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# On the Geography of Digital Specialization of Greek Regions

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# Introduction



- The world is currently undergoing a **vast digital transformation**, accelerated by the novel **capabilities and technologies** brought by **Industry 4.0** and the major implications of Covid-19 aftermath.

- Information and Communication Technologies (**ICT**) have always been on the foreground both in terms of relevant **research** as well as **applications in everyday life and business.**

- **ICTs** are constantly gaining momentum as they are **reshaping and redefining business models**, **industrial production** and even **transforming whole economies**.

- Yet, **this technological 'force for change' does not have a ubiquitous transformative effect everywhere and for everyone**, as different countries, and regions within, them tend to receive different gains from the digitalization process based on their specialization patterns.

- This raises questions about the **positioning and participation of regions** in the national and global production networks and the expected economic and social benefits that they could reap from their digitalization processes.

# There is already a wealth of relevant literature about ICTs/I4.0/growth/investment/innovation



- **At the firm level**, it is widely acknowledged that **emerging digital technologies improve/accelerate innovation** through **organisational transformation** (Boeker et al., 2021; Carayannis et al., 2006; Verstegen et al., 2019).
  - The digitalization process of firms includes the **convergence of several types of I4.0** emerging technologies which results into **novel cyber-physical and intelligent systems** that can create or add value to several industrial activities (Alejandro G. Frank et al., 2019; Liao et al., 2017; Müller et al., 2018)
- **At the national level**, several studies investigated the ICT capital effect on different samples of developed and developing economies and their findings suggest the presence of a **positive linkage between ICT investment and economic growth** across different samples (Papaioannou and Dimelis 2010; Niebel 2018; Myovella et al. 2020).
  - The ICT impact on the economy – although positive – **is subject to geographical and economy specific characteristics** (Dedrick et al. 2013; Myovella et al. 2020).
  - ICT effects on growth are **non-linear** and depend on the **development level of each economy** and the organizational capabilities of its firms, presenting heterogenous patterns even in regions with high development levels, such as the EU (Albiman and Sulong, 2017; Vu et al., 2020).
  - A different strand of literature showed that **developed, high-income economies** experience higher growth gains from ICT utilization (Venturini, 2015; Cheng, et al., 2021). But even among them, there is significant heterogeneity regarding their effects, such as the case of the l**ower impact of ICTs on Europe compared to the US** (Timmer et. al, 2010; Kretschmer, 2012) → different factors may be at play and that the diversity in ICT gains among different economies may stem from **differences in firm-specific characteristics** (Castiglione et al. 2014), **or from sub-national, regional patterns of ICT integration**
- **At the regional level,** earlier aspirations for **leveraging the comparative strengths** of regions towards innovation and **adoption of new technologies** were met with concerns that higher regional specialisation would leave other regions **more exposed to the negative effects of the relocation of firms** and other location-related imbalances (Martin, 1999; Hallet, 2000; Midelfart-Knarvik and Overman, 2002).
  - Many of the early empirical efforts at the **sub-national level** were hindered by **data unavailability issues** (Hallet, 2000).

# What is the situation in Greece ?



- Various studies have shown that **productive and technological transformation in Greece were slow over the years** and coupled with **institutional and governance inefficiencies** reflected on low and decreasing productivity and competitiveness (Caloghirou, 2008; Giannitsis, 2013; Giannitsis et al., 2009; Giannitsis & Kastelli, 2014; Kastelli & Zografakis, 2017; Papayannakis, 2008).
  - The first comprehensive national plan related to leveraging the new I4.0 ICTS was prepared only in 2020
  - The Covid-19 pandemic was a huge probably catalyst
- Specific **structural characteristics** of the Greek business ecosystem **are major constraints for rapid ICT diffusion**: the **small firm size**, the high contribution of **labour compensation in gross production** value, the **low R&D** investments, the **weak inte**ractions among the actors of the business ecosystem, etc.
- As for **DT, Greece ranks low in relevant digitalization indicators** (European Commission, 2021), and Greek SMEs still lag the EU average in assimilating new technologies and engaging in e-business activities (European Commission, 2016).
  - Greece's digital performance in the **DESI** presents some improvement (connectivity and use of internet), although important issues remain to be solved, and it is **consistently ranked in the bottom 3 places.**
  - Greece also ranks high -23$^{rd}$ among 64 countries- in terms of **digital trade restrictions**
  - Greece has presented some relative improvement in some dimensions, including connectivity and internet use, but digital skills, the digitalization of the business sector and digital public services still have a long way to go for Greece to converge with the EU average (Laitsou, 2020)
- **BUT** despite these hindering factors, **ICTs can still be considered as a major growth driver for the Greek economy**.
  - Antonopoulos and Sakellaris (2009) provided evidence that the **deepening in ICT investments can provide significant gains to growth, especially benefiting service sectors of the economy**.
  - European Investment Bank (2019) shed light to a different dimension of this contribution and the great potential of enhancing this effect, by finding that the **difference between the average labour productivity** of digital adopters and non-adopters in Greece **is one of the highest in the EU**.
  - Tsakanikas et al. (2021) provided updated **evidence regarding a significant deepening in ICT capital intensity** and a **re-orientation of the Greek industrial policy agenda** towards the prioritization of the digitalization of the Greek public and private business sectors.
  - From a different perspective, Stamopoulos et al. (2022) found that the **domestic ICT sector provides a significant contribution to the Greek GDP and employment**, but **the diffusion of ICTs in the economy is rather sluggish** because of the low responsiveness of the business sector to the integration of digital technologies.

# Scope – Objective



This working paper attempts to **build on these remarks** and empirically **investigate the regional dimension of specialization in ICT** related digital products/services and **regional patterns of digital technology adoption** on regional output (i.e., **value added**) and competitiveness across the Greek economy.

**In essence, we aim to address the following research questions:**

1. **How** specialized is each Greek region in **producing ICT** related digital products/services?
2. **What** is the situation regarding **ICTs adoption** in each Greek region?
3. Do these aspects, along with other possible factors (e.g. regional research output, differences in trade destinations etc) **affect regional competitiveness?**

# Methodology



We follow a three-stage methodological procedure:

1. Data gathering and **harmonization** based on the **NACE rev.2** system of industrial classification

2. Development of proxy indicators for each ICT-related aspect
   - Regional level: specialization, production, research
   - Firm level: Adoption levels of specific ICT technologies, digital skills of employees, trade destination and origin

3. Investigation of the effects on regional competitiveness

# Data



- This research effort attempts to **combine data from existing sources** (Statistical Institutes and Business Registries) **with extensive datasets collected from field surveys**.
- We utilize data at two different levels (regional and firm level) from different sources:

➢ **Regional data**

- Greek business registry.
- Detailed information about the **number of enterprises, employment, and financial aspects** up to the **NUTS3** level
- Source: Hellenic Statistical Authority (ELSTAT) and Eurostat.
- Data regarding **regional research intensity** and level of participation in research networks are compiled from the results of the "NentOnKIE" project (HFRI-FM17-3087).

➢ **Firm-level data**

- Diverse sample of **1014 Greek manufacturing firms**
- Information about different **ICT technology adoption, digital skills, GVC** participation etc.
- Field survey conducted in 2019 by the Laboratory of Industrial and Energy Economics of the National Technical University of Athens (LIEE-NTUA) in collaboration with the Greek Foundation for Economic and Industrial Research (FEIR/IOBE)
- Structured (closed format) questionnaires that targeted the **CEOs and CFOs** of the firms, utilizing the **CATI method**

➢ **Supplementary Data**

- Additional social, geographical and economic data are drawn from Eurostat's regional statistics accounts.

# ICT Sector: Background and Definitions



- The term ICT is usually adopted to describe information management techniques, telecommunication technologies, devices and applications that enable the production, processing, grouping, retrieval, and storage and transformation of information (Brady et al., 2002).
- The **ICT umbrella term** has been expanded to account for applications that enable the generation and access to data, data collection, processing, storage, and transmission (Jorgenson, 2005).

➢ **We focus on the bulk of activities that constitute the ICT sector's services component**, in line with OECD's formal definition and the corresponding segments of UNCTAD's digital economy, **without** considering sectors that engage in the hardware manufacturing of ICT related hardware

| NACE rev. 2 Code | Description |
|---|---|
| J.58 | **Publishing activities** |
| · J.58.1 | Publishing of books, periodicals and other publishing activities |
| · J.58.2 | Software publishing |
| · J.58.21 | Publishing of computer games |
| · J.58.29 | Other software publishing |
| J.59 | **Motion picture, video and television programme production, sound recording and music publishing activities** |
| J.60 | **Programming and broadcasting activities** |
| J.61 | **Telecommunications** |
| · J.61.1 | Wired telecommunications activities |
| · J.61.10 | Wired telecommunications activities |
| · J.61.2 | Wireless telecommunications activities |
| · J.61.20 | Wireless telecommunications activities |
| · J.61.3 | Satellite telecommunications activities |
| · J.61.30 | Satellite telecommunications activities |
| · J.61.9 | Other telecommunications activities |
| J.61.90 | Other telecommunications activities |
| J.62 | **Computer programming, consultancy and related activities** |
| · J.62.0 | Computer programming, consultancy and related activities |
| · J.62.01 | Computer programming activities |
| · J.62.02 | Computer consultancy activities |
| · J.62.03 | Computer facilities management activities |
| · J.62.09 | Other information technology and computer service activities |
| J.63 | **Information service activities** |
| · J.63.1 | Data processing, hosting and related activities; web portals |
| · J.63.11 | Data processing, hosting and related activities |
| · J.63.12 | Web portals |
| · J.63.9 | Other information services activities |

**Note:** The J.58.1 code does not correspond to an actual ICT activity. However, we include this code due to data unavailability and under the hypothesis that its actual contribution to J.58 is rather limited compared to J.58.2.

# Methodology (1): Constructing ICT specialization indicators at the regional level



- **Horizontal ICT specialization**: Share of ICT producing firms relative to the total number of firms in the region

$$S_N^r = {N_{ICT.firms}^{region}} \Big/ {N_{Allfirms}^{region}}$$

- **Economic ICT specialization**: Share of turnover of the ICT producing firms relative to the turnover of the total number of firms in the region

$$S_{\mathrm{TO}}^r = {Turnover_{ICT.firms}^{region}} \Big/ {Turnover_{Allfirms}^{region}}$$

- **Employment ICT specialization**: Share of employment of the ICT producing firms relative to the total employment of the firms in the region

$$S_{\mathrm{Emp}}^r = {Employees_{ICT.firms}^{region}} \Big/ {Employees_{Allfirms}^{region}}$$

# Methodology: (2) Developing a regional level competitiveness indicator



- This working paper **approaches competitiveness through the gross value-added (GVA) produced in each region**, attached to a **comparative perspective** in order to provide a **baseline** that defines the performance of each region against the aggregate national performance.
- This is accomplished through a standard **Ricardian-type (revealed) comparative advantage indicator (RCAIs).** We develop an adjusted competitiveness RCA-type indicator that reflects regional economic performance for our sample:

$$gva.rc_r = \frac{\frac{GVA_{region}}{POP_{region}}}{\frac{\sum_{regions} GVA_{region}}{\sum_{regions} POP_{region}}}$$

- This indicator depicts the share of each region's GVA per capita, relative to the aggregate GVA per capita produced in all Greek regions (national level GVA per capita).

# Methodology (3): Developing indicators that account for trade and research activities at the regional level



- **Regional trade at the firm level - sales per destination**
  - % of sales directed to the same NUTS2 region (as the firm)
  - % of sales directed to another NUTS2 region
  - % of sales directed abroad
- **Regional trade at the firm level - purchases per origin**
  - % of purchases originating in the same NUTS2 region (as the firm)
  - % of purchases originating in another NUTS2 region
  - % of purchases originating abroad
- **Regional research intensity and research participation**
  - Number of research joint ventures undertaken by the region's firms and universities
  - Intensity of regional research joint ventures is approached with the number of connections made by the region's firms and universities

# Methodology (4): Indicators that capture I4.0 tech utilization at the firm level based on survey data



**ICT usage intensity (5-point scale) for:**

- New production planning systems
- Advanced solutions for production and quality control
- Use of 3D printing systems for rapid prototype development, custom components manufacturing etc.
- Advanced systems for communication with partners/suppliers/customers (e.g., e-invoicing, digital procurement, etc.)
- Advanced systems for equipment maintenance and accident prevention (e.g., sensors, predictive maintenance, devices worn for safety, etc.)
- Access to Big Data and use of data analytics
- Access to next generation networks and use of appropriate solutions and architectures (cloud, hardware & software as a service)
- Integration of new business models for digital environments, such as e-commerce, participative platforms, etc.
- Effective management of privacy and cybersecurity risks

**Additional indicators about ICTs and employees.**

- Intramural investment in digital technologies/solutions related to employee's development and learning.
- Availability of employees with the necessary skills in order to take advantage of the opportunities offered by digital technologies

# Main descriptives and some salient facts: The manufacturing demography of our sample



- Our field research sample focuses on the **manufacturing firms** in different **NUTS3** Regions
- We present the frequency (no. of firms in the sample) and the in-sample share that our field research covers.
- There is an observable heterogeneity among regions:
  - Low representation for several regions with limited manufacturing activities (mostly islands)
  - **Concentration of activities in the Attica** (Athens) and Thessaloniki regions
  - **However**, the sample is diversified enough to provide a **mapping of ICT specialization in Greek manufacturing**

| NUTS3 Region | Frequency | % (in-sample) | NUTS3 Region | Frequency | % (in-sample) |
|---|---|---|---|---|---|
| Achaia | 18 | 1.8% | Kalymnos, Karpathos, Kasos, Kos, Rodos | 11 | 1.1% |
| Aitoloakarnania | 5 | 0.5% | Karditsa, Trikala | 16 | 1.6% |
| Anatoliki Attiki | 54 | 5.3% | Kastoria | 8 | 0.8% |
| Andros, Thira, Kea, Milos, Mykonos, Naxos, Paros, Syros, Tinos | 8 | 0.8% | Kentrikos Tomeas Athinon | 70 | 6.9% |
| Argolida, Arkadia | 16 | 1.6% | Kerkyra | 4 | 0.4% |
| Arta, Preveza | 10 | 1.0% | Kilkis | 11 | 1.1% |
| Chalkidiki | 11 | 1.1% | Korinthia | 12 | 1.2% |
| Chania | 16 | 1.6% | Lakonia, Messinia | 3 | 0.3% |
| Chios | 4 | .4% | Larisa | 18 | 1.8% |
| Drama | 22 | 2.2% | Lasithi | 6 | 0.6% |
| Dytiki Attiki | 44 | 4.3% | Lefkada | 1 | 0.1% |
| Dytikos Tomeas Athinon | 47 | 4.6% | Lesvos, Limnos | 8 | 0.8% |
| Evros | 12 | 1.2% | Magnisia | 24 | 2.4% |
| Evrytania | 1 | 0.1% | Notios Tomeas Athinon | 42 | 4.1% |
| Evvoia | 10 | 1.0% | Peiraias, Nisoi | 55 | 5.4% |
| Florina | 3 | 0.3% | Pella | 14 | 1.4% |
| Fokida | 3 | 0.3% | Pieria | 7 | 0.7% |
| Fthiotida | 6 | 0.6% | Rethymni | 10 | 1.0% |
| Grevena, Kozani | 9 | 0.9% | Rodopi | 7 | 0.7% |
| Ikaria, Samos | 2 | 0.2% | Serres | 7 | 0.7% |
| Ileia | 12 | 1.2% | Thasos, Kavala | 15 | 1.5% |
| Imathia | 10 | 1.0% | Thesprotia | 2 | 0.2% |
| Ioannina | 7 | 0.7% | Thessaloniki | 126 | 12.4% |
| Irakleio | 25 | 2.5% | Voiotia | 45 | 4.4% |
| Ithaki, Kefallinia | 1 | 0.1% | Voreios Tomeas Athinon | 117 | 11.5% |
| | | | Xanthi | 0.8 | .8% |
| | | | | Total | 1014 (100.0%) |

# Main descriptives and some salient facts: ICT adoption in regions by I4.0 tech type



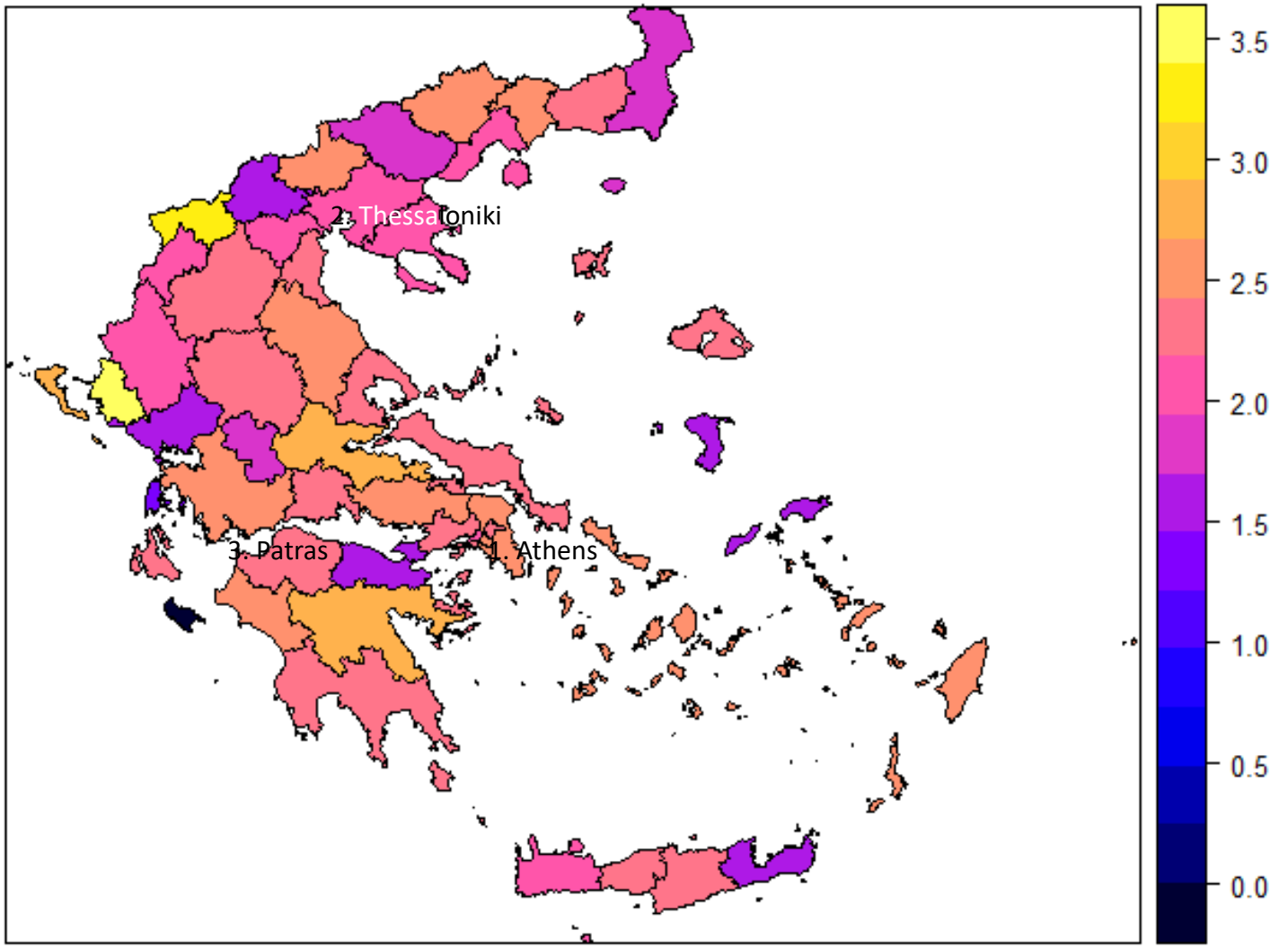
- Most firms in our sample appear to have adopted and utilize advanced solutions for production and quality control and advanced systems for maintenances and accident prevention → **production-related, tangible I4.0 ICTs are the most adopted**.
- Cybersecurity, cloud services, hardware, software as a services and advanced communication techs are highly utilized as well but not as production-related I4.0 ICTs.
- **Advanced I4.0 technologies** such as 3D printing systems, e-commerce, digital platforms and new business. models are still at **very early stages** of adoption
- **Greek manufacturing** firms appear to be at the **initial stages** of the **digital transformation process** where tangible technologies are integrated in the production.

| I4.0 tech type | Unit | N | Mean | Median | Std. Dev. | Min. | Max |
|---|---|---|---|---|---|---|---|
| Advanced solutions for production and quality control | 5-pt. scale | 52 | 2.76 | 2.71 | 0.73 | 1 | 5 |
| Advanced systems for equipment maintenance and accident prevention (e.g., sensors, predictive maintenance, devices worn for safety, etc.) | 5-pt. scale | 52 | 2.6 | 2.71 | 0.82 | 1 | 5 |
| Effective management of privacy and cybersecurity risks | 5-pt. scale | 52 | 2.44 | 2.52 | 0.68 | 1 | 4 |
| Access to next generation networks and use of appropriate solutions and architectures (cloud, hardware & software as a service) | 5-pt. scale | 52 | 2.39 | 2.39 | 0.73 | 1 | 4 |
| Advanced systems for communication with partners/suppliers/customers (e.g., e-invoicing, digital procurement, etc.) | 5-pt. scale | 52 | 2.24 | 2.33 | 0.67 | 1 | 4 |
| New production planning systems | 5-pt. scale | 52 | 2.18 | 2.28 | 0.56 | 1 | 3 |
| Access to Big Data and use of data analytics | 5-pt. scale | 52 | 1.88 | 1.91 | 0.59 | 1 | 3 |
| Integration of new business models for digital environments, such as e-commerce, participative platforms, etc. | 5-pt. scale | 52 | 1.72 | 1.77 | 0.45 | 1 | 3 |
| Use of 3D printing systems for rapid prototype development, custom components manufacturing etc. | 5-pt. scale | 52 | 1.26 | 1.22 | 0.35 | 1 | 2 |

# Mapping the average intensity of I4.0 technologies adoption in Greece by NUTS3 region



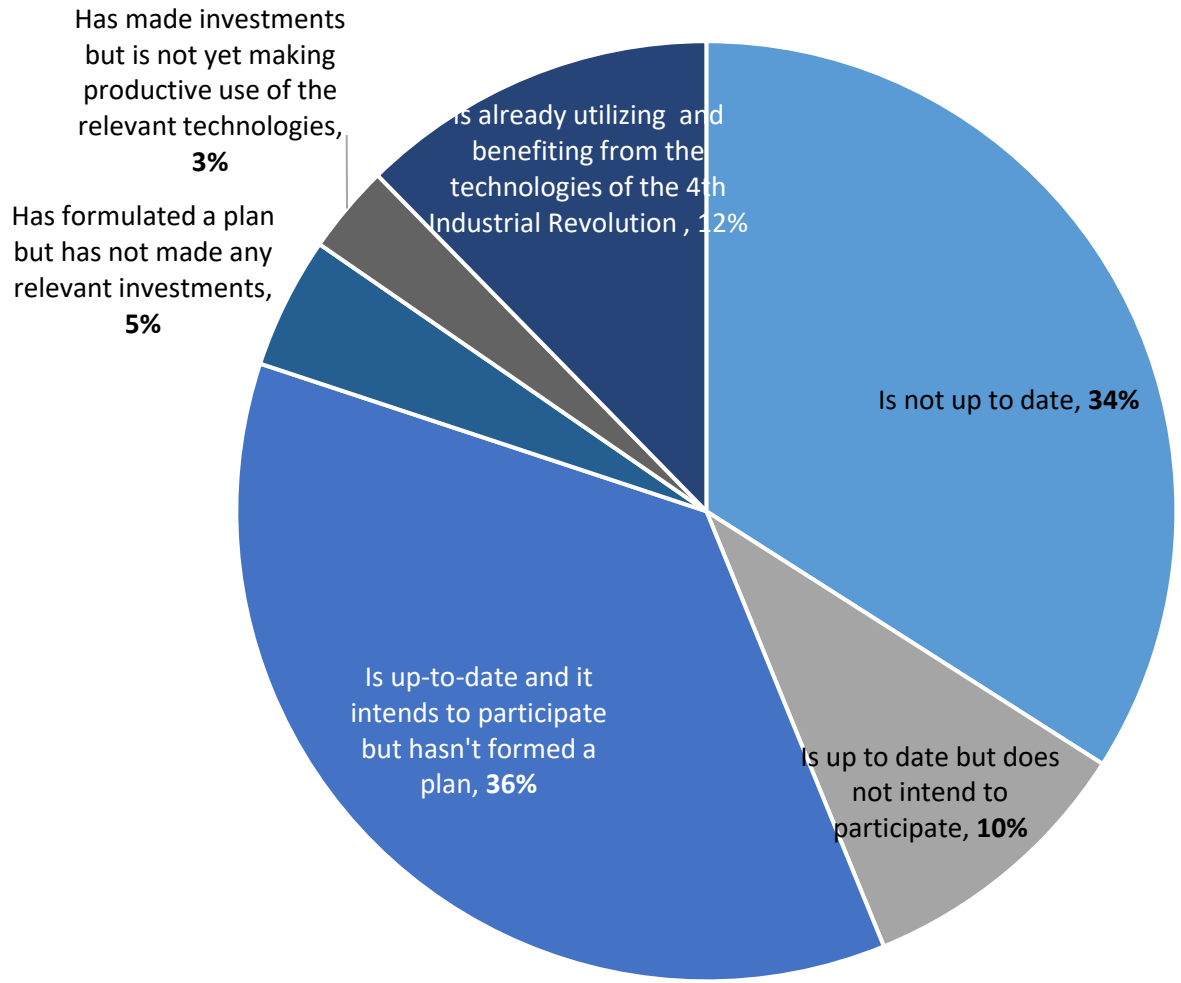
- Average values of the firms' responses on the 5-point scale I4.0 ICTs adoption
- The regions with the largest cities and production are not always the most inclined to adopt the new I4.0 ICTs
- Neighboring regions do not differ greatly, but there are some interesting cases at the extremities of the scale
- No clear patterns emerge → future steps need to turn to spatial analysis to identify regional interactions (if any)



# Main descriptives and some salient facts: Digital awareness of the Greek manufacturing firms



- Interestingly, regarding digital awareness, our sample shows **an important lag**.
- **Only 12.3% already adopts** and benefits from I4.0T, while **44%** are either **not up-to-date or didn't even intend to participate** in the I4.0 transformation.
- There results indicate that:
  - either firms **don't have a clear understanding** of the benefits arising from the adoption of digital technologies, or
  - they are **engaged in low-tech activities** and do not directly benefit from the digitalization process.
  - They face difficulties in securing the **necessary funding** for investing in I4.0



# Preliminary results: Identifying interesting specialization patterns in different regions (1)



**Horizontal ICT specialization** follows high GVA population centers

| NUTS3 | Horizontal specialization |
|---|---|
| Voreios Tomeas Athinon | 4.18% |
| Kentrikos Tomeas Athinon | 3.24% |
| Notios Tomeas Athinon | 3.12% |
| Anatoliki Attiki | 2.25% |
| Dytikos Tomeas Athinon | 1.88% |
| Peiraias, Nisoi | 1.71% |
| Thessaloniki | 1.64% |
| Achaia | 1.44% |
| Ioannina | 1.15% |

**Economic ICT specialization** showcases some unexpected regions.

| NUTS3 | Economic specialization |
|---|---|
| Voreios Tomeas Athinon | 8.43% |
| **Xanthi** | **8.42%** |
| Anatoliki Attiki | 5.43% |
| **Chios** | **3.34%** |
| Kentrikos Tomeas Athinon | 3.09% |
| **Irakleio** | **2.84%** |
| Notios Tomeas Athinon | 2.78% |
| Peiraias, Nisoi | 2.08% |
| Thessaloniki | 1.24% |

**Employment ICT specialization** aligns with economic specialization.

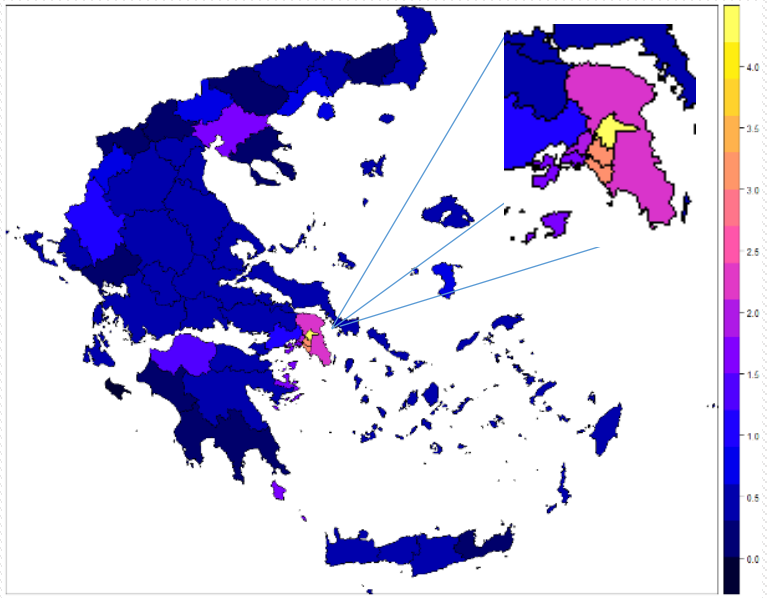
| NUTS3 | Employment specialization |
|---|---|
| Voreios Tomeas Athinon | 7.93% |
| Anatoliki Attiki | 4.76% |
| **Xanthi** | 4.22% |
| Notios Tomeas Athinon | 2.88% |
| Kentrikos Tomeas Athinon | 2.49% |
| Thessaloniki | 1.59% |
| **Chios** | 1.40% |
| Peiraias, Nisoi | 1.28% |
| **Irakleio** | 1.10% |

- ICT specialization follows the pattern of ICT geography and is concentrated in Attica, Thessaloniki and Piraeus
- However, some interesting patterns emerge in terms of economic and employment ICT specialization
- Specific regions with relatively low horizontal ICT specialization (i.e., share of ICT firms in the region) present significant patterns of economic performance:
  - Evidence of large ICT firms in the region
  - Most firms in the regions are engaged in non-ICT activities **but**
  - ICT activities are **more profitable** and provide **more jobs** compared to the rest of the economic activities in these regions

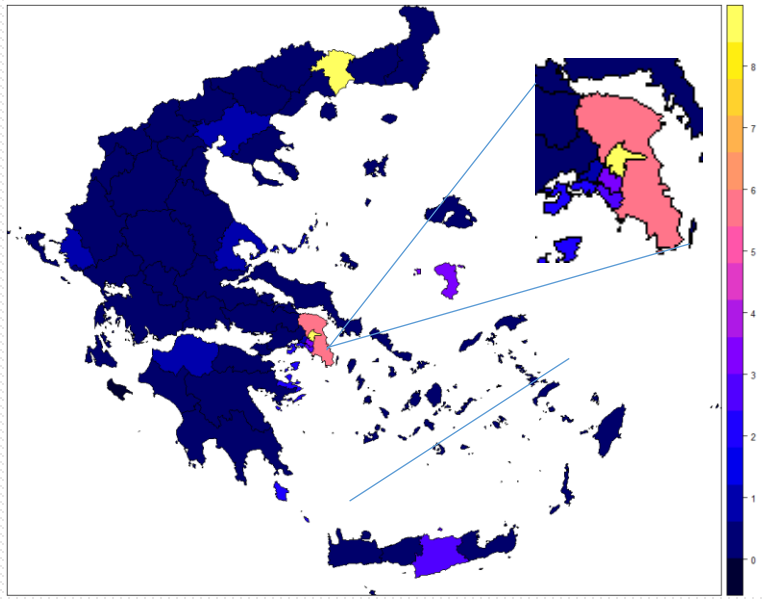
# Preliminary results: Identifying interesting specialization patterns in different regions (2)



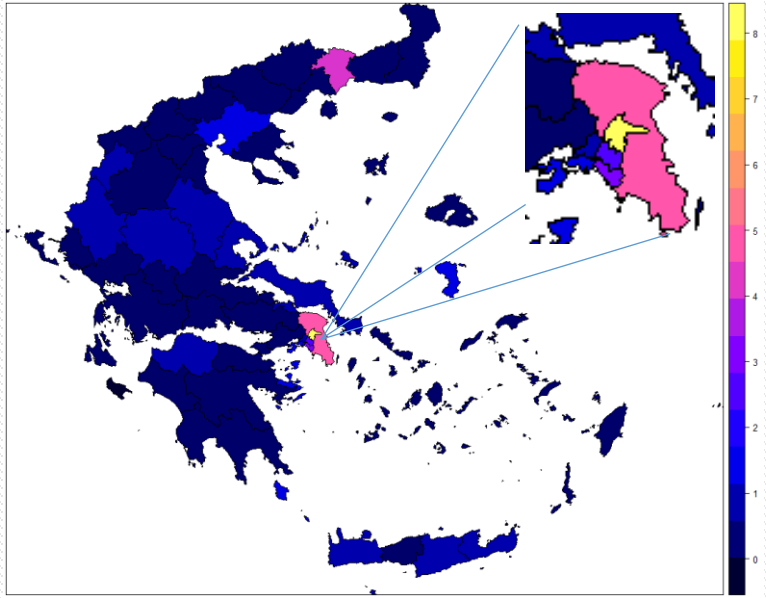
**Horizontal ICT specialization**



**Economic ICT specialization**



**Employment ICT specialization**



- Most regions present a less than 1% specialization rate regardless of type, with the **top performers** standing at around **3-8%.**
- This clear concentration of ICT specialization in specific regions of the economy can be interpreted through two different channels.
  - A **homogenous, country-wide digital lag** with limited exceptions including mostly sub-regions of the wider Attica metropolitan area.
  - A second interpretation aligns with the early results of Vicente and Jesús-López (2011), where a significant **digital divide** between the leading ICT regions (Attica) and the lagging regions (rest of Greece) is present.

# An initial attempt to link ICTs' adoption and specialization with competitiveness at the regional level



- I4.0 ICTs are **not ubiquitously correlated** with regional competitiveness.
- Introduction of new business models and digital environments (although one of the least-adopted technologies by Greek firms) alongside advanced communication systems are positively correlated with competitiveness
- The creation of knowledge and collaborations for research via university-firms cooperation within the region is strongly correlated with regional competitiveness.
- The same holds for employees with necessary digital skills to assimilate ICTs and for investments in employees' digital skills development and learning → **digital skills matter for regional competitiveness**
- Domestic and foreign trade indicators may present diverging correlation patterns – but more granular approaches are required (to *who* are the sales directed?)
- The different types of **ICT specialization are strongly correlated** with **regional competitiveness** hinting at a **virtuous circle of benefits:**
  - Horizontal specialization presents the strongest correlation
  - Economic specialization presents the weakest (yet statistically significant and stronger than other variables) correlation

| | Indicator\Aspect of ICT in relation with Regional economic competitiveness indicator | Corr. Value and Significance level |
|---|---|---|
| 1 | **Regional competitiveness indicator** | 1.000 |
| 2 | Use of Big Data and data analytics | 0.138*** |
| 3 | Access to next generation networks and use of appropriate solutions and architectures | 0.141*** |
| 4 | Integration of new business models for digital environments | 0.142*** |
| 5 | Effective management of privacy and cybersecurity risks | 0.046 |
| 6 | Advanced production planning systems | 0.073* |
| 7 | Advanced solutions for production and quality control | -0.039 |
| 8 | Use of 3D printing | 0.066* |
| 9 | Advanced systems for communication with partners/suppliers/customers | 0.142*** |
| 10 | Advanced systems for equipment maintenance and accident prevention | -0.014 |
| 11 | Investing intensity in digital technologies/solutions related to employee's development and learning | 0.122*** |
| 12 | Availability of employees with the necessary skills in order to take advantage of the opportunities offered by digital technologies | 0.199*** |
| 13 | Participation of the region in EU-funded programmes | 0.366*** |
| 14 | Linkages of the region in research networks created by its participation in EU-funded programmes | 0.334*** |
| 15 | % of sales directed to the same NUTS2 region (as the firm) | 0.094** |
| 16 | % of sales directed to another NUTS2 region | -0.018 |
| 17 | % of sales directed abroad | -0.132** |
| 18 | % of purchases originating in the same NUTS2 region | 0.119*** |
| 19 | % of purchases originating in another NUTS2 region | -.0140** |
| 20 | % of purchases originating abroad | 0.000 |
| 21 | Horizontal regional specialization in ICT production | 0.622*** |
| 22 | Economic regional specialization in ICT production | 0.325** |
| 23 | Employment regional specialization in ICT production | 0.435*** |

# Discussion of the preliminary results



Our preliminary results provided a first rough take on our research hypotheses:

1. **How** specialized is each Greek region in **producing ICT** related digital products/services?
   - In all cases, less than 10%
   - Few regions lead ICT specialization and are significantly ahead compared to the majority
   - Most regions present less than an 1% ICT specialization (in all three specialization types)
   - Some interesting cases appear in unexpected areas, such as Xanthi (among the lowest GPDpc regions of Greece that presents significant economic and employment ICT specialization), where ICT specialization can provide significant benefits to regional competitiveness
2. **What** is the situation regarding **ICTs adoption** in each Greek region?
   - Significant heterogeneity among different regions
   - Interesting patterns emerge as the adoption of new I4.0 ICTs is not strictly attached to highly populated urban areas
   - From the I4.0 technology standpoint, production-related tangible I4.0 ICTs are the most adopted among Greek firms
3. How these aspects, along with other factors (e.g., high-tech regional research) **affect regional competitiveness?**
   - The results regarding the correlation between regional specialization and trade transactions are inconclusive
   - Research collaborations, ICT specialization (all types) and employee digital skills are strongly correlated with regional competitiveness → potential driving factors that enhance regional performance

# Preliminary conclusions and some policy implications



- There is an **asymmetry** in the ICT specialization and among different regions in the Greek economy
- Most regions appear to lag in ICT specialization and ICT activities are concentrated into **highly populated urban areas**
- However,
  - the adoption of different I4.0 technologies diverges from the above pattern with different regions appearing to be more inclined to adopt them
  - ICT activities are an **opportunity to provide profits and jobs** in regions that specialize into different activities or were "left behind" in earlier digitalization processes
- Overall, ICT diffusion/adoption and the **digital transformation** in the Greek economy is diversified and is still at very **early stages**
- The foundations of this underperformance are connected with a **long-standing conservative status-quo** in both the business economy and the Greek state (Tsakanikas, 2014; Tsakanikas et al., 2020; Stamopoulos et al., 2022)
- Traditionally, investment in **ICTs, digital infrastructure, and competencies was not necessarily a priority** in economic and industrial policy agendas. **This established a lack of know-how** that was further amplified by the inadequacy of proper funding mechanisms towards technological upgrade and the promotion of the DT in the national economy.
- For the apparent digital transformation to become an amplified force of growth for the economy, policy should target the **horizontal upgrading of ICT** and digital **infrastructure**. **Firms can not be expected to bear the costs alone**, especially if they can't see the potential benefits.
- The policy focus **should shift** from simple "invest-in-ICT" interventions, and be redirected towards targeted strategic plans that consider:
  - The Greek business geography
  - ICT leaders and laggards in different Greek regions
  - Growth potential from ICTs adoption and investment
  - Digital skills and readiness (investment in I4.0 technologies will not benefit firms if their employees do not know how to use them!)

# Limitations & future steps



- Formulate a more concrete set of hypotheses with these indicators and data
- Adopt the formal ICT sectoral definition from OECD instead of using the J sector (requires a lengthy and laborious empirical process subjected to confidentiality issues on data availability – underway)
- Explore the regional aspect more in depth
  - ICT regional spillovers?
  - Examine different kinds of research ventures on regional competitiveness. Maybe select only some areas of funded research.
  - Conduct more in-depth spatial correlations between the most interesting aspects
  - Quantify specialization and production effect sizes with spatial models (imminent next step - probably Spatial-Lag Regression Models)

***Thank you for your time and attention***