

Value chains and Industry 4.0 technologies: evidence from Tuscan manufacturing

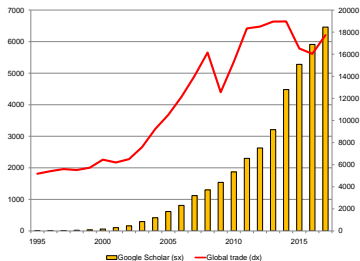
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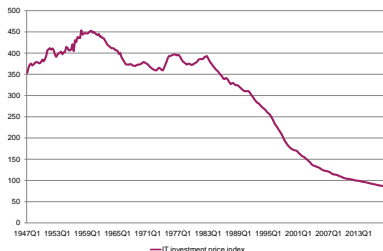
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Motivations



- i. Rise of global trade since the end of the 90s
- ii. Steep increase in trade in intermediates and decline in the value added exports (VAX)

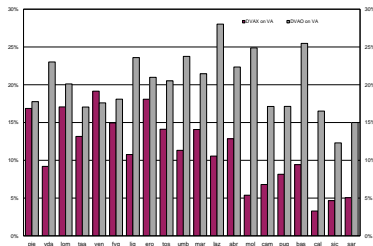


- i. The increasing pervasiveness of IT technologies in production systems and its implications for firms productivity
- ii. ICT and the management of complex supply chains...

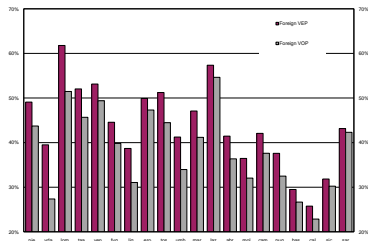
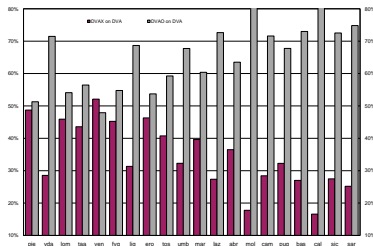
GVCs and ICT: the second unbundling

- i. The Great Convergence (Baldwin, 2016): the ascent of ICT lowered the cost of moving ideas and contributed to the leap forward of (a subset of) developing countries, accompanied by:
 - **international separation of factories** (better communication made possible to coordinate complex activities at distance)
 - US productivity revival; decline in manufacturing employment, job polarization and rising inequality in developed countries (see, e.g., Autor and Salomons; IMF, 2017; Cetto et al., 2016; Milanovic, 2016; Fernald, 2014)
- ii. Mastering ICT (coupled with management practices) has been found as a key determinant of firm productivity (see, e.g., Bloom et al., 2012), and its lack has been put at the center of the Italian productivity stagnation (e.g., Rossi, 2006)

Tuscany in GVCs (source: Bentivogli et al., *forth*)



- i. International/interregional trade and value added
- ii. The weight of international trade
- iii. The foreign content of value added exports



Manufacturing firms and GVCs in Tuscany: basics

	plants	employees	high-skilled	value added	wages
<i>domestic vs. all exporters/importers</i>					
domestic	69,2	28,1	9,8	17,9	18,0
in GVCs	30,8	71,9	90,2	82,1	82,0
<i>quasi domestic vs. top exporters/importers</i>					
domestic	90,6	68,0	52,9	60,6	60,2
in GVCs	9,4	32,0	47,1	39,4	39,8

- A relatively small subset of firms are directly connected with GVCs
- However, their shares in terms of (high-skilled) employees, value added and wages highly outpace that in terms of number of plants

Our work

We look at the interrelations between the spatial complexity of the supply chain in which (Tuscan) firms are embedded and the degree of pervasiveness in the adoption of digital technologies. More precisely, we look at the relation between **the degree of complexity of internal and external operations** and...

- i. As to Tuscan large firms: **the adoption of I4.0 technologies/practices so as to monitoring internal and external segments of the supply chain**
- ii. As to Tuscan SMEs: **the propensity to exploit data analysis to take decisions**

To this end, we exploit information stemming from two questionnaires on Tuscan firms, administered between the second half of 2017 (large firms) and the first half of 2018 (SMEs).

Methodology

We administered **two surveys to Tuscan manufacturing firms** (drawn from Asia unità locali 2013) through which we collected data about ownership, management, supply chain structure, internal organization, human capital and *I4.0-related* technologies and practices:

- Large firms (at least 1 plant with more than 30 employees in Tuscany): CAPI interviews
- SMEs (max employees in a plant between 5 and 30 employees): CATI interviews

We estimated a bunch of **(weighted) binary and multinomial logistic regressions** so as to assess the relation between *I4.0-related* technologies and practices and firms characteristics.

We present the outcomes in the form of **(average adjusted) predictions for different groups of firms**

Dependent variables: answers from two surveys

i. Large firms:

- Internal monitoring throughout digital technologies or formal practices
- Supply chain monitoring throughout digital technologies
- Use of advanced softwares (ERP, CRM, SCMS) to monitor internal processes and the supply chain
- Machines with sensors embedded in production processes
- (Collected) data management (i.e., integration)

ii. SMEs:

- Internal monitoring throughout digital technologies or formal practices
- Use of advanced softwares (ERP, CRM, SCMS) to monitor internal processes and the supply chains
- Importance of data analysis in order to take decisions
- Training to enhance soft skills
- Investment in *I4.0-related* technologies in the period 2015-2017

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Covariates

Embeddedness in value chains:

- Large firms: direct exporters & importers + multinational firms
- SMEs: firms directly involved in interregional/international trade

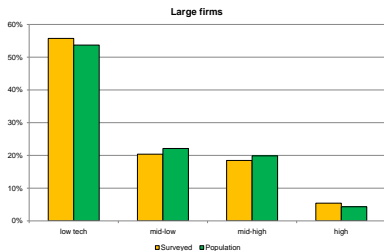
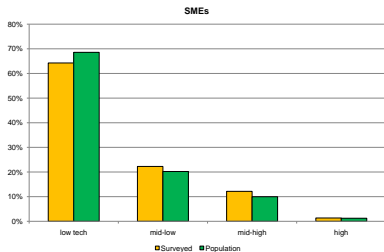
Other characteristics concerning with firms organizational complexity:

- Groups
- Multi-plant firms
- Presence of all functions (pre-, production, post-)

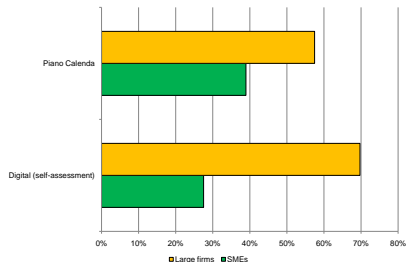
Also controlling for:

- Industry, size, skilled (graduated) employees, “conto terzi” firms (only large firms)

Statistics from the two samples



- i. 1.267 Manufacturing SMEs (out of 10.149)
- ii. 314 man. large firms (out of 972)
- iii. Rather balanced samples
- iv. Rather different samples



Value chain complexity and I4.0: Tuscan large firms

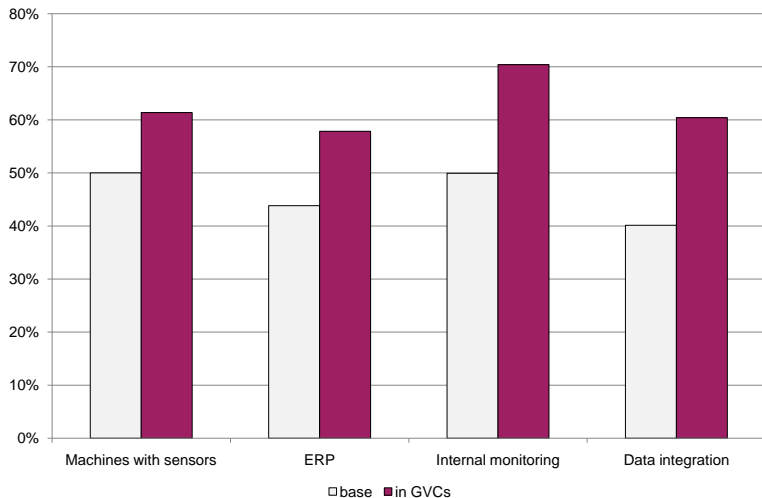
i. Internal monitoring with digital tools

- Machines with sensors
- Use of ERP
- Digital/Formal monitoring of internal functions
- Collected data are integrated for internal monitoring purposes

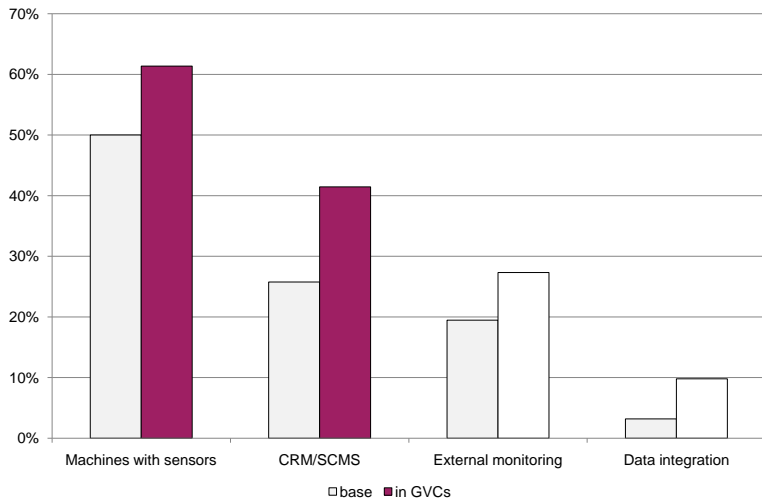
ii. External (upstream or downstream) monitoring with digital tools

- Machines with sensors
- Use of CRM/SCMS
- Digital/Formal monitoring at the supply chain level
- Collected data are integrated for external monitoring purposes

Large firms: internal monitoring



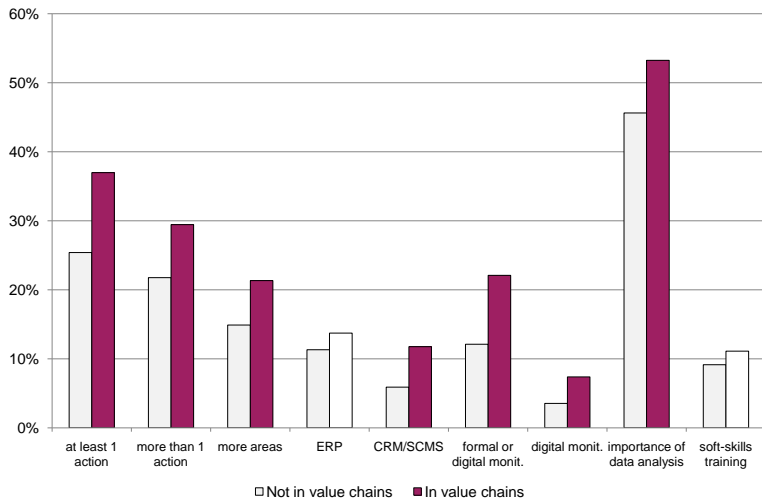
Large firms: external monitoring



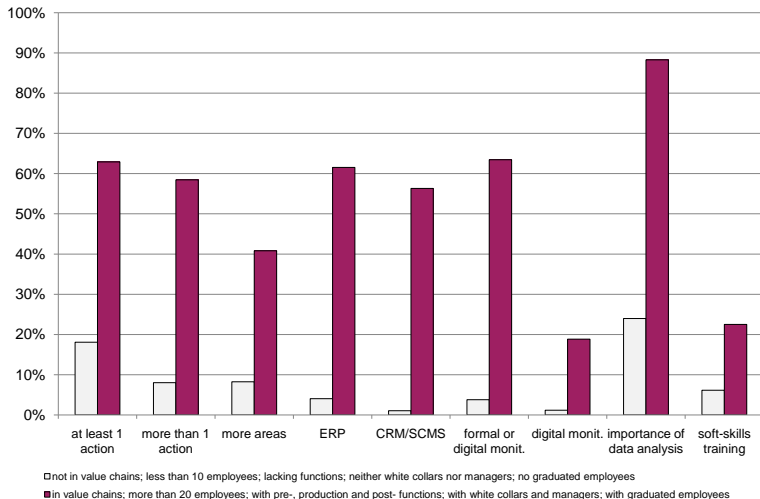
Value chain complexity and I4.0: Tuscan SMEs

- Investment in *I4.0-related* technologies between 2015 and 2017 (at least one area; more than one; new areas with respect to 2008-2014)
- Diffusion of softwares so as to check internal functions (ERP) and to manage the whole supply chain (CRM,SCMS)
- Reliance upon digital monitoring of internal processes
- Pervasiveness of data analysis in order to take decisions
- Training programs in order to enhance soft-skills

SMEs, value chains and Industry 4.0



Not only value chains: digging into firms heterogeneity



To sum up...

- Tuscany is (relatively) well embedded in GVCs, due to the action of a small but relevant subset of firms
- Such firms display the usual characteristics (export productivity and wage premia)
- In line with theoretical predictions, they also appear to make a larger use of data in order to take decisions
- High heterogeneity, especially for SMEs, also due to size, human capital, organizational complexity, sector technological intensity

Further research

- A I4.0-*relatedness* index
- The digital era, GVCs embeddedness and local development
- Better characterize trajectories and profiles in firms upgrading towards the I4.0 paradigm
- Working on *ceteris paribus* conditions in a dynamic setting: e.g., assessing the role of human capital, training, ownership and management characteristics
- *Coordination* vs. *information* technologies and offshoring vs. reshoring: Tuscan firms and globalization 3rd unbundling
- Re-assessing learning-by-exporting at the dawn of the 4th industrial revolution (I export \Rightarrow I exploit IT vs. I exploit IT \Rightarrow I export)