change the economic structure and firm size, markets' dimensions should also be broadened. Thus, demand-side policies should also be envisaged which enhance returns to scale and accelerate further investment both in high-tech and skills needed to utilized it.

THANKS FOR YOUR ATTENTION

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ANNO EUROPEO DELLE COMPETENZE

How do skilled workers contribute to innovation?

BIBB, Dec.1st 2023

Torgeir Nyen and Johan Røed Steen,

Fafo Institute for Labour and Social Research, Oslo

Research questions

- How does skilled workers and apprentices contribute to innovation in firms: In which ways? Through which processes?

- What factors on firm level and societal level stimulates usage of vocational competence for innovation?
  - Does industrial relations on the firm level matter?
- Fafo-report 2021:30

Cases (8)

- Borregaard
- Framo Flatøy
- Gumpen Auto Vest
- Kongsberg Defence & Aerospace
- Moelven limtre
- OneCo Technologies
- Scandic Oslo Airport
- Veidekke (Ulven project)

Key findings in innovation studies

- Innovation capacity is related to workforce skills
- Educational institutions are part of innovation systems
- Innovation is often incremental

Fafo

VET as part of national innovation systems

- VET educated workers acquire skills conducive to innovation
- Broad practical and theoretical capabilities → flexibility
- Formal qualifications → labour market mobility
- Technology diffusion: Spreading new technologies and processes, especially to SMEs

VET as part of national innovation systems

Requirements:

(Backes-Gellner & Lehnert 2021)

- Comprehensive, future oriented curricula
- Systematic and frequent updates, input from companies and social partners
- Attractive career opportunities
- Bridges between the vocational pillar and the academic pillar of the education system

VET as part of national innovation systems

Quantitative studies:

- Companies with apprentices have higher innovation activity
  (Rupietta & Backes-Gellner 2019; Rupietta et al. 2021)
- Positive effect on reported process innovation
  (Matthies et al. 2021)
- Largest effect for SMEs

Skilled workers' contributions to innovation at company level

- Participants in innovation activities and projects

- Incremental innovation (especially process innovation)

- Employee-driven innovation

- Implementing innovations

→ Need to be competent, autonomous and flexible

Organizational Preconditions

Stable and secure workplaces, worker control and autonomy → incremental innovation (Hall & Soskice 2001)

Measures: Task rotation, team organization, regular meeting points, cooperation, systematization of innovation activity (e.g. employee driven innovation)

Framo Flatøy

- 320 employeers, 180 skilled workers
- Special production, tailor-made customer-specific products

- Flexible use of skilled workers in production
- Formal occupatonal structure, but very open communication between positions and departements
- Formal industrial relations

- Customer-driven product innovation
- Employee-driven process innovation – spurred by a crisis and aided by external process support

Digital product system (DPS) at Framo Flatøy

*Digitalisation of the production (folder system)

*Skilled workers heavily involved in the project

*Quick implementation of ideas stimulated further improvement ideas

*Some people involved in soft ware development had a background as skilled worker in the company

*Innovation resulted in a digital tool which in itself facilitated further incremental improvements (also after the project was finished)

OneCo Technologies

- “An innovative and future-oriented electronic, automation and telecom company”"
- 3000 employees in the OneCo group,
  45 employees and 7 apprentices in the building automation section in Sandnes

- Skilled electrical workers and automation technicians
- Flexible job categories, flat structure

- Innovation: Self-developed software

OneCo Technologies

- Culture of process improvement and innovation
- Opportunities for learning and competence development
- Close collaboration between employees with different educational backgrounds
- Project-based teams
- Open lines of communication and flat structure
- Formal structures and social dialogue less central

How do skilled workers contribute to innovation?

Firm level factors which influence whether skilled workers contribute to innovation

- Skilled workers have a level of discretion/autonomy (stimulates ideas, allows for experimentation)
- Open communication between different occupational groups both vertically and horizontally,
- Clear channels for improvement suggestions
- Having clear organizational routines and structures for how to work with improvement and innovation
- Innovation only part of industrial relations in cases in industry, not in cases from the service sectors

Fafo

Swiss Leading House VPET-ECON

A Research Center on the Economics of Education, Firm Behavior and Training Policies

Vocational Education and Training as a Driver of Innovation

Patrick Lehnert, University of Zurich

Vocational Education, Skilled Workers and Transformation in an International Perspective, BIBB Bonn, 01 December 2023

Universität Zürich[UZH]

UNIVERSITÄT BERN

Vocational Education as a Driver of Innovation: A Paradox?

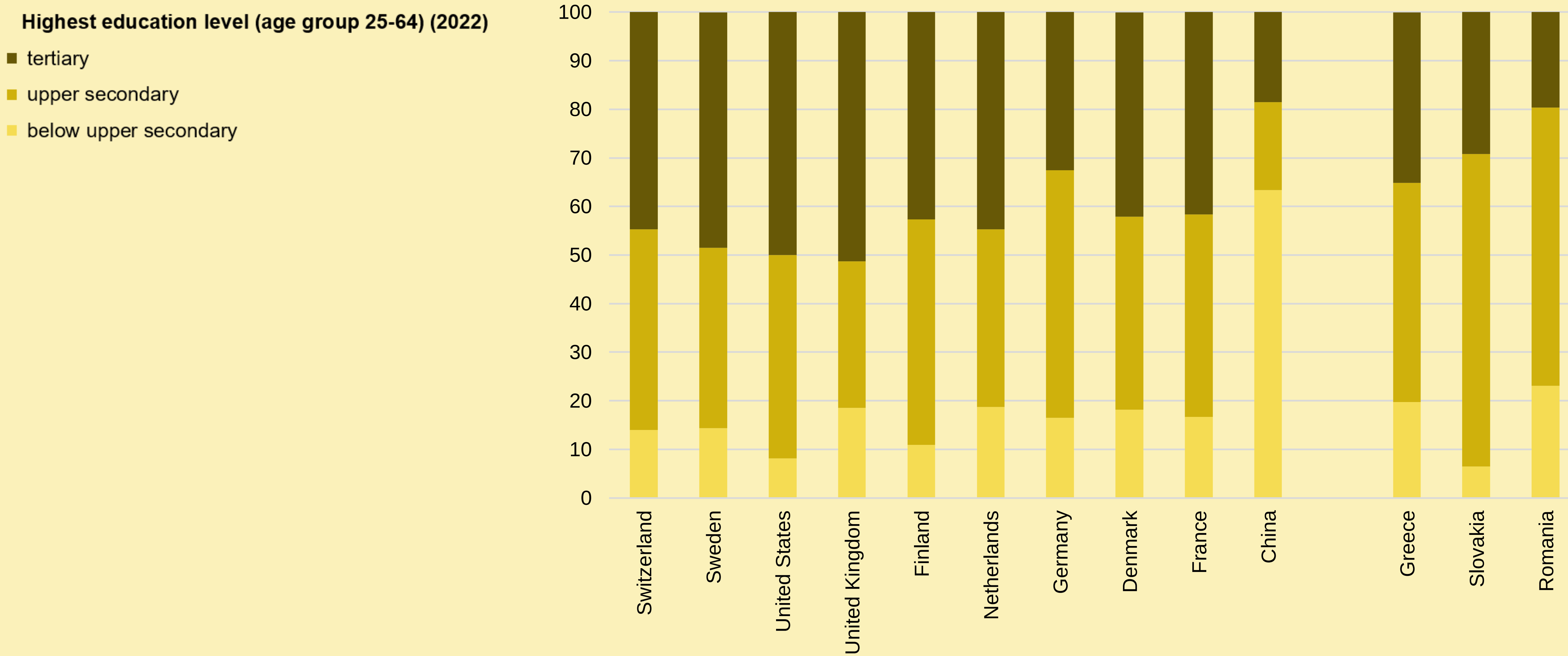
Many scholars argue that …

… highly innovative countries need to increase tertiary general education to achieve further economic growth (e.g., Vandenbussche et al., 2006)

… countries that emphasize vocational education have lower economic and technology growth rates than countries that emphasize general education (e.g., Krueger & Kumar, 2004)

But, if so, why are countries that emphasize dual vocational education and training (VET), such as Germany and Switzerland, among the leaders in economic and innovation performance?

Innovation, Economic Growth, and Education



	Switzerland	Sweden	United States	United Kingdom	Finland	Netherlands	Germany	Denmark	France	China	Greece	Slovakia	Romania
Global Innovation Index Rank (2023) (max. 132)	1	2	3	4	6	7	8	9	11	12	42	45	47
European Innovation Scoreboard Rank (2023) (max. 39)	1	3	-	12	4	5	9	2	14	-	25	28	38
GDP Per Capita Growth (2002-2022) (in %)	116	87	101	52	87	91	92	102	69	1008	46	224	650

Source: Own representation based on data from European Commission (2023, p. 28), OECD (2023a, 2023b), WIPO (2023, p. 19), and World Bank (2023).

Innovation, Economic Growth, and Education

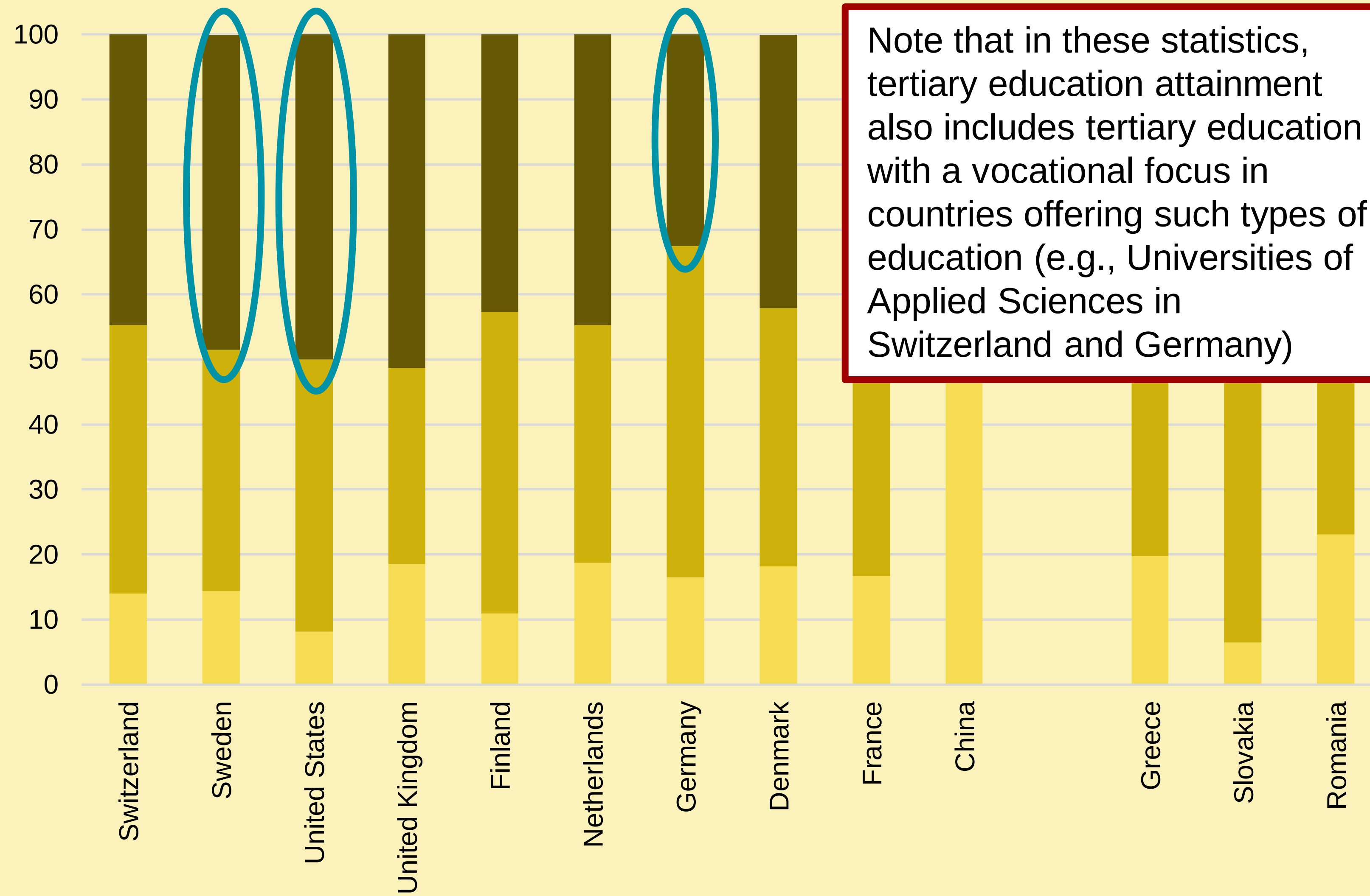
Highest education level (age group 25-64) (2022)

- tertiary
- upper secondary
- below upper secondary

Statement about the need of tertiary education for achieving economic growth in innovative countries …

… applies to, e.g., Sweden, United States

… does not apply to, e.g., Germany (low share of tertiary educated population), United Kingdom (low GDP growth compared to other innovative countries)



Note that in these statistics, tertiary education attainment also includes tertiary education with a vocational focus in countries offering such types of education (e.g., Universities of Applied Sciences in Switzerland and Germany)

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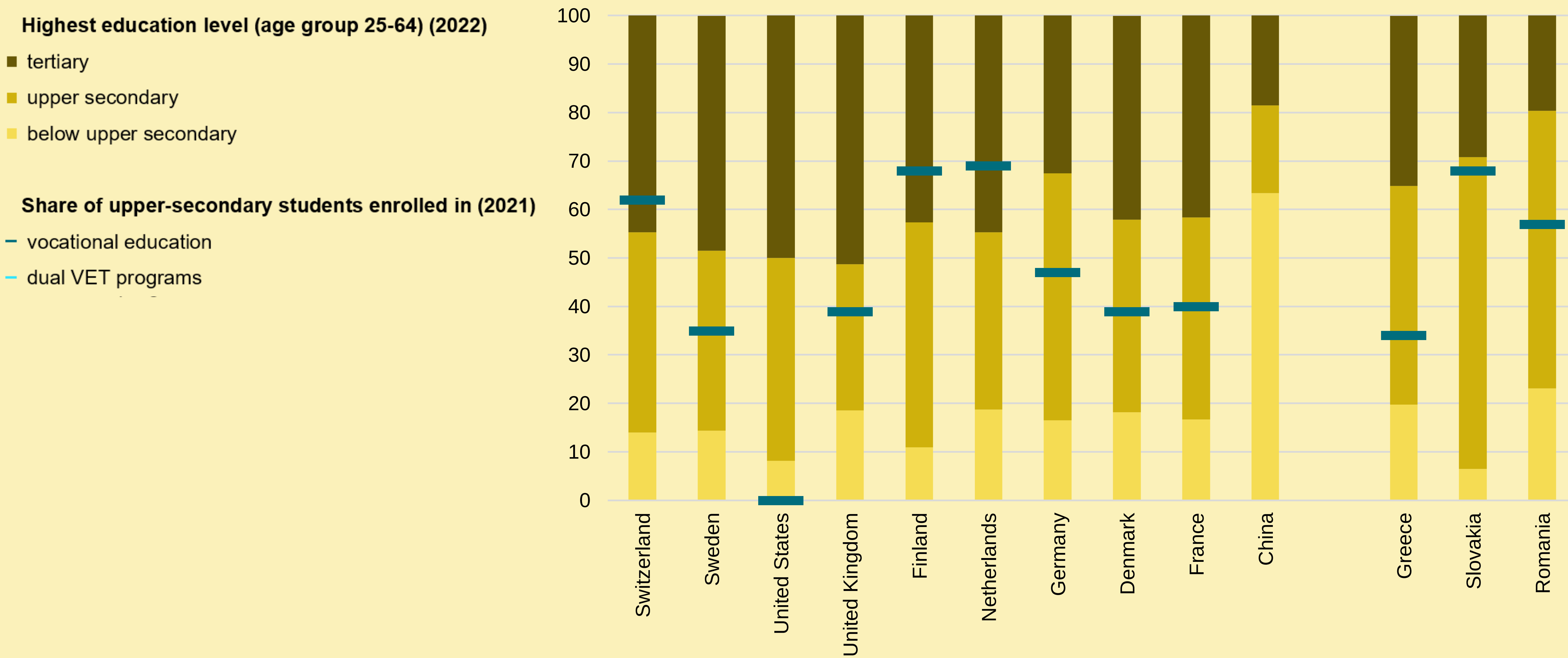
Innovation, Economic Growth, and Education



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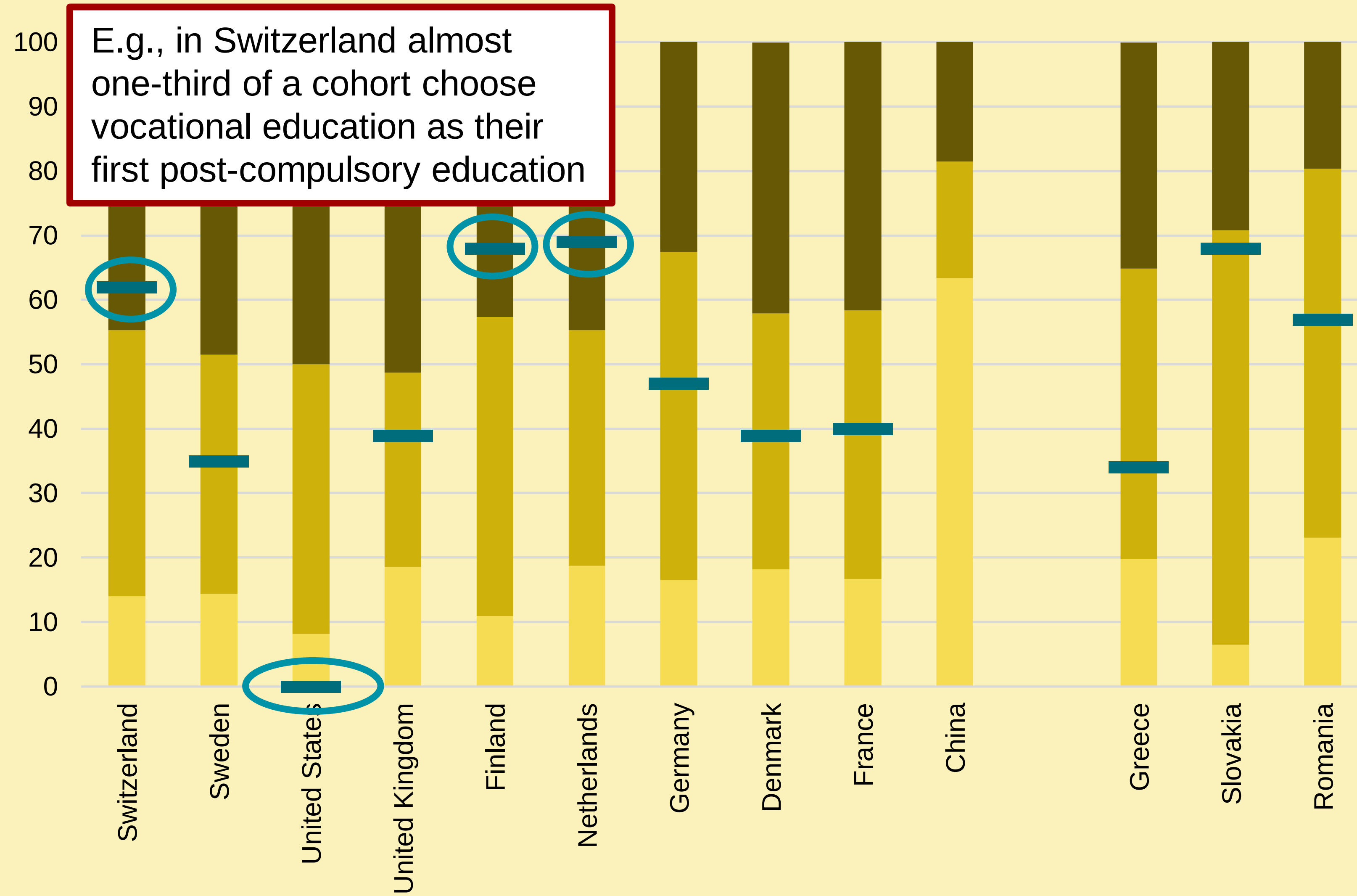
Innovation, Economic Growth, and Education

Highest education level (age group 25-64) (2022)
- tertiary
- upper secondary
- below upper secondary

Share of upper-secondary students enrolled in (2021)
- vocational education
- dual VET programs



Statement about importance of general education for achieving innovation and economic growth …
… applies to, e.g., United States (no upper-secondary vocational education), Slovakia (low innovation performance)
… does not apply to, e.g., Switzer-land, Finland, Netherlands

	Switzerland	Sweden	United States	United Kingdom	Finland	Netherlands	Germany	Denmark	France	China	Greece	Slovakia	Romania
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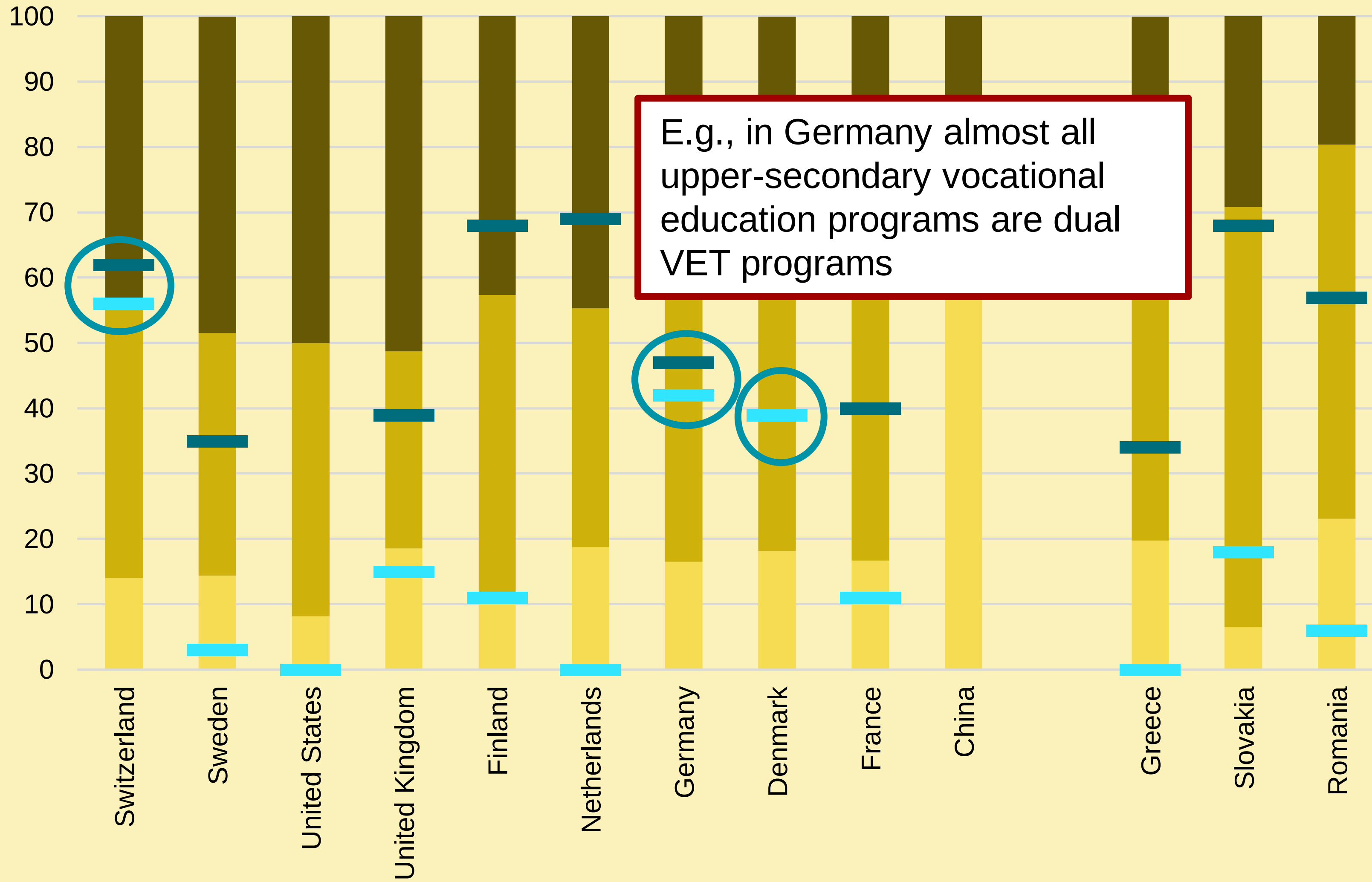

In particular, countries that emphasize dual VET are among the leading innovation and economic performers (Switzerland, Germany, Denmark)
→ Dual VET has to be a driver of innovation in these countries

	Switzerland	Sweden	United States	United Kingdom	Finland	Netherlands	Germany	Denmark	France	China	Greece	Slovakia	Romania
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Preview

How do dual VET systems such as those in Germany and Switzerland ensure a strong contribution to innovation?

→ Three key elements

Curriculum design process	Occupational skill mix	Connection to applied research
• Systematic curriculum updates • Creation of new occupations and removal of outdated ones • Participation of all relevant stakeholders	• Broad set of general and innovation-enabling skills • Preparation for various labor market options • Permeable education system	• Combination of vocational and applied research skills at tertiary level • Innovation activities of Universities of Applied Sciences

Based on joint review articles with Uschi Backes-Gellner:

- “Berufliche Bildung als Innovationstreiber: ein lange vernachlässigtes Forschungsfeld”, Perspektiven der Wirtschaftspolitik, 2023
- “The Contribution of Vocational Education and Training to Innovation and Growth”, Oxford Research Encyclopedia of Economics and Finance, 2021

Characteristics of Dual VET Programs

- Typically after compulsory school at age 15-16 (in Germany, increasingly also after high school at age 18-19)
- Duration of 3-4 years (depending on VET occupation)
- “Dual”: combinationof apprenticeship training at a firm (about 3-4 days per week) and classroom education at a vocational school (about 1-2 days per week)
- To get an apprenticeship position, adolescents have to apply to firms (just as for regular employment positions)
- Attractive option for adolescents due to good labor market prospects and several tertiary-level educational career options after graduation
- However: decreasing participation rates, especially in Germany

Sources: Autorengruppe Bildungsberichterstattung, 2020; Destatis, 2022; EFI, 2014; FSO, 2023; SCCRE, 2023; SERI, 2022

Curriculum Design Process

How updates of VET curricula contribute to knowledge diffusion

Example: Schultheiss & Backes-Gellner (2022)
Do VET curriculum updates promote the diffusion of new technologies?

Methodology

- Event study design
- Historical VET curriculum texts as data to study the implementation of three new technologies into Swiss VET curricula in the late 1990s/early 2000s: CAD, CNC, and desktop publishing
- Historical job ad texts as data to measure technology adoption by firms (i.e., mentioning the respective technology in job ads)
- Patenting activities related to the respective technology to account for general trend in technology diffusion

Main findings

- Curriculum updates accelerate technology adoption compared to the general trend
- Effect sets in immediately after implementation, i.e., before first graduates enter the labor market
- In consistence with prior empirical evidence (e.g.,Rupietta & Backes-Gellner, 2019b), substantial part of effect comes from mainstream firms (SMEs without R&D)

Curriculum Design Process

How updates of VET curricula contribute to knowledge diffusion

Continuous updates of VET curricula contribute to the diffusion of technological and organizational innovations (e.g., Backes-Gellner, 1996; Janssen & Mohrenweiser, 2018; Rupietta & Backes-Gellner, 2019b; Schultheiss & Backes-Gellner, 2022) …

… but what are the necessary preconditions?

Curriculum Design Process

How updates of VET curricula contribute to knowledge diffusion

Backes-Gellner & Pfister (2019) identify three key criteria:

1) VET curricula must be nationally defined and binding
   - Ensures that all firms (independent of size and own research activities) teach the same skills and that all students possess the same skills upon graduation
   - Frontier training firms can thus integrate VET students into modern work processes while mainstream training firms are obliged to acquire those processes
   - In Germany and Switzerland, VET is regulated in federal laws and student assessments are organized by organizations of work (*Berufsverbände, Kammern*)

Curriculum Design Process

How updates of VET curricula contribute to knowledge diffusion

Backes-Gellner & Pfister (2019) identify three key criteria:

2) VET curricula must be systematically updated

- Ensures that recent technological developments are part of the VET programs and thus spread among alll firms → benefits for both firms and individuals (e.g., Bühler et al., 2023; Rupietta & Backes-Gellner, 2019b; Rupietta et al., 2021)
- Updates include
  - adding new and removing outdated contents in existing occupations, e.g., update of VET curricula in the automative industry in the 2010s to include skills in manufacturing electric cars (see Müller & Kohl, 2014)
  - merging occupations that have become similar due to technological developments, e.g., update of metal-working occupations in the 1980s (see Backes-Gellner, 1996)
  - Creating new occupations, e.g., IT occupations in the 1990s (see BIBB, 2013)
- Takes place in intervals of around five years upon the initiative of all involved stakeholders

Curriculum Design Process

How updates of VET curricula contribute to knowledge diffusion

Backes-Gellner & Pfister (2019) identify three key criteria:

3) All relevant stakeholders must be involved
   - Stakeholders include training firms, industry experts, worker representatives, organizations of work, government, and vocational teachers
   - Ensures that VET skills are relevant for production and innovation, effectively teachable, and oriented towards the labor market (Backes-Gellner, 2017; Backes-Gellner & Pfister, 2019; Bolli et al., 2018a; Busemeyer & Trampusch, 2012)
   - Involvement of innovative training firms and industry experts is crucial (Backes-Gellner & Pfister, 2019)

Occupational Skill Mix

Why dual VET skills are an important input for innovation activities

Example: Backes-Gellner et al. (2017)
Can VET graduates enhance the productivity of other workers?

Methodology

- Swiss employer-employee data to measure the educational composition at the firm level
- Panel estimators and instrumental variable approach that exploits differences in dual VET provision across language regions in Switzerland to overcome potential endogeneity problems

Main findings

- Reverse educational spillovers exist from workers with a dual VET degree to workers with a tertiary academic degree → workers with a tertiary academic degree are more productive when working together with workers with a VET degree
- Consistent with case studies (Backes-Gellner & Pfister, 2019) and empirical evidence (e.g., Meuer et al., 2015; Rupietta & Backes-Gellner, 2019a) that workers with a dual VET degree make significant contributions to innovation activities in firms

Occupational Skill Mix

Why dual VET skills are an important input for innovation activities

The skills that individuals acquire in dual VET programs are an important input for innovation activities (e.g., Backes-Gellner & Pfister, 2019; Backes-Gellner et al., 2017; Bolli et al., 2018b, Meuer et al., 2015; Rupietta & Backes-Gellner, 2019a; Teuber et al., 2016) …

… but what types of skills are these?

… and what ensures that enough individuals participate in dual VET?

Occupational Skill Mix

Why dual VET skills are an important input for innovation activities

Characterization of the skills that individuals acquire in dual VET

- General skills, including
  - organizational skills (e.g., meeting deadlines, organizing projects), quality-oriented work habits (e.g., precision, goal orientation), and basic IT skills through integration into regular work environments (Bierhoff & Prais, 1997; Kiener et al., 2023b; Mühlemann & Wolter, 2014)
  - other general skills such as communication, teamwork, foreign languages as part of VET curricula (Backes-Gellner & Pfister, 2019)
  - non-cognitive personality traits, which are positively affected through dual VET (Bolli & Hof, 2018; Hoeschler et al., 2018)
- High-level and broad occupation-specific skills that are taught at the tertiary-level in other countries (Bierhoff & Prais, 1997; Ryan et al., 2007)

Occupational Skill Mix

Why dual VET skills are an important input for innovation activities

Incentives for participating in dual VET

- Dual VET graduates have very good labor market prospects in general (Aepli et al., 2017; Koomen & Backes-Gellner, 2022; Murphy & Oesch, 2018), with some tradeoffs depending on the specificity of the acquired skill bundle:
  - Graduates from programs with a high degree of specificity can earn higher wages and can profit from positive external shocks (e.g., trade shocks) (Eggenberger et al., 2018; 2022; Geel et al., 2011; Kiener et al., 2023a; Rinawi & Backes-Gellner, 2021),
  - whereas graduates from programs with a low degree of specificity (i.e., broad skill bundles) have higher job flexibility and suffer less from negative external shocks (e.g., technology shocks) (Eggenberger & Backes-Gellner, 2023; Eggenberger et al., 2018; 2022; Geel et al., 2011; Rinawi & Backes-Gellner, 2021)

Occupational Skill Mix

Why dual VET skills are an important input for innovation activities

Incentives for participating in dual VET

- In a permeable education system, dual VET graduates also have several consecutive educational options with further labor market benefits (Balestra & Backes-Gellner, 2017; Cattaneo, 2011; Kamhöfer et al., 2019; Pfister et al., 2017; Wolter & Weber, 1999):
  - professional education (e.g., master‘s certificate)
  - university education (academic or applied)

→ A permeable education system with an emphasis on dual VET also contributes to intergenerational income mobility (Chuard-Keller & Grassi, 2021):

- In Switzerland, intergenerational income mobility is very high in international comparison, while educational mobility is comparably low
- This divergence originates in the permeable VET system, which offers many options for upward mobility after completing a dual VET program

Connection to Applied Research

How Universities of Applied Sciences foster innovation

Profile and goals of Universities of Applied Sciences (UASs)

- Offer tertiary-level educational option for dual VET graduates at same level as academic universities (Nikolai & Ebner, 2013; SCCRE, 2023)
- Teach vocational and applied research skills (BMBF, 2004; Lackner, 2019; Lepori & Kyvik, 2010)
- Engage in applied research projects (Enders, 2010; Kulicke & Stahlecker, 2004; SERI, 2023)
- Founded in the late 1960s in Germany (research goal added in the 1980s); in the 1990s in Switzerland (Enders, 2010; Kulicke & Stahlecker, 2004; Lepori, 2008; Pfister, 2017)

Connection to Applied Research

How Universities of Applied Sciences foster innovation

Example: Lehnert et al. (2020)
Do firms use the skills taught at UASs for innovation?

Methodology

- Repeated cross-sectional firm survey data to measure firms' R&D intensity in terms of
  - percentage of R&D personnel relative to total personnel
  - percentage of total wages paid to R&D personnel
- Staggered openings of UAS campuses in STEM fields as a natural experiment with quasi-random variation in location and timing
- Difference-in-differences estimation strategy to study the effects of UAS campus openings

Main findings

- Firms near a UAS campus experience a supply shock of skilled labor and, as a result, increase their R&D intensity
- Both percentage of R&D personnel and percentage of R&D wages increase → UAS graduates are not cheaper replacements for academic university graduates
- Very small firms (potential start-ups) and very large firms profit most

Connection to Applied Research

How Universities of Applied Sciences foster innovation

Universities of Applied Sciences stimulate innovation activities in the regions where they are located (e.g., Eberle et al., 2020; Lehnert et al., 2020; 2022; Pfister et al., 2021) …

… but what are the underlying mechanisms and regional preconditions?

Connection to Applied Research

How Universities of Applied Sciences foster innovation

Indirect effects through provision of human capital

- UASs teach their students to transfer basic research findings into R&D applications (Backes-Gellner & Pfister, 2019; BMBF, 2004)
- This type of human capital is an important input for firms' R&D activities (Lehnert et al., 2020)
- UAS graduates serve as bridge builders between vocationally trained and academically educated workers, enabling firms to better integrate vocationally trained workers into R&D activities and thus to better exploit their innovation potential (Backes-Gellner & Pfister, 2019; Schultheiss et al., 2023)

→ The human capital effect of UASs on innovation originates in the combination of vocational and applied research skills in their teaching

Connection to Applied Research

How Universities of Applied Sciences foster innovation

Direct effects through engagement in applied research projects

- As part of their research mandate, UASs engage in joint projects with firms, in particular SMEs, thus strengthening the innovative capacities of their cooperation partners (Arvanitis et al., 2008; EFI, 2018; Fritsch & Schwirten, 1999; Hachmeister et al., 2015)
- As a result, regions located near a UAS campus in STEM experience an increase in innovation outcomes as measured by
  - patent applications, both quantitatively and qualitatively (Eberle et al., 2020; Lehnert et al., 2020; Pfister et al., 2021)
  - creation of innovative firms and engagement in innovative activities by previously non-innovative firms (Fritsch & Aamoucke, 2017; Lehnert et al., 2020; Pfister et al., 2021)

Connection to Applied Research

How Universities of Applied Sciences foster innovation

Innovation-enabling regional infrastructures as preconditions

- Research infrastructure: stronger UAS effect if complementary research knowledge is available in a region (e.g., Max Planck and Fraunhofer institutes) (Lehnert et al., 2022)
- Economic infrastructure: regional high tech intensity as well as labor market size and dynamics determine UAS effect (Berlingieri et al., 2022; Schlegel et al., 2022b)

→ Given the regional preconditions, UASs can contribute to sustainable developments of innovation and, consequently, firms (Schlegel et al., 2022a)

Conclusion

VET drives innovation through …

… systematic and future-oriented curriculum updates that contribute to the diffusion of knowledge among firms, in particular among those that do not operate at the knowledge frontier

… providing graduates with a skill mix that enables them to participate in innovation activities and that offers them attractive labor market and educational career options

… the connection to applied research at UASs, which enhance the skills of vocationally trained workers and build bridges between academic research and vocational practice

Policy Implications

Dual VET must stay attractive for individuals

- As in many other countries, educational policies in Germany are generally prioritizing academic education despite the importance of dual VET for innovation (EFI, 2014)
- This prioritization makes dual VET less attractive and, consequently, leads to decreasing participation rates in dual VET and shortages of skilled labor (BIBB, 2021; Destatis, 2022)
- These developments also hamper the contribution of dual VET to innovation

→ The dual VET system must become more attractive again for individuals by ensuring both labor market and educational career options (e.g., at a UAS) that are worthwhile pursuing after a dual VET program

Policy Implications

UASs must keep their original profile

- Despite their positive innovation effects resulting from their original focus on vocational and applied research knowledge, UASs in Germany (and increasingly also in Switzerland) are tending towards becoming more and more similar to academic universities in their focus (e.g., Enders, 2010; Imboden, 2018; Ziegele et al., 2016)
- Thus UASs are losing their distinct profile as an educational career path for dual VET graduates and jeopardizing their important role in fostering regional innovation

→ UASs must maintain and strengthen their original focus on vocational practice and applied research to continue contributing to both the attractiveness of the VET system and regional innovation

Avenues for Future Research

Many questions on dual VET and innovation remain open, e.g.:

- What further adjustments are necessary to keep up with technological change (e.g., trainer qualification, examination modes)?
- How do different types of human capital interact in innovation processes?
- How does the UAS effect on innovation develop while they are changing their profile?
- What is the role of dual VET for innovation in countries that do not (yet) emphasize it in their education systems?

Thank you for your attention!

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A short input from the project vocational tasks in international comparison and moderation

Soorin Yoon & Viktor Ulbrich

How the joint research between BIBB and KRIVET went (2018~2022)

Year	Main Research Topics
Year 1 (‘18~’19)	- Reviewed internationally comparable statistics and analytical frameworks on topics such as Industry 4.0 and Arbeit 4.0, and conducted joint seminars.
Year 2 (‘19~’20)	- Comparison amongst Korea-Germany-Spain in terms of occupational skills: using PIAAC data - Comparison between Korea-Germany in terms of skills mismatch: using PIAAC data - Comparison of occupational characteristics and skill requirements in Korea-Germany: using ES(Germany) and KNOW(Korea) - Pilot estimates of EKI: using ES, PIAAC, KNOW, etc.
Year 3, Year 4 (‘20~’22)	- Automation and intellectual skills: focusing on SME workers - A study of the use of experiential knowledge in complex problem solving: Manufacturing workers. - Comparing differences between Korea and Germany in job activities

Autonomy and Technological Change

- Paper from my dissertation
- Focus: moderating role of qualification requirements for employees at work and of the occupational position
- Analysis with national level data from Germany

Research context

Content/tasks and characteristics of jobs

- Technological and organisational requirements
- Social and personal needs of employees (Rush 1971: 5)

Job Design

- Different requirements and needs
- Autonomy as quality aspect (Wall/Parker 2001)

Positive effects for employees

- Job quality
- Job satisfaction
- Intrinsic motivation (Lissitsa/Chachash-vili-Bolotin 2020)

Research motivation

- Main research motivation: analyzing inequalities on the labor market regarding non-monetary occupational characteristics like autonomy

- Until now the focus lied on analyzing inequalities on the labor market in terms of monetary occupational characteristics like wages

Theory

- First main question: When does the employer grant autonomy to the employees?
- Granting autonomy should increase productivity (vgl. Van Hoorn 2018: 1; Choi et al. 2008: 422)
- Important: the employee has to signal his productivity and competence to the employer

- Employers‘ trust in competence → more freedom and autonomy at work → increased productivity (vgl. Gur/Bjørnskov 2017; Van Hoorn 2017; Van Hoorn 2018: 5)

- To increase trust, the employees have to invest in reliable signals like educational credentials or certificates (Spence 1973; Damelang/Abraham 2016: 93; Chatterji et al. 2003)
- This signaling/information value then leads to increased trust because the employer has the information security concerning the competence of the worker

Theory

- There is still an inconsistency relating to the effects of technological change on autonomy at work (Gerten et al. 2019)

- Technological change can have an autonomy-increasing or autonomy-restricting effect
  - autonomy-increasing by means of higher flexibility of employees and due to the increased decentralisation of work
  - autonomy-restricting by means of increased digital/technological monitoring and controling possibilitie s of work

- Analysis of relevant moderating variables/factors

Theory

- Past research from the Australian labor market (Choi et al. 2008): role of the qualification level of employees in promoting autonomy at work in relation with techn. change
  - A higher qualification level leads to increased autonomy when new technologies are introduced

- Kirchner et al. (2020) und Kirchner/Giering (2021) related the technology effects on autonomy to the specific occupational task content of employees at work
  - A digital/technological freedom (autonomy-enhancing) is achieved by employees with mainly knowledge-based type of tasks (rather high(er) qualification reqirements at work)
  - A digital/technological taylorism (autonomy-restricting) occurs for employees with mainly production-based and/or service-related type of tasks (rather low(er) qualification requirements at work)

Hypotheses

- H1: Technological changes are autonomy-enhancing when new technologies are introduced in occupational areas with high(er) qualification requirements.

- H2: Technological changes are autonomy-restricting when new technologies are introduced in occupational areas with low(er) qualification requirements.

Theoretical remark

- Role of trust: the type of technologies introduced in occupational areas with rather higher qualification requirements have a certain complexity to deal with

- The employer has to trust in the specific/high competence of the employees that deal with complex techn. change because he himself has not the required qualification/position
  - Specific high competence needed to work with complex techn. change → techn. freedom and autonomy at work → increased productivity

- New technologies introduced in occupational areas with rather lower qualification requirements are expected to be less complex
  - Strategy of the employer: standardizing working steps relating to new technologies introduced in order to boost productivity (see Choi et al. 2008) → autonomy-loss for employees

Data/Method

- **Data:** BIBB/BAuA Employment Survey from 2018
- Representative survey of employees in Germany

Main dependent variables

→Decision-making-autonomy

→ How often do you have to take difficult decisions at work on your own? Never (1), Sometimes (2), Often (3)

→Autonomous work organization

→ Plan and schedule your own work (Never (1), Rarely (2), Sometimes (3), Often (4), for all items below)

→ Have influence on the amount of work

→ Decide when to take a break

Data/Method

Central independent variable: Did technological changes occur at your workplace since the last 2 years in terms of…

- new machines or plants,
- new process- or manufacuring-technologies,
- new software-applications introduced? Yes, No

- The regression models are differentiated by the qualification requirements at work in a **first step**
  - Helper (without qualification, vocational degree)
  - Professionals (with dual/school-based apprenticeship contract)
  - Specialists (with a higher qualified vocational degree)
  - Experts (with tertiary/University degrees)
- **Second step:** also differentiating the occupational position of respondents (Based on the classification of occupations in Germany, KldB)
  - Production-based occupations (manufacturing workers, craft trade workers, etc.)
  - Primary (clerks, clerical workers, etc.) and secondary service occupations (technicians, scientific workers, etc.)

Data/Method

- **Third step:** estimate interaction effects on autonomy concerning the qualification requirements for employees and the respective technology-type that changed for all occupations and different occupational areas

- **Typical controls:** age, gender, firm size, technical/computer skills/knowledge, complexity of work (problem solving), etc.

Results

- Rather an autonomy-benefit can be generally observed with the introduction of new software-applications (for professional, complex specialist and highly complex expert tasks)

- Autonomy-loss in general rather observable for new machines or plants and new process- or manufacturing-technologies introduced at work

- Differences can be detected between occupational groups and in terms of qualification requirements for employees

Results

	Prod. sector			Primary service sector			Sec. service sector		
Significant effects of technologies introduced at work	Professionals	Specialists	Experts	Professionals	Specialists	Experts	Professionals	Specialists	Experts
New process- or manufacturing-technologies	+			-	-	-			
New software-applications	+	+	+	+	+	+		+	+
New machines or plants	+			-			-	-	-

Interpretation/Outlook

- See Pfeiffer (2015): complex production sector and high situative laboring capacity of professionals within the production sector in Germany (specific competence of workers, see apprenticeship system in Germany)

- Complementary impact of new technologies introduced on tasks for professionals with mainly production related or service related type of tasks

- Possibility of increased autonomy also for professionals (not necessarily technological taylorism)

- **Effect of technological change on autonomy at work depends on respective technology type and on the usage within the respective occupational group/position**

Interpretation/Outlook

- Too simple: autonomy-benefit with technological change when qualification requirements increase

- Correlation between qualification requirements at work and complexity/standardization of work

- Better use highest completed education as measure for the qualification level of employees?

- What can we learn from national level data analysis when thinking of the availability of measures on technological change and workplace characteristics on an international level?

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Introducing a study

: Korea-Germany comparison of job characteristics of production workers and technical workers in manufacturing industry

(Me Rhan KIM, AhnKook KIM, Soorin YOON)

Why manufacturing? Why production workers and technical workers?

- Both countries are manufacturing-oriented
  - Germany > Italy > Korea > Japan > France > UK
- The advancement of automation technology has become very important in modern manufacturing.
  - The work of technical and production workers will be affected especially by digital transformation

Data used

- Comparison of Korean skills survey data and German Employment Survey(2018) data

  - Exploring the nature and methods of work performed by manufacturing workers, work intensity, technological change, human capital, and skills mismatches.

* Skills Survey data(Korea)

  - In 2021, 818 engineering professionals and technicians, production workers, and machine operators and assemblers (25 at the 2-digit occupation level) in the manufacturing industry were surveyed on topics regarding product and task scope, skill requirements, work process, facing and solving complex problems, use of computers and automated machines, skill mismatch etc.

Technical workers & Production workers

- The different nature of work between technical and production roles was found to be common to both Korea and Germany.
- Therefore, we focused on the differences between Korea and Germany

KOR-GER comparison of production and technical occupations: job characteristics, skills and human capital

	Contents	Korea		Comparison: KOR vs.GER	Germany	
		Technical Workers	Production Workers		Technical Workers	Production Workers
Job Characteristics	How detailed the job description is	11.3	20.9	<	5.3	34
	How repetitive the details of the task are	19.1	28.4	<	10.8	47.8
	New and difficult tasks arise	2.6	1.9	<<	68.6	44.9
	Need to improve workflow and try something new	6.1	1	<<	52	29.6
	Do something unfamiliar/unlearned	2.6	3.6	<<	8.4	10.4
How a work is processed	Multi-tasking	0	4.1	<<	73.4	53.4
	Requires frequent communication/coordination with peers	80.9	47.5	<<	97.9	85.6
	Combining instruction and independent performance	59.1	54.3	>>	5	22

KOR-GER comparison of production and technical occupations: job characteristics, skills and human capital

	Contents	Korea		Comparison: KOR vs.GER	Germany	
		Technical Workers	Production Workers		Technical Workers	Production Workers
Tasks Intensity	Requires maximum performance	0	0.1	<<	10.8	12.1
	Feeling pressure to meet deadlines or perform	3.48	0.72	<<	53.03	47.28
Change of Technology	Introducing new manufacturing/process technologies	27.83	27.83	<<	52.77	61.7
	Introducing new computer programs	32.17	12.03	<<	68.6	49.17
	Introducing new machinery/equipment	27.83	22.46	<<	46.44	70.69
Skills Mismatch	Over-challenged	22.6	27.5	>>	3.4	4.3
	Matches with Skills	70.4	68.7	<<	91.6	79.2
Average years of service		6.42	7.60	<<	14.43	11.90
Educational Background	High school diploma or less	0	67.1	<	7.7	77.3
	College degree or higher	100	32.9	>	92.3	22.7

Some Findings

- Overall, Germany is higher than Korea in terms of job characteristics, work style, work pressure, and technological change.
- Germany-Korea gap is larger than the gap between production workers-technicians
- This is likely due to the different institutional backgrounds, but more specifically, the combination of technology and production methods or work organisation at the workplace level is quite different between Korea and Germany.

Some Findings

- In addition, the findings that Korean production workers are more educated than their German counterparts, but are less skilled, and that there is less demand for improvement/innovation in their jobs, suggest that they may be less efficient in terms of work organisation, in addition to their relatively short tenure.
- Perhaps the most important institutional difference is that Germany has a well-developed career progression ladder across the lifespan through its dual vocational education and qualification system.

Korea-German comparison of differences between large and small firms after controlling for occupation : job characteristics, skills and human capital

	Contents	Production Workers					Technical Workers				
		KOR		Difference	GER		KOR		Difference	GER	
		SME	LE		SME	LE	SME	LE		SME	LE
Job Characteristics	How detailed the job description is	20.5	23.1	<	28.5	38.7	11.4	11.1	<	9.5	3.9
	How repetitive the details of the task are	27.6	34.1	>	47.1	47.4	19.3	18.5	~/=	11.6	10.7
	New and difficult tasks arise	0.8	8.8	>	45.7	43.3	1.1	7.4	>	67.4	69.0
	Need to improve workflow and try something new	0.7	3.3	>	30.3	29.9	3.4	14.8	>	55.8	51.3
	Do something unfamiliar/unlearned	2.8	8.8	>	9.1	10.8	2.3	3.7	~/=	6.3	9.3
How a work is processed	Multi-tasking	3.2	9.9	<	47.1	60.3	0.0	0.0	.	64.2	76.5
	Requires frequent communication/coordination with peers	43.6	73.6	>	83.7	88.1	80.7	81.5	~/=	97.9	97.9
	Combining instruction and independent performance	56.6	39.6	>>	24.0	20.6	63.6	44.4	>	7.4	4.3
Tasks Intensity	Requires maximum performance	0.2	0.0	~/=	11.8	12.4	0.0	0.0	-	6.3	12.5
Skills Mismatch	Over-challenged	26.9	31.9	>>	3.2	5.2	15.9	44.4	>	2.1	3.9
	Matches with Skills	70.6	56.0	<<	81.5	76.8	77.3	48.2	>	92.6	91.1
Educational Background	High school diploma or less	69.5	75.1	.	51.7	79.3	0.0	6.3	.	0.0	8.2
	College degree or higher	30.6	24.9	<<	48.4	20.7	100.0	93.7	.	100.0	91.8

Some Findings

- For production workers, the difference between SMEs and LEs are larger in Korea than in Germany for most items, mainly for job nature, work methods, and skill mismatch.
- In terms of job characteristics, Korea is notably different from Germany in that there is less demand or activity for innovation in the workplace.

Policy Recommendation

- Governments need to actively deregulate to allow companies more discretion, i.e. to recognise and enhance the diversity of training courses, in order to correspond to demand for higher skills in manufacturing industry.

- It is necessary to strengthen support for the implementation of training for SMEs, platform companies, etc. There is a need to shift skills development for young incumbent workers from short-term training to long-term career development support.

Many thanks!

Regimes of robotization in Europe

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Friday, 1 December 2023

Vocational Education, Skilled Workers and Transformation in an International Perspective

Federal Institute for Vocational Education and Training (BIBB)

Panel: The technological side of Transformation

Motivation and contribution (1)

- The ’robots-workers race’ as an economics’ evergreen: from Smith, Ricardo and Marx to the nowadays’ labour/innovation literature (Montobbio et al., 2022)

- Digitalization is giving new strength to the process of robotization (e.g. more autonomy and flexibility of robots, see Fernández-Macías et al. 2021) rising (again) fears of **mass technological unemployment** (Autor, 2022)

- There is an increasing interest in studying the effects of robots, BUT:
  i) **inconclusive evidence**;
  ii) **relevant sources of heterogeneity** often neglected (technological, sectoral and country-level)

Motivation and **contribution** (2)

1. Relying on the IFR data and adopting IV approach à la Acemoglu and Restrepo (2021) to:
   i) provide fresh evidence on robots diffusion;
   ii) analyse potentially heterogenous impact of robotization across occupational groups;

2. Perform cluster analysis to group European countries according to their **technological capabilities, competitive strategies, hierarchical positioning in GVCs** → to empirically test the long-standing literature on core-periphery dynamics in the EU (Celi et al. 2018, 2020; Grabner and Hafele, 2020)

- **Link two literature strands**: Test for the presence of **robotization regimes** - differences in the robot-employment relationship according to economies' structural and technological traits

Robots vs employment: **background**

From a theoretical point of view,
the impact of robots on employment is not clear a priori $\Rightarrow$

- **The Marxian-Ricardian approach** $\rightarrow$ machines (robots) as a mean to discipline workers and push wages downwards [(-), TECH UNEMPLOYMENT]

- **The Keynesian approach** $\rightarrow$ disruptive effects if labor-saving technological change combines with sluggish aggregate demand [(-), TECH UNEMPLOYMENT] and compensation mechanisms are not at work;

- **The Neoclassical approach** $\rightarrow$ productivity enhancing effects and market compensation mechanisms [(NE or +)] and differentiated impact across occupational groups/tasks (SBTC and RBTC)

- **Structuralist and evolutionary approaches** $\rightarrow$ institutions, idiosyncratic technological capabilities, sectoral specialization, labour market characteristics and demand regimes matter [HARDLY PREDICTABLE]

"Whether workers race with or against machines
remains an empirical question"

Empirics

Paper	Coverage/Methods	Effect	Level of analysis
Acemoglu and Restrepo (2018, 2019, 2020a)	share of robot adoption using IFR data for the US	displacement effects on low-wage workers	industry level
Chiacchio et al 2018	AR framework adopted for six EU countries	robot introduction is negatively associated with the employment rate	industry level
Graetz and Michaels (2018)	robot adoption (IFR and EUKLEMS data to estimate robot density) in 17 countries from 1993 to 2007	robots do not significantly reduce total employment, although they do reduce the low-skilled workers' employment share	industry level
Dauth et al. (2021)	German industry adopting IFR data over the 1994-2014 time-span, using a measure of local robot exposure for every region	no evidence that robots cause total job losses and there are positive and significant spillover effects in services	industry level
Domini et al. (2020)	French manufacturing employers over the period 2002–2015	robotic adoption or, alternatively, imported capital equipment, do not limply labour expulsion, but rather employment growth	firm-level
Bonfiglioli et al. (2020)	French data over the 1994-2013 period	initial positive employment effect as a response to robot adoption but then turning into a negative one	firm-level
Koch et al. (2021)	robot adoption using data from Spanish manufacturing firms over the period 1990-2016	within four years robot adopters raise their overall employment by around 10 percent, particularly for high-skilled workers	firm-level

Figure 1: Selected empirical studies, Montobbio et al. 2022

Our research questions

RQ1: What is the net employment impact of robots in European industries?

RQ2: Is there a heterogeneous impact of robotization across occupational (ISCO) groups?

RQ3: Can different robotization regimes be observed in Europe? Does robotization interact with the structural core-periphery divergence (Celi et al. 2018) characterising the European economy?

Data and descriptive evidence (1)

- **Industry-level data**
- **Sample selection**
  2011-2018, 21 European countries, 15 manufacturing sectors
- **Data sources**
  IFR $\rightarrow$ IFR provides information on robots (stock and new installations).
  Robots are "automatically controlled, re-programmable, multipurpose [...] which can be either fixed in place or mobile for use in industrial automation applications" (ISO 8373, IFR)
  Handling, welding, assembling machines $\rightarrow$ physical tasks (moving and manipulation of objects)
  LFS $\rightarrow$Labor Force Survey: age, gender, education, type of contract, occupations (Eurostat)
  ICIO $\rightarrow$Narrow and Broad offshoring (OECD)
  STAN $\rightarrow$Sectoral demand growth (OECD)
  ICP $\rightarrow$RTI, Digital use, Digital tasks (O*NET-type data source for Europe, INAPP-ISTAT survey)

Data and **descriptive evidence** (2)

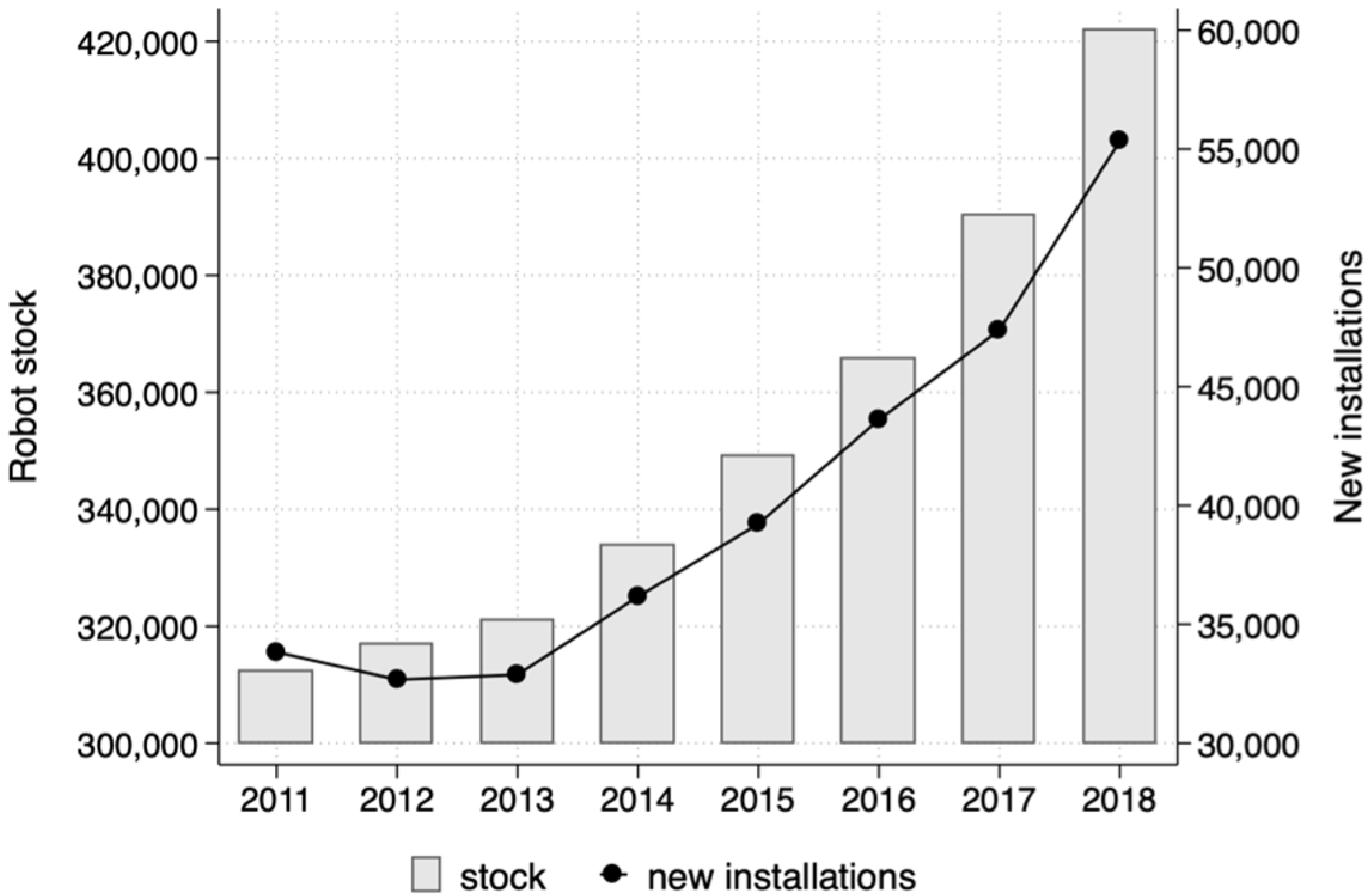

Figure 2: 'Robotization wave' in Europe, 2011-2018

Data and **descriptive evidence** (3)

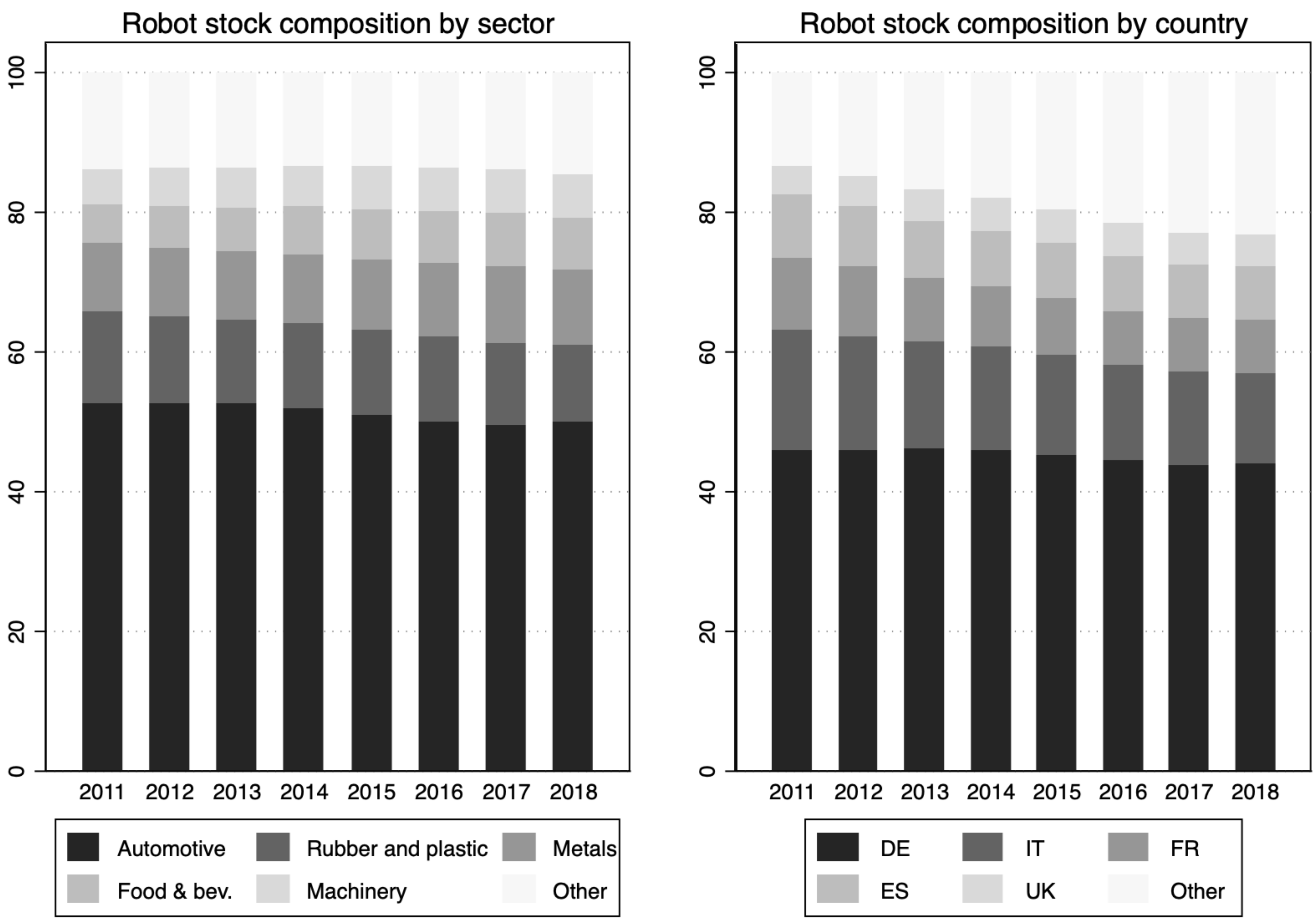

Figure 3: Decomposition of robot stock by sector and country, 2011-2018

Econometric strategy and results

$$\Delta lnY_{ijt} = \alpha_0 + \beta_1 Robots_{ijt-1} + \beta_2 Trade_{ijt-1} + \beta_3 ICT_{ijt-1} + X_{ijt-1}'\gamma + \mu_i + \chi_j + \tau_t + \epsilon_{ijt} \quad (1)$$

Y →Total employment, Hours Worked, Employment by 4 ISCO groups (Managers, Clerks, Craft workers, Manual workers) - annual change

Robots →Robot stock per 1000 workers

Trade →Narrow/Broad offshoring indicators

ICT →RTI, Digital tasks/use

X →Demand growth, Labour market characteristics (age, sex, education, contract)

- Method: POLS, FE, IV
- Identification strategy IV: robot density in Japan - ahead of Europe - to reveal the impact of robot diffusion (alternatively US)
- Estimation: aggregate effect, by ISCO occ. groups, by cluster
- Robustness checks: IV US, HW, different proxies of offshoring and digitalization

Econometric strategy and **results** (1)

Table 1: Robotization and Employment

	(1) OLS 1	(2) OLS 2	(3) FE	(4) IV 1	(5) IV 2	(6) IV 3	(7) HW, IV
Robot density	0.0455***	0.0302***	0.113**	0.0444*	0.0547**	0.0413**	0.0611**
	(0.0133)	(0.0112)	(0.0564)	(0.0238)	(0.0251)	(0.0201)	(0.0297)
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year FE	No	Yes	No	No	Yes	No	No
Country x Pavitt FE	No	Yes	No	No	No	Yes	No
Kleibergen-Paap F statistic				16.366	15.588	22.849	13.650
Constant	-0.285	4.734*	0.0374	3.484	3.173	5.123**	1.047
	(0.503)	(2.685)	(4.243)	(2.505)	(2.496)	(2.378)	(3.108)
Observations	2,166	1,971	1,971	1,971	1,971	1,971	1,805
R-squared	0.138	0.369	0.118	0.203	0.333	0.238	0.130

Note: Robust standard errors clustered at country-industry level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

- One more robot per thousand employees is associated with a 0.04-0.05% increase in employment, approximately 73 workers.

*All specifications include time, country and broad industry fixed effects

ISCO occupational groups

- We define four macro-occupational groups based on the 1-digit International Standard Classification of Occupation (ISCO) ⇒ advantage: reflects **hierarchical position of workers, task content of jobs, levels of education and wage differences** (Cirillo, 2017; Reljic et al., 2021)

Professional groups	ISCO classes
Managers	Managers, senior officials and legislators Professionals Technicians and associate professionals
Clerks	Clerks Service and sales workers
Craft workers	Skilled agricultural and fishery workers Craft and related trade workers
Manual workers	Plant and machine operators and assemblers Elementary occupations

Econometric strategy and **results** (2)

Table 2: Robotization effect across occupational groups, IV 2SLS

	(1) Managers	(2) Clerks	(3) Craft workers	(4) Manual workers
Robot density	0.213***	-0.0101	-0.0605	-0.120*
	(0.0740)	(0.0899)	(0.0569)	(0.0652)
Controls	Yes	Yes	Yes	Yes
Kleibergen-Paap F statistic	17.276	17.940	16.940	16.994
Constant	-7.794	20.57	20.86**	2.520
	(8.884)	(15.06)	(8.979)	(8.503)
Observations	1,454	1,056	1,687	1,631
R-squared	0.064	0.048	0.036	0.046

Note: Robust standard errors clustered at country-industry level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

- Employment gains are asymmetrically distributed, favouring 'managers' while penalising manual workers

A theory-driven cluster analysis

- Buildingon the literature documenting core-periphery divergence in Europe (Celi et al. 2018, 2020), we rely on a two-step cluster analysis to test whether structural/technological/ competitive hierarchies are reflected in the data

- First step: Hierarchical clustering (Ward linkage) to determine the number of distinct clusters according to 14 variables
  $\rightarrow$ **knowledge creation and technological patterns** (public R&D, researchers, patents, public procurement, investment in intangibles);
  $\rightarrow$ **production capabilities and GVC positioning** (firm size, share of HT, value added, degree of foreign control, domestic VA in gross exports)
  $\rightarrow$ indicators of **functional specialisation - fabrication, R&D, marketing and management (RCA)**

  Result: **4 clusters**

- Second step: Non-hierarchical k-means cluster analysis to assign each observation to a specific cluster

Mapping clusters: visualizing the **core-periphery** divide

Figure 4: Mapping clusters: k-means/k-medians; Core (AT, DE, DK, FI, FR, NL, SE); Service-Oriented (BE, EE, IE, UK, SI); Periphery East (CZ, HU, PO, SK); Periphery South (IT, SP, GR, PT) with Baltics (LT and LV)

Clusters - overview

- **Peripheral regions** are depicted by considerably weaker innovation capacity, lower investments in ICT intangibles and smaller average firm size in manufacturing(<10 employees) wrt core (20 employees) and SO countries

- **Core** specialises in strategic R&D and management functions, based on high-skilled labour with low relocation propensity;
- **EP** has a comparative advantage only in fabrication - production of intermediate inputs and assembly;
- **SO** specialises in management activities (owing to the size of the business service sector);
- **SP** specialises in marketing activities (sale and distribution);
- Dynamics 2011-2018: **no signs of core-periphery convergence**; core countries "dominate" the rest of Europe in all NSI-related dimensions

Mapping clusters: **descriptive evidence**

Table 3: Descriptive statistics by cluster

	Core	SO	EP	SP & Baltics
Public R&D (% GDP)	**0,90**	0,63	0,51	0,57
Public procurement (% GDP)	**15,86**	13,23	13,88	11,79
Researchers in R&D (per million people)	**5.110**	3.760	2.435	2.600
Patents application to EPO (per million people)	**260**	84	9	20
Fixed broadband subscriptions (per 100 people)	33	28	21	23
Investment in software and databases (% GDP)	1,89	1,08	1,00	0,94
Average firm size in manufacturing	**19,14**	14,86	9,15	9,68
Medium and high-tech manufactured exports	57,94	55,10	66,08	41,12
Degree of foreign control (% VA) in manufacturing	31,79	51,84	59,06	27,58
Domestic value added in gross exports	71,50	64,56	58,17	72,99
Functional specialisation, Management	1,01	1,61	0,87	1,14
Functional specialisation, R&D	1,32	1,02	0,95	0,75
Functional specialisation, Marketing	1,03	0,93	0,96	1,07
Functional specialisation, Fabrication	0,81	0,76	1,12	0,99

Source: Authors' elaboration

Notes: SO (Service-oriented); EP (Eastern periphery); SP (Southern periphery).

In search of robotization regimes: **sample split**

Table 4: Robotization and Employment, core-periphery

	(1) Core	(2) SP & Baltics	(3) Eastern periphery	(4) Service oriented
Robot density	0.0453**	0.0419	0.818	0.135**
	(0.0191)	(0.0342)	(0.514)	(0.0554)
Controls	Yes	Yes	Yes	Yes
Kleibergen-Paap F statistic	14.023	6.954	4.202	12.747
Constant	-1.828	-1.571	15.03**	13.13**
	(2.144)	(3.105)	(7.415)	(6.506)
Observations	714	503	420	334
R-squared	0.283	0.423	0.066	0.078

Note: IV estimates. Robust standard errors clustered at country-industry level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

- **'Labour-friendly' robotization regime** → strong technological capabilities and 'high-road' competitiveness strategy based on innovation and skills reward in terms of market shares and employment

Discussion: Key results (1)

1. **Positivenet employment effect** in European manufacturing industries ⇒ one additional robot per thousand employees increases the employment growth by about 0.04-0.05%
2. Jobgains are concentrated only in the **upper part of occupational distribution** ⇒ directly involved in the process of governing and managing new technologies are reaping the benefits
3. 'Labour-friendly'regime emerges only in core and SO countries, characterised by stronger technological capabilities and 'high-end' competitiveness strategies => **robotization regimes** reflects the well-known core-periphery divide in Europe (Simonazzi et al. 2013; Celi et al. 2018)

Discussion (2)

- Our findings contribute to a better understanding of the inconclusive evidence in the empirical literature regarding the robot-employment nexus in Europe

- The technology-employment nexus is a very important channel of transformation in labour markets, but not the only one $\rightarrow$ **robotization is unlikely to be the major driving force of employment dynamics in Europe**

- In line with an evolutionary approach to technology and employment **structural and demand-related factors** are (as expected) key to understand the technology-employment relationship $\rightarrow$ history, institutions, technological and power asymmetries matter

- Our results are supported by a series of robustness checks

Thank you for your attention!

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economics letters

Regimes of robotization in Europe

Jelena Reljic [a], Valeria Cirillo [b], Dario Guarascio [a]

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https://doi.org/10.1016/j.econlet.2023.111320

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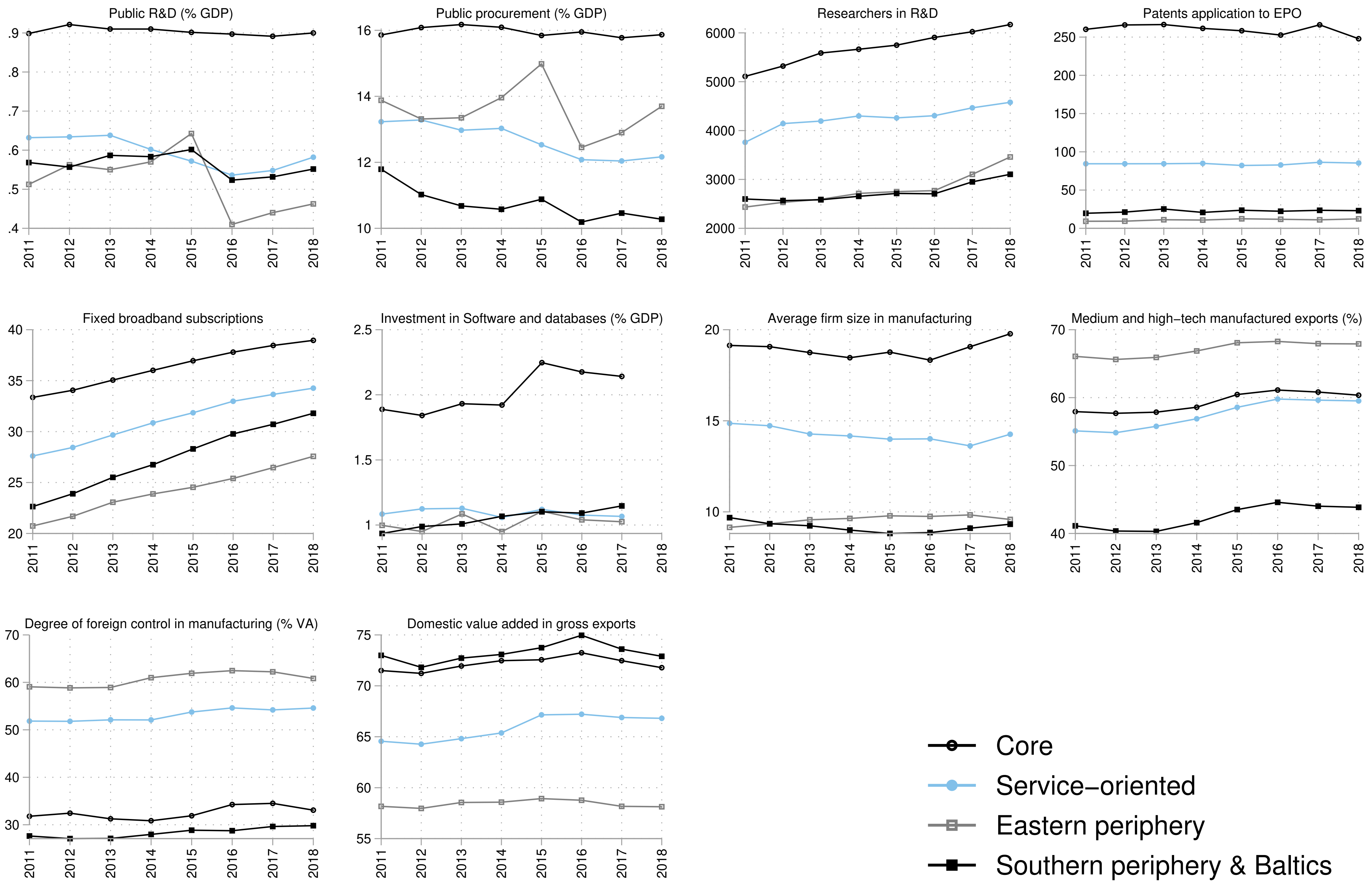
Abstract

This work analyses the impact of robots on employment testing for the presence of different *robotization regimes*. Focusing on European manufacturing industries, we find that robot adoption positively affects total employment. Heterogeneous patterns are detected across both countries and occupational groups, however. The labour-friendly impact of robotization is detected only in core and service-oriented countries and for those at the top of the occupational structure (i.e. managers and technicians). In turn, peripheral countries and manual workers do not seem to benefit at all from robotization.

- Reljic, J., Cirillo, V., Guarascio, D. (2023) Regimes of robotization in Europe, Economics Letters, Volume 232, 2023, 111320, ISSN 0165-1765, https://doi.org/10.1016/j.econlet.2023.111320.

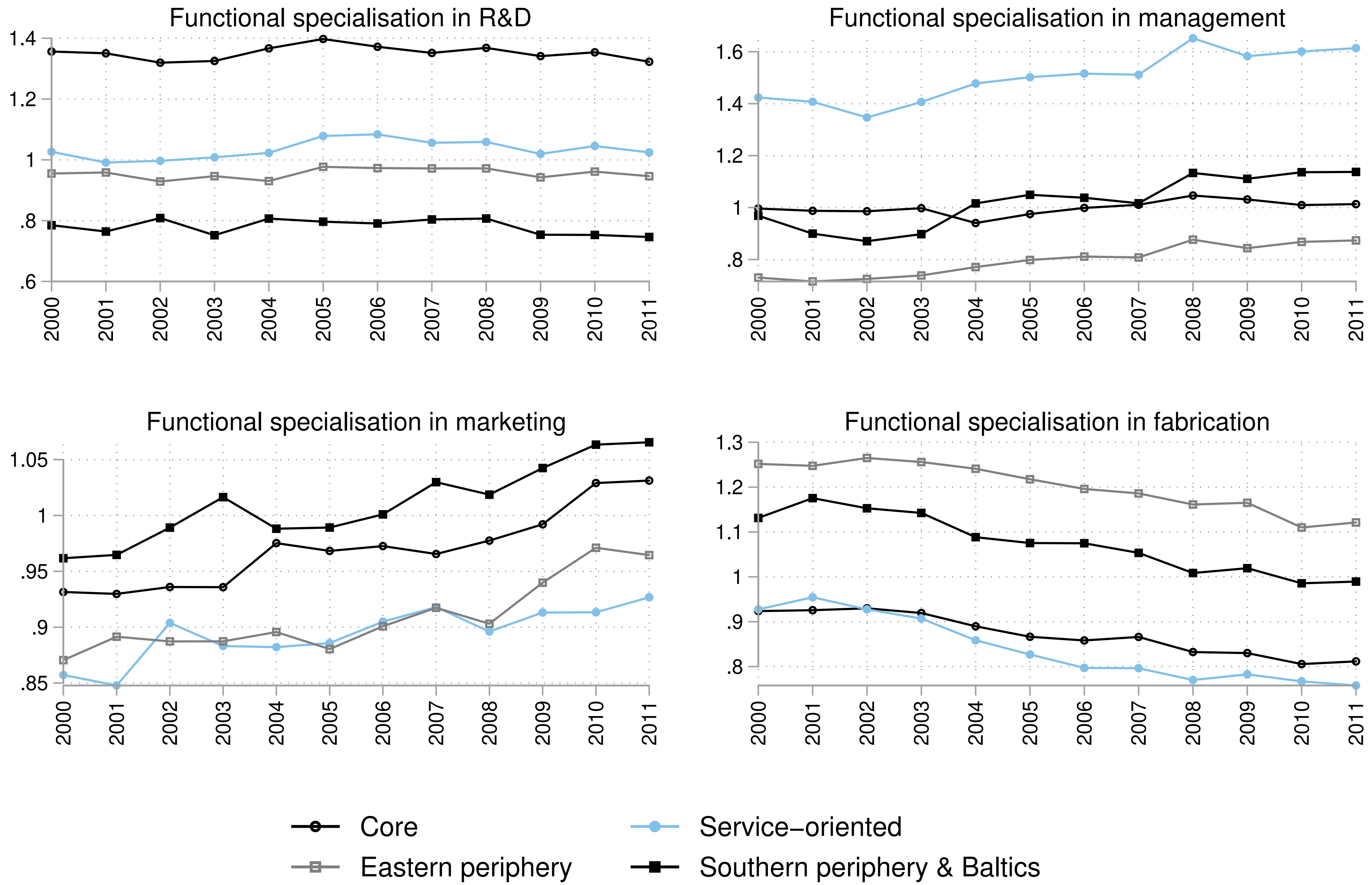
Appendix: Clusters - robustness check (1)

Figure 5: Evolution over the period 2011-2018



Appendix: Clusters - robustness check (2)

Figure 6: Evolution over the period 2000-2011



Source: Authors' elaboration

Appendix: **Robustness checks**

Table 5: Robotization and Employment - robustness checks

VARIABLES	(1) IV2	(2) IV2_US	(3) IV2_narrow	(4) IV2_digital
Robot density	0.0567**	0.0437**	0.0730***	0.0513**
	(0.0257)	(0.0185)	(0.0282)	(0.0243)
Controls	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes
Constant	3.912	4.237*	5.104**	2.897
	(2.527)	(2.404)	(2.421)	(2.607)
Observations	2,013	2,013	2,013	2,013
R-squared	0.311	0.315	0.302	0.313

Note: Robust standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix: **Mapping clusters**

Table 6: Robotization regimes in Europe

Clusters	Core	SP & Baltics	EP	SO
ΔEmployment, annual	0,32	-0,46	1,93	0,09
ΔEmployment, 2011-2018	2,27	-4,26	13,54	0,64
Robot stock per 1000 workers	9,02	6,51	2,14	3,71
ΔRobot stock per 1000 workers, 2011-2018	35,40	32,23	154,56	57,93
Digital tasks, scale 0-1	0,19	0,14	0,12	0,21
Digital use, scale 0-1	0,40	0,30	0,33	0,35
RTI, scale 0-1	0,57	0,59	0,73	0,45
Share of high-skilled	24,75	17,76	15,09	30,29


Industry 5.0: redirecting technology towards productivity. Lessons from comparing Belgium and the Netherlands
Prof. dr. S. Dhondt
Start presentation
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Industry 5.0: redirecting technology towards productivity. Lessons from comparing Belgium and the Netherlands

Working Group 2 – The Technological side of Transformation - BIBB

Prof. dr. S. Dhondt | Bonn

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Industry 5.0: European policy to dynamise Industry 4.0

Industry 5.0: human-centricity, sustainability, resilience are central for European Commission

- How to get companies to invest more in technology that is more productive?
  - Better use of knowledge and talent.
  - Get more out of technology and R&D (higher added value)
- And do it in such a way that companies take more account of externalities (sustainability, resilience)
- **Main question: is it one path for all countries?**

(DG RTD, 2021)

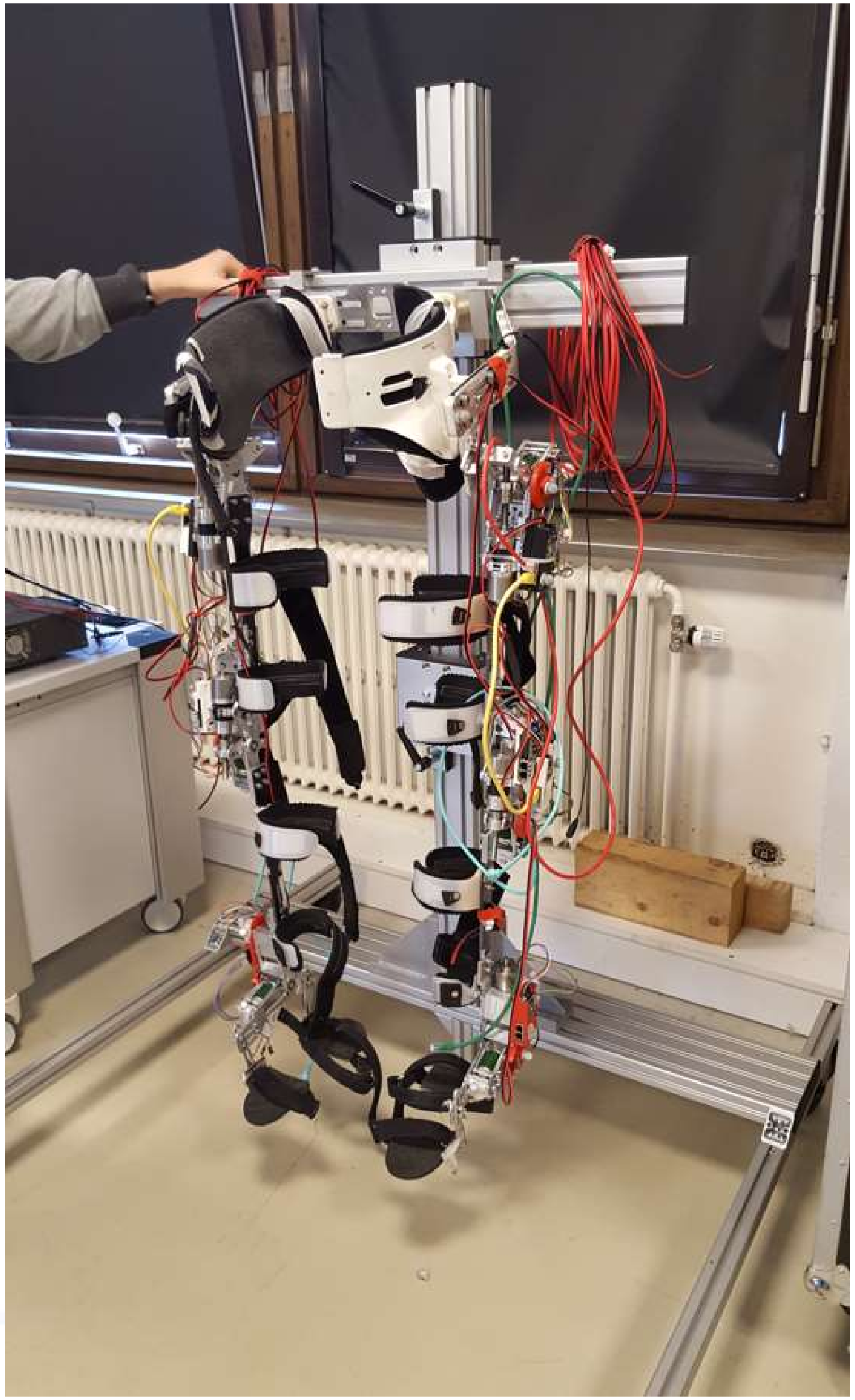
A change in perspective

What is the focus of current transformation research?

- Technology is seen as exogeneous.
- Impact on occupations is evaluated from skills perspective.
- Occupations are seen as ‘fixed’. Focused is on occupations.

What is overlooked?

- Institutional differences play a role in transformation
- Impacts arise from changing labour division: work content is dependent on organisational choices
- Prediction should be focused on organisational change, not on occupational change



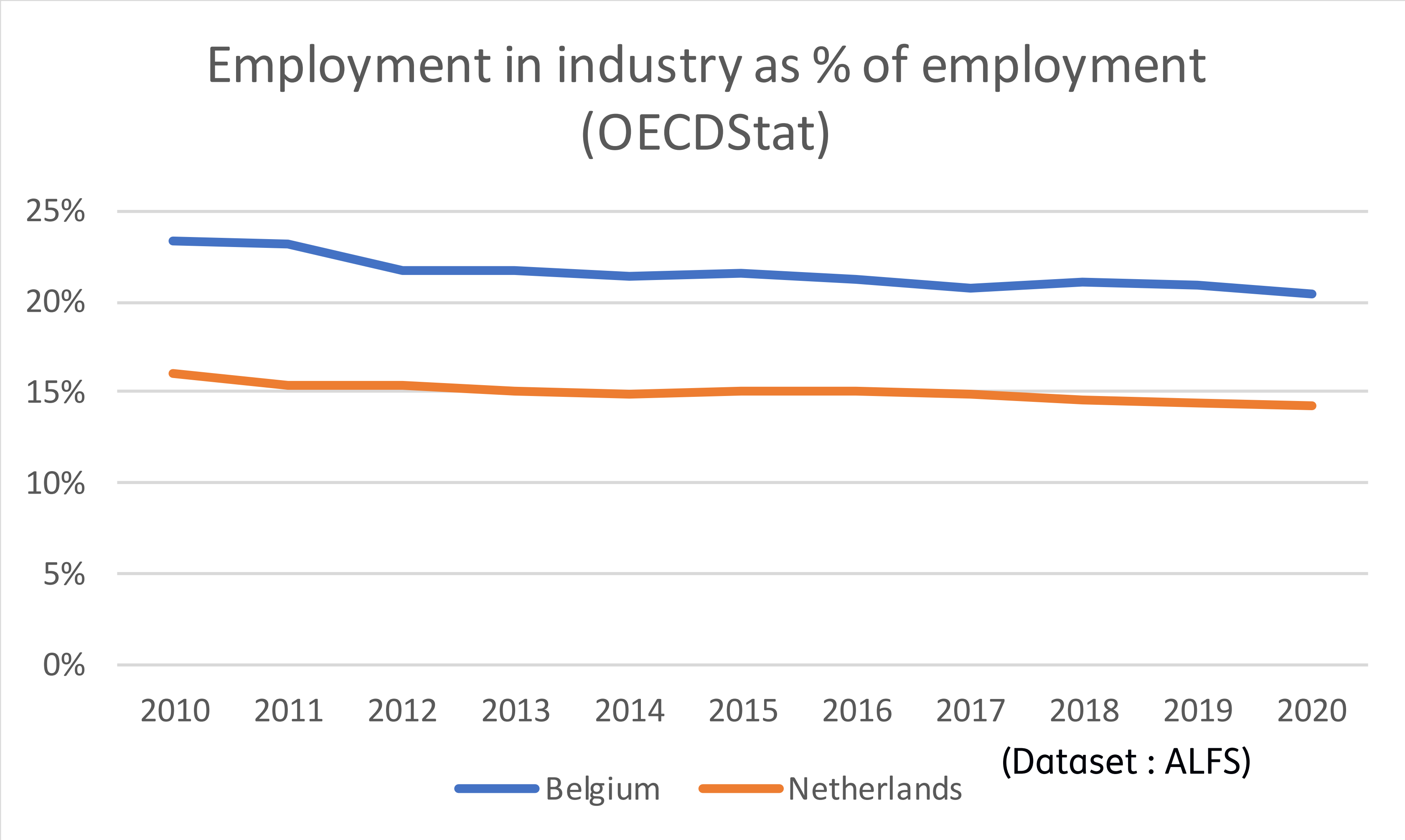
Industrial transformation towards Industry 5.0?

Comparing two ‘transformators’

- Belgium and The Netherlands are countries very much exposed to international competition
- Both: no natural resources, competition mainly based on knowledge and expertise
- Industrial policy debate: shifted towards Industry 5.0
  - Netherlands: Smart Industry + Climate fund + Growth fund
  - Belgium/Flanders: Flanders Make
- Both digital leaders in Europe (DESI, 2023)

- **But major differences in performances**
- **Analysis shows different transformation paths**

Industrial employment has stabilised after long decline in both countries



(Dataset : ALFS)

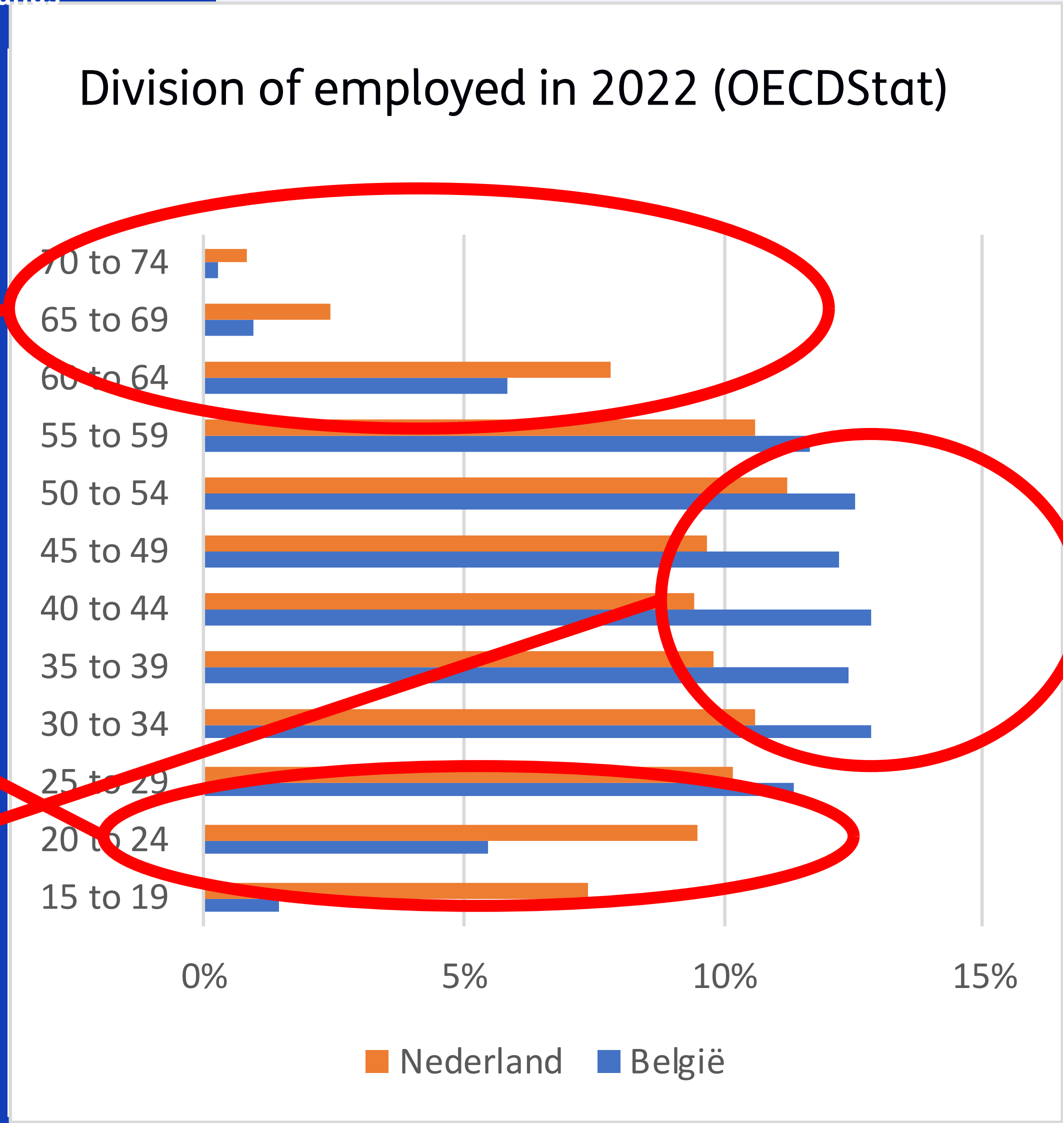
Healthy Living & Work

Industry 5.0 – Comparing Belgium (Flanders) to the Netherlands

Different labour market participation rates?

Netherlands demands more commitment from very young young people and lets older people continue working

Belgium demands commitment from middle-aged, higher-educated groups



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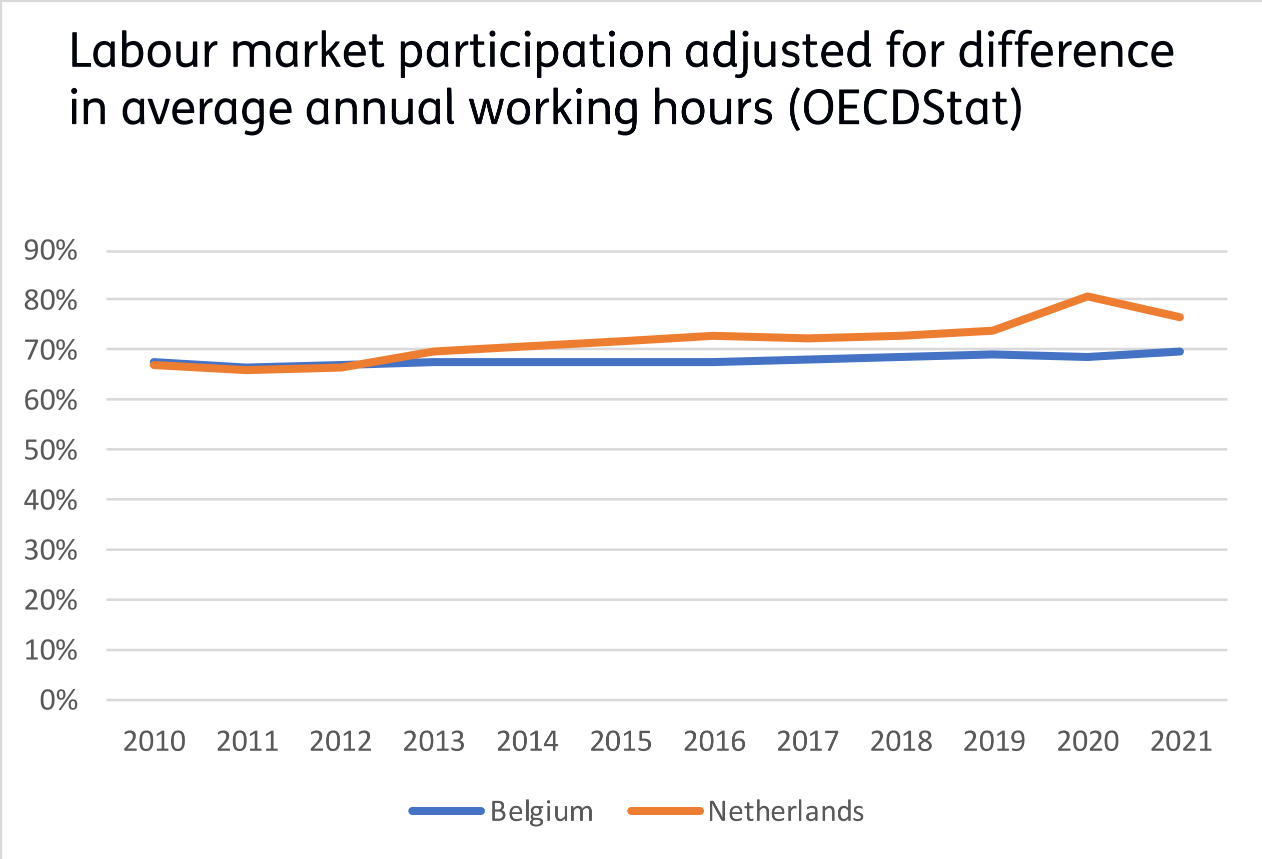
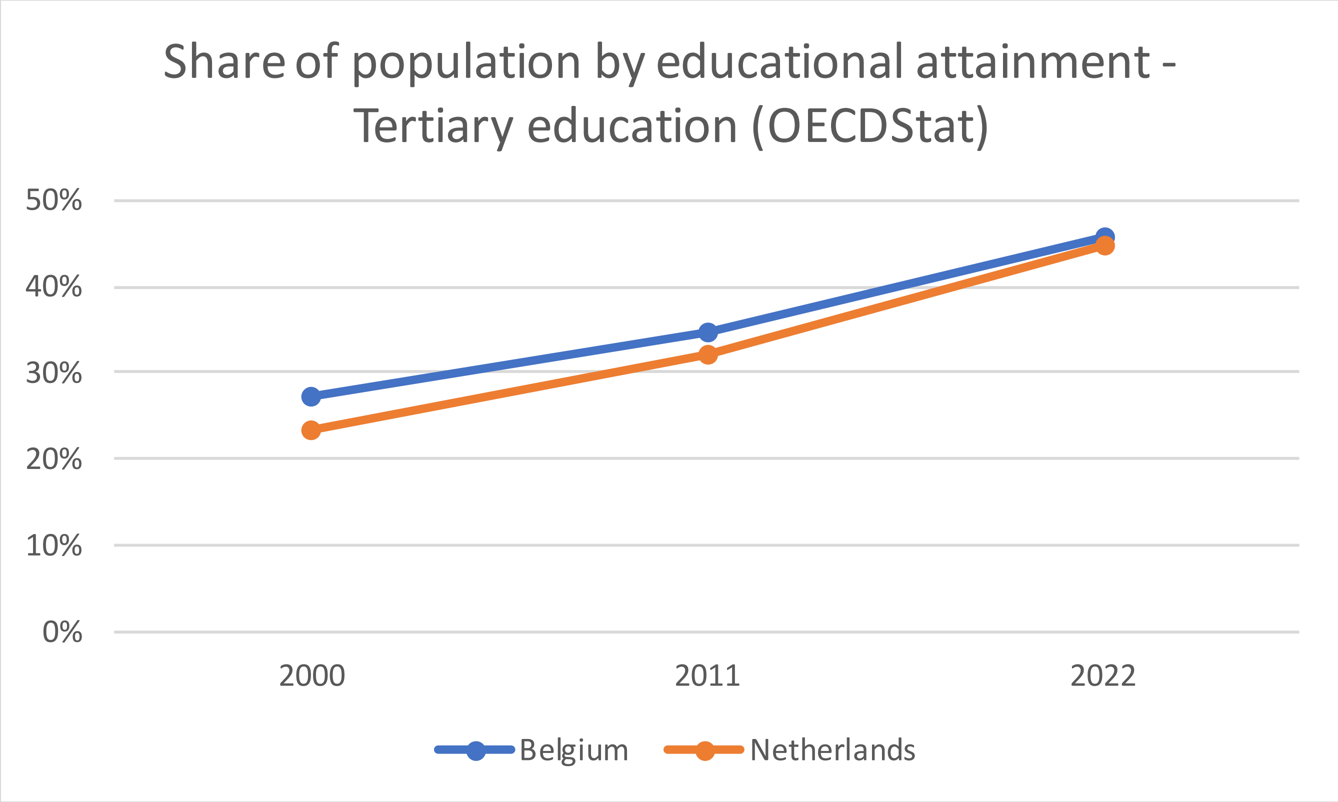
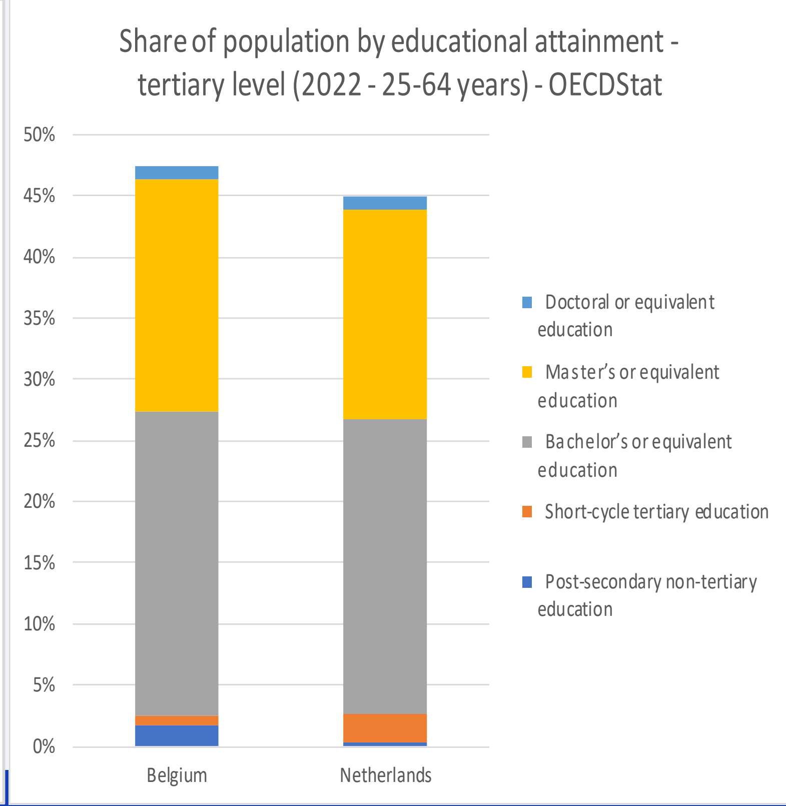
Participation rates should be adjusted for difference in annualised working hours

- Difference in participation rate remains, but convergence is clear.
- COVID period obscures figures.
- Both countries show increasing participation rates over time.
- Long-term increase in both countries remains significant: the welfare states have less 'weight' to carry.



Both countries try to profit from 'skills-biased technology change'

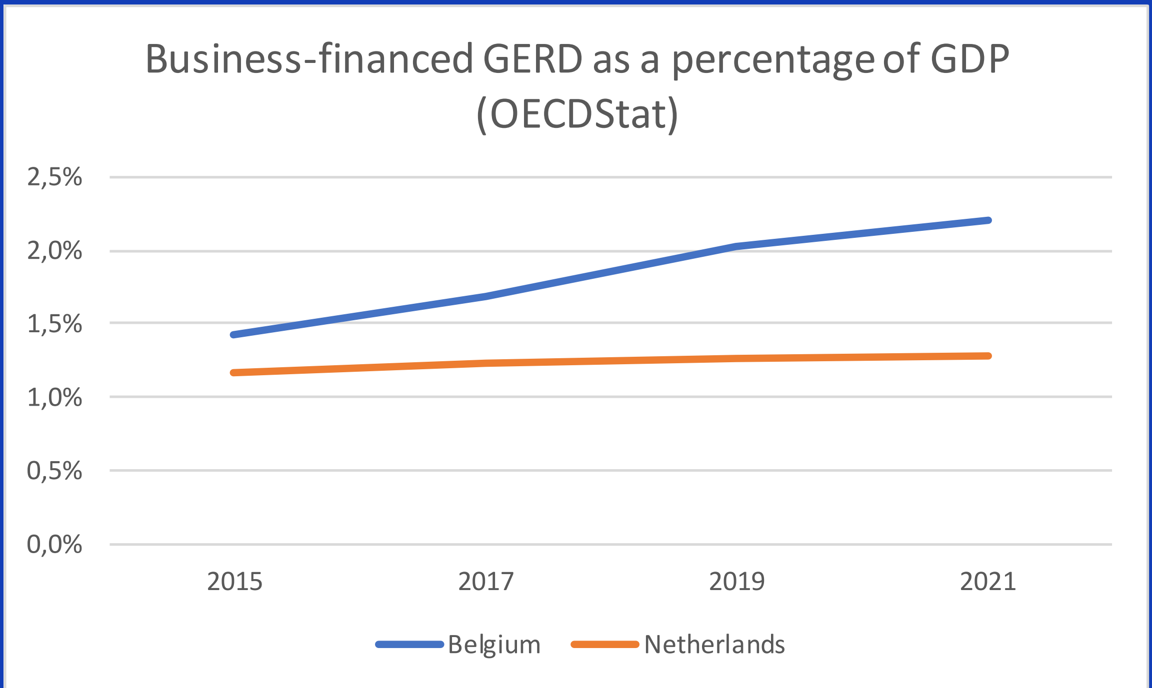


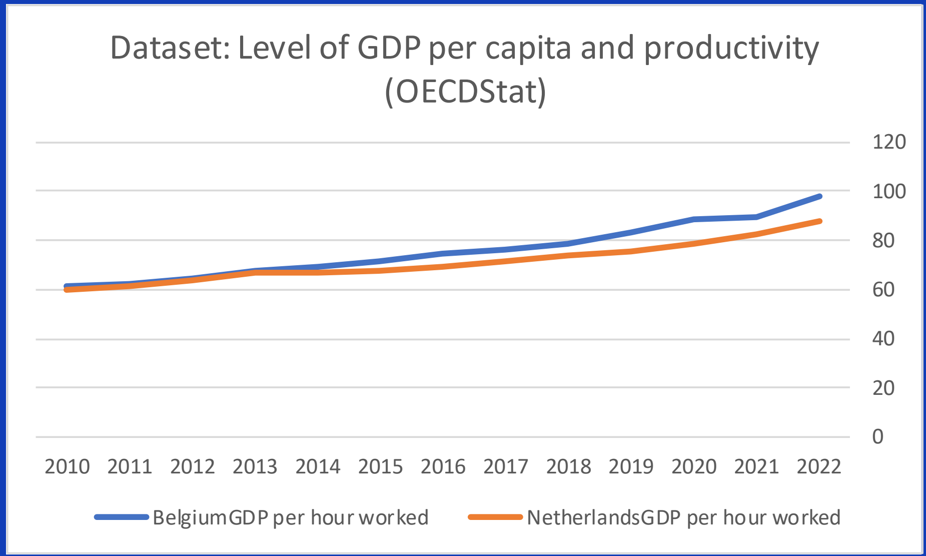


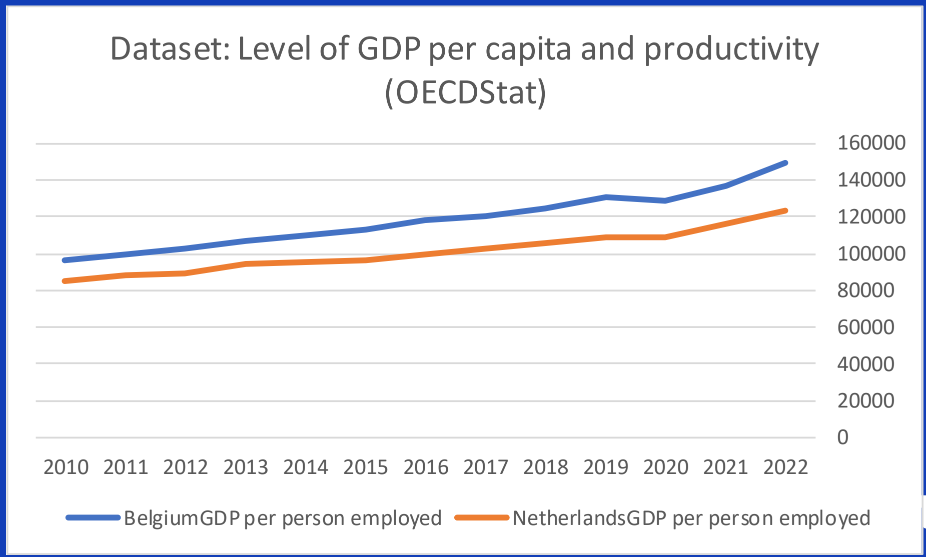
Healthy Living & Work

Industry 5.0 – Comparing Belgium (Flanders) to the Netherlands

But R&D-investments and productivity levels are different







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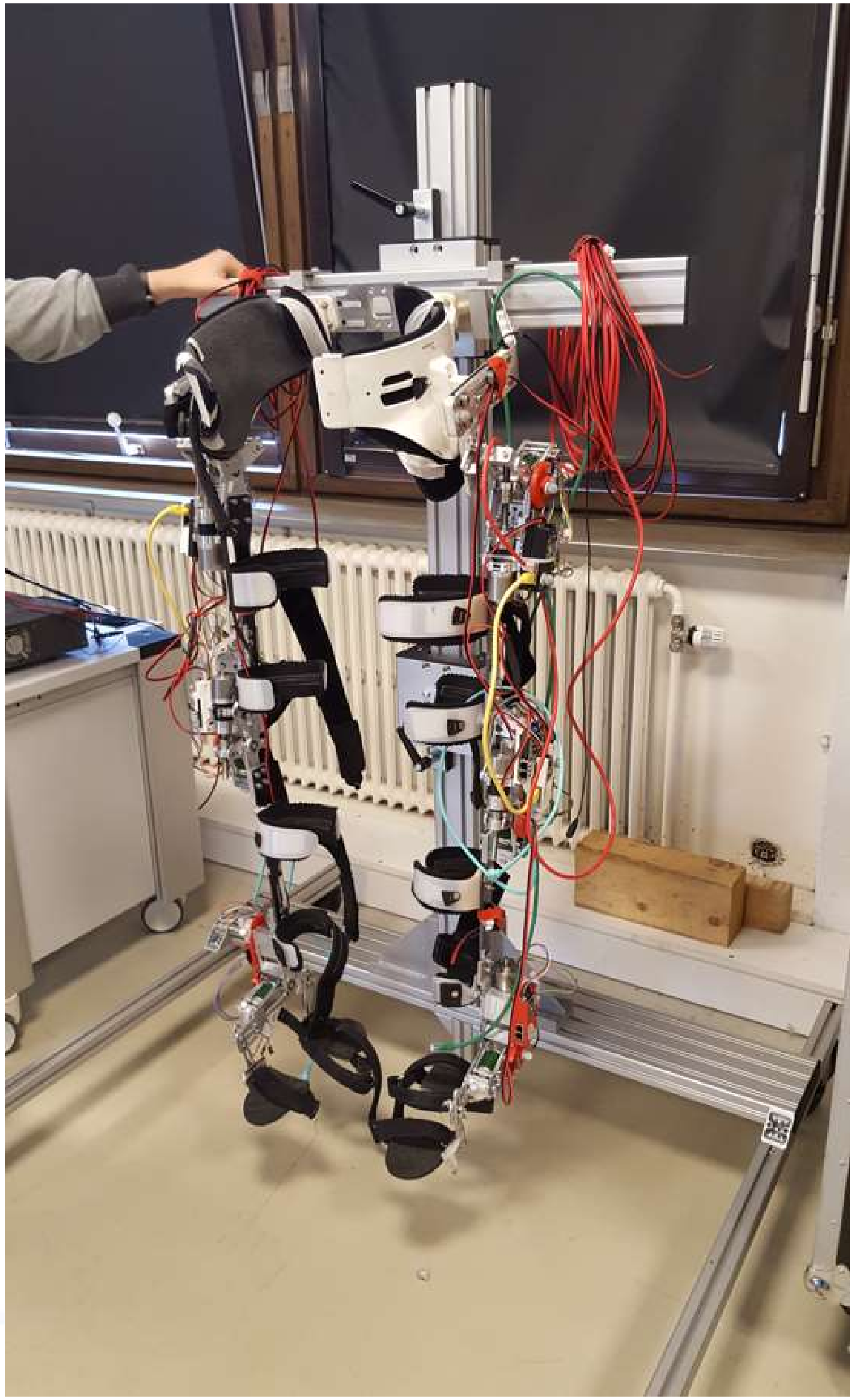
The research question and methodology

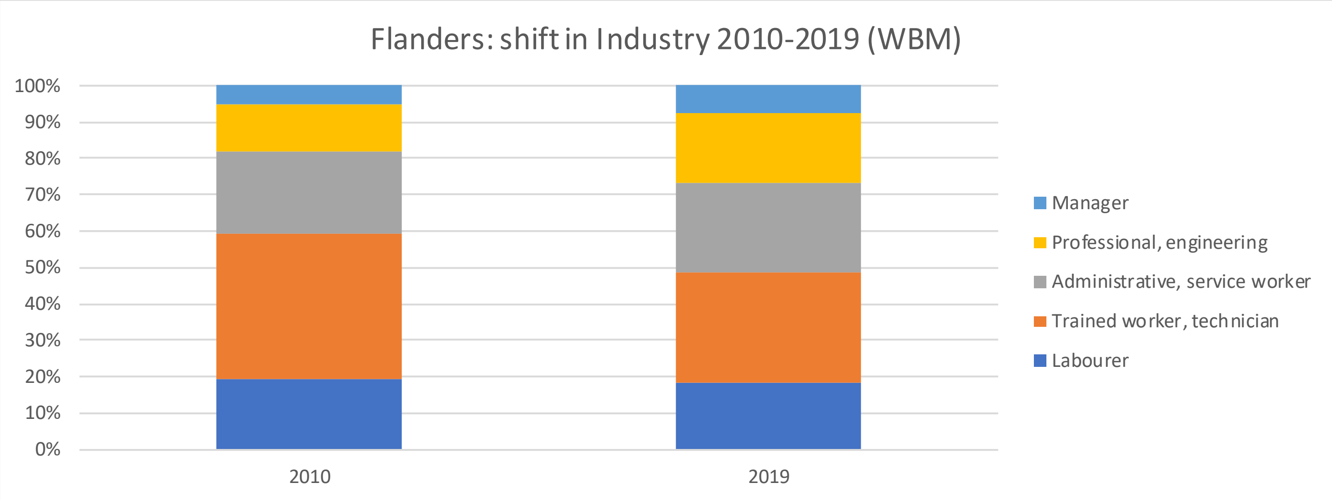
What can we see at the level of the Industry?

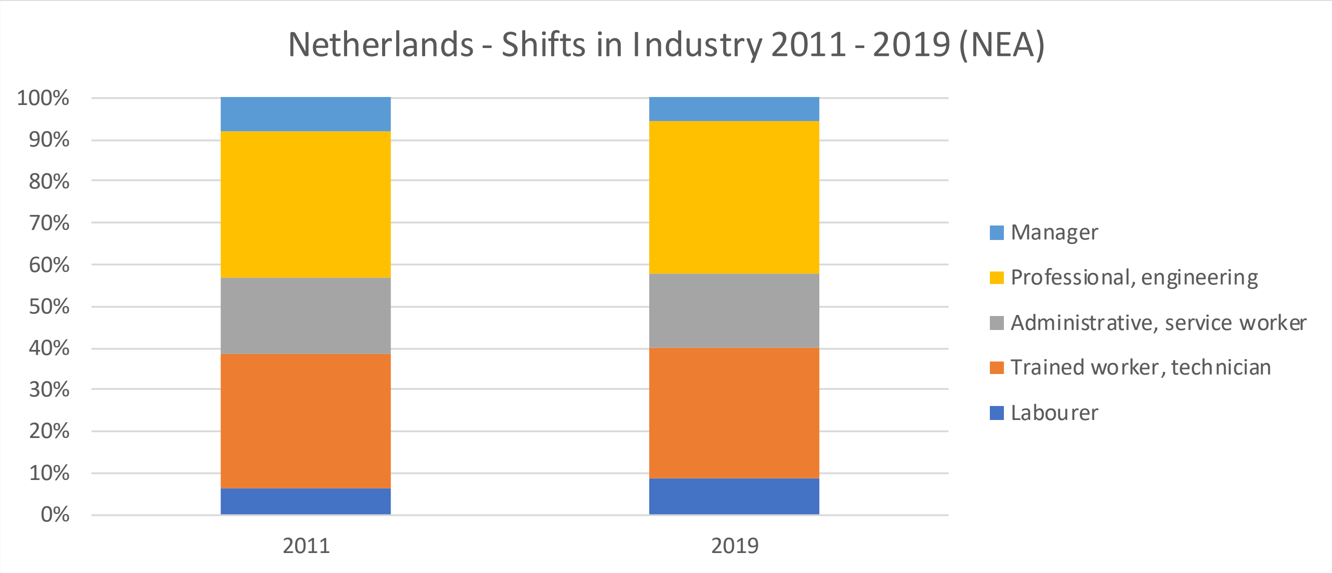
- We used two comparable datasets, measuring work content dimensions
  - Flanders: Werkbaarheidsmonitor (2004 – 2023)
  - Netherlands: Nederlandse Enquête Werk (2005 – 2023)
- We selected comparable periods:
  - Before Frey & Osborne: 2010 – 2012
  - After Frey & Osborne: 2019 – 2020
- We limited the comparison to the Industrial sectors
- We checked the results for company size, educational levels, gender, working time. In the Dutch situation: also for automation and computerisation.

bridges 5.0



The labour division in industrial sectors is changing





- Flanders has higher number of 'labourers'. This has to do with the specific category of "arbeiders" which does not exist in the Netherlands. In the Netherlands, the contractual system pushes out low-educated workers.
- There are many more Dutch workers in the professional, engineering group. In Flanders, this percentage is increasing rapidly at the expense of other groups. Competition is more 'knowledge driven'.
- The development in number of managers is diverging between the two countries.
- The results are the same for SMEs/Large companies in both countries.

Flanders: worsening work situation over time

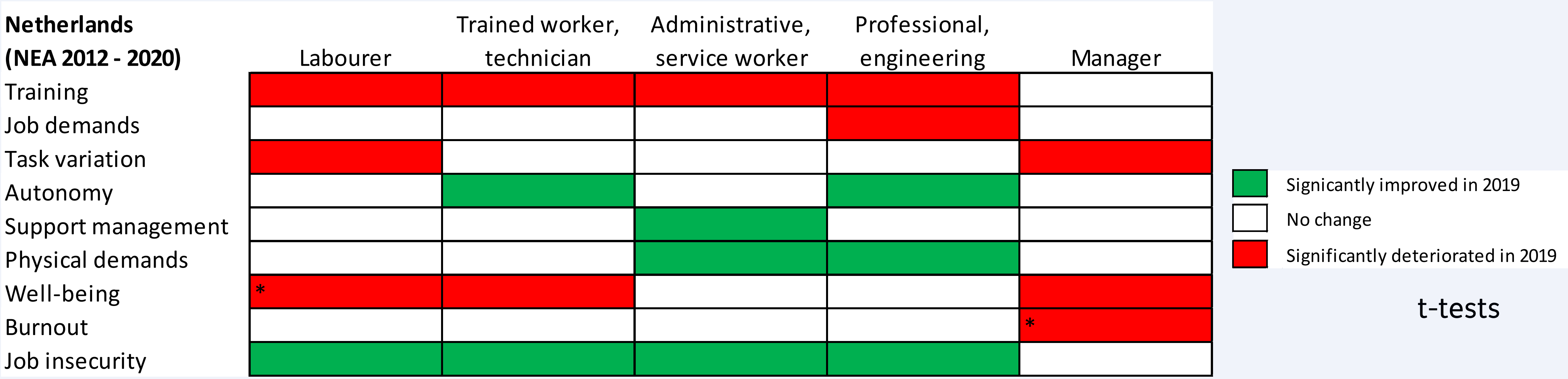
Flanders (WBM 2010 - 2019)	Labourer	Trained worker, technician	Administrative, service worker	Professional, engineering	Manager
Training	Improved	Improved	Improved	Improved	Improved
Job demands	Deteriorated	Deteriorated	Deteriorated	No change	No change
Task variation	Deteriorated	Deteriorated	No change	Deteriorated	Deteriorated
Autonomy	No change	No change	No change	Deteriorated	Deteriorated
Support management	No change	No change	Improved	Improved	No change
Physical demands	Deteriorated	Deteriorated	Deteriorated	No change	No change
Well-being	Deteriorated	Deteriorated	Deteriorated	Deteriorated	No change
Burnout	Deteriorated	Deteriorated	Deteriorated	Deteriorated	No change
Job insecurity	Improved	Improved	Improved	Improved	Improved

Signicantly improved in 2019
No change
Significantly deteriorated in 2019

t-tests

- All employee groups report more training efforts by the companies.
- Except for the white collar – administrative workers, the different working conditions have deteriorated over time.
- The working outcomes have deteriorated over time except for managers.
- We controlled for gender, parttime, educational levels, size of company and time, but main results do not change significantly.

Netherlands: diverging work situations over time



- All employee groups report less training efforts by the companies.
- Except for the white collar and professionals, the different working conditions have deteriorated over time, even for managers.
- The working outcomes have deteriorated over time for labourers, technical personnel and managers.
- Controls: men and fulltimers are worse off.
- Automation: mainly impacts on professionals (more job demands and physical job demands, but also more task variation and autonomy). Working at the screen brings more diverging impacts between jobs.

Job autonomy: stability and changes over time in the Flemish and Dutch Industrial companies

Autonomy - WBM	Low					High
Manager					2019	2010
Professional				2019	2010	
White collar, administrative			2010, 2019			
Technician		2010, 2019				
Labourer	2010, 2019					

Autonomy - NEA	Low					High
Manager						2012, 2020
Professional					2012, 2020	
White collar, administrative				2012, 2020		
Technician		2012	2020			
Labourer	2020	2012				

ANOVA, SNK test

- Job dimensions show limited shifts over time.
- Situation at the organisational level is not the same: work content is worse at lower occupational levels and remains so over time.

Burnout: situation in Flemish and Dutch Industrial companies

Burnout - WBM	**High**		**Low**
Manager	2010, 2019		
Professional	2010, 2019		
White collar, administrative		2019	2010
Technician			2010, 2019
Labourer	2019		2010

Burnout - NEA	**High**		**Low**
Manager		2020	2012
Professional		2012, 2020	
White collar, administrative		2020	2012
Technician		2012, 2020	
Labourer	2012	2020	

ANOVA, SNK test

- Burnout figures vary between functions in the Flemish companies. The high and low paid jobs report highest figures. Improving economic situation leads to higher burnout scores.
- In the Dutch companies, all occupations seem to have converged to the middle. Situations have improved and deteriorated.

Job insecurity: simularities between the Flemish and Dutch Industrial companies

Job insecurity - WBM	High				Low
Manager			2010		2019
Professional		2010		2019	
White collar, administrative	2010				2019
Technician	2010			2019	
Labourer	2010	2019			

Job insecurity - NEA	High		Low
Manager	2012		2020
Professional	2012, 2020		
White collar, administrative	2012		2020
Technician	2012		2020
Labourer	2012		2020

ANOVA, SNK test

- Job insecurity has declined in Flanders and the Netherlands in the observed period.
- In Flanders, insecurity was higher in the lower paid jobs, now most occupations feel more secure.
- In the Netherlands, feelings of insecurity was high among all jobs in 2012. Only professionals feel more insecure than other jobs in 2020.

innovation for life

Explanations

Same pressures, different industries

- In Flanders and the Netherlands, the situation in 2010-2011 was one of impact of the financial crisis. The austerity years impacted more than technology did.
- Both countries see rising investments in technology, but more pronounced in the Flemish situation. As far as we can look at technology, impact on work is positive in the Netherlands. In the Flemish case, we can see a strong deterioration of working conditions. Higher productivity in Flanders comes at a cost on the shopfloor.
- The organisational model channels the ‘pressures’ of the market to the workforce differently. Better paid jobs have more possibilities to deal with changes.
- Importantly, Flemish companies invest in training. Dutch companies seem to be investing less.
- All of this does not lead to higher levels of job insecurity in both countries.

Conclusion

Institutional differences matter for Industry 5.0

- Differences in reaction on the shopfloor can be explained by different institutional contexts and different organisational approaches:
  - Flemish companies still have large groups of low-skilled/low-paid jobs. Situation is stable.
  - Dutch companies have let go of low-skilled/low-paid jobs, mainly because of contractual situation.
- Automation, only visible in the Netherlands, seems to have positive impact on working conditions.
- Investing more in technology may be the most important way forward to deal with the personnel shortages in both countries.
- To implement a strategy such as Industry 5.0 will require different policies and approaches in both countries.

Thanks for your attention

In-Demand Skills for Emerging Technologies

DATE
1 December 2023

EVENT
BIBB: Vocational Education, Skilled Workers and Transformation in an International Perspective

LOCATION
Bonn, Germany

PRESENTER
Adele Whelan

ESRI ECONOMIC & SOCIAL RESEARCH INSTITUTE

Introduction

- BIBB conference aims to bring together research expertise on the active contribution that vocational education and qualified workers can make to technological and ecological innovation

    - Presentation draws on European projects that my team and I are currently working on including **CHAISE (Erasmus+)**, **CoWork4YOUTH (EEA and Norway Grants Fund)**, and a research programme skills for the **Department of Further and Higher Education, Research, Innovation and Science (DFHERIS)** in Ireland

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blockchain skills for Europe

WP3: FORECASTING BLOCKCHAIN DEMAND AND SUPPLY

ESRI

Seamus McGuinness, Adele Whelan, Paul Redmond, Klavs Ciprikis, Elisa Staffa

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chaise blockchain skills for Europe

Work to Date

- CHAISE Blockchain Skills Forecasting Model: https://chaiseblockchainskills.eu/wpcontent/uploads/2022/06/CHAISE_WP3_D3.2.1-Annual-Blockchain-Skills-Forecasts_2022.pdf
- Blockchain Skills Forecasting Results (2021/22): https://chaiseblockchainskills.eu/wpcontent/uploads/2022/06/CHAISE_WP3_D3.2.1-Annual-Blockchain-Skills-Forecasts_2022.pdf
- Blockchain Skills Forecasting Results (2022/23): https://chaiseblockchainskills.eu/wpcontent/uploads/2023/07/CHAISE __WP3_Annual-Blockchain-Skills-Forecasts-2023.pdf

FORECASTING METHODOLOGY

BLOCKCHAIN DEMAND

- Scraping BC jobs from job sites and mapping them using job title and descriptions to specific ISCO occupational categories
- Proportion of each of ISCO categories that are Blockchain jobs
- CEDEFOP employment forecasts for each occupational category

BLOCKCHAIN SUPPLY

- Proportion of BC graduates from total graduates in BC related fields of study such as ICT
- Forecasts for 2020-2026 using linear trends sourced from 2015-2020 Eurostat Data

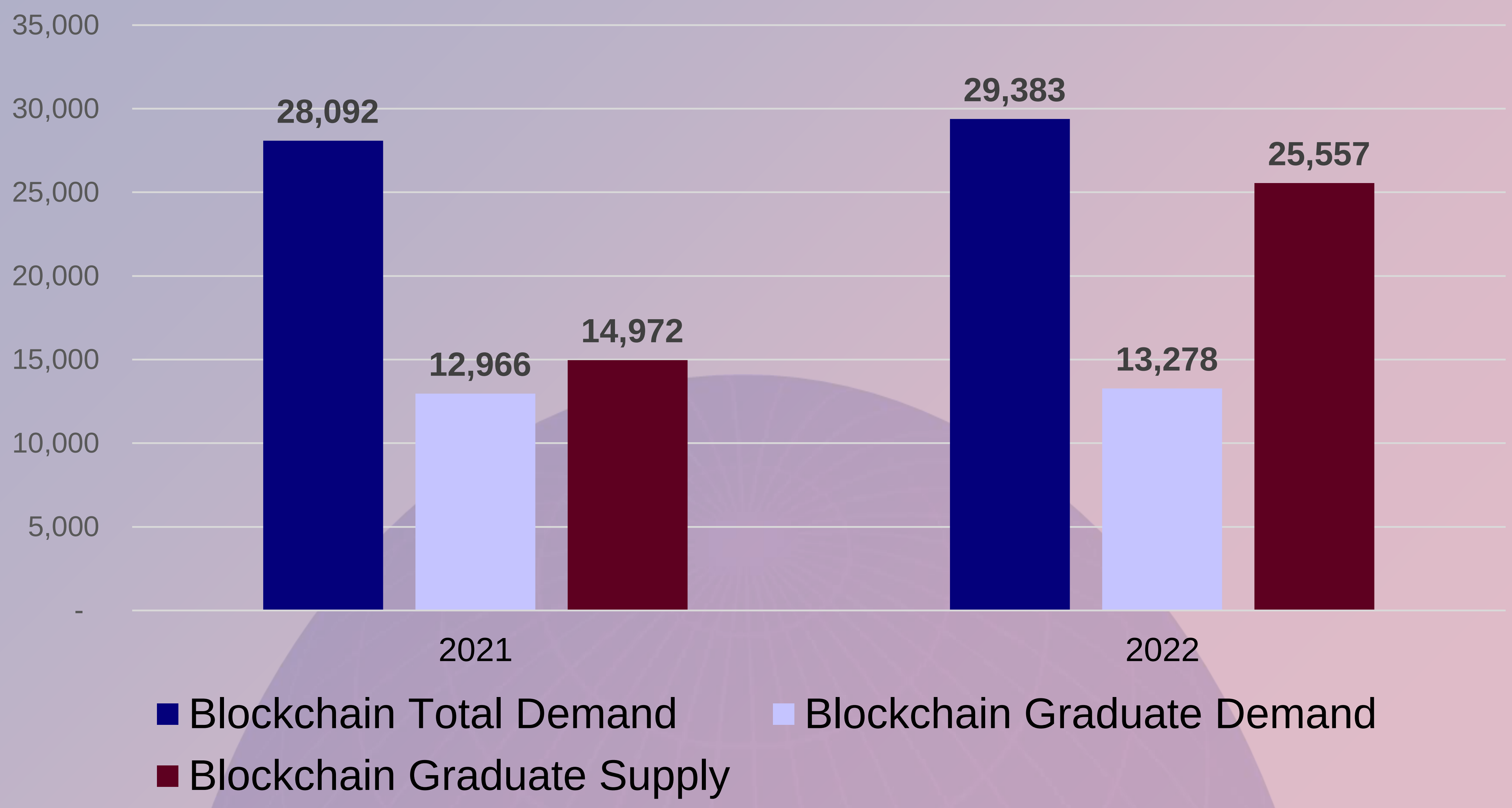
Summary of Findings from 2022/2023

- Estimated number of blockchain workers in the EU in 2021: **361,767**
  - Equivalent to 0.2% of all workers
  - Blockchain related jobs account for approximately **0.24%** of all EU jobs advertised on LinkedIn

- We have noticed a significant decline in the numbers of job postings for blockchain skills (7,304 in 2020, 6,262 in 2021, 4,715 in 2022 jobs postings scraped at an EU level)

- Our blockchain skills forecasts for Europe indicate modest numbers from 2020 to 2026:
  - Demand for blockchain workers is estimated at **29,383**
  - Supply of blockchain graduates is estimated at **25,557**

Comparing EU Blockchain Skills Forecasting results for 2020 to 2026



Comparing Blockchain Skills Forecasting Results for 2020 to 2026

Country	Total Blockchain Demand (#)	Blockchain Graduate Demand (%)	Blockchain Graduate Demand (#)	Total ICT Graduate Supply	Blockchain Graduate Supply
Germany	3,879	42.10%	1,633	200,139	1,981
Ireland	955	23.30%	222	53,548	1,237
Italy	2,101	45.10%	947	48,219	1,717
Netherlands	-70	45.23%	-31	40,871	1,050
EU-27 Total	**29,383**	**45.19%**	**13,278**	**1,029,417**	**25,557**

Conclusion I

- Novel dynamic methodological framework for forecasting demand and supply

- The forecasts are designed to be a key input into any national, or EU level, skills strategies designed to ensure that the growth of blockchain employment is not restricted as a consequence of skill mismatches

- The results indicate that demand for blockchain workers, expressed as a proportion of new jobs, remains quite small in most EU countries (from 0.25% in Sweden to 4.4% in Croatia in 2021)

Conclusion II

- 81% of emerging blockchain jobs are concentrated in just three detailed occupational groups
  - Software and Applications Developers and Analysts
  - Information and Communications Technology Services Managers
  - Business Services and Administration Managers

- The demand for blockchain professionals is likely to remain modest over the 2021 to 2026 period
  - Highest rates of job growth expected in France (9,899), Poland (4,091),Spain (2,113) Italy (1,825), Sweden (1,801) and Germany (1,720).

- The gap between the demand for new blockchain graduates and the supply from universities is not substantial in the vast majority of countries chaise

blockchain skills for Europe

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chaise-blockchainskills.eu

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Skill Requirements for Emerging Technologies in Ireland

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Joint Research Programme between the ESRI and DFHERIS

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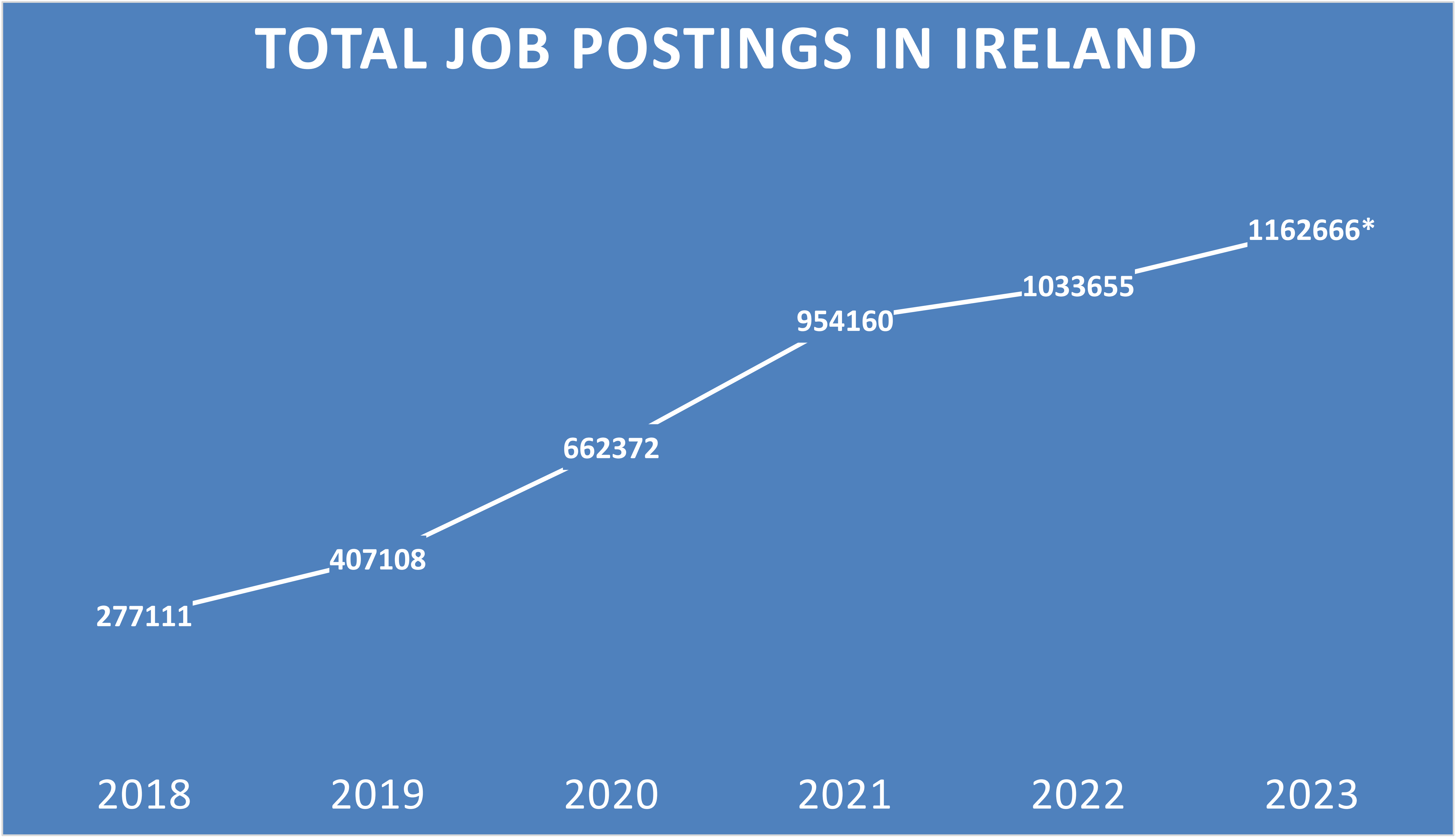
Introduction

➢ Using **recent online job vacancy advertisements**, we will analyse the type of jobs and skills that are becoming more important in Ireland in the agreed fields of emerging technologies:

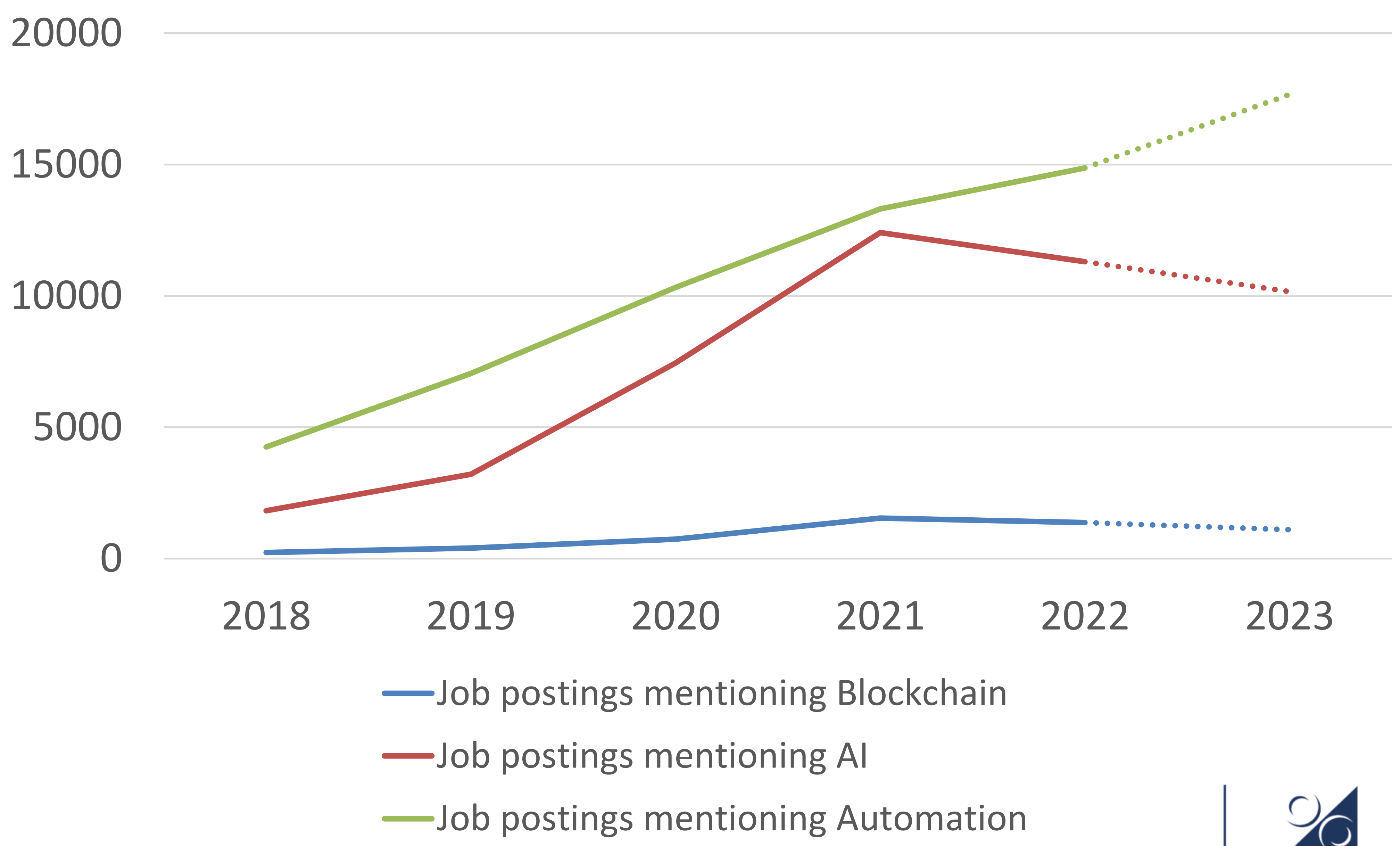
- **Artificial Intelligence**
- **Blockchain**
- **Automation**
- Cybersecurity
- Cloud Computing
- Sustainability, Renewable Energy (Green Skills)

Lightcast Data

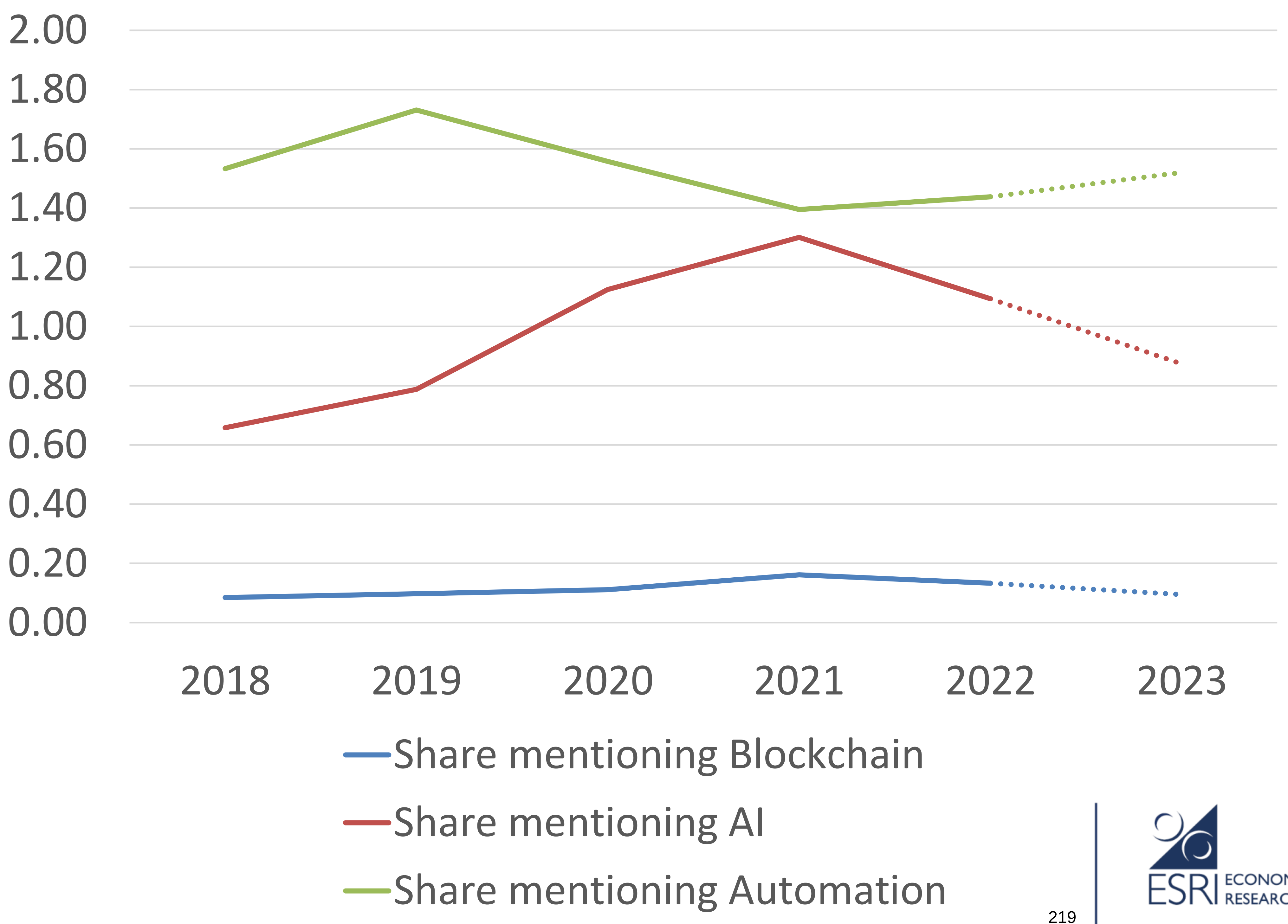


Note: data for 2023 forecasted as double data supplied to June 2023

Total Job Postings in Ireland - Emerging Technologies (Lightcast, 2018-2022)



Shares (%) of Total Job Postings in Ireland Related to Emerging Technologies (Lightcast, 2018-2022)



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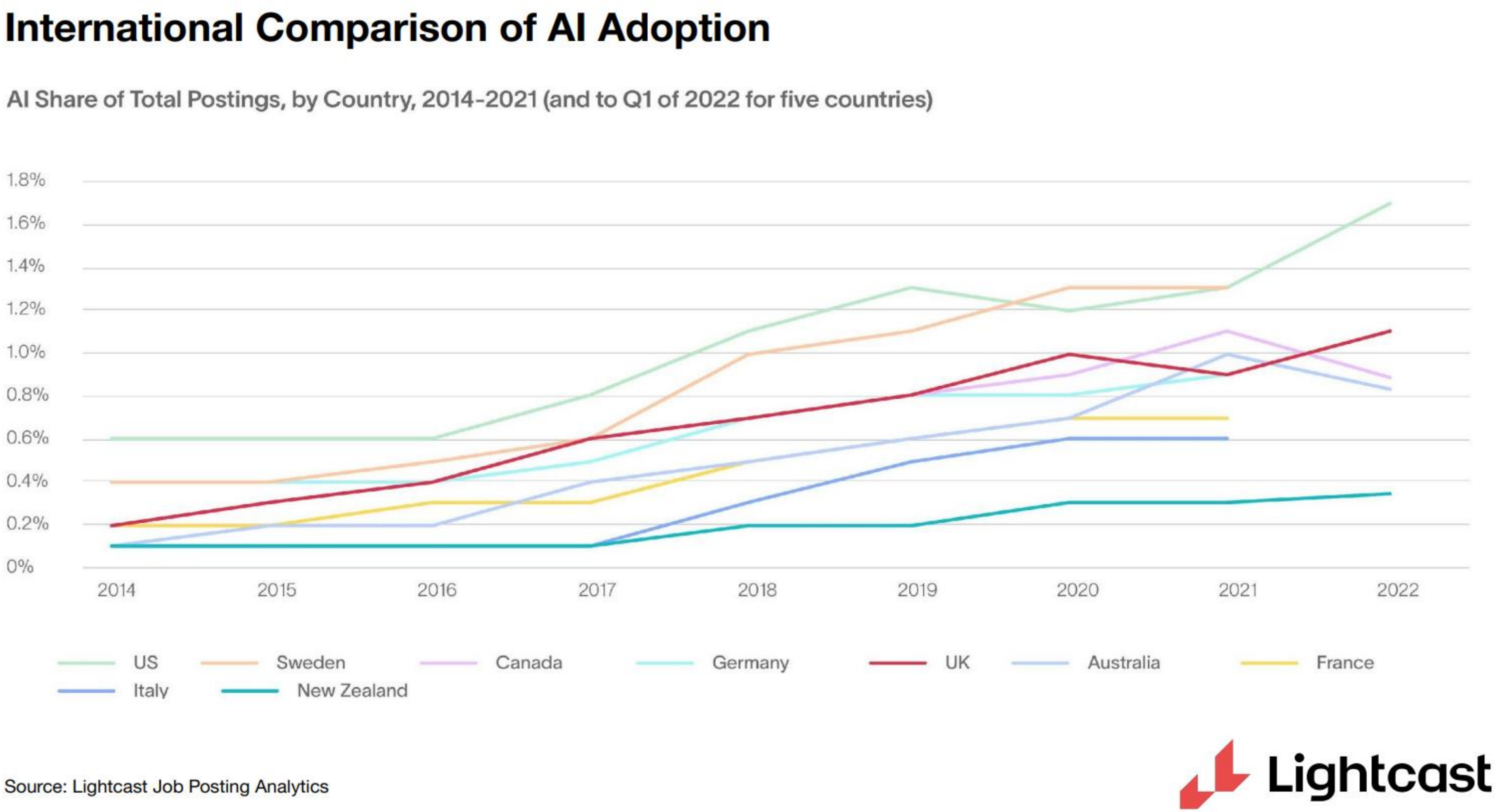
AI postings in other countries



DEMAND – JOB ADVERTS

Lightcast Data

Automation Jobs, Ireland, Lightcast 2021

ISCO codes	ISCO occupation	Freq	%
21	Science and Engineering Professionals	5,719	42.81
31	Science and Engineering Associate Professionals	1,372	10.27
25	Information and Communications Technology Professionals	921	6.89
74	Electrical and Electronics Trades Workers	862	6.45
12	Administrative and Commercial Managers	686	5.13
24	Business and Administration Professionals	446	3.34
71	Building and related trades workers, excluding electricians	433	3.24
13	Production and Specialized Services Managers	322	2.41
	Other	2,599	19.46
	TOT	13,360	100

*80 per cent of employment within these occupations

Sample of companies include Bristol-Myers Squibb, Google, Johnson & Johnson, Lotusworks, Pfizer

AI Jobs, Ireland, Lightcast 2021

ISCO code	ISCO occupation	Freq	%
25	Information and Communications Technology Professionals	4,080	32.57
21	Science and Engineering Professionals	1,497	11.95
24	Business and Administration Professionals	1,445	11.53
12	Administrative and Commercial Managers	939	7.50
26	Legal, Social and Cultural Professionals	612	4.89
31	Science and Engineering Associate Professionals	396	3.16
74	Electrical and electronic trades workers	359	2.87
42	Customer Services Clerks	320	2.55
33	Business and Administration Associate professionals	311	2.48
81	Stationary Plant and Machine Operators	294	2.35
	Other	2,275	18.15
	TOTAL	**12,528**	**100**

Sample of companies include Amazon, Apple, Deloitte, Dublin City University, Google, IBM, Intel, Johnson & Johnson, Meta, Microsoft, NUI Galway, Qualcomm, UnitedHealth Group, UCD

Blockchain Jobs, Ireland, Lightcast 2021

ISCO code	ISCO occupations	Freq	%
25	Information and Communications Technology Professionals	517	33.46
24	Business and Administration Professionals	195	12.62
21	Science and Engineering Professionals	163	10.55
12	Administrative and Commercial Managers	154	9.97
26	Legal, Social and Cultural Professionals	100	6.47
13	Production and Specialized Services managers	51	3.3
74	Electrical and Electronics Trades Workers	43	2.78
81	Stationary Plant and Machine Operators	34	2.2
	Other	288	18.65
	TOTAL	**1,545**	**100**

Sample of companies include Ernst & Young, Deloitte, IBM, Accenture, Consensus Systems, Latoken, Coinbase, Citigroup, Crypto International Ltd., KPMG

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Job Application
Complete your application!
PERSONAL INFORMATION
JOB INFORMATION
ADDITIONAL QUESTIONS
SUMMARY
First Name *
Last Name *
Birth Month
Birth Day
Birth Year
Address
E-mail *
Phone *

SUPPLY

Total ICT Graduates

- Align closely with Eurostat figures showing substantial increase in numbers over time at a rate significantly above the EU average

Total ICT Graduates, 2015-2021								
Country	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Increase 2015 to 2021**
Ireland	4,449	4,851	5,275	6,251	6,271	7,154	6,966	57%
Total EU-27	108,913	117,533	126,136	130,943	136,244	151,419	150,383	39%

Source: Eurostat

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Supply Forecasting Methodology I

Baseline Scenario: Using Higher Education Authority data, assume that the numbers remain constant, similar to 2020-2021 number of graduates

	2017	2018	2019	2020	2021	Average per year
AI	0	0	125	390	335	363
Automation	95	125	190	210	310	260
Blockchain*	0	0	0	15	25	20

Source: HEA data for AI, Automation and Blockchain (HEA and non-HEA Institutions), SOLAS data for FET.

NB: Additional work to be completed for supply estimates as accurately as possible

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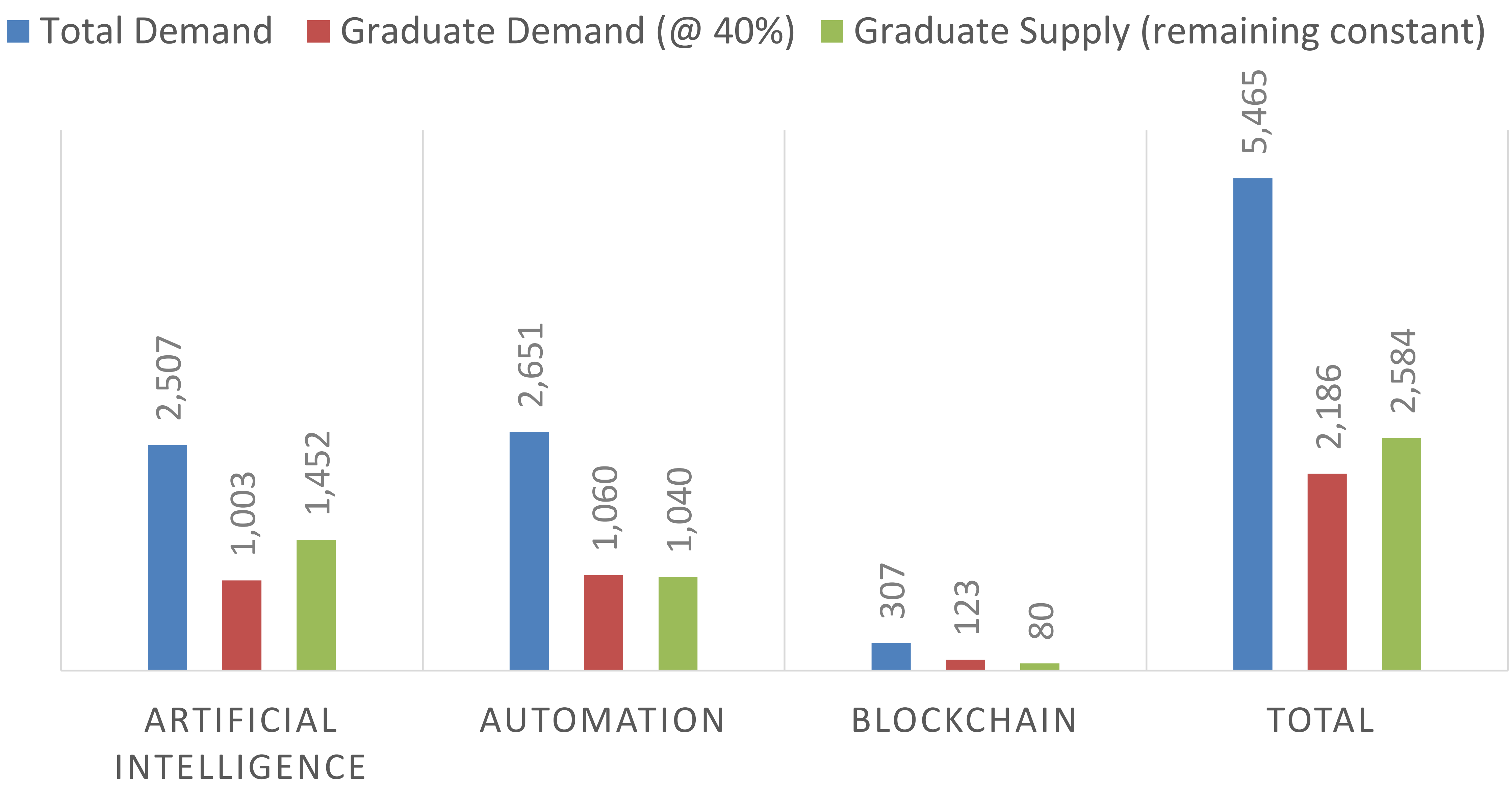
Five-Year Demand and Supply Forecasts for Ireland, 2021- 2025



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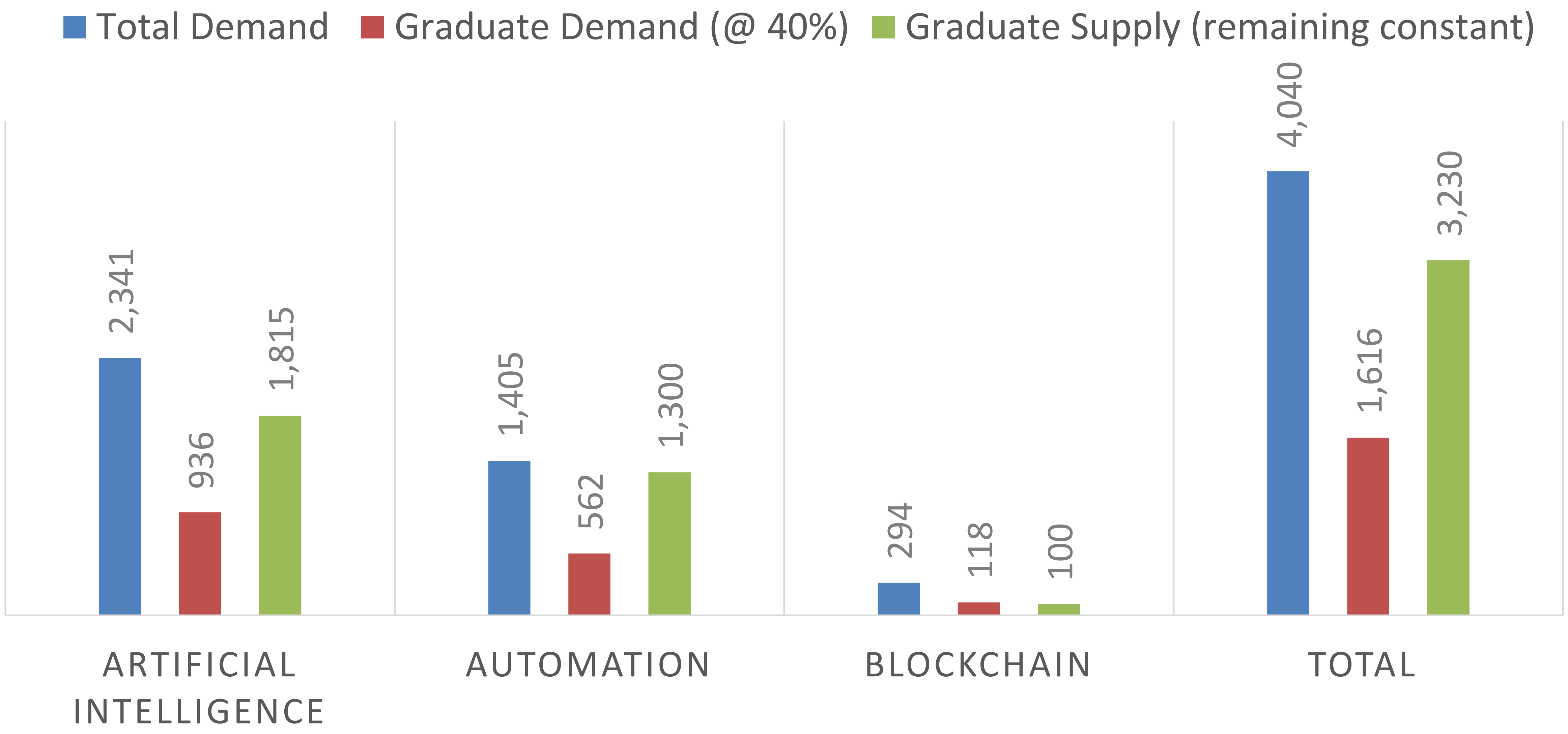
Five-Year Demand and Supply Forecasts for Ireland, 2025-2030



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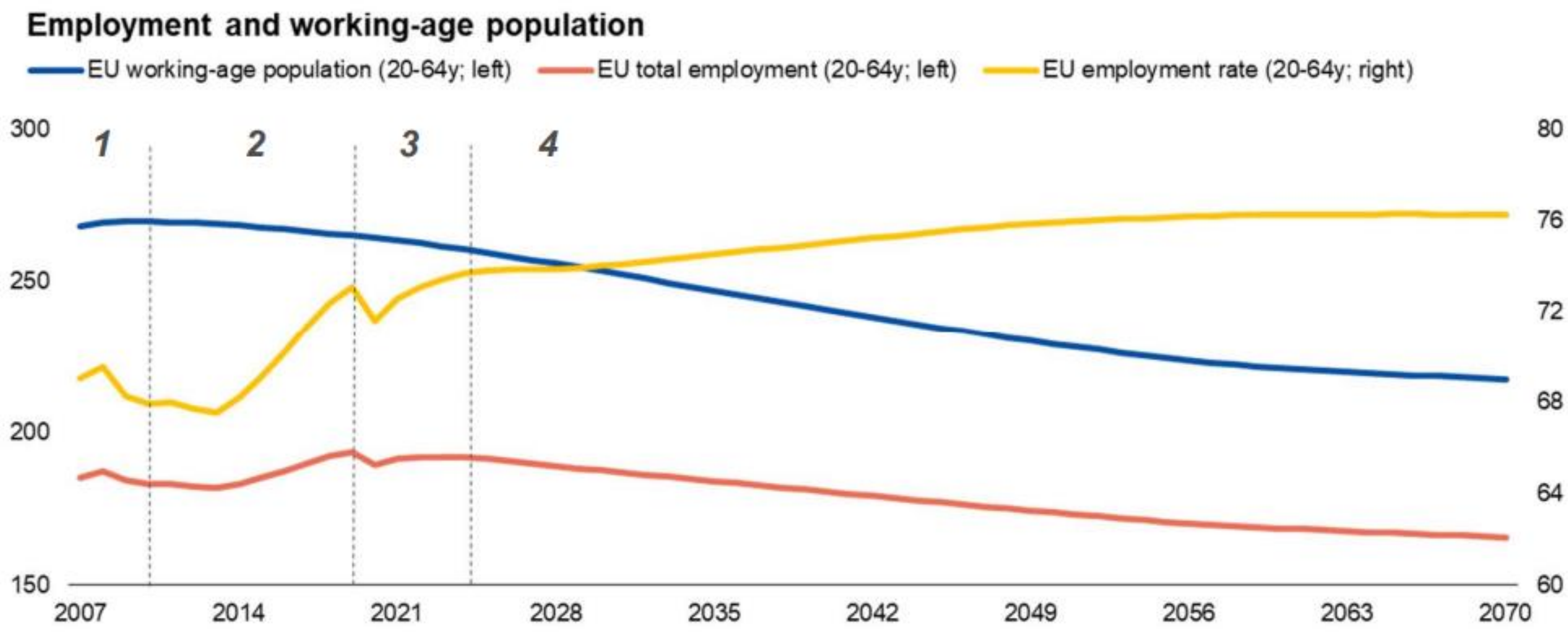
Why decreasing forecasts in 2025-2030?

- **Lower CEDEFOP Skills Forecasts for relevant ISCOs** for 2025-2030, compared to 2021-2025
- **Long-term projections** in CEDEFOP Skills Forecasts employs data from 2021 Ageing report

The employment outlook



Source: 2021 Ageing Report

"As of 2024, both employment and working age population decline"

1. until 2010: sluggish employment and slow growth in working-age population
2. 2011-2019: rising employment, working-age population started to decline
3. 2020-2023: impact of the Covid-19 crisis and subsequent recovery
4. as of 2024: both employment and working-age population decline

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Conclusions for Ireland

- In relation **to job adverts and modelling potential shortages**
    - **'Automation' posts have the highest number and share of job adverts**
    - **Potential shortages are currently greater for 'Automation'** (particularly, new entrants) and **for 'AI' in Manufacturing**
    - **Demand for new entrants in 'Blockchain' has fallen**
    - Some **variations by geographical locations**

- Preliminary **five-year demand and supply forecasts for graduate jobs in emerging technologies appear broadly aligned in terms of numbers**
    - **Substantial increase in overall ICT graduates since 2015**, at a rate significantly **above the EU average**
    - **Long-term projections from CEDEFOP** Skills Forecasts assumes that from 2024 both **employment and working age population decline**
    - **Further examination of specific skills requirements** to be analysed

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Methodology: Skills Requirements

Our dataset of Lightcast data from 2021 contains:

- ❑ 13,412 automation related job postings
- ❑ 12,525 artificial intelligence related job postings
- ❑ 1,591 blockchain related job postings

- Using Python and some machine learning techniques, we extract the most common skills required.

- We mapped into into three categories: **Technical, Business, and Transversal**
    - Also, examined differences **across seniority levels**: entry, mid-senior and senior

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Technical Skills by Emerging Tech

Black: technology specific
Orange: common to 2 technologies
Green: common to 3 technologies

Automation

Skill	Frequency
Control systems	0.34
Programmable logic controllers	0.26
Building automation	0.24
Pharmaceuticals	0.21
Good manufacturing practices	0.19
Supervisory control and data acquisition (scada)	0.18
Systems engineering	0.14
Electrical engineering	0.12
Commissioning	0.12
Hvac	0.10

*Automation appears as skill in 34% of job postings

Artificial Intelligence

Skill	Frequency
Machine learning	0.61
Python (programming language)	0.38
Computer science	0.33
Data science	0.22
Agile methodology	0.20
Sql (programming language)	0.19
Data analysis	0.19
Amazon web services	0.18
Software engineering	0.16
Software development	0.15

*AI appears as skill in 51% of job postings
Automation appears as skill in 18% of job postings

Blockchain

Skill	Frequency
Agile methodology	0.31
Amazon web services	0.24
Microsoft azure	0.21
Devops	0.20
Java (programming language)	0.20
Kubernetes	0.19
Computer science	0.18
Software engineering	0.18
Software development	0.17
Application programming interface (api)	0.17

*Blockchain appears as skill in 90% of job postings
Automation appears as skill in 18% of job postings

Technical Skills – an extension to 20 skills

Black: technology specific
Orange: common to 2 technologies
Green: common to 3 technologies

Automation

Skill	Frequency
Control systems	0.34
Programmable logic controllers	0.26
Building automation	0.24
Pharmaceuticals	0.21
Good manufacturing practices	0.19
Supervisory control and data acquisition (scada)	0.18
Systems engineering	0.14
Electrical engineering	0.12
Commissioning	0.12
Hvac	0.10
Auditing	0.10
Computer science	0.10
Instrumentation	0.10
Human machine interfaces	0.09
Change control	0.09
Mechanical engineering	0.08
Continuous improvement process	0.08
New product development	0.08
Distributed control systems	0.07
Environment health and safety	0.07

Artificial Intelligence

Skill	Frequency
Machine learning	0.61
Python (programming language)	0.38
Computer science	0.33
Data science	0.22
Agile methodology	0.20
Sql (programming language)	0.19
Data analysis	0.19
Amazon web services	0.18
Software engineering	0.16
Software development	0.15
Java (programming language)	0.15
mathematics	0.13
Microsoft azure	0.13
Scalability	0.12
Big data	0.12
Algorithms	0.12
R (programming language)	0.12
Application programming interface (api)	0.10
Devops	0.09
Javascript (programming language)	0.09

Blockchain

Skill	Frequency
Agile methodology	0.31
Amazon web services	0.24
Microsoft azure	0.21
Devops	0.20
Java (programming language)	0.20
Kubernetes	0.19
Computer science	0.18
Software engineering	0.18
Software development	0.17
Application programming interface (api)	0.17
Financial services	0.17
Microservices	0.17
Python (programming language)	0.17
Scalability	0.16
Docker software)	0.16
Machine learning	0.14
Finance	0.14
Sql (programming_language)	0.14
Ethereum	0.13
Javascript (programming_language)	0.13

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Business Skills

Black: technology specific
Orange: common to 2 technologies
Green: common to 3 technologies

Automation

skill	frequency
management	0.32
operations	0.25
project management	0.25
customer service	0.13
sales	0.08
process improvement	0.06
procurement	0.06
training and development	0.05
time management	0.05
change management	0.04

Artificial Intelligence

skill	frequency
management	0.24
customer service	0.16
sales	0.16
operations	0.16
project management	0.12
marketing	0.09
business development	0.08
business intelligence	0.07
product management	0.06
workflow management	0.06

Blockchain

skill	frequency
management	0.22
project management	0.19
operations	0.19
sales	0.11
marketing	0.09
customer service	0.08
customer relationship management	0.08
workflow management	0.08
stakeholder management	0.07
business development	0.07

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Transversal Skills

Black: technology specific
Orange: common to 2 technologies
Green: common to 3 technologies

Automation

skill	frequency
communications	0.43
problem solving	0.22
troubleshooting (problem solving)	0.21
planning	0.16
leadership	0.14
self-motivation	0.13
interpersonal communications	0.12
detail oriented	0.11
innovation	0.10
investigation	0.08

Artificial Intelligence

skill	frequency
communications	0.42
research	0.21
problem solving	0.20
innovation	0.19
leadership	0.17
writing	0.13
detail oriented	0.12
planning	0.10
presentations	0.10
self-motivation	0.10

Blockchain

skill	frequency
communications	0.48
problem solving	0.22
self-motivation	0.22
leadership	0.20
innovation	0.19
consulting	0.15
planning	0.15
detail oriented	0.15
coaching	0.13
writing	0.13

Conclusions: Skills Requirements I (Lightcast)

- Skill Requirements by Category: Approx. 50-60% of skills requested are 'Technical', 20-30% are 'Transversal', and 20% are 'Business', across emerging technology jobs examined
  - **Technical Skills:** Some overlap between artificial intelligence and blockchain; As we consider a higher number of skills, the overlap increases; Many skills are technology-specific
  - **Business Skills:** A wide skills overlap; some skills are common to Artificial Intelligence and Blockchain; Some are technology-specific (but less required)
  - **Transversal Skills:** High degree of overlap between the three emerging technology areas; Few skills that are technology specific
  - **Green Skill Areas:** Top five areas for Ireland appear to be Environmental Regulations, Waste Management; Energy Management; Clean Energy; Environmental Engineering and Restoration (approx. 80% of all green skill jobs)

Conclusions: Skills Requirements II (LinkedIn)

- Skill Requirements by Emerging Technology:
  - **Technical Skills -** stronger requirements for entry and mid senior level posts; some overlap at mid-senior level across all technologies
  - **Business Skills -** stronger requirements for senior level posts; high degree of overlap across all seniority levels
  - **Transversal Skills -** similar requirements across all seniority levels; some degree of overlap across all seniority levels

Policy Conclusions

- Ireland's graduates supply in emerging technologies is expected to meet the forecasted labour demand for emerging technologies over the next years (over-supply)
- Main focus now is to deeply analyse the skill requirements for jobs and its alignment with educational provisions at FET and HE levels in order to provide the required skills for workers, and to prevent future skill mismatches
    - Many benefits of using contemporaneous data
    - Importance for human capital development and curriculum design
    - Balance between technical, business and transversal skills
- Provision of adequate education including the required skills accumulation: the present work will feed into skills development policy by DFHERIS

In-Demand Skills for Emerging Technologies

DATE
1 December 2023

EVENT
BIBB: Vocational Education, Skilled Workers and Transformation in an International Perspective

LOCATION
Bonn, Germany

PRESENTER
Adele Whelan

THANKS

Q&A

ECONOMIC & SOCIAL RESEARCH INSTITUTE

Sustainable Work and Continuous Education: A Capability approach

Bénédicte Zimmermann

EHESS Paris, Centre Georg Simmel

and Wissenschaftskolleg zu Berlin

L'ÉCOLE DES HAUTES ÉTUDES EN SCIENCES SOCIALES

CENTRE GEORG SIMMEL Recherches franco-allemandes en sciences sociales UMR 8131 EHESS / CNRS

Wissenschaftskolleg zu Berlin INSTITUTE FOR ADVANCED STUDY

Structure of the paper

- A shift in the understanding of work along three requirements
- The challenge of integration and the need for a normative framework
- Capabilities as a normative framework
- Implications for sustainable work and vocational education

Three requirements for reconceptualising work along sustainability

(Herzog & Zimmermann, forthcoming 2024)

- Addressing jointly the environmental and social effects of work
- Moving beyond paid and formal work towards sustainable work and lives
- Taking local embeddedness of work and global interdependencies seriously

The UNDP definition of sustainable work
(UNDP, 2015: 37)

“Sustainable work is defined as work that promotes human development while reducing or eliminating negative externalities that can be experienced over different geographic and time scales. It is not only critical for sustaining the planet, but also for ensuring work for future generations.

Sustainable work is not just about paid work; it also encompasses the often impactful efforts of caregivers, volunteers, artists, advocates and others, which have positive impacts on human development. Furthermore, sustainable work concentrates on activities that can achieve the dual mutual goal of high sustainability and high human development’”

The challenge of integration

- Making explicit the normative foundations of sustainability
- Three main competing frameworks
  - Preference-based
  - Need-based (Max-Neef et al. 1991; Aigner et al. 2016; Gough 2022)
  - Capability-based (Nussbaum and Sen 1993)

Capabilities as a normative framework
(Adapted from Robeyns 2005)

Conversion factors and processes

Choice factors and processes

Resources → Capability Set → Valuable Achievements

Individual or collective resources (e.g. rights, public and company training programmes…)

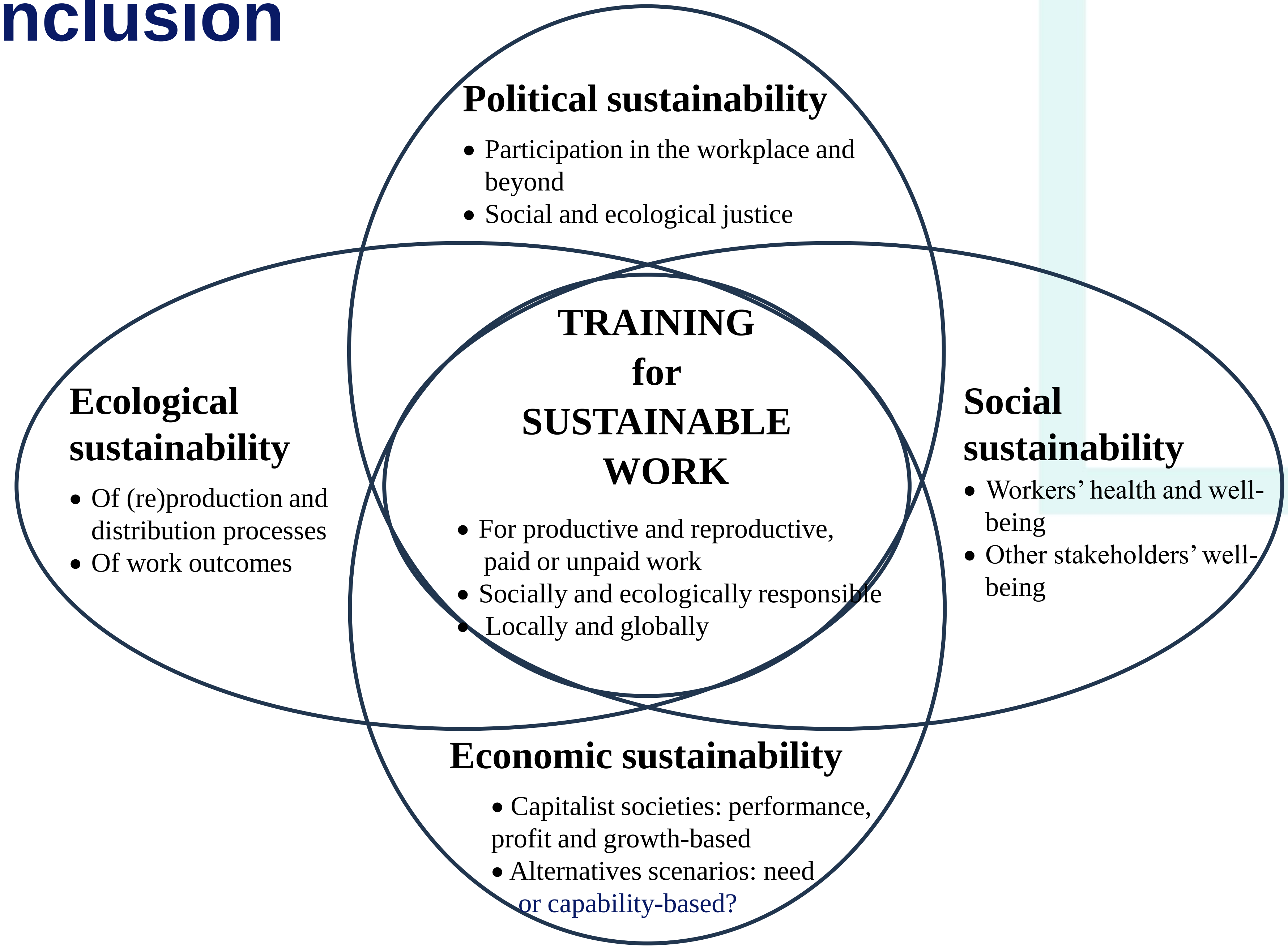
Training capability set

Type of training, modalities etc.

Implications of the capability framework for sustainable work and vocational education

- An understanding of human beings as receivers, doers and judges (Bonvin & Laruffa, 2018)
- What does it involve?
  - Workers as receivers
  - Workers as doers
  - Workers as judges
- Broadening the purposes of vocational education

Conclusion


Political sustainability
• Participation in the workplace and beyond
• Social and ecological justice
Ecological sustainability
• Of (re)production and distribution processes
• Of work outcomes
TRAINING for SUSTAINABLE WORK
• For productive and reproductive, paid or unpaid work
• Socially and ecologically responsible
• Locally and globally
Social sustainability
• Workers' health and well-being
• Other stakeholders' well-being
Economic sustainability
• Capitalist societies: performance, profit and growth-based
• Alternatives scenarios: need or capability-based?

Thank you for your attention!

Wissenschaftskolleg zu Berlin

INSTITUTE FOR ADVANCED STUDY

L'ÉCOLE DES HAUTES ÉTUDES EN SCIENCES SOCIALES

École des hautes études en sciences sociales

Paris – Aubervilliers – Marseille – Lyon – Toulouse

WWW.EHESS.FR

Differing union and employer involvement in vocational education and training (VET) for zero carbon building in Europe

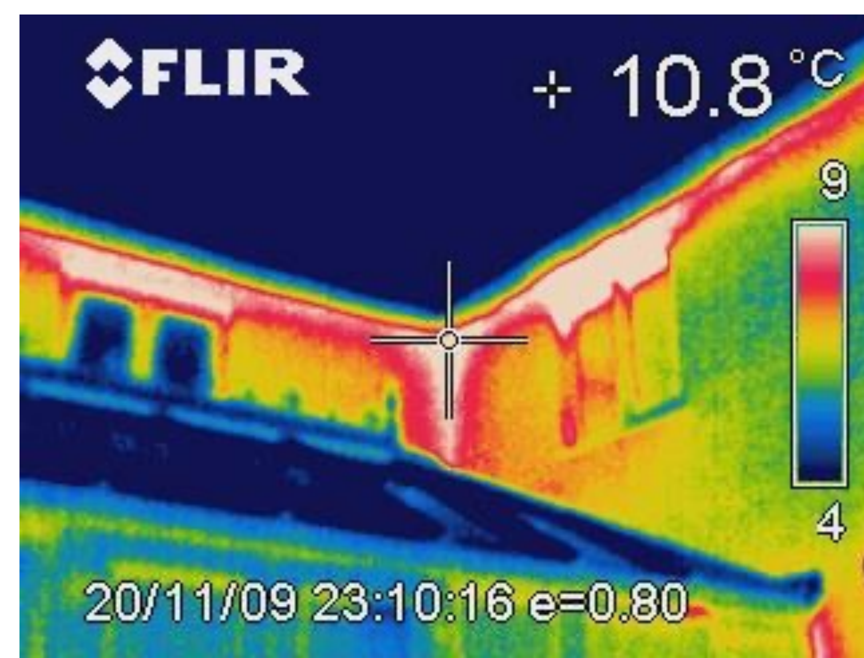
Professor Linda Clarke

Centre for the Study of the Production of the Built Environment (ProBE)

University of Westminster

BIBB conference: Vocational Education, Skilled Workers and Transformation in international perspective

1 December 2023



VET and zero carbon construction

- ***Low Energy Construction*** (LEC/NZEB): Airtight building envelopes, thermal bridge-free construction, on-site renewable energy
- ***EU policies, programmes and targets***:
  - Build-up Skills – 30 countries (Pillars 1&2),
  - EPBD – reduce carbon emissions 55% by 2030,
  - European Green Deal
- ***VET requirements***
  - Holistic, building as single thermal unit
  - Social interaction of occupations, teamworking, communication
  - Broader and deeper knowledge, skills and competences
  - Climate literacy, greater equality and worker agency
- ***Diverse approaches***
  - Long term/mainstreaming → short courses/add-on modules
  - Strong formal institutions/social partnership →market mechanisms

Divergent VET systems: Coordinated vs Liberal Market Economies

Occupational (CMEs):

- statutory framework
- social partnership
- recognised qualifications
- multi-dimensional competence
- ‘occupational capacity’ and knowledge
- comprehensive VET programmes
- general and civic education
- permeability

Skill-based (LMEs):

- weak statutory framework
- marginalisation of stakeholders
- fragmented narrow skills sets
- functionalist-behavourist concept of competence
- minimal underpinning knowledge
- employer/skill-based VET
- neglect general/ civic education
- remedial functional skills
- lack of permeability

Methodology

- ***6 case studies*** –
  - CMEs = Sweden, Belgium, Denmark, Germany
  - LMEs = Ireland, UK
- ***Desk res**earch* on climate and NZEB policy and VET context
- ***Site visi**ts*: Ireland and Wales involving group interviews with 17
- ***37 interviewees*** in total (20 on Zoom)
- ***Research participants*** included
  - Union representatives
  - Education providers
  - Employer associations
- ***Transparency Tool***, as checklist for curriculum design, with range of choices – e.g. roofer/flat-roofer in Belgium

<table>
<tr><th colspan="7">Aims of qualification</th></tr>
<tr><td colspan="2">Vocational</td><td>Civic</td><td colspan="4">Liberal</td></tr>
<tr><td colspan="2"></td><td></td><td colspan="4">allows scope for continuing development</td></tr>
<tr><td colspan="7">Attributes</td></tr>
<tr><td colspan="2">knowledge</td><td>know-how</td><td colspan="4">Competence or Attitude</td></tr>
<tr><td rowspan="2">systematic</td><td rowspan="2">non-systematic</td><td>Mastery of technique</td><td colspan="4"></td></tr>
<tr><td>Skill:</td><td colspan="2">individual</td><td colspan="2">social</td></tr>
<tr><td>Technical theory, e.g.: Principles of ‘quality’ building:</td><td>Contingent aspects</td><td>Transversal abilities
Co-ordination
Communication
Evaluation
Negotiation</td><td>Work place</td><td>Other Locations</td><td>Work-place</td><td>Other Locations including simulations and classroom</td></tr>
<tr><td>Normative theory
Health and safety legislation. EPBD.</td><td>Local procedures</td><td>Process management ability
Understanding of NZEB building process</td><td colspan="4"></td></tr>
<tr><td>Social science theory
Understand NZEB role</td><td>Materials
Insulation</td><td>Occupational capacity
Displaying conduct, way of thinking, behaviour to practise</td><td colspan="4"></td></tr>
</table>

CME: School-based Swedish VET4LEC

- ***Swedish National Agency for Education*** (*Skolverket*):
  - overall responsibility for VET
  - issues general guidelines
  - sets learning outcomes.

- ***Social partners*** advise and support *Skolverket* in development & implementation (68% unionisation)
- ***Building and Construction VET***: 3-year school-based programme with work placements, combining general secondary + vocational, followed by 1-2 years' work-based apprenticeship
- ***Climate change*** addressed as part of social studies
- *Skolverket* guidelines:

  Students should develop "knowledge of …. what sustainable development means in the industry"

Swedish Building and Construction programme learning outcomes

1. Knowledge of different methods, materials, tools and machines.
2. Knowledge of laws and other regulations in professional area.
3. Knowledge of common professions and work processes in building and construction industry, and what sustainable development means.
4. Ability to search for information, plan, organise and carry out common tasks.
5. Skills in following task descriptions and using drawings.
6. Ability to handle and maintain materials, tools and machines.
7. Ability to assess work processes and results and document work.
8. Ability to carry out risk assessments of tasks.
9. Ability to work safely with regard to health, working environment and ergonomics.
10. Ability to cooperate and communicate with others and use professional language appropriately.

NZEB - technical training in principles of renewable energy sources (e.g. heat pumps for plumbers)

CME: School-based Belgium VET4LEC

- ***Constructiv***:
  - social partnership organisation overseeing VET (50% unionisation rate)
  - designs occupational profiles and curricula for sector for initial and continuing VET
- ***'School-based'*** VET system
- Emphasise on ***occupational overlaps*** to enable co-ordination
- ***Attitudes*** in workplace considered important
- ***Comprehensive coverage*** of NZEB techniques though no specific material on climate literacy

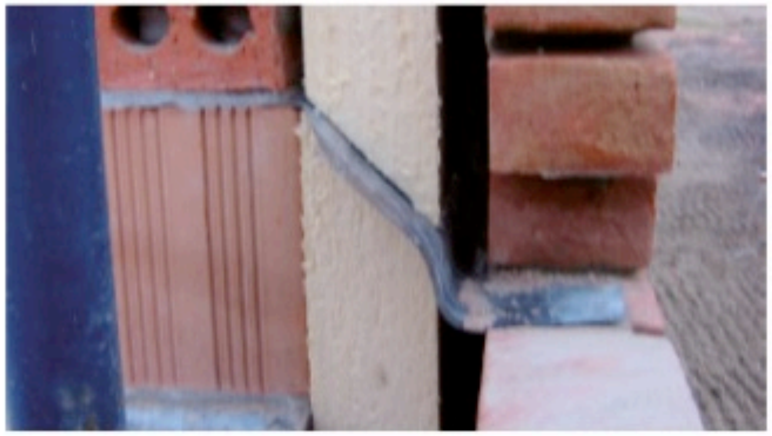
Photos: Belgian college workshop equipment and low energy house simulation

Placement d'un élément isolant (ici : verre cellulaire)
sous le premier bloc pour éliminer le pont themique

Élévation des blocs intérieurs
avec pose des membranes d'étanchéité

Placement de l'isolation en pied de mur

Placement des panneaux isolants contre les blocs :
bon contact contre le mur + fermeture
et alternance des joints.
La pose des panneaux doit se faire en totale
indépendance de la mise en oeuvre du parement
afin de garantir la continuité de l'isolation.



Source : architecte Luc Boddin

Mise en oeuvre du parement
après placement soigné de l'isolation

Continuité de l'isolation du mur jusqu'en charpente

CME: German Dual system VET4LEC

- ***Governance of VET*** by social partnership, though low unionisation rate (16.3%)
- ***VET stepped system*** over 3 years with occupational specialisation in final year
- ***Curricula*** regularly updated by social partners, project based, supported by textbooks, featuring NZEB and climate literacy
- ***Workplace competence*** very broadly conceived
- ***Illustration*** from teaching material for plasterer (*Stuckateur*) trainee.

Embedding climate literacy into the curriculum of the *Stuckateur*

CME: Danish Social-partner VET4LEC

- ***VET jointly governed by social partners*** at all levels (67% unionisation)
- ***Advisory Board*** for Education and Training for Building and Construction Industry sets competency outcomes for all construction courses, turned into teaching units by colleges
- ***VET comprehensive***, 3-3.5 years, dual-system alternating school and workplace learning
- ***Energy efficiency*** long embedded in VET

Photos: Danish Insulation training centre

Denmark - electricians

- ***4.5-5 years***. Post-secondary education (Basic+Main)

- ***Traditional training*** + specialisation in new technologies

- ***Green modules as options*:** installation of renewable energy systems (e.g. heat pumps), building automation, HVAC systems, EV charging points, wind power

- ***NZEB expertise*** part of curriculum, but technical education not explicitly connected to climate crisis

- ***Union campaign*** to promote active engagement with climate change and enhance climate literacy

LME: State and employer-led Irish VET4LEC

- ***VET policy*** led by the government Department of Education and Skills, with "*inconsequential*" social partner input (26% unionisation)
- ***NZEB training*** for current workforce, from EU-funded pilot to national roll-out: 10 short, trade specific courses
- ***Detailed course specification*** for each construction occupation sets out knowledge and understanding, skills/know-how and personal & social competencies
- ***Introduction to NZEB*** makes reference to climate change
- ***Courses designed as introduction***, combining theory with demonstration

Ireland – NZEB Fundamentals

1. NZEB Principles, Building Regulations and Product Standards
2. Building Fabric
3. Building Physics
4. Building Services
5. Renewable Energy, Photo-Voltaic, Metering and Electric
6. Communication and User Information.

Course aimed at carpenters, bricklayers, plasterers, general construction workers, plumbers, electricians + occupation specific emphasis

Photos: Irish training workshop and class for existing workforce on insulation

LME: UK – Employer-based VET4LEC

- ***Employer-based***, though weak work-based training infrastructure, marginalization of unions (unionization 10%)
- ***Many climate change union initiatives*** e.g. retrofit taskforces, public ownership, direct labour
- ***Significance of regional and local authorities*** e.g. PAS 2035 ensuring coordination of installation
- ***Further education (FE) colleges*** provide apprentice and full-time construction training – increasingly better workshops for LEC
- ***E.g. Leeds College Building*** – prefers block rather than day release, work-based learning unit, new renewables workshop
- ***Increasing stakeholder alliances***: FE, employers, unions, local authorities, e.g. London hubs

UK VET4LEC developments

- ***Moving from frameworks to standards*** e.g. National Occupational Standards (NOS) include how occupations relate
- ***Retrofit Coordinators and Assessors,*** necessary for PAS2035, need cross-occupational awareness
- ***Upgrading building service occupations*** all learn about low carbon/energy construction e.g. electricians: development of domestic electrician and development of installation electricians
- ***Insulation:*** L3 NOS under development
- ***Women in construction:*** many initiatives e.g. procurement
- ***Barriers to embedding climate literacy:*** trainer training, geographical differences, funding, employer disinterest

Conclusions: Strengths and weaknesses of different VET systems

- ***CMEs with union involvement***
  - o *Sweden*: school-based climate literacy but insufficiently detailed
  - o *Belgium*: mainstreaming, but not directly embracing climate literacy
  - o *Denmark:* significant knowledge base through workshop/ classroom elements (block release) but just energy literacy
  - o *Germany*: stepped system → holistic understanding, covers climate literacy but low unionisation
- ***LMEs***: ***unions marginalised*** by market but less so in taking initiatives
  - o *Ireland:* state initiatives, Fundamentals
  - o *UK:* union and local/regional authority initiatives
- **Overall** - energy literacy rarely connected to climate crisis → barriers to embedding climate literacy

- ***Need to move from skill-based to occupation-based systems, from employer-based to education-based*** *VET* if LEC requirements to be addressed and climate literacy embedded to empower workers and achieve equality

BIBB Conference 2023

Defining Green Occupational Groups in the Spanish VET System: An Emerging Approach

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PAPER

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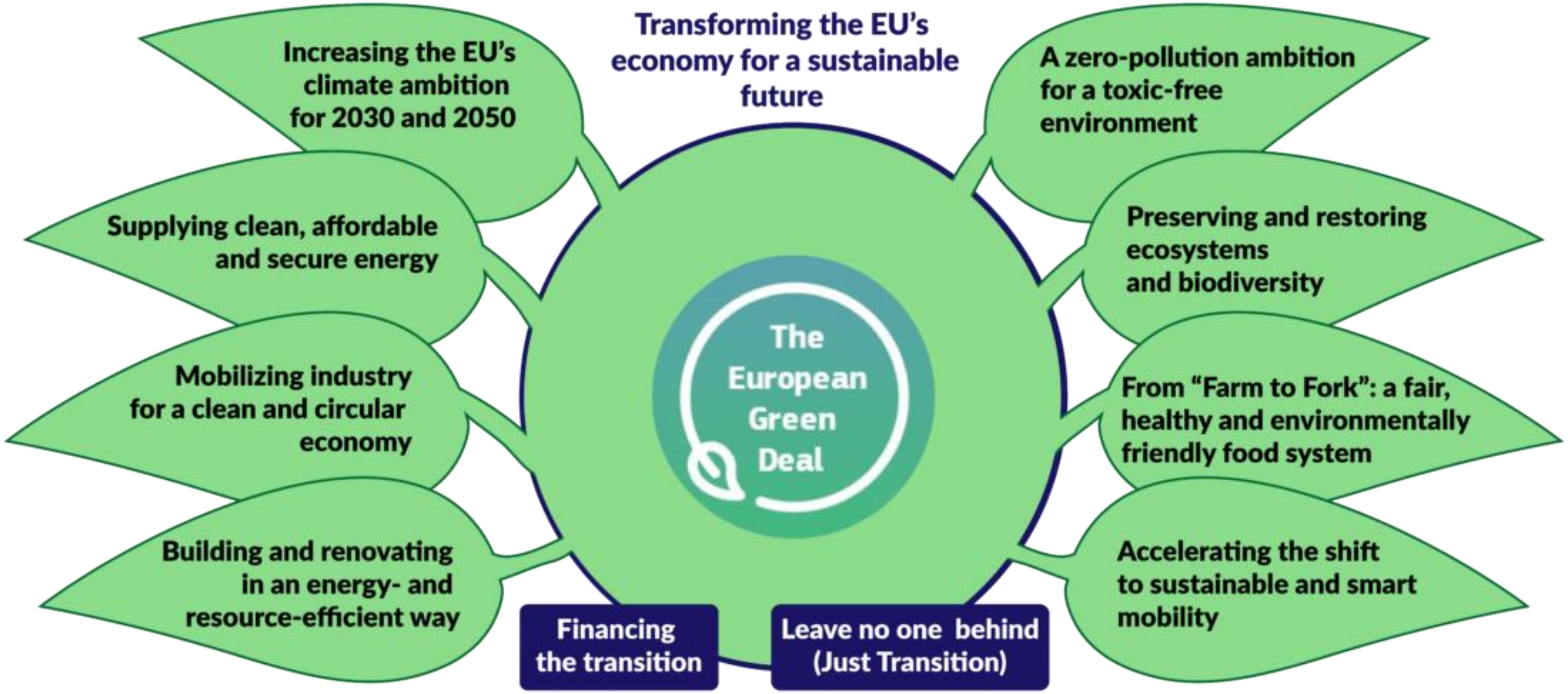
PURPOSE

The aim is to propose a **categorisation of green VET occupational groups** within Spain's VET system that matches the growing workplace, socio-political and environmental demands, addressing them from the perspective of the green economy.

What does the green transition mean in terms of VET?



The European Green Deal includes more than 50 policy initiatives and will be funded with more than 1 trillion euros. © macpixxel for GIS

LITERATURE REVIEW- ENVIRONMENT & VET

	VET for economic growth	VET for sustainable / green growth	VET for sustainable development
Ethos	Productivism & androcentrism	Productivism, social inclusiveness & technocracy	Ecologism, ecocentrism
Approach to environment	Instrumental: source of human and natural resources for economy	Functional: economic development for solving social & environmental problems	Integrated: economic, environmental and social development
	Continuist: 'unlimited resources and constraints'.	Reformist: 'renewable resources' (regulation, efficiency & new techs)	Transformative: 'natural limits. Environment as a driver'
Assumptions in VET	Training for growth (based on patterns of stability)	Education and training for growth and employment for all	Education and training for SD (new patterns of production, consumption, work)
	Skills for productivity	Skills for productivity and employability. New green skills & 'sector niches'	SD applies objectives competences based. Combination of competences
Focus of VET	Industry-focused. Shaped by short and medium-term market demand	Industry and worker-focused. Adaptation to new work contexts, Techs & accreditation	System-focused: holistic, interdependency and transdisciplinary
Orientation of VET providers	Supplying human resources	Facilitating labour transitions: qualifying, up reskilling	Facilitating human capacities for alternative futures
References	Anderson (2008,2009) Giddens (1994) Rees (1990) Stevenson (1993)	Elder (2015), Fien et al. (2005), Goldney *et al.* (2007), Malloch *et al.* (2021), Muller (2021).	FieN *et al.* (2009) Hemkes *et al.* (2021) McGrawth *et al.* (2016,2018) Pavlova (2009)

Source: adapted from Moso-Diez (2019).

LITERATURE REVIEW – ENVIRONMENT AND VET

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1st) Environment as a **source of unlimited resources**, a related notion to the VET system is understood as a provider of human resources (**skills for productivity**) (Anderson, 2009; Giddens, 1994; Rees, 1990; Stevenson, 1993).

2nd) The environment is understood **from a solving-problem and technocratic perspective** that allows regenerating the natural resources and environment, where VET provides **new technological and green skills** for both traditional industry and new flourishing green subsectors or niches (Goldney *et al.*, 2007; Muller, 2021).

3rd) Environment key for sustainable development (SD). The SD seeks a new type of development, not based on growth, but on new forms of work because of new forms of production, consumption and relationship with the environment. VET provides new competences for sustainability where the environment is the catalyst.

Learning in VET:

- Environment as a source: an input approach
- Environment as a good or service: an output approach
- Environment for greening other sectors: a process approach
- Environment as a catalyst: a systemic approach

.

3-LAYER FOCUS

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- **Sustainable development** has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).
  - The concept of 'needs', in particular, the essential needs of the world's poor, to which overriding priority should be given; and
  - The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

- It requires **an integrated approach** that takes into consideration economic development, social development and environmental protection (UN, 2023)
  - Action-oriented concept with shared metrics

EVOLUTION OF THE 3-LAYER FOCUS

1972 – Stockholm Declaration and Action Plan for the Human Environment – Emerging SD focus

1987 – Our Common Future (Bruntland Report, UN) – SD definition

1992 – UN Conference on Environment and Development, Rio de Janeiro – 1st. Institutionalisation

2002 – The Johannesburg Declaration on Sustainable Development & Agenda 21 – Local approach

2015 – The 2030 Agenda for Sustainable Development, (2015-2030) – New global SD agenda

2016 – 'Next steps for a sustainable European future" (EC, 2016) – EU commitment for SDG

2019 – "Towards a sustainable Europe by 2030" (EC, 2019d) – Education as a key horizontal enabler

2019 – EU Political Guidelines for the period 2019-2024 – Monitoring progress SDG (2019, 2023)

Source: adapted from Moso-Diez (2019).

UNDERSTANDING SUSTAINABLE DEVELOPMENT

UN (2015-2030)

17 Goals
169 targets
232 indicators

EU (2020)

17 Goals
100 indicators

Source: Stockholm Resilience Centre, 2016.

UNDERSTANDING SUSTAINABLE DEVELOPMENT & TVET

UNESCO TVET STRATEGY (2022-2029):

‘Transforming Technical and Vocational Education and Training for successful and just transitions’

UNESCO will support Member States to respond to current and future challenges in TVET, proposing three main priorities:

1. Develop skills for all individuals to learn, work and live;
2. Develop skills for inclusive and sustainable economies and;
3. Develop skills for inclusive and peaceful societies.

GREECOMP- THE EUROPEAN SUSTAINABILITY COMPETENCE FRAMEWORK (JRC)

GreenComp consists of 12 competences (in **bold**) organised into the four areas (in *italics*) below:

- *Embodying sustainability values*, including the competences
  - **valuing sustainability**
  - **supporting fairness**
  - **promoting nature**
- *Embracing complexity in sustainability*, including the competences
  - **systems thinking**
  - **critical thinking**
  - **problem framing**

Envisioning sustainable futures, including the competences

- **futures literacy**
- **adaptability**
- **exploratory thinking**

Acting for sustainability, including the competences

- **political agency**
- **collective action**
- **individual initiative**

Source: Bianchi et al. (2022)

STARTING POINT

A VERTICAL DIMENSION OF VET PROVISION

Our starting point is that the green component of Spanish VET **is mainly present in core activities related to sectors linked to:**

- **renewable energy**
- **the environment**
- **environmental sustainability**
- and shows room for improvement in comparison with other qualifications.

LITERATURE REVIEW - CATEGORISATION

Other classifications of occupational groups are related to (Gamboa *et al.*, 2021):

- sectoral areas (e.g. **industrial occupational groups**)
- technological ones (e.g. **STEM**) (STEAM Euskadi, 2018)
- **ICT** (based on Calvino *et al.*, 2018).

SCOPE

Occupations related to economic activities and sectors that directly provide services involving natural and renewable energy resources and are considered drivers of the European economy's green transition as set out in the European Green Deal (Cedefop & OECD, 2022).

Before climate change public discourse, traditional classifications were heterogeneous (Fundación Biodiversidad y Observatorio de la Sostenibilidad en España, 2008):

- Waste management
- Resource efficiency (efficient manufacturing and eco-design)
- Oil decontamination
- The integrated water cycle,
- Air
- Ecosystems

After climate change discourse public discourse:

- + the energy sector (Amanatidis & Laky, 2019).

This study is based on a proprietary working definition of the green occupational groups that spans a significant number of qualifications required by the activities that the **ILO** (2013) considers to forming part of the provision of environmental goods and services.

The basic unit of analysis used to identify the green occupational groups is the **vocational qualification and its relationship to the activities** involving environmental goods and services.

1st Stage

The sectors of activity in which there is demand for green vocational qualifications were identified.

To this end, a literature review was conducted, identifying two distinct classes of business activity that could be considered green (ILO, 2013):

- **the classification of environmental protection activities** (CEPA)
- **the classification of resource management activities** (CReMA).

These classifications contain the distinct activities described by Fernández Gómez and Larrea Basterra (2022) — 75 activities grouped into 9 categories in the case of the CEPA and 10 activities in the case of the CReMA.

METHODOLOGY

2nd Stage

The vocational areas and qualifications currently taught in both Initial VET and Continuous VET, irrespective of occupational group and as listed by the Instituto Vasco de Conocimiento de la Formación Profesional (IVAC, 2022), were identified.

3rd Stage

From the overall group of vocational areas and qualifications, those that bore either a direct or indirect relationship to the CEPA and CReMA, and the occupational groups of which they form part, were selected.

4th Stage

Direct relationships were identified via the name of the activity and the description of the content of the vocational qualifications listed by the Instituto Nacional de las Cualificaciones (INCUAL, 2023).

5th Stage

Indirect relationships were identified in qualifications that referred to development of the skills necessary to perform activities requiring knowledge of environmental regulation or of techniques designed to protect the environment or miniminise the risks to it.

FINDINGS

Table 1. Occupational groups with strong or medium-strength links with the environmental goods and services sector, by number of qualifications available and CEPA and CReMA activities affected

Strength of link	Occupational group	No of qualifications by type of CEPA or CReMA activity	% of CEPA or CReMA activities affected by the qualifications (as % of total CEPA or CReMA activities)
Strong	Safety an Environment (SaE)	8 CEPA	66.7 % of CEPA
Strong	Energy and Water (EaW)	2 CEPA 13 CReMA	11.1% of CEPA 40.0% of CReMA
Medium	Farming (FARM)	2 CReMA	20.0% of CReMA
Medium	Equipment Installation and Maintenance (EIaM)	1 CEPA 2 CReMA	11.1% of CEPA 10.0% of CReMA

Source: Compiled in-house from Fernández Gómez and Larrea Basterra (2022), IVAC (2022) and INCUAL (2023)

Table 2. CEPA activities (1 digit) linked to the environmental goods and services sector and closely related qualifications and occupational groups

Specific activity	Vocational qualification	Vocational area	Occupational group
1. Protection of ambient air and climate	Control of air pollution	Environmental Management	SaE
2. Wastewater management	Operation of water treatment plants	Environmental Management	SaE
	Installation and maintenance of water networks	Water	EaW
	Management and monitoring of installation and maintenance of water and sewerage networks and facilities	Wate	EaW
	Installation and maintenance of building water supply and drainage facilities	Electromechanical maintenance	ElaM
3. Waste management	Collection, sorting and initial storage of waste	Environmental Management	SaE
	Waste management	Environmental Management	SaE
4. Protection and remediation of soil, groundwater and surface water	Cleaning in open spaces and industrial facilities	Environmental Management	SaE
5. Noise and vibration abatement	Noise and vibration control and sound insulation	Environmental Management	SaE
6. Protection of biodiversity and landscape	—	—	—
7. Protection against radiation	—	—	—
8. Environmental research and development	—	—	—
9. Other environmental protection activities	Environmental education and awareness-raising	Environmental Management	SaE
	Environmental Management	Environmental Management	SaE

Source: Compiled in-house from Fernández Gómez and Larrea Basterra (2022), IVAC (2022) and INCUAL (2023).

Note: Safety and Environment (SaE), Energy and Water (EaW), Equipment Installation and Maintenance (ElaM).

Table 3. CReMA activities linked to the environmental goods and services sector and closely related qualifications and occupational groups

Specific activity	Vocational qualification	Vocational area	Occupational group
10. Management of water	Management of efficient wate use	Energy efficiency	EaW
11.A Management of forest areas	Management of afforestation and forestry practices	Forestry	FARM
11.B Minimisation of the intake of forest resources	Auxiliary Woodland conservation and improvement activities	Forestry	FARM
12. Management of wild flora and fauna	—	—	—
13.A Production of energy from renewable resources	Auxiliary renewable energy plant installation and maintenance operations	Renewable energy	EaW
	Installation and maintenance of solar thermal plants	Renewable energy	EaW
	Installation and maintenance of solar photovoltaic plants	Renewable energy	EaW
	Installation and maintenance of closed-circuit geoexchante systems	Renewable energy	EaW
	Management of installations and maintenance of wind farms	Renewable energy	EaW
	Planning and development of solar photovoltaic plants	Renewable energy	EaW
	Planning and development of solar thermal plants	Renewable energy	EaW
	Management of closed-circuit geoexchange plants	Renewable energy	EaW
13.B Heat energy saving and management	Building energy efficiency	Energy efficiency	EaW
	Energy auditing	Energy efficiency	EaW
	Installation of heat and sound insulation systems and of fire and radon protection in buildings	Installation and assembly	BaCW
	Installation and maintenance of heat and sound insultation systems and fire protection	Insulation systems	EaW
	Management and supervision of installation and maintenance of heat and sound insulation systems and fire protection		EaW

Source: Compiled in-house from Fernández Gómez and Larrea Basterra (2022), IVAC (2022) and INCUAL (2023).

Note: Energy and Water (EaW), Farming (FARM), Building and Civil Works (BaCW), Installation and Maintenance (IaM). Codes 11 and 13 are not included in the table because it is understood that they are represented by 11.A, 11.B, 13.A, 13.B and 13.C.

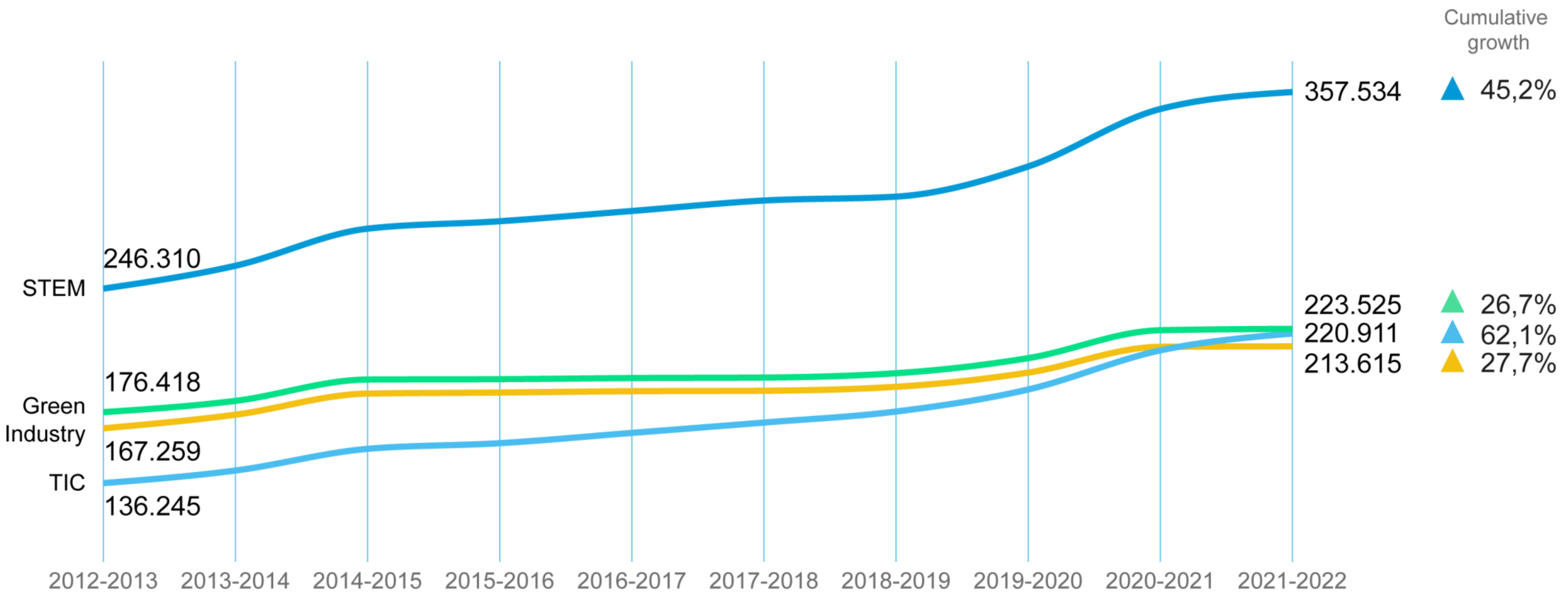
Table 3. CReMA activities linked to the environmental goods and services sector and closely related qualifications and occupational groups

Specific activity	Vocational qualification	Vocational area	Occupational group
13.C Minimisation of the use of fossil energy as raw materials	Planning and development of solar photovoltaic plants	Renewable energy	EaW
	Planning and development of solar thermal plants	Renewable energy	EaW
14. Management of minerals	—	—	—
15. Research and development activities for resource management	—	—	—
16. Other resource management activities	—	—	—

Source: Compiled in-house from Fernández Gómez and Larrea Basterra (2022), IVAC (2022) and INCUAL (2023).

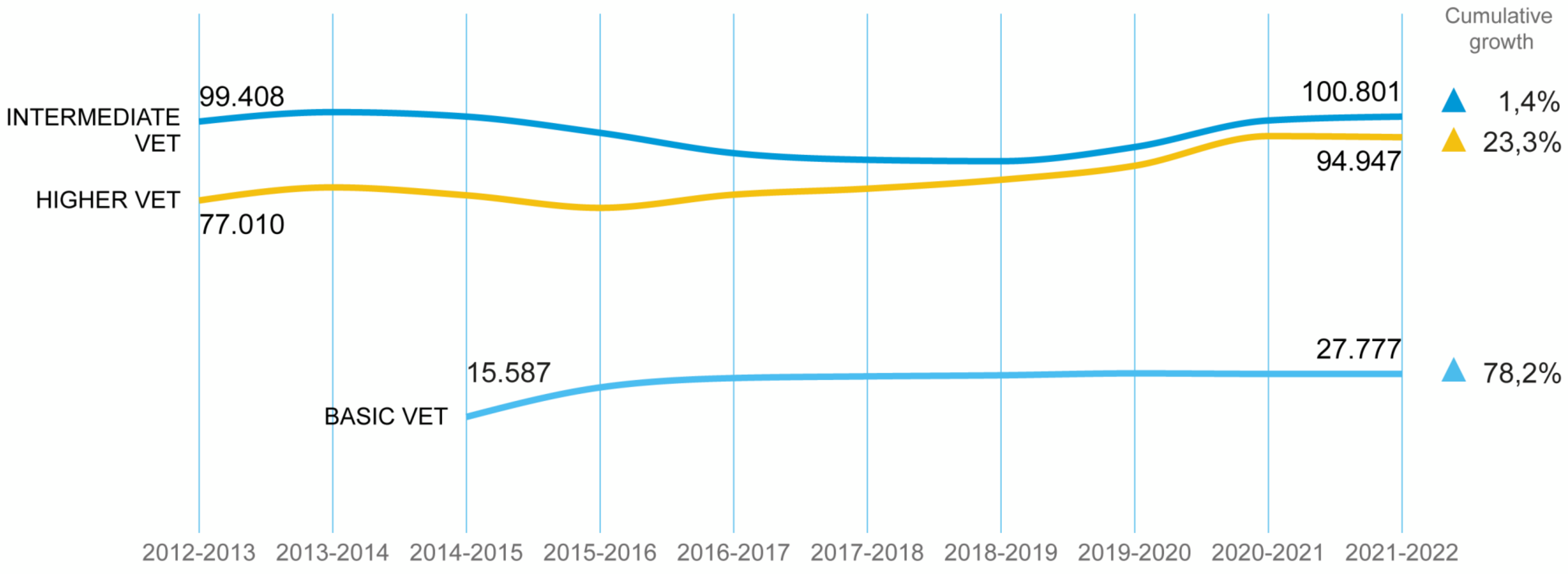
Note: Energy and Water (EaW), Farming (FARM), Building and Civil Works (BaCW), Installation and Maintenance (IaM). Codes 11 and 13 are not included in the table because it is understood that they are represented by 11.A, 11.B, 13.A, 13.B and 13.C.

Figure 2. Students enrolled in VET by vocational family (STEM-INDUSTRIAL-ICT-GREEN families). Spain (course 2012-2013 to 2021-2022)



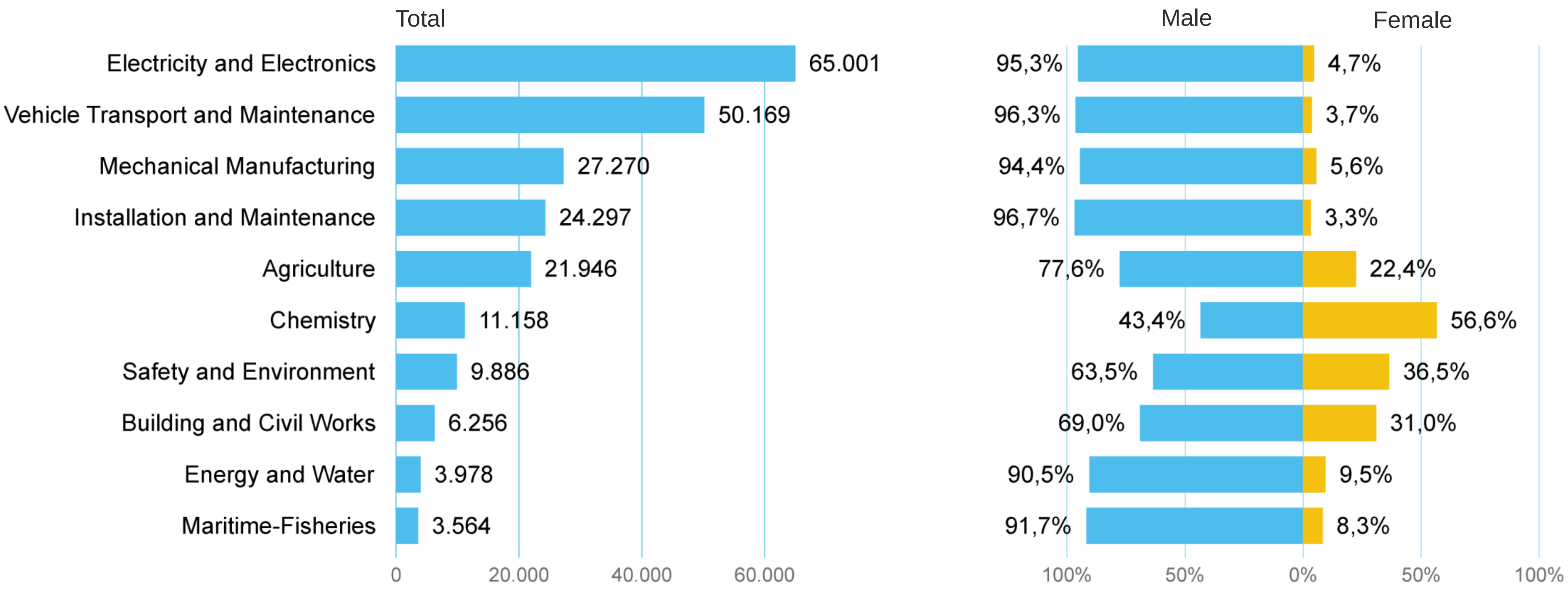
Source: Observatorio de la FP en España. CaixaBank Dualiza

Figure 3. Students enrolled in GREEN Families by educational level.
Spain (course 2012-2013 to 2021-2022)



Source: Observatorio de la FP en España. CaixaBank Dualiza

Figure 4. Students enrolled in green vocational families by gender.
Spain (course 2021-2022)



Source: Observatorio de la FP en España. CaixaBank Dualiza

DISCUSSION

1. Only two occupational groups considered to be core to green employment (SaE and EaW) have been identified.

2. Differences in green intensity and scope of activities are detected between the two groups:

- The SaE group comprises two completely separate areas one focused on the environment and the other on safety with no relation to the environment.
- The EaW occupational group is largely devoted to environmental goods and services, but it covers a smaller percentage of activities.

Due to these differences, **the analysis needs to be broken down** into specific training programmes and occupational certificates directly linked to this area.

DISCUSSION

3. Although it is clear that there should be a typology of specific core occupational groups developing the skills required by the environmental goods and services industry, there is currently **an intermediate layer of groups** that offer fewer qualifications for the sectors covered by the CEPA and CReMA.

The latter have the potential to be even greener and, in the future, could be rated as medium-strength and strong sources given their environmental importance (e.g. Building and Civil Works, and Farming).

DISCUSSION

4. The current range of qualifications does not cover all the activities in the CEPA and CReMA, which is striking given their relevance and, at the same time, opens a window of opportunity for VET.

Therefore, an analysis of present and future demand for the activities could indicate the priorities for VET to address, their intensity and the gaps in supply. In this regard, the greater availability of information on workplace demand and the green economy than on the training available in this field is noteworthy

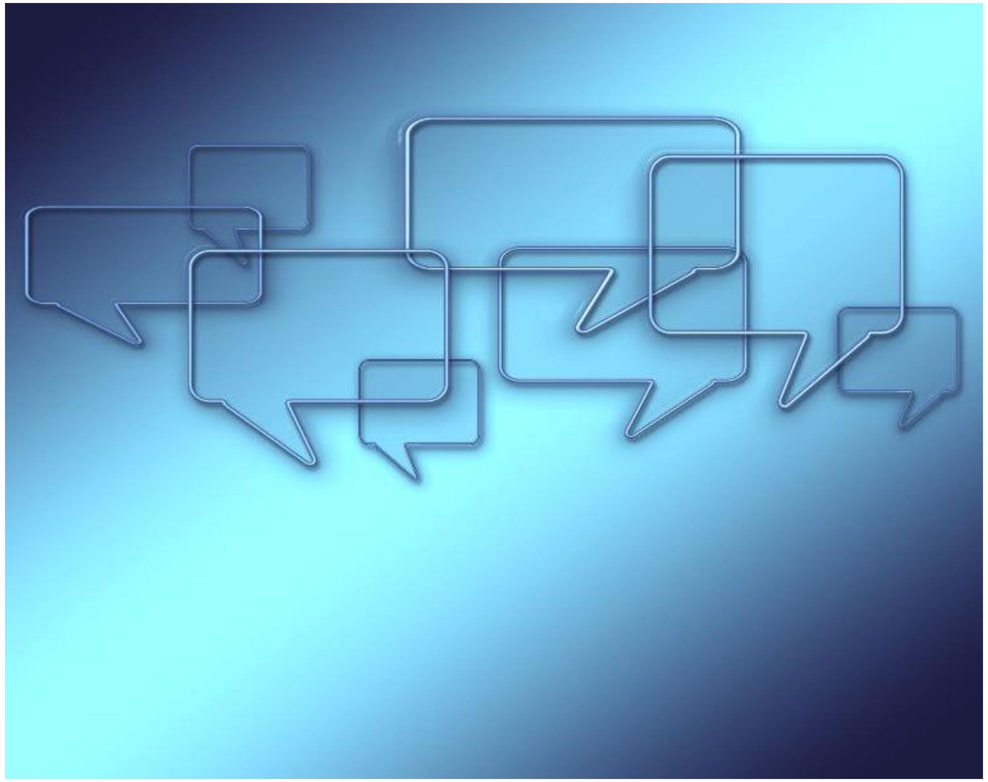
CONCLUSION

This paper provides an initial outline of the scope of the green VET offering via those qualifications directly related to energy and the environment.

In the future, this initial approach will need to be extended to the other occupational groups in order to gain an understanding of the extent to which Spain's VET systems are ready for the green transition.

QUESTIONS

- Do you know other occupational categorisation of green VET occupational groups?
- And if you don't know, how would you build Green VET into your national VET system
- How would you link green occupations to VET programmes?



Thanks!
Danke!
¡Gracias!

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Skills Alliance for Industrial Symbiosis (SAIS)
A Cross-sectoral Blueprint for a Sustainable Process Industry (SPIRE)

Antonius Schröder
TU Dortmund University

Conference:

Vocational Education, Skilled Workers and Transformation in an International Perspective

BIBB, Bonn, 1st of December 2023

Co-funded by the Erasmus+ Programme of the European Union

Skills Alliance for Industrial Symbiosis (SAIS)
A Cross-sectoral Blueprint for a Sustainable Process Industry (SPIRE)

Co-funded by the Erasmus+ Programme of the European Union

EU Programme: ERASMUS+ “New Skills Agenda”
- Duration: January 2020 – June 2024
- Funding: 4 Mio Euro
- 24 Partners + 13 associated partners
- Already 25 funded sectoral blueprints

Key components of SPIRE-SAIS:
- Build on existing A.SPIRE coordination, projects and activities
- Cross-sectoral approach, covering all the ten A.SPIRE energy intensive industry sectors
- Sector associations as central communication and dissemination intersection

Skills Alliance for Industrial Symbiosis -
A Cross-sectoral Blueprint for a Sustainable Process Industry
(SPIRE-SAIS)

Co-funded by the
Erasmus+ Programme
of the European Union

Industry driven consortium

PROJECT PARTNERS AND COUNTRIES

Industry sector associations: A.SPIRE, ESTEP, IMA Europe, European Aluminium, Water Europe, ECEG, Cerame-Unie

Companies: Covestro (Chemicals), Sidenor, Ferriere Nord (Steel), MYTILINEOS (Aluminium), Suez (Water)

Education/training providers & RTOs: Scuola Superiore Sant'Anna, Fundation Circe, ITC, ISQ, International Synergies, H2Opeople

Research institutions: TU Dortmund University, CSM/RINA, Visionary Analytics, IMNR, Łukasiewicz-IMN

Regional institutions: ART-ER

Associated partners: EIT Raw Materials, thyssenkrupp Steel Europe, CEFIC, CEMBUREAU, ITQ (Universitat Politècnica de València), Carbon Market Watch, Circle Economy, University of Deusto

- 24 partners
- 13 associated partners
- 12 countries
- 10 industry sectors

Cement	Ceramics	Chemicals	Engineering	Non-ferrous metals
Minerals	Pulp & paper	Refining	Steel	Water

Blueprint Framework

Technological and Economic Demands and Skills Requirements

- Technological, Economic, and Societal Development and Demands
- Skill needs

Skills Adjustment

- Skills Classification
- Job Profile Assessment
- VET Support

Strategies / Measures

- Foresight Observatory
- Training Offers
- Learning Arrangements
- Division of Responsibilities
- Pilot Measures/Tests
- Incentives: Awards, Online Fora
- Image/Recruitment/ Talent Management

Alliances and Leadership

- EU Level: SPIRE, P4Planet Sector Associations
- European Community of Practice for Industrial Urban Symbiosis
- National/Regional: associations, training providers

Implementation and Rollout

- Hubs for Circularity (Regions)
- EU Open Coordination (European Community of Practice)
- National VET Systems (in cooperation with industry blueprints)

Sustainable Ongoing Skills Alliance

Current Skills Situation

- The current **level of implementation and skills** is higher for EE rather than for IS
- Beneath internal and industrial actors: **public actors** are also main actors of IS (41%) and EE (48%)
- The **main barriers for EE/IS**:
  - cost of investments
  - regulatory issues (IS)
  - outdated plants, infrastructure and equipment
  - cooperation challenges, integration of regional stakeholders, working across different sectors
  - skills gaps.
- Mainly **no specific training programs (57% EE, 74% IS)**
  current training measures are primarily **non-formal/unstructured**
- **Low/middle level of skills needs** to be updated:
  - Specific job-related technical / professional skills
  - Transversal skills (esp. digital, green and personal skills)
  - Management skills
- IS is leading to **new jobs/professions** and higher workforce performance


Skills Alliance for Industrial Symbiosis:
A Cross-sectoral Blueprint for a Sustainable Process Industry (SPIRE-SAIS)

Industrial Symbiosis and Energy Efficiency in European Process Industry: State of Art and Future Scenario

Co-funded by the Erasmus+ Programme of the European Union

VET Support

Key gaps and barriers across countries:

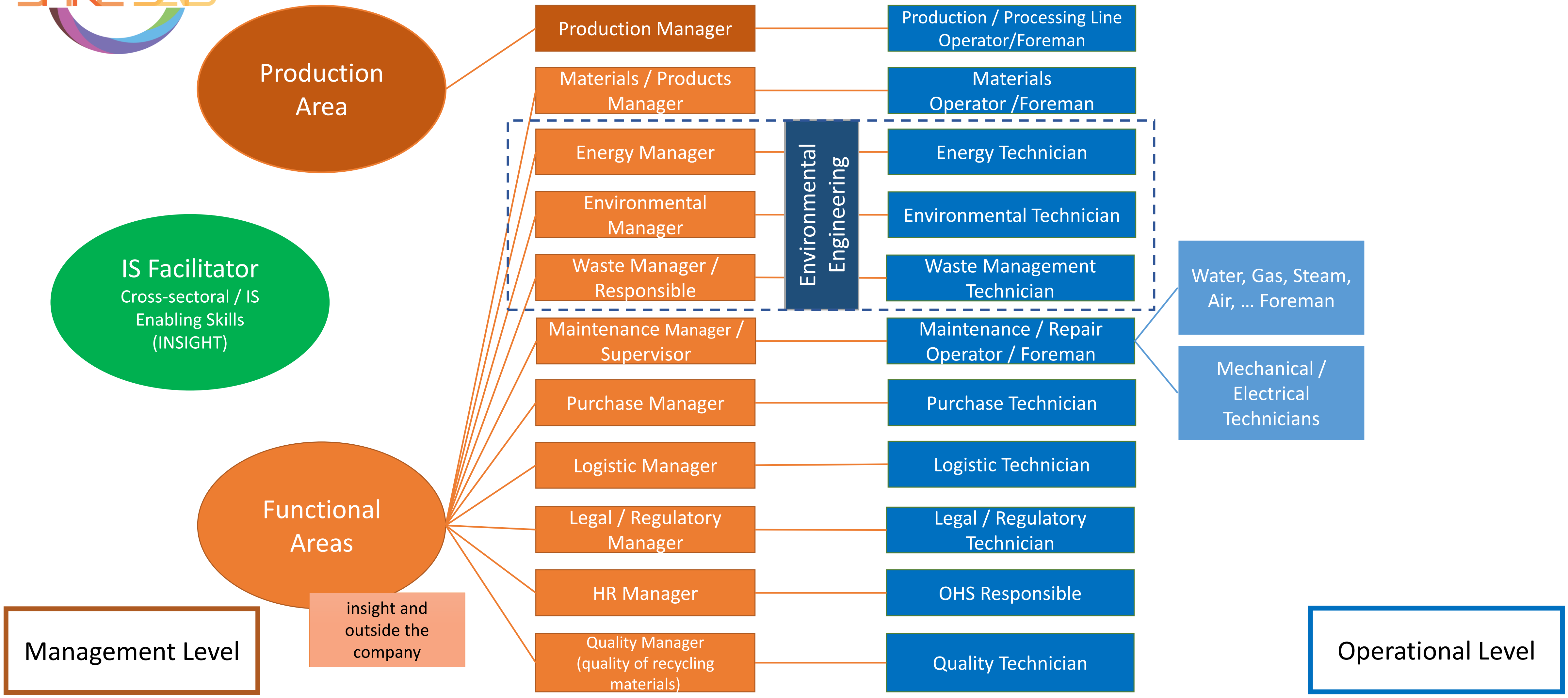
- **Educators' readiness:** Teachers often lack competencies and knowledge on how to teach green skills effectively.
- **Poor evidence base:** Robust assessments of relevant educational programmes' effectiveness are necessary to replicate the good practices.
- **Course structure and tools:** Establishing a cross-sectoral IS/EE module that could be integrated in different occupational trainings could be helpful. Ideally, it should be accompanied by easily accessible didactic materials and guidance for education providers on how to deliver it best.
- **A uniform skills recognition system:** Green skills are not easily verified and certified, which discourages learners (as they rarely receive a formal certificate upon completion of training) and hinders skills tracking and forecasting.

Other important barriers:

- **Lack of coherent policies:** The responsibility for green skills delivery is usually split between many stakeholders (educational, industrial, and environmental ministries, regional governments, VET schools, civic organisations, etc.) and not guided by a single overarching strategy.
- **Insufficient funding:** Funding tends to be fragmented and short-term.

Blueprint: Industrial Symbiosis Related Job Profiles

Cross-sectoral Generic Job Profiles



Blueprint: Skills Classification

ASPIRE

SPIRE-SAIS

Management and Operator

Management

Technological

Industrial Symbiosis

- **IS basic understanding** (core concepts, resource, re-use and recycling, methodologies)
- **System optimisation & process analysis**
- **Field experience (in IS)**
- **Product life cycle thinking assessment** (incl. eco-design of product, technology and processes)
- **Sustainable resource management** (incl. waste management - reduction and prevention, water conservation, environmental monitoring)

Energy Efficiency

- **Understanding energy use & costs** (incl. manufacturing principles to reduce energy consumption)
- **Energy management of equipment and parts**
- **System optimisation & process analysis**
- **Energy data collection & analysis** (selection and use of monitoring equipment for energy consumption, developing and installing analysis systems for energy use, monitoring and investigating, complex information processing and interpretation)
- **Field experience (in EE)**

Individual / Personal

- **Environmental awareness** (of consequences of energy and materials use)
- **Collaboration** (incl. team-based approach, multidisciplinary thinking and acting, effective communication, …)
- **Initiative taking & entrepreneurship** (incl. strategic thinking, working autonomously, decision making)
- **Complementary, systematic, critical thinking**
- **Creativity**

Regulatory

- **General regulatory awareness** (incl. legislation, compliance)
- **Legislation on waste management & CO_2 emissions**

Business related

- **Business knowledge** (commercial, economics, complex financial analysis, financial planning/management, accounting and audit)
- **Identification of potential opportunities** (considering emerging trends, entrepreneurial mindset, integrate energy efficiency findings into cross-business plans, business cases)
- **Fostering cooperation** (incl. networking, encourage collective decisions, negotiation)
- **Business model transformation**
- **Project planning and management**

Training Framework

Generic IS Training

Thematic
Indepth / Advanced
Training Courses

- Financial Assessment
- Critical Raw Materials
- others

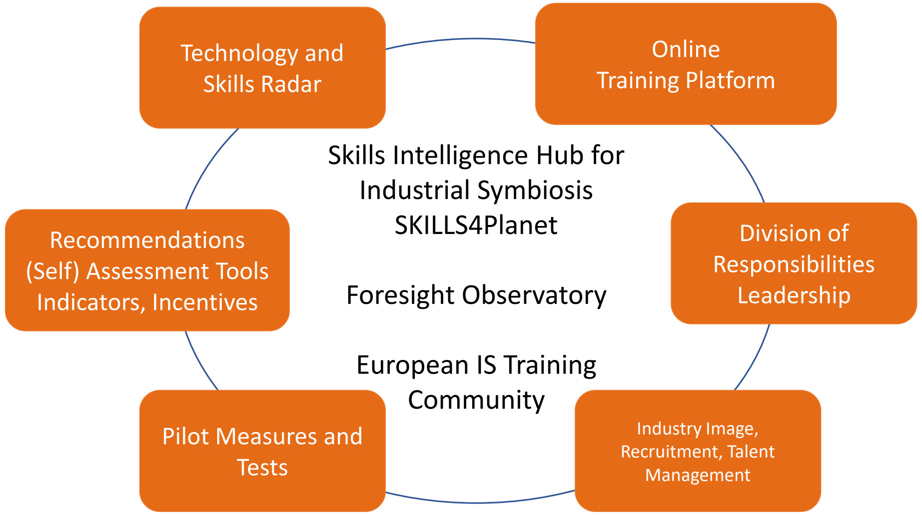
Sector Specific Illustrations / Specifications

Job Profile / Function
Related Courses

managerial
operational

- Production Areas
- Functional Areas
- IS Facilitator

Blueprint: Governance Structure



A.SPIRE
Pact for Skills: Large Scale Partnership Energy Intensive Industries

Foresight Observatory
Technology and Skills Radar

aligned with
PWG Societal Innovation
Foresight Team

Skills Intelligence Hub
SKILLS4Planet Online Training

aligned with
ESSA / Hubs for Circularity
Online Platform

Training Community of Practice
for Sectoral-Regional Training Eco-Systems
aligned with
A.SPIRE *Sector Representatives*
Hubs for Circularity Online Platform

Connection with other European Activities in Relation to Skills

SKILLS4Planet OnlineTraining Platform

Hosting system for engaging and immersive digital learning solutions

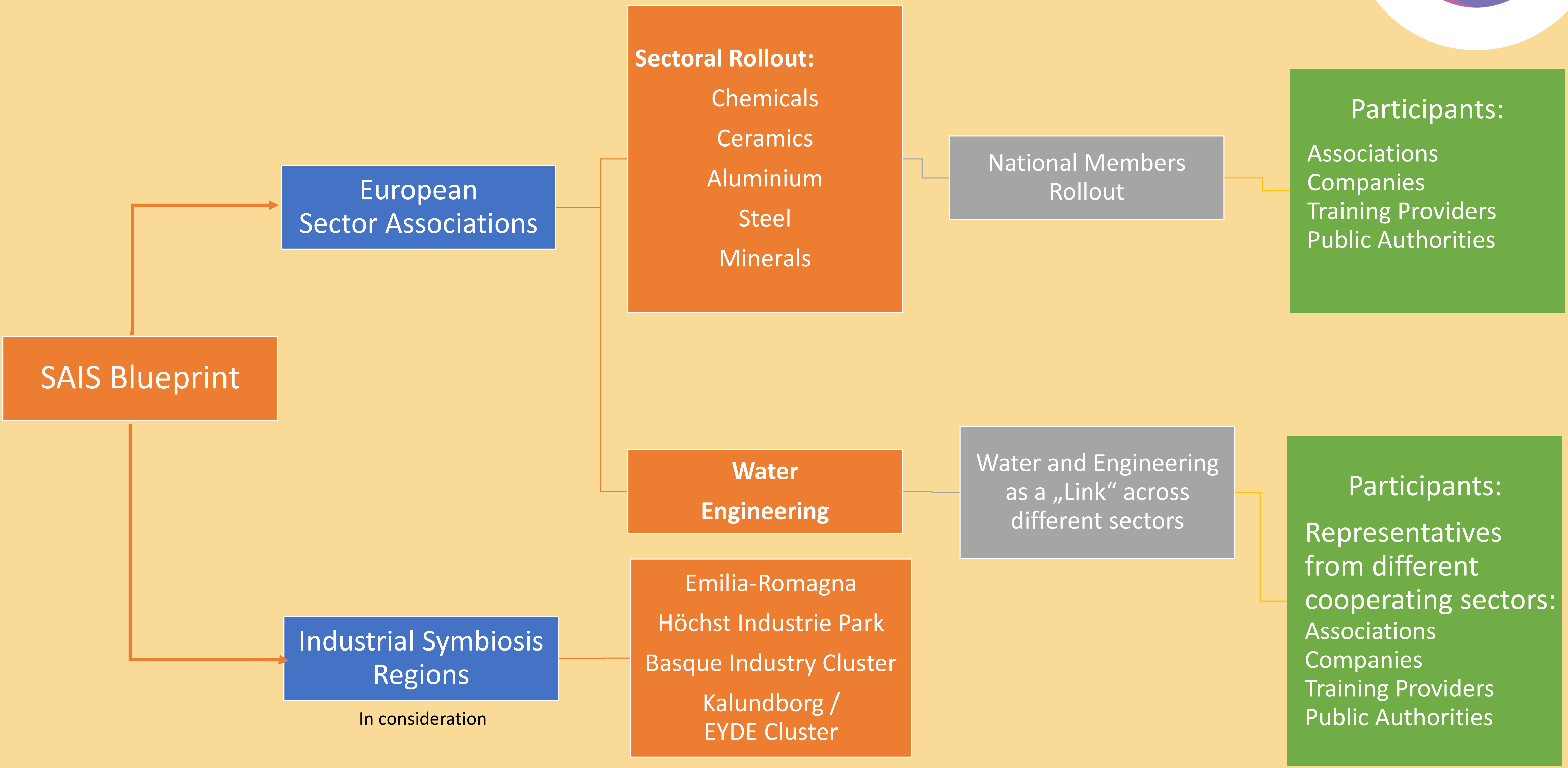
- Game-based learning and simulations
- 3D Animated Videos
- Interactive 3D Models
- E-learnings
- VR/AR solutions
- Webinars

Basic Oxygen steelmaking simulation

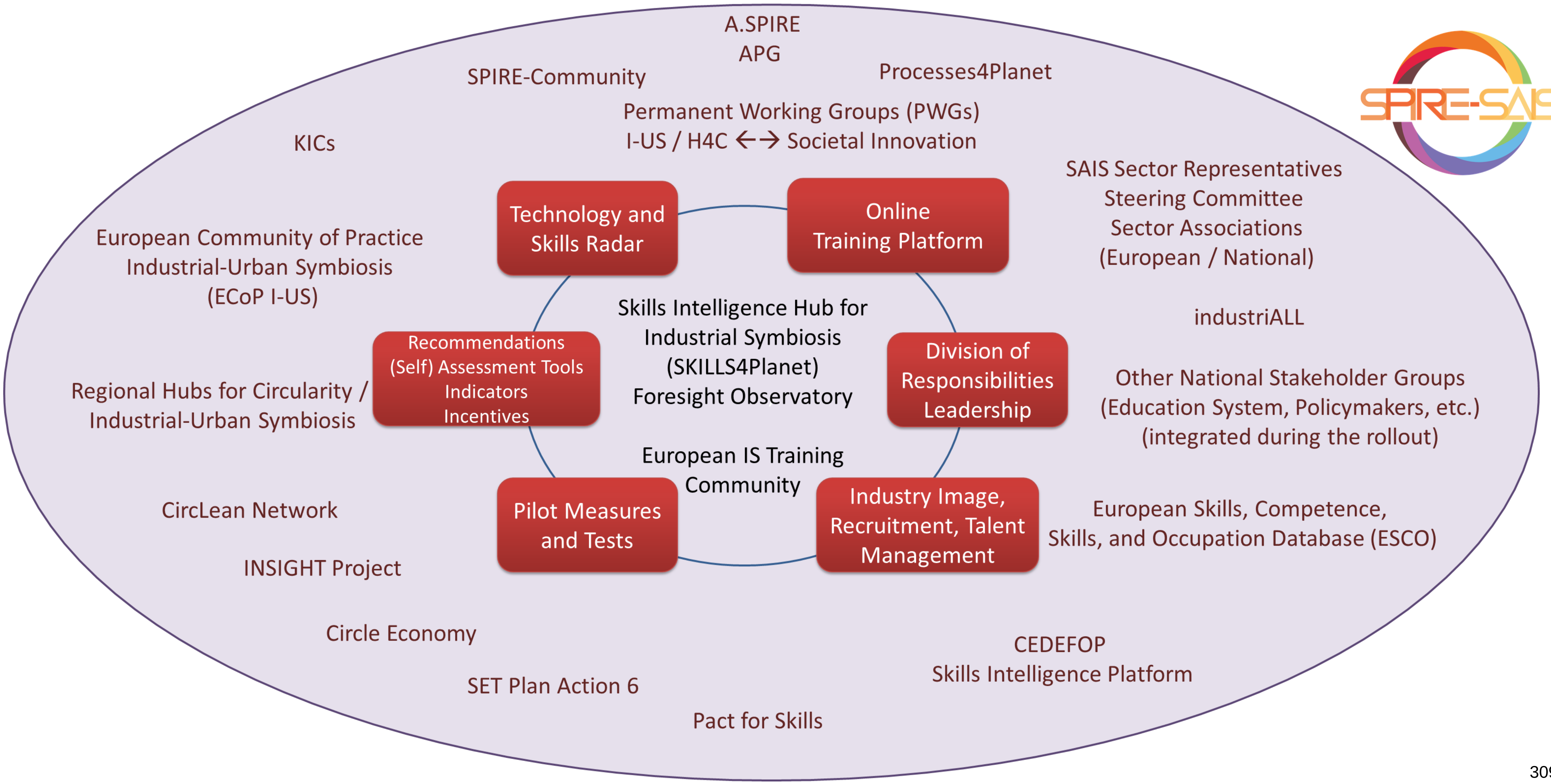
Virtual Reality (VR) games for safety training

3D Interactive model of Blast Furnace

Open Coordination of the Rollout via Sectors and Regions



Blueprint: Alignment with European Programs and Activities



European Pact for Skills:
Large Scale Partnership Energy Intensive Industries

EUROPEAN STEEL SKILLS AGENDA

SPIRE-SAIS

We are looking for a **common all sectors comprising framework** with two specific foci:

- SAIS = cross-sectoral and **industrial symbiosis skills** specific blueprint
- ESSA = example of a **specific sector** related blueprint including an incremental upskilling of representative job profiles (t-shaped skills: technical and transversal skills (green, digital, social, individual, and methodological))

PACT FOR SKILLS Leader

An initiative of the European Commission

Already Participating Organisations

Asocaición de Investigación de las Industrias Cerámicas (ITC-AICE)
ArcelorMittal Spain Holding
Cardiff University
Celsa Group
CIELFFA
CIRCE - Centro Tecnológico
EIT Raw Material Academy
EUROFER - The European Steel Association
European Federation for Welding, Joining and Cutting
European Steel Technology Platform ESTEP
Ferriere Nord
H2O-People
Höchst Industriepark
IDENER
IMA-Europe
INEGI - Institute of Science and Innovation in Mechanical and Industrial Engineering
InnoGlobal
Instituto de Soldadura e Qualidade
Liberty Steel Group
National Research&Development Institute for Non-ferrous and Rare Metals - IMNR
NCE EYDE
Pittini Group
Provadis Hochschule
RINA Consulting - Centro Sviluppo Materiali S.p.A.
SCUOLA SUPERIORE SANT'ANNA
Sidenor Aceros Especiales SLU
thyssenkrupp Steel Europe AG
TU Dortmund University
University of DEUSTO
worldsteel
Zaragoza Logistics Center

Energy Intensive Industries

The Energy-Intensive Industries ecosystem includes raw materials, chemicals, iron and steel, forest-based products, plastics, refining, cement, rubber, metals and fertilisers.

PACT FOR SKILLS Leader

An initiative of the European Commission

Vocational Education, Skilled Workers and Transformation in an International Perspective

Conclusion from the working groups:
WG 1: Organizational aspects of Transformation
Dr. Jörg Markowitsch

Bonn, 01.12.2023

Dr. Irene Brunetti & Dr. Marco Biagetti (INAPP, Italy)	Workforce skills, on-the-job training and firms' propensity to invest in new technologies
Dr. Torgeir Nyen & Johan Røed Steen (Fafo Institute, Norway)	How do skilled workers contribute to innovation?
Prof. Dr. Patrick Lehnert (University of Zurich, Switzerland)	Vocational education and training as a driver of innovation: a long-neglected field of research

Key points of research & Findings from presentations

- There exists a reciprocal relationship between investments in new technologies and skills (IT).
- Evidence at micro-level that more training / higher skilled worlforce lead to more investment in technologgy & I4.0 (IT)
- Factors conducive to innovation at the firm level include a high level of discretion and autonomy, open and flat communication across different occupational groups (engineers, skilled workers), and clear improvement channels. Formal industrial relations structures matter more in manufacturing, while they play a lesser role in the service sector. (NO)

Key points of research & Findings from presentations

- The updating of VET (Vocational Education and Training) curricula can accelerate the diffusion of new technologies. This is particularly effective when VET is nationally defined and binding, systematically updated, and involves all relevant stakeholders. (CC)

- VET graduates contribute to the overall workforce productivity and facilitate bi-directional innovation spillovers, extending from VET to tertiary education. (CH)

- The University of Applied Science (UAS) holds significance in regional innovation systems, provided it maintains its distinct profile and doesn't evolve into a Research University. (CH)

Major messages for policies

- VET has to stay an attractive option (career options, job mobility,..)
- Permeability of education systems
- VET to become an integrative element of innovation policy (funding needed!!!)
- Skills eco-systems need to include VET schools, UAS, HE, …
- More efforts to avoid skills mimtaches (in terms of supply & demand of VET)
- More research
- Innovation vs. inclusion???

Future research

- What economic structures incentivises innovation? (Macro-ecomic)
- How can educational policy support knowledge spillover for inidviduals and businesses?
- How does innovation and (educational) inequality relate?
- Creative disruption vs. Incomany innovation, the role of VET?
- What are the implicit pre-requisites for innvation?
- What further adjustments are necessary to keep up with technological change (e.g., trainer qualification, examination modes)?
- What is the role of dual VET for innovation in countries that do not (yet) emphasize it in their education systems?

> VET Partner institutes to invite policy stakeholders to their meetings/events

Thank you for your participation!

Next:

- Coffee break

Vocational Education, Skilled Workers and Transformation in an International Perspective

Conclusion from the working groups:
WG 2: The technological side of Transformation
Prof. Dr. Valeria Cirillo

Bonn, 01.12.2023

Q1: In a few sentences, what were the key points of research addressed in the workshop?

1- The technology-employment nexus is a very important channel of transformation in labour markets, but not the only one: robotization alone is unlikely to be the major driving force of employment dynamics in Europe, need to consider structural and demand-related factors

2- Investments in robots had heterogeneous effects in Europe, on average ´Labour-friendly' robotization regime, but:

(i) employment gains are asymmetrically distributed, favouring 'managers' while penalising manual workers

(ii) 'Labour-friendly' regime emerges only in core and SO countries, characterised by stronger technological capabilities and 'high-end', not significant in Eastern, Baltics and Southern Periphery

→ **Robotization is not a threat if country/sectors have the right capabilities to react**

3 – Lots of conclusion based on social media and real time data should be considered with more caution and required more theory behind to be interpreted

Q2: What were the most relevant findings when it comes to the contribution of VET and skilled work to transformation?

- Skilled workers are favoured by technological change more than manuals; functional specialization in R&D
- Increasing qualifications promotes the adoption of new technologies
- Technologies matter (different types can differently affect work organizations), not only qualifications levels but also it is worth considering occupational positions
- Heterogeneous effects of technologies on autonomy of workers

Q3: What were the major messages for policies and future research and development?

- The **case for industrial policy**: need to invest in public R&D, researchers, public procurement, intangibles; improve production capabilities and GVC positioning; functional specialization in R&D activities

- Need to focus on organizational policies (Industry5.0 practices) – workplace practices (human-centricity, sustainability, resilience)

Q4: Based on findings and expertise gathered in the working group, how would a future research project look like?

- New research on how technology is actually used, not only labour-substituting effects but also labour-augmentation strategies (complementing quantitative with qualitative research)
- Involvement of employees into decision concerning technologies
- Improving integration of several sources of data at the international level
- Technology in context: need to understand the institutional drivers behind technological patterns

Q5: Are there any concrete initiatives that should be taken?

- Evaluating how and to which extent National Resilience and Recovery Plans are effective in shaping the building blocks of NSI
- Involvement of employees into decision concerning technologies

Thank you for your participation!

Next:

- Coffee break

Vocational Education, Skilled Workers and Transformation in an International Perspective

Conclusion from the working groups:
WG 3: Ecological Challenges and Transformation
Prof. Dr. Terence Hogarth

Bonn, 01.12.2023

Q1: In a few sentences, what were the key points of research addressed in the workshop?

- Role of agencies in shaping the transition
- Collective action
- The voice of the learner → Expansion of perspective
- Complexity of sustainability: not an easy task with focus on VET
- VET provides not just skills, but citizens
- Empowering individuals depends upon VET models LME/CME
- Different approaches for different systems
- Perspectives of regions and systems
- Need to adjust policy actions
- Focus also on low-skilled workers
- Learning for “sustainable” market
- Conflicting meanings of sustainability
- Ecological literacy

Q3: What were the major messages for policies and future research and development?

- Reshaping/adapting the institutional set-up (role/participation of the learner); Programme to collect data on learner's situation
- Coordinated multilevel ecosystem approach (intergenerational)
- Different aspects of sustainability (ecological, social …)
- Measure of wealth; We work with employment and labour market indicators, we would need environmental or social evolution indicators

Q4: Based on findings and expertise gathered in the working group, how would a future research project look like?

- Climate literacy

Thank you for your participation!

Next:

- Coffee break