Mapping the Evolution of the Digital Divide: Comparative Analysis of European Research and the Multifaceted Dimensions in Italian Enterprises

Luis Carlos Castillo

Binational Doctorate
University of Urbino and Universty of Bremen
Ph.D. Program in Global Studies
Supervisor: Prof. Francesco Vidoli
Co-Supervisor: Prof. Dr. Christian Cordes

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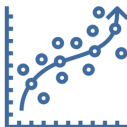# Cumulative Dissertation

Chapter 1

Bibliometric Analysis of European Research on Digital Divide: An Exploration of the Corporate Landscape

Chapter 2

Adapting Van Dijk's Resources and Appropriations Theory: Toward a Resources and Technology Integration Framework at the Firm Level

Chapter 3

Exploring Patterns and Shifts: Factor Analysis of the First and Second-Level Digital Divide in Italian Enterprises

Exploring Patterns and Shifts: Factor Analysis of the First and Second-Level Digital Divide in Italian Enterprises

Content I

1. Introduction

- DT play a pivotal role in reshaping business models (Trischler and Li-Ying, 2023) , driving innovation (Ciarli et al., 2021), and fostering competitive advantages (Jegan Joseph Jerome et al., 2024).

- The unequal adoption of DT has led to significant challenge: the digital divide.

- The digital divide at the firm level is a multifaceted gap characterized not only by disparities in access, skills and usage of DT, but also the derived benefits from different types of use.

- While the digital divide is a global issue, its impact on enterprises, especially in Italy, presents unique challenges and opportunities.

2. Digital divide overview

- ▶ The digital divide at the firm level is a topic that needs further exploration (Pejic Bach et al., 2013; Acilar et al., 2021; Lythreatis et al., 2022; Thonipara et al., 2023; Shakina et al., 2021; Siqueira et al., 2019).

- ▶ **Fragmented research:** Highlights the different frameworks and measurements in the field. (Forman, 2002; Vehovar et al., 2006; Shakina et al., 2021; Acilar et al., 2021; Ndulu et al., 2022).

- ▶ **Impact on Business Performance:** Addresses how DT impact innovation (Usai et al., 2021), productivity (Cusolito et al., 2020), and wages between high and low skilled labor (Vasilescu et al., 2020) . Leaving room for further analysis on the underlying causes of digital disparities.

3. Objectives

- ▶ Develop composite indices to track trends in the first and second-level digital divide.

- ▶ Analyze variations in the first and second-level digital divide across firm sizes, sectors, and regions in Italy.

- ▶ Evaluate the alignment of resources and technology integration theory with observed data.

- ▶ Propose targeted policy interventions based on research findings.
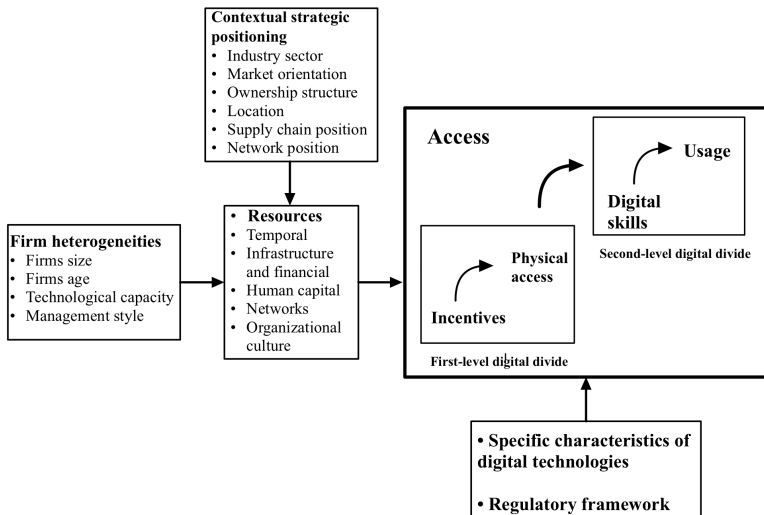
3.1. Research Questions

▶ How does the Resources and Technology Integration theory reflect observed patterns in DT adoption across different Italian enterprises?

▶ What are the evolving patterns and shifts in access, skills, and usage among Italian enterprises, and how do these dynamics reflect the disparities between the three indices across different firm sizes, sectors, and regions over a six-year period?

▶ According to the findings, what policy interventions can be recommended to help Italian enterprises more effectively bridge the digital divide?

4. Theoretical Framework

▶ Adaptation of the Resources and Appropriation Theory (van Dijk 2005, 2020) toward the Resources and Technology Integration Theory.

Contextual strategic positioning
- Industry sector
- Market orientation
- Ownership structure
- Location
- Supply chain position
- Network position

Firm heterogeneities
- Firms size
- Firms age
- Technological capacity
- Management style

- **Resources**
- Temporal
- Infrastructure and financial
- Human capital
- Networks
- Organizational culture

Access

Usage

Digital skills

Second-level digital divide

Physical access

Incentives

First-level digital divide

• **Specific characteristics of digital technologies**

• **Regulatory framework**

5. Data

- The dataset was derived from the ICT Usage in Enterprises Survey conducted annually between 2014 and 2019 by ISTAT.

- Each year, the survey collected an average of 19741.5 observations.

- The analysis focused on a selection of variables from the survey that met certain criteria.

- Considerations and Limitations.

    - Independence of Annual Data

- Data treatments, codes, and summary statistics are available on my GitHub repository for replicability and further analysis.

▶ In total 26 variables were used.

- ▶ Access index 6 variables
- ▶ Skills index 9 variables
- ▶ Usage index 11 variables

Variable Name (Continuous and Binary Variables)	Composite Index - First level Digital Divide
Percentage of employees using the computer out of the total employees (C)	Access
IT training courses for employees without specialist ICT skills (B)	
Percentage of employees using computers connected to the internet (C)	
Enterprise provides mobile devices with mobile connection (B)	
Internet download speed low (B)	
Internet download speed high (B)	

▶ (C) Continuous variables, (B) Binary variables.

5.2 List of Variables II

Variable name (Binary Variables)	Composite Index - Second level Digital Divide
Employment of specialists in computer subjects	
IT training courses for employees with specialist ICT skills	
Use of internal personnel for ICT infrastructure maintenance	
Use of internal personnel for office software support	
Use of internal personnel for enterprise software development	**Digital Skills**
Use of internal personnel for enterprise software support	
Use of internal personnel for web development	
Use of internal personnel for web development support	
Use of internal personnel for IT security management	
The company has website	
Possibility to place orders or reservations online eg online shopping cart	
Access to product catalogs or price lists	
Links or references to company profiles on social media	
Use of social network	
Use of social media and multimedia	**Digital Technology Usage**
Using ERP software	
Use operational CRM software	
Use analytical CRM software	
Announcement of vacancies or possibility to apply for employment online	
Web sales through intermediary websites or ecommerce sites marketplaces or apps	

6 Methodology

▶ The indices were constructed using dimensionality reduction techniques Factor Analysis for Mixed Data (FAMD) and Multiple Correspondence Analysis (MCA).

▶ Visualise and measure adoption patterns.

$$\text{Access Index}_i = a_1 \cdot X1_i + a_2 \cdot X2_i + \ldots + a_6 \cdot X6_i$$

$$\text{Skills Index}_i = b_1 \cdot Y1_i + b_2 \cdot Y2_i + \ldots + b_6 \cdot Y6_i$$

$$\text{Usage Index}_i = c_1 \cdot Z1_i + c_2 \cdot Z2_i + \ldots + c_{11} \cdot Z11_i$$
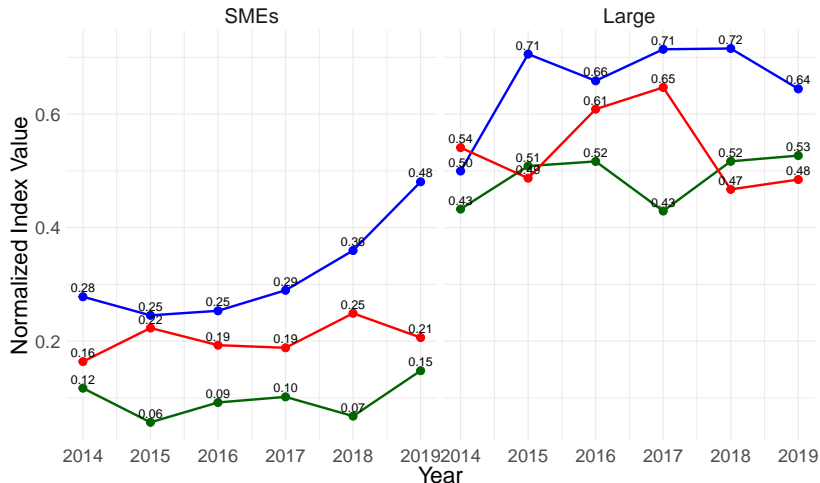
Where **X**, **Y**, and **Z** are the matrices of observations, and **a**, **b**, and **c** are the vectors of weights derived from FAMD and MCA contributions of each variable to the retained dimensions.

Yearly Trends in Access vs Skills vs Usage
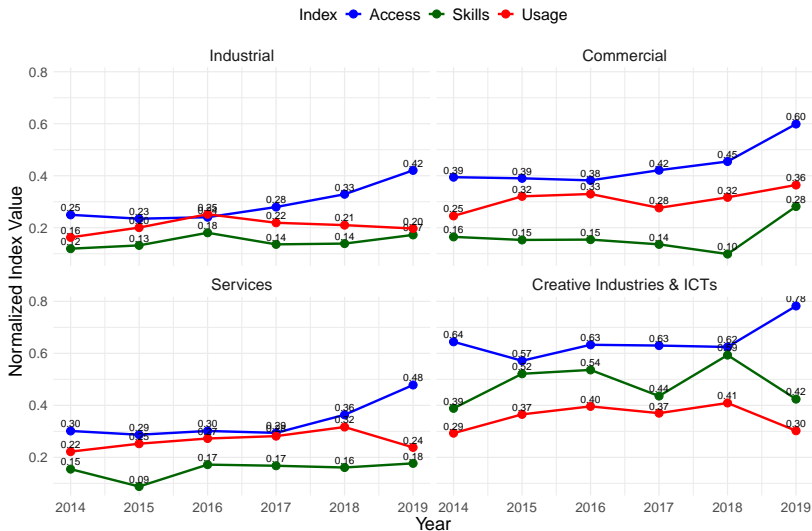
7. Key takeaways I

- ▶ While SMEs can maintain continuous growth in access, larger firms face different challenges.

- ▶ These findings align with Bratta et al. (2020), who discuss the hyper-depreciation measure issued in 2016.

- ▶ SMEs face more challenges in acquiring digital skills. There is a significant shortage of ICT graduates in Italy according to the "Digital Skills Observatory" in 2019.

- ▶ A higher usage index is present in SMEs as existing technologies need to be operated either by outsourcing digital skills or maximising the existing workforce.

7.1. Results II

Yearly Trends in Access vs Skills vs Usage

Index ● Access ● Skills ● Usage

7.1. Key takeaways II

- ▶ Notable progress in digital access across sectors due to effective policy measures like hyper-depreciation.

- ▶ The digital skills index remains low, highlighting challenges in developing necessary competencies.

- ▶ Commercial, Industrial, Service Sectors: Growing digital access and stable usage, but significant skills gap.

- ▶ Creative Industries and ICT Sector: High levels of access and skills but moderate usage, reflecting different technological needs in workflows.

7.2. Results III

Yearly Trends in Access vs Skills vs Usage
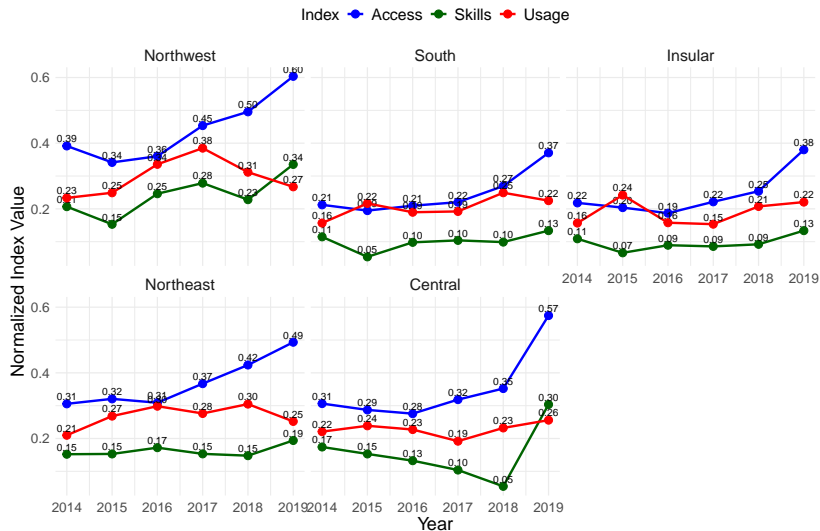
7.2. Key takeaways III

- Northern and Central Regions:
    - Significant improvements in digital access.
    - Benefits from robust industrial bases and policy interventions.
    - Persistent skills gap, slight increase towards the end.

- South and Insular Regions:
    - Lag behind in both access and skills. Reflecting systemic issues.
    - Need targeted policy efforts.

- Usage Trends:
    - Similar trends across regions.
    - DT integration driven by national policies, market forces, and sectoral requirements.

Sequential Model Challenges: While the theory posits a sequential model of technology adoption (access $\rightarrow$ skills $\rightarrow$ usage), our data shows that skills development has not kept pace with access, and usage sometimes surpasses skills. This indicates that firms may adopt technologies without fully developing digital skills, relying on external support or simpler applications.

Inequality in Resources: The theory suggests inequality in access to resources leads to disparities in technology adoption. However, our data only infers this inequality without direct proof.

Accelerate Digital Skills Acquisition: Promote and subsidize e-learning platforms and certification programs for rapid, flexible digital skills training.

Enhance Digital Infrastructure and Support for SMEs in Lagging Regions: Expand broadband and mobile network coverage in under-served regions through public-private partnerships.

Thank you for your attention

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