Jobs in Global Value Chains and their Exposure to Automation

Intangible Assets, Digitalisation and Asymmetries in European Value Chains - PRIN Workshop

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Outline

Context

- Covid-19, Ukraine war, US–China tensions $\Rightarrow$ expose fragility of GVCs.
- Debate: de-globalization vs. nearshoring; industrial policy and de-coupling.

- Against this background, the rise of digital automation technologies brings further uncertainty.

Context

- Covid-19, Ukraine war, US–China tensions $\Rightarrow$ expose fragility of GVCs.
- Debate: de-globalization vs. nearshoring; industrial policy and de-coupling.

- Against this background, the rise of digital automation technologies brings further uncertainty.
- ICT $\Rightarrow$ coordination across distance, lengthening GVCs.
- Automation $\Rightarrow$ task replacement or complementarity.
- But: uneven diffusion $\Rightarrow$ heterogeneous impacts across countries and sectors, redistributional issues.

Digital technologies and jobs in GVCs

To understand the technology-labour nexus in a GVC context we decompose employment into domestic and GVC jobs...

...And in changes in three key drivers:

1. *Productivity*: the labour required to produce one unit of output.
2. *GVC linkages*: country-industries' competitiveness and aggregation within GVCs.
3. *Final demand*: changes in demand for final product will affect employment across country-industries participating to GVCs.

We follow [Pahl et al., 2022] and decompose changes along these three components.
We then explore their relationship with measures of digital technological change.

Main results

1. GVCs account for a significant (up to 25%) share of total employment and follow different patterns from total employment.
2. Productivity and final demand are the main drivers, often working in opposite directions.
3. The relationship between technology, and employment is nuanced, depending on the digital technology at hand.
4. Hetereogenous sector-level patterns, structural change is afoot with employment growth in services, especially GVC jobs.

Outline

Data Sources

- OECD ICIO and TiM 2024 release:
  - Employment changes and GVC jobs.
  - GFCF in computing equipment.
  - Complement TiM data with ILO (Employment by sex and economic activity - ILO modelled estimates,) to maximise country coverage.
- TechXposure database [Prytkova et al., 2025]: provides information on industries' exposure to 40 technologies grouped in 9 families.
- We cover 74 countries and 45 industries.

GVC-Jobs Matrix

- E' = a diagonalised vector of employment per unit of value added across all available ICIO countries.
- V = VA per unit of output.
- B = Leontief inverse (inter-country/inter-industry linkages).
- F' = final demand.

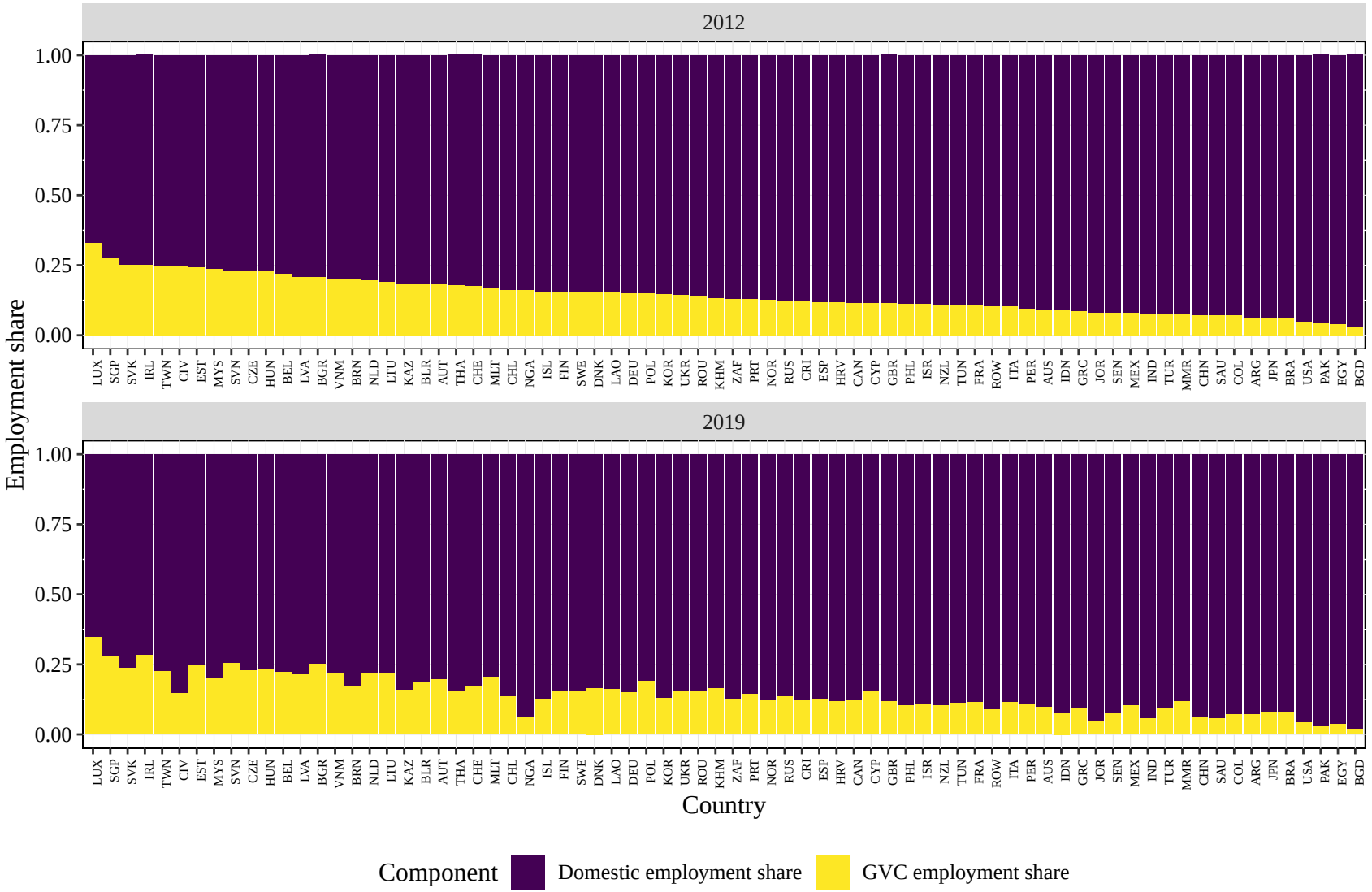
$$\text{Total Employment} = E'\,VB\,F'$$

By removing domestic linkages we obtain:

$$\text{GVC jobs} = E'\,V\hat{B}\,F'$$

$$E'V\hat{B}F' = \begin{bmatrix} 0 & e_a vb_{ab} f_b & e_a vb_{ac} f_c \\ e_b vb_{ba} f_a & 0 & e_b vb_{bc} f_c \\ e_c vb_{ca} f_a & e_c vb_{cb} f_b & 0 \end{bmatrix}$$

Employment and GVC jobs



Decomposition Framework

We perform an average polare decomposition
[Dietzenbacher and Los, 1998, Miller and Blair, 2022] of $\Delta E'VBF'$:

1. Productivity effect ($\Delta E'$) - i.e. changes in labour per unit of output
2. GVC linkage effect (ΔVB) - i.e. changes in the share of value added supplied to GVCs.
3. Final demand effect (ΔF) - i.e. changes in (global) final demand.

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$$\Delta EVBF = E'VBF'_{t1} - E'VBF'_{t0} = \Delta E' + \Delta VB + \Delta F' =$$

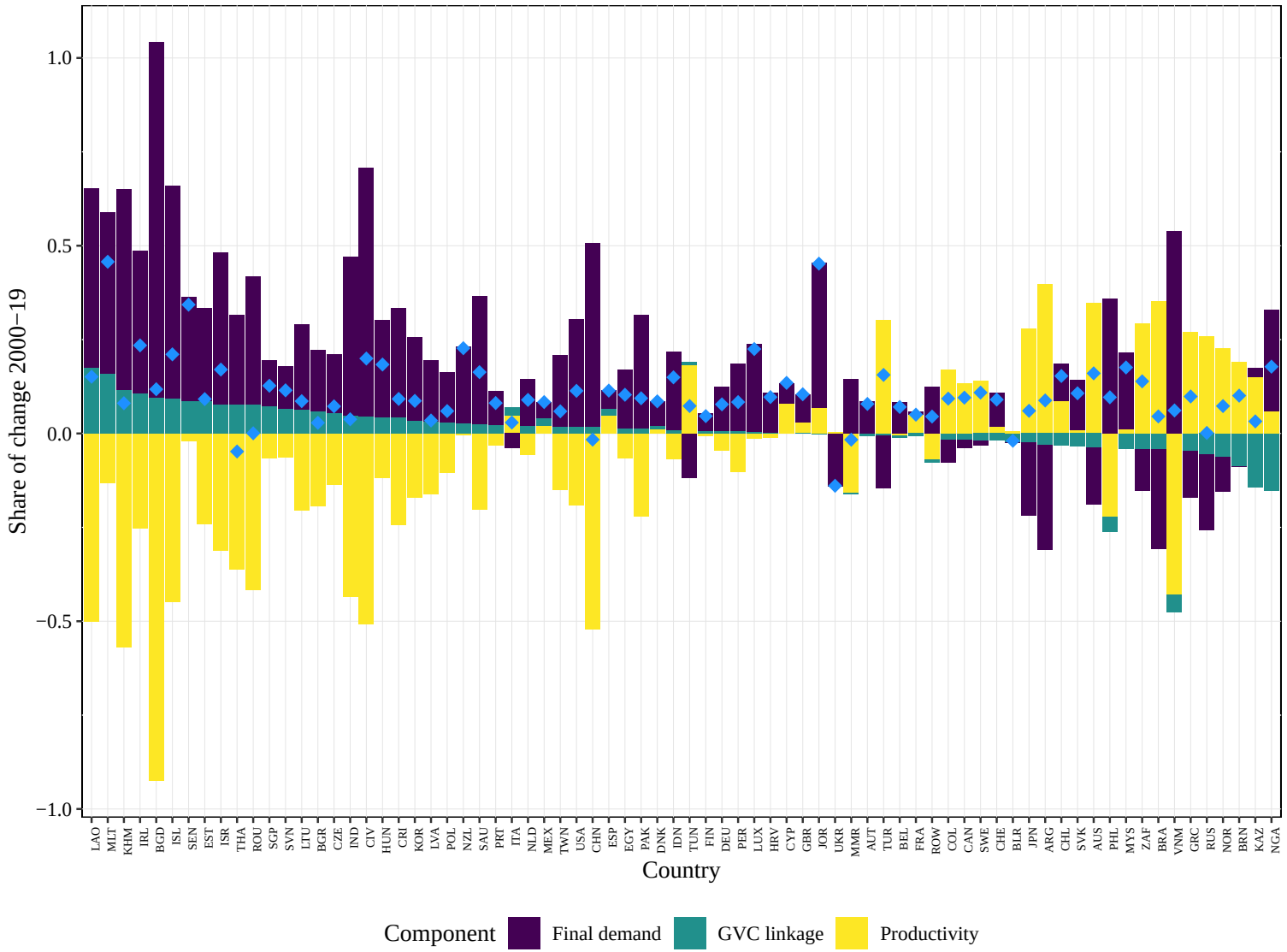
$$= \underbrace{\frac{(\mathrm{E}'_{t1} - E'_{t0})\, VB_{t0} F'_{t0} + (\mathrm{E}'_{t1} - E'_{t0})\, VB_{t1} F'_{t1}}{2}}_{\text{Productivity}}$$

$$+ \underbrace{\frac{E'_{t0}\,(VB_{t1} - VB_{t0})\, F_{t1} + E'_{t1}\,(VB_{t1} - VB_{t0})\, F_{t0}}{2}}_{\text{GVC linkages}} \tag{1}$$

$$+ \underbrace{\frac{E'_{t0} VB_{t0}\,(F'_{t1} - F'_{t0}) + E'_{t1} VB_{t1}\,(F'_{t1} - F'_{t0})}{2}}_{\text{Final Demand}}$$

Total employment decomposition: countries, 2000-2019

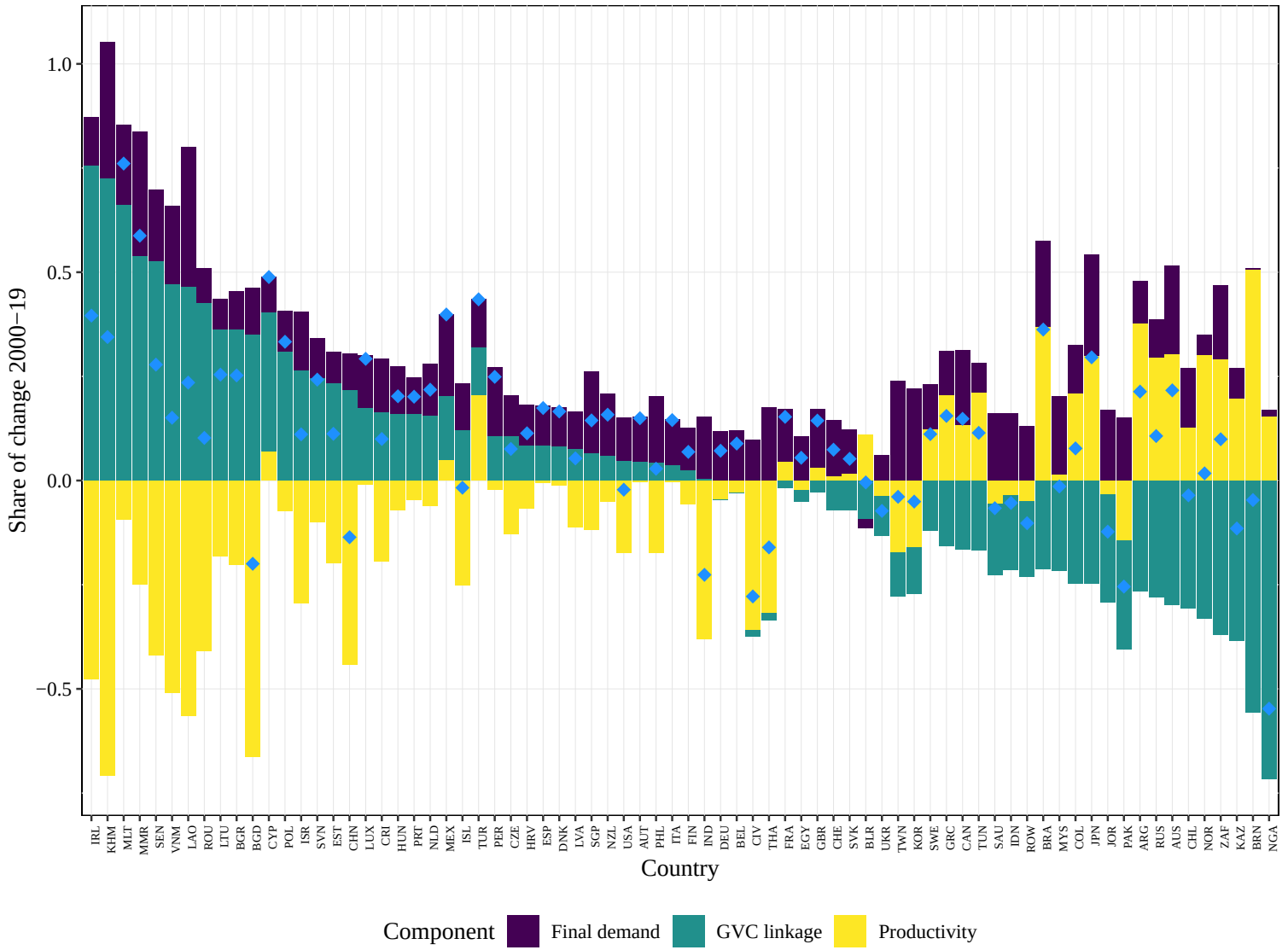
Final demand and productivity offset each other



Change components have been normalised by total employment in 2012

Total employment decomposition: countries, 2000-2019

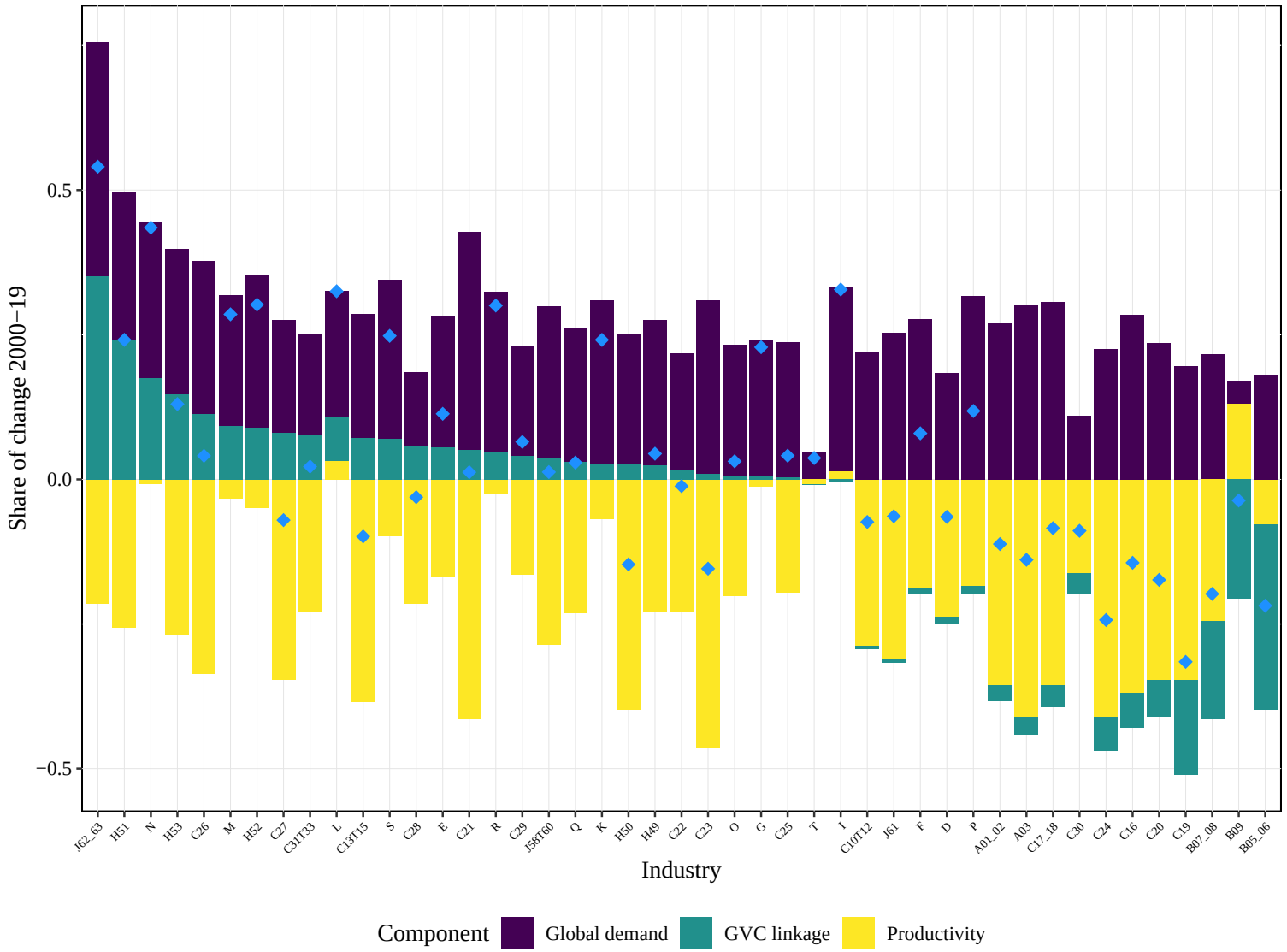
GVC linkages account for a higher portion of GVC jobs growth.



Change in GVC jobs components have been normalised by total employment in 2012

Total employment decomposition: industries, 2000-2019

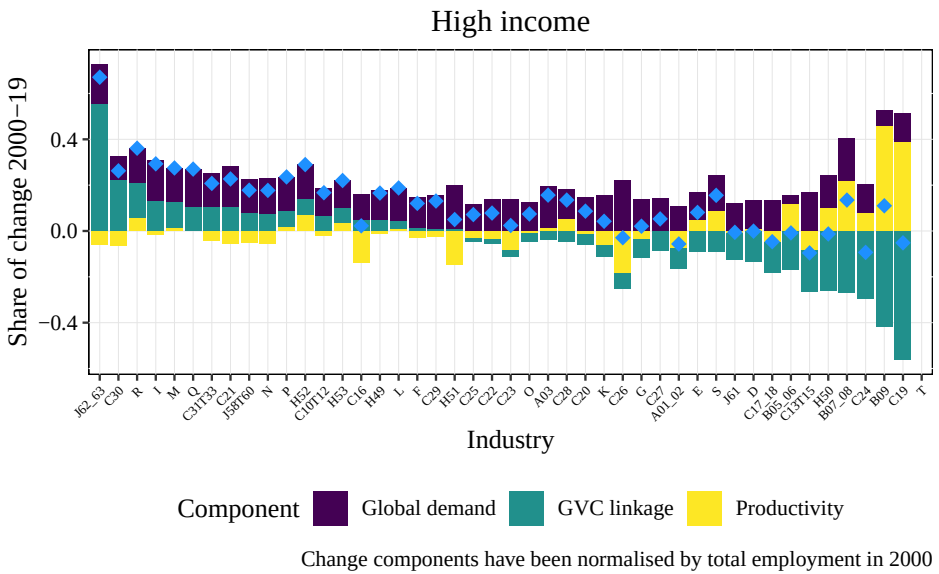
Structural change towards GVC dominated sectors



Change components have been normalised by total employment in 2000

GVC jobs decomposition across income groups

GVC Employment percentage change and components by industries and World Bank Income Group



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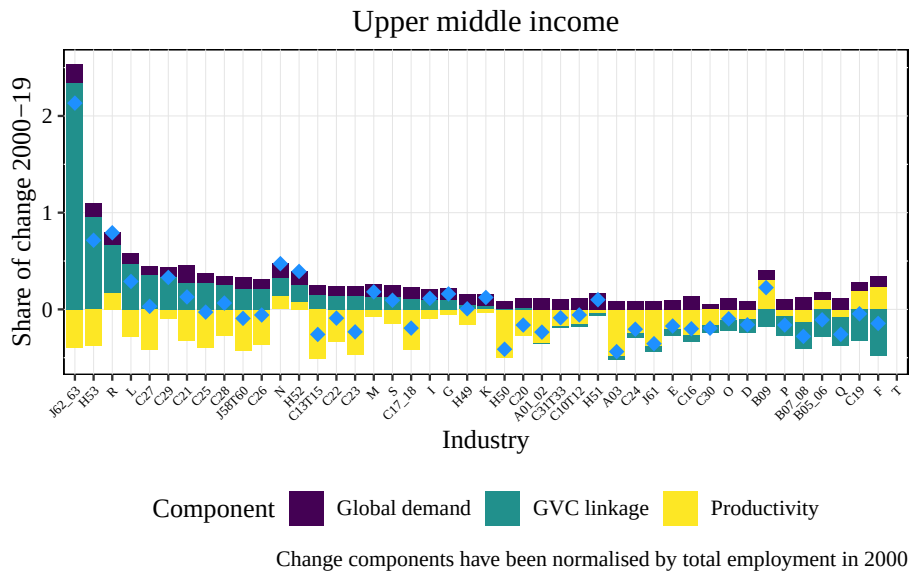

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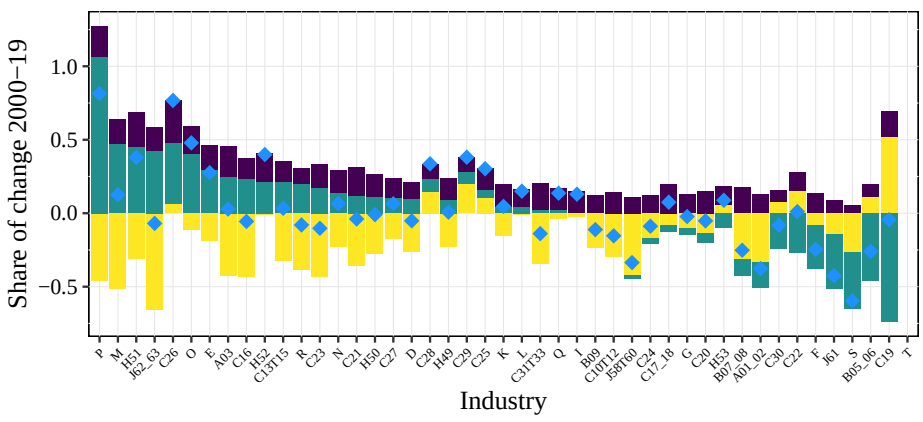

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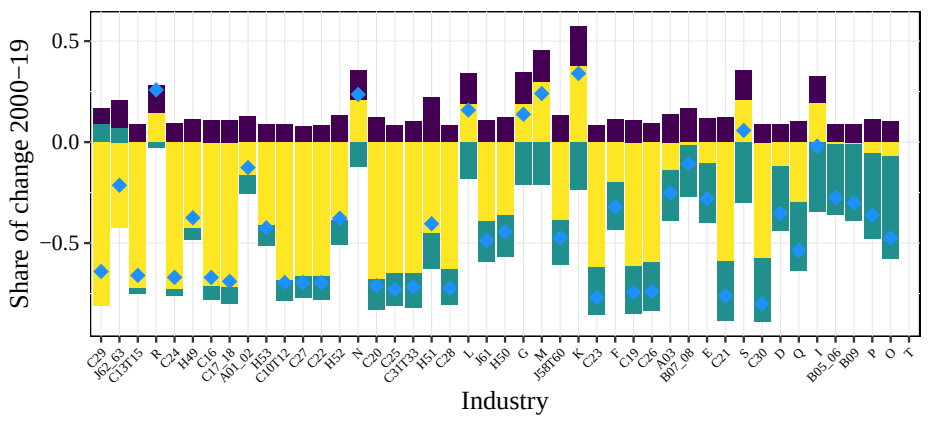
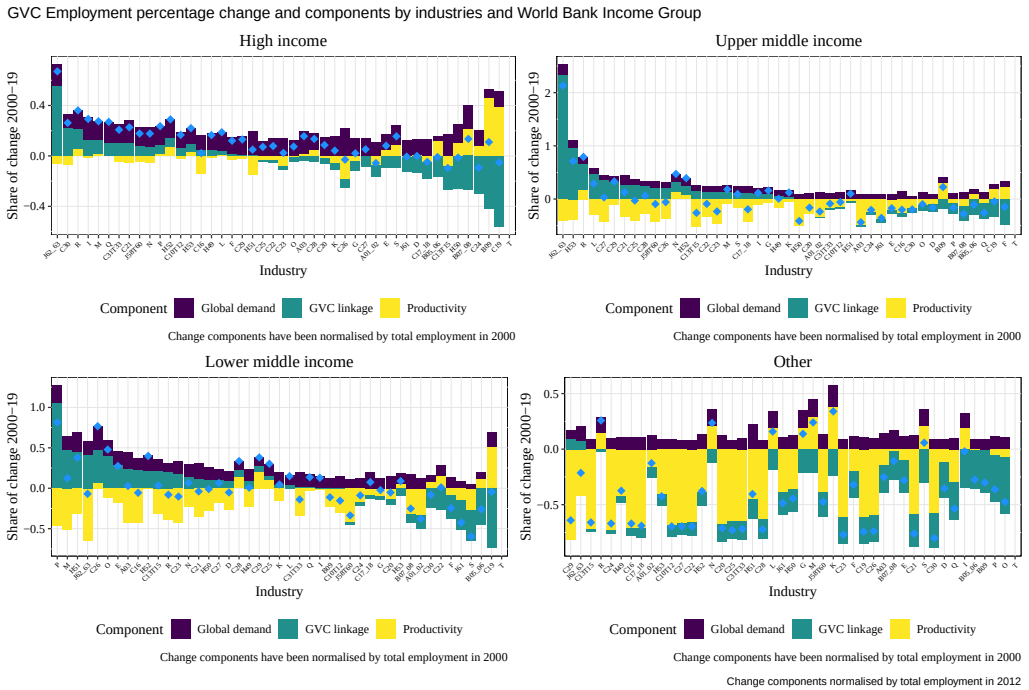


Change components have been normalised by total employment in 2000

Change components normalised by total employment in 2012

GVC jobs decomposition across income groups

- HIC: mostly demand led GVC; in services (ICT, business services, transport) more visible benefits from the GVC-linkage
- UMIC: deepening GVC participation expands relatively labour-intensive stages; especially in mid/high-tech manufacturing (chemical, machinery, automotive); large increase in IT services
- LMIC: higher gains than in HIC from GVC, but mostly in business, public services (E,P,O).



Digital Exposure Measures

- To compute measures of digital technological change we start from the measure of *techXposure* [Prytkova et al., 2025].
- The measures relies on text analysis of embeddings of patents over the period 2012-19 that are matched to ISIC 2-digit industries.
- Technological change at the frontier won't affect all countries equally.
- We complement this information with measures of country-level readiness to adopt.

$$\text{Digit}^{\text{tech}}_{ij,y} = \text{TechXposure}^{\text{tech}}_{j,y} * \text{Adoption}_{i,y0} \tag{2}$$

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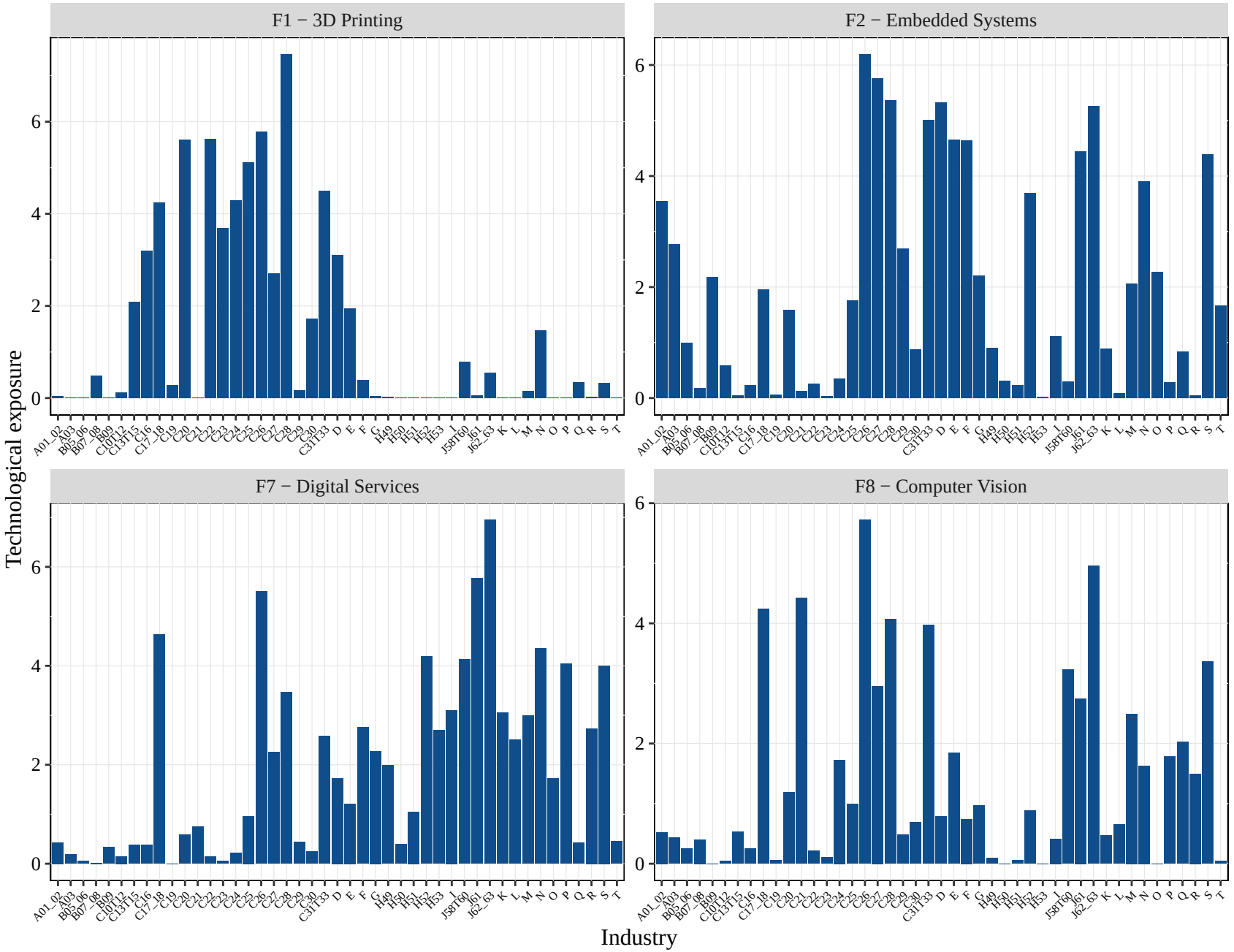
$\text{Adoption}_{i,y}$ is the pre-sample ($y0 =$ 2007-11) gross fixed capital formation (GFCF) from ICIO, produced by the computer, electronic, and optical equipment industry (C26).

$$\text{Digit}^{\text{tech}}_{ijy} = \text{TechXposure}^{\text{tech}}_{j} \times \overline{cpte}_{i,07-11} \tag{3}$$

Technological exposure across industries



Econometric Approach

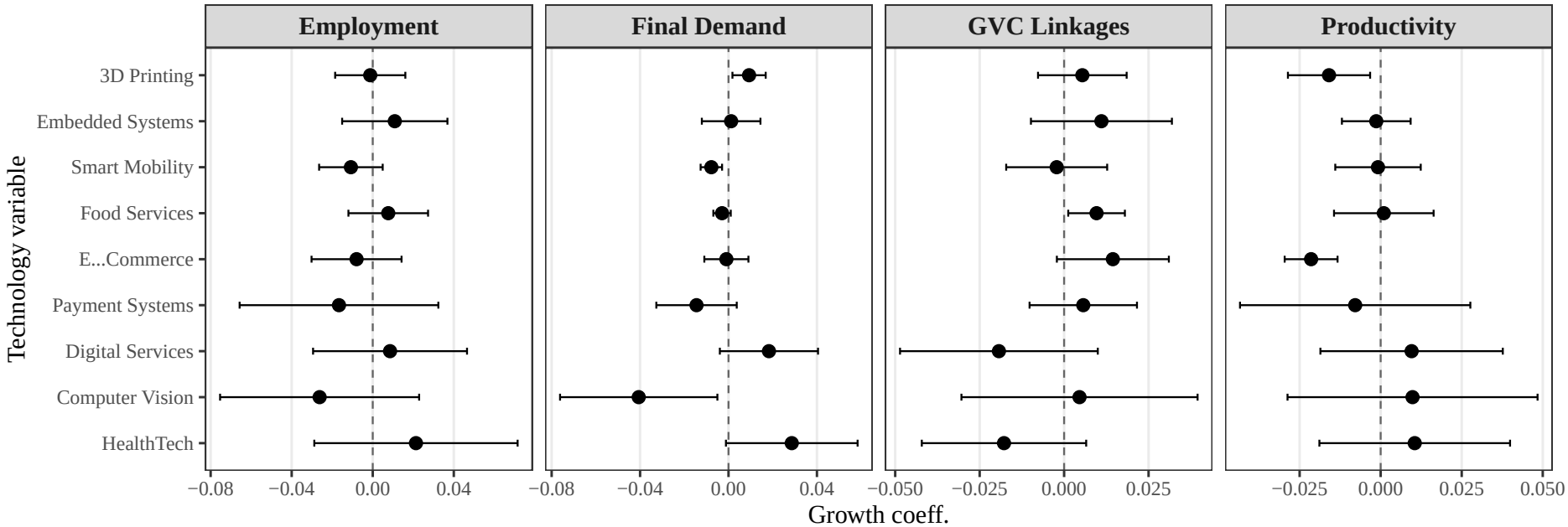
We test the relationship among our technological variable and % growth in employment ($\Delta E_{ij,y}$) in a simple OLS framework, for $y = 2019 - 12$:

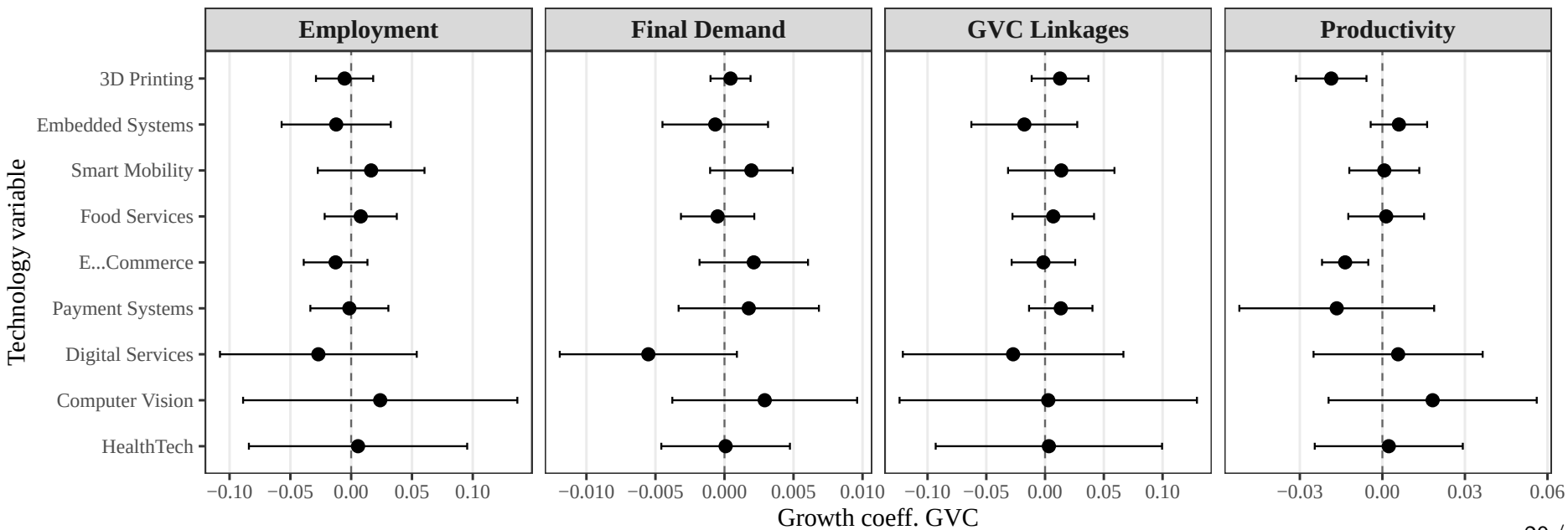
$$\Delta E_{ij,y} = \alpha + \beta_1 \sum_{tech} Digit_{ij,y}^{tech} + \kappa_i + \delta_j + \varepsilon_{ij,y} \tag{4}$$

- Our outcome variable ($\Delta E_{ij,y}$) is change in total or GVC jobs.
- $i, j =$ country and industry, respectively
- We include fixed effects κ_i, δ_j.
- $y =$ 2019-12 period.
- We include all 9 technological families to account for complementarities and substituability among them.
- We exclude primary and non-market sectors.

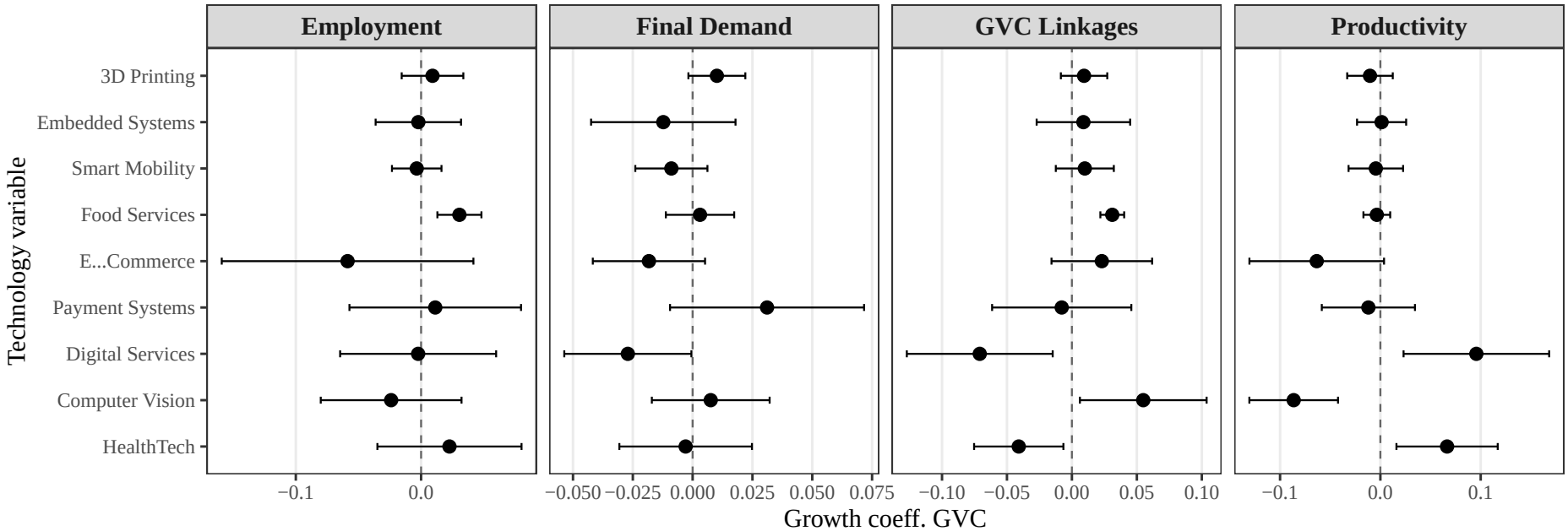
Outline

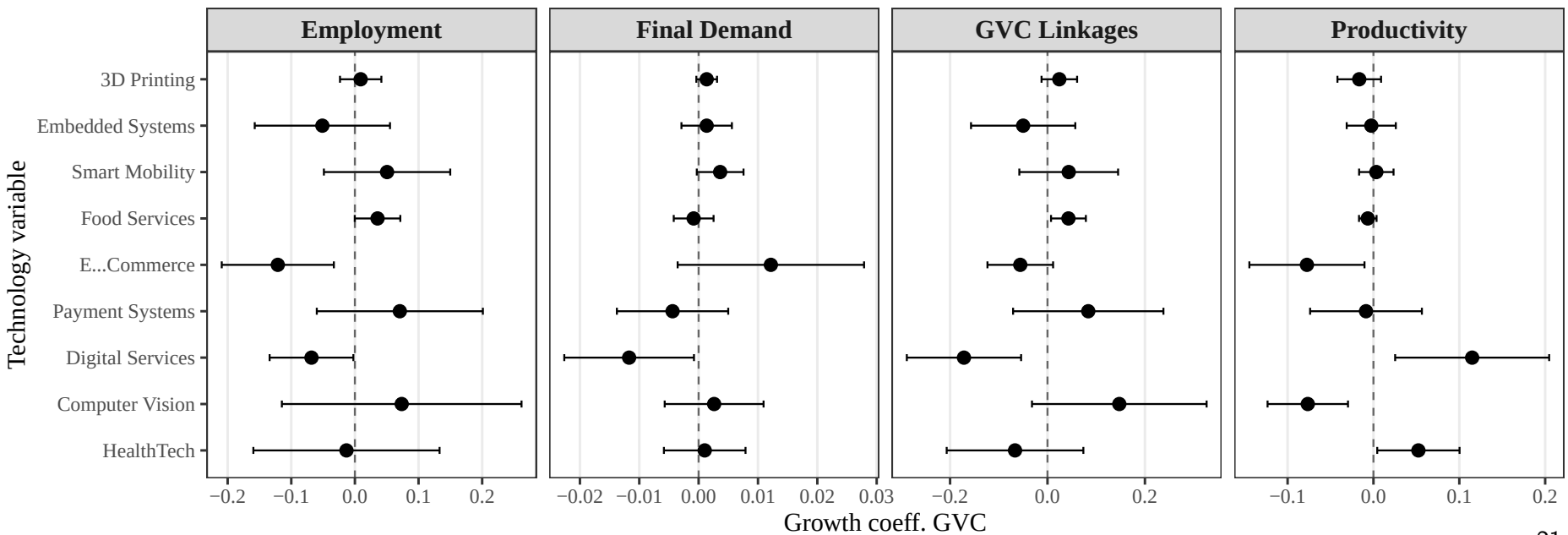
Main Results



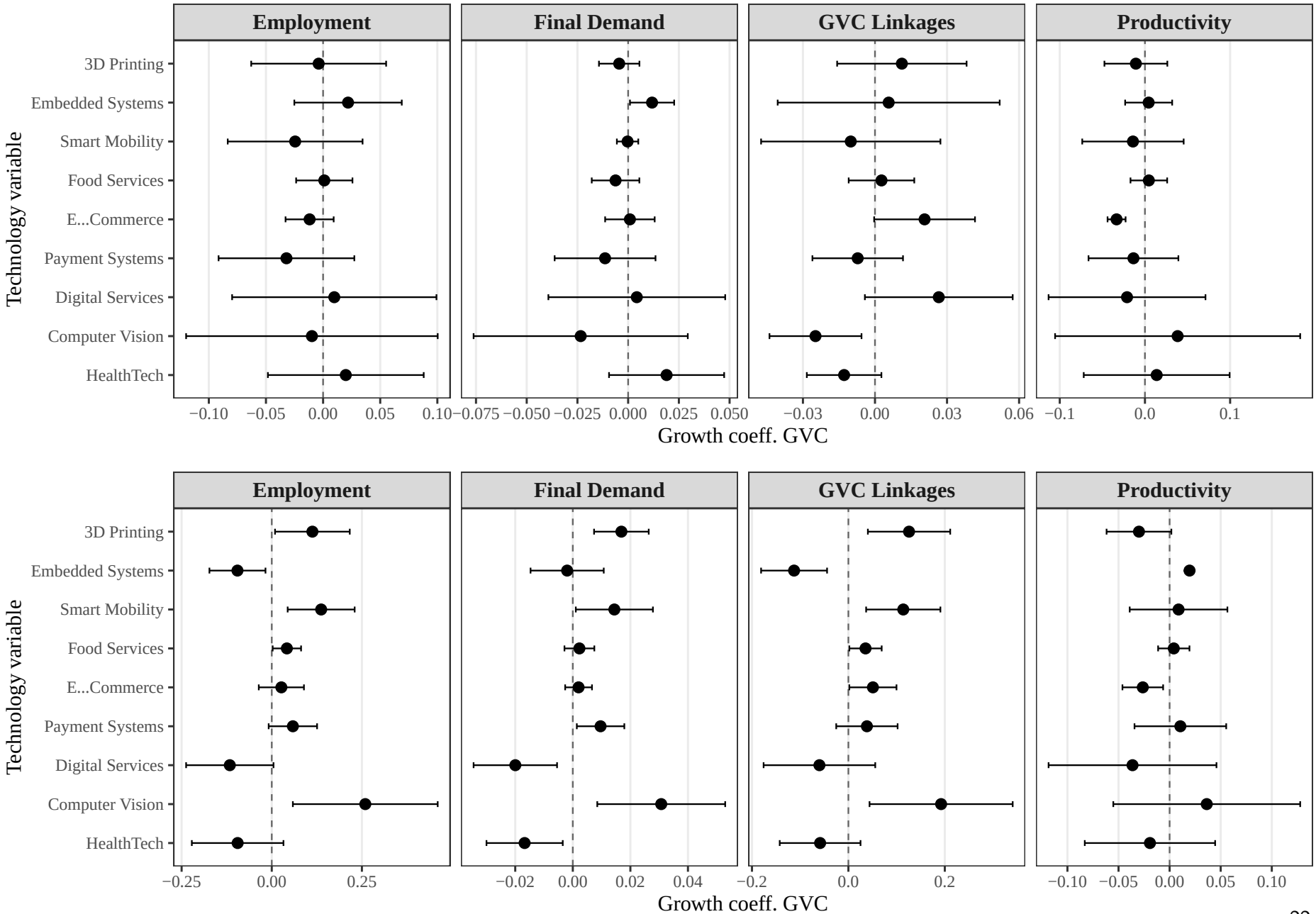


Main Results - manufacturing





Main Results - services



Outline

Conclusions

1. Overall employment effects are far from straightforward, as productivity, demand, and GVC-linkage channels often offset each other.
2. Digital technologies can automate jobs, expand or contract GVCs and final demand and also create new non-routine tasks and jobs.
3. Sectoral heterogeneity is key: digital technologies are mainly labour-saving in manufacturing and market-expanding in services.
4. A nuanced approach is key when evaluating the possible impact of new digital technologies on employment and its redistributional implications.

Outline

Technologies - from Prytkova et al. 2025

	Family		Emerging Digital Technology
F1	3D Printing	01	3D Printer Hardware
		02	3D Printing
		03	Additive Manufacturing
F2	Embedded Systems	04	Smart Agriculture & Water Management
		05	Internet of Things (IoT)
		06	Predictive Energy Management and Distribution
		07	Industrial Automation & Robot Control
		08	Remote Monitoring & Control Systems
		09	Smart Home & Intelligent Household Control
F3	Smart Mobility	10	Intelligent Logistics
		11	Autonomous Vehicles & UAVs
		12	Parking and Vehicle Space Management
		13	Vehicle Telematics & Electric Vehicle Management
		14	Passenger Transportation
F4	Food Services	15	Food Ordering & Vending Systems
F5	E-Commerce	16	Digital Advertising
		17	Electronic Trading and Auctions
		18	Online Shopping Platforms
		19	E-Coupons & Promotion Management
F6	Payment Systems	20	Electronic Payments & Financial Transactions
		21	Mobile Payments
		22	Gaming & Wagering Systems
F7	Digital Services	23	Digital Authentication
		24	E-Learning
		25	Location-Based Services & Tracking
		26	Voice Communication
		27	Electronic Messaging
		28	Workflow Management
		29	Cloud Storage & Data Security
		30	Information Processing
		31	Cloud Computing
		32	Recommender Systems
		33	Social Networking & Media Platforms
		34	Digital Media Content
F8	Computer Vision	35	Augmented and Virtual Reality (AR/VR)
		36	Machine Learning & Neural Networks
		37	Medical Imaging & Image Processing
F9	HealthTech	38	Health Monitoring
		39	Medical Information
		40	E-Healthcare

Notes: This table lists the 40 emerging digital technologies along with their respective emerging technology families. Emerging digital technologies are obtained by clustering the embeddings using the k–means algorithm, where the embeddings are derived with the sentence transformer all-mpnet-base-v2. For a short description of these technologies, refer to Tables A.1 to A.3 in Appendix A.2. Technologies are grouped by families, where a family comprises technologies whose occupation structure of semantic links is highly correlated.

References

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