Chapter 2. Supply chain analysis: advancements in official statistics

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2.1 Introduction

Many economic experts have addressed and systematized the issue of relations between businesses, considered a key concept underpinning competitive capacity. Economic theory offers several angles for the analysis of production relations and, more generally, supply chains. Concepts related to this include advantages arising from the integration of units, with the reduction of costs due to the presence of positive externalities, economies of scale (greater production capacity and lower unit costs) and economies of scope (reduction of costs due to specialisation in certain activities).

In recent decades, the interest of academics and policymakers has been heightened by globalisation and the consequent extension of supply chains worldwide - the global value chain - in which the stages of production take place in different countries, taking advantage of the expertise and resources available on the global level. In this scenario, the economic theory of the supply chain provides a useful conceptual framework for understanding the complex dynamics of the production of goods and services in a globalised modern economy.

For these reasons, the study of supply chains has gradually gained ground to become an issue of industrial policy, in which the theoretical reference point is no longer the individual company, but rather a cluster of companies engaged in a series of activities and processes that make up the stages of production of a good or service. These stages range from the production of raw materials (acquiring and processing the basic resources necessary for production) to manufacturing (the transformation of raw materials into finished goods or services), then distribution (transporting and delivering products to points of sale or directly to consumers) to retail (direct sale of products to the end consumer) and from there to after-sales (assistance, maintenance and additional services supplied after purchase of the product).

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In order to move from theory to empirical observation, the availability of data is crucial. Analysis of production processes through the lens of the supply chain is essential for characterising the profile of companies and the production system.

Until the final months of 2022, information gleaned from official statistics provided data about supply chains only in aggregated form, mainly sourced from national accounts, and therefore did not allow analysis of individual companies, their positioning within the system and their ability to activate production as part of supply chains. The latter is crucial information in terms of policy and thus of targeting funding in order to activate multiplying processes on state investment.

In this context, ISTAT launched a major project to study such data at the micro level, with the aim of classifying companies and identifying their roles within supply chains.

The sources used for this analysis are the permanent census of enterprises and the electronic invoicing database. These two complementary sources give a comprehensive picture of the country's production system, seen through the lens of supply chains. The first allows us to gain information about the qualitative characteristics of the companies surveyed (target population is enterprises with 3 or more persons employed), how they position themselves within supply chains and the extent of their ability to influence the prices, quantities and quality of the products and services they offer. Businesses involved in the study were asked to indicate, from a set list of 28 supply chains, which they contributed to in terms of the production of raw materials, semi-finished goods, finished products, machinery specific to the chain and service-based activities such as consultancy, R&D, marketing and so on. The resulting data have been available since 14 November 2023 and for the first time it is possible to reconstruct a general picture of supply chains based on information acquired directly from the companies themselves.

Thanks to its comprehensive nature, the second source - electronic invoicing - allows us to identify the entirety of relationships between production units. Electronic invoicing was introduced in Italy as an administrative and fiscal obligation in 2019, and affects all transfers of assets and provision of services carried out between residents or businesses established in Italy[6]. There are three

6 On 6 June 2014, e-invoicing became obligatory for commercial operations with central public administration, and in 2014 this was extended to local administration. On 1 January 2019 electronic invoicing was also applied to transactions between private entities resident or established in Italy. Since 1 July 2022, e-invoicing has been obligatory for flat-rate tax regimes. Since 1 October 2022 moratorium is no longer an option, so e-invoices must comply with the 12-day limit. Electronic invoices must be sent to the customer via the Sistema di Interscambio (SdI), managed by the Revenue Agency, which verifies the existence of obligatory data for tax purposes and the VAT numbers of suppliers and customers.

main types of electronic invoicing, and therefore three different databases held and updated by the Revenue Agency:

- B2G (Business to Government) electronic invoicing - towards central and local public administration (obligatory since 31 March 2015);
- B2B (Business to Business) electronic invoicing - between private entities registered for VAT, i.e. invoices between businesses (obligatory since 1 January 2019);
- B2C (Business to Consumer) electronic invoicing - towards the end consumer, who can decide whether to receive invoices in paper form or by certified email.

Of these three databases, the most useful in terms of analysing supply chain relations between companies is undoubtedly B2B, which includes information at the individual transaction level.

While census data relies on self-declaration to assess belonging to a supply chain in response to the ISTAT questionnaire, with electronic invoicing the reconstruction of relations between companies is based on connections by invoice, which identify the customer and the supplier, allowing the network of exchange for goods and services to be traced. Although a simple process when the number of invoices is limited, this kind of elaboration becomes extremely complicated when the amount of data increases considerably and the network becomes a great deal more complex. To handle such complexity, specific techniques are needed, and graph theory can provide a useful help.

At the current time, census data - available, as mentioned, since 14 November 2023 - allow us to construct an initial general outline of supply chains, while electronic invoicing databases are not yet available to ISTAT, since the process of transferring data from the Revenue Agency to ISTAT is currently being established. Furthermore, once ISTAT has access to the databases, a methodology will be needed to reconstruct the networks of production, and this stage will also require more time, given the complexity of the algorithms required. For this reason, census data remains the only available source for an initial reconstruction of supply chains on the basis of micro data.

2.2 Supply chains – the overall picture emerging from the latest permanent census of enterprises

On 14 November 2023, ISTAT released the preliminary results of the second edition of its multi-scope survey, an integral part of the permanent census of enterprises.

The survey considered a sample of approximately 280,000 enterprises with 3 or more persons employed, representing 1,021,618 units (22.5% of Italian enterprises) producing 85.1% of the value added and employing 96.0% of

employees (11.5 million), and therefore an essential segment of our production system. The direct survey was carried out between November 2022 and March 2023, and the reference year for data collected was 2022.

Over three-quarters of the companies studied (805,000, 78.9% of the total) are micro-enterprises (3-9 persons employed); 189,000 (18.5% of the total) are small enterprises (10-49 persons employed), while medium-sized (50-249 persons employed) and large companies (250 or more persons employed) account for 2.2% (22,861 companies) and 0.4% (3,969 companies, including 1,622 with 500 or more persons employed). Over half the enterprises operate in northern Italy (28.7 in the north-west and 22.7 in the north-east); 21.3% in central Italy and 27.3% in the south of the country.

Initial results confirm substantially uniform distribution in terms of production units. As evident in Figure 2.1, the supply chains most commonly contributed to are agro-food (indicated by 20% of respondents), construction (16.2%), tourism (12.9%) and road transport (10%). In this initial analysis it is interesting to see that some supply chains are less important than may be expected. One example is a prominent section of Made in Italy production, "clothing and footwear", which involves fewer than 10% of enterprises (7.5% of the total with 3 or more persons employed).

In terms of value added (Figure 2.1), the picture changes and we see the emergence of other supply chains and a prominent role played by companies with a larger average size. This is the case of energy suppliers, manufacturers of industrial electrical appliances and generic machinery, pharmaceuticals and products for personal, pet and home care.

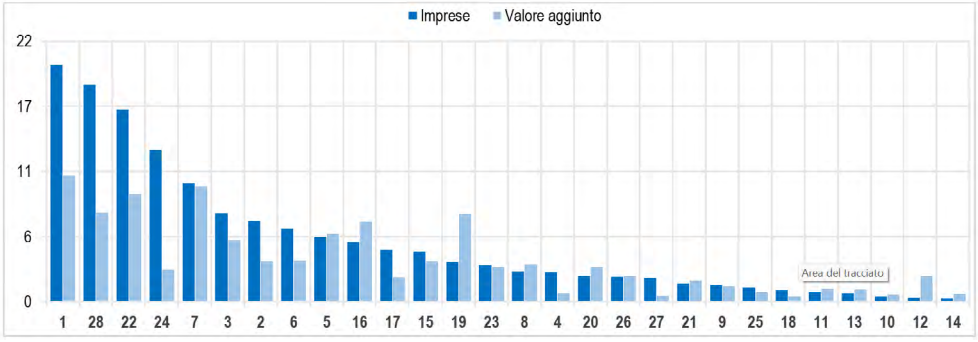

Figure 2.1 Distribution of companies and added value by supply chain. Year: 2022
Percentage values (a) (b) (c).

Source: ISTAT.

(a) Supply chains: 1 = Agro-food; 2 = Furniture; 3 = Clothing, footwear and accessories; 4 = Publishing; 5 = Pharmaceutics and products for personal, pet and home care; 6 = Health and social care; 7 = Road vehicles; 8 = Road transport infrastructure and services; 9 = Sea transport vessels; 10 = Sea transport infrastructure and services; 11 = Railway and cableway vehicles; 12 = Railway and cableway infrastructure and services; 13 = Aerospace and defence equipment; 14 = Air, aerospace and defence infrastructure and services; 15 = Electrical and electronic household appliances; 16 = Industrial electrical appliances, machinery and gear for unspecified supply chains; 17 = Non-electrical tools and equipment; 18 = Precious stones; 19 = Energy infrastructure and services; 20 = Waste management and circular economy; 21 = Water infrastructure and services; 22 = Construction; 23 = Finance; 24 = Tourism and leisure; 25 = Audio and audiovisual content; 26 = Telecommunications infrastructure and services; 27 = Education and professional training; 28 = Other (e.g. toys, sports equipment not for gyms or wellness centres, personal services and public services other than the above).

(b) The sum of percentages may be higher than 100 because each company was permitted to indicate more than one chain.

(c) Due to the design of the statistical records used in the survey, the distribution in terms of added value does not include companies in the banking and financial sectors (Codes 64, 65 and 66 of the Ateco classification – Section K). The added value of supply chain 23 shown in the figure therefore refers to companies that participate in the Finance chain but do not belong to the banking, finance and insurance sectors; similarly, the graphs relating to other chains do not include the added value of companies in the same sectors.

An important development at ISTAT is undoubtedly the centrality of statistical registers, which provide information on the subjects of analysis at micro level. This has made it possible to cross-reference data from surveys with statistical registers, which contain information about the economic variables of enterprises.

By drawing on a classification of forms of internationalisation[7], it was possible to gain an idea of the level of Italian companies' participation in global value chains. In particular, the taxonomy in question classifies production units in five mutually exclusive groups. The first group is companies that only import goods ("importers only"); the second, companies that export solely ("exporters only"); the third is companies that both export and import ("two-way traders"); the remaining two categories group companies engaged in internationalisation of production, consisting of active units in Italy that are owned

7 For example see ISTAT's Report on competitiveness in manufacturing sectors, 2022 edition (https://www.ISTAT.it/it/archivio/268378).

by foreign-controlled multinationals ("foreign multinationals") or by Italian groups ("Italian multinationals")[8].

In such scenario (12.4% of companies have commercial and production relations with other countries), it is possible to map Italian companies' participation in global value chains. The chains that see the greatest participation by Italian companies are aerospace and defence equipment (where 41.3% of companies are internationalised), air and aerospace infrastructure and services (in which 37.9% of companies are internationalised), railway transport infrastructure and services (33.2%) and precious stones (32.8%). At the other end of the scale, the chains whose focus is primarily on the domestic market are tourism (with just 5.5% of companies internationalised), education and training (6.9%) and finance and insurance (7.9%, despite a relatively high number of companies belonging to multinationals).

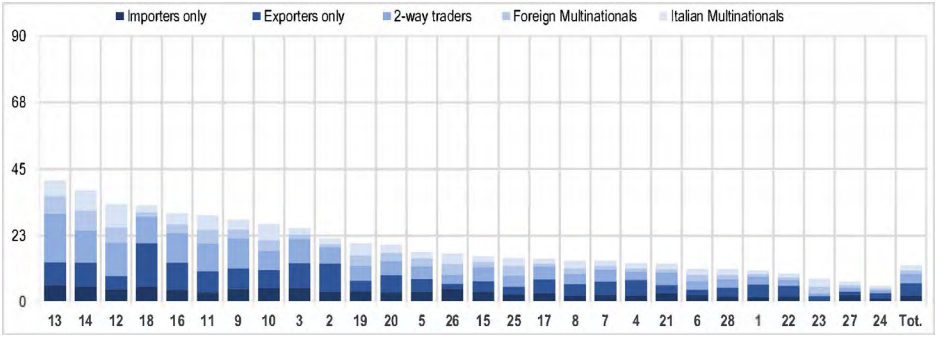

Figure 2.2 Forms of internationalisation by supply chain. Year: 2022. Percentages of the total number of companies participating in the chain (a).

(a) See note (a) Figure 2.1

One interesting analysis is that which combines the economic sector with the value chains. This gives us possible to analyse the production system by sector (horizontal) and by supply chain (vertical).

By considering the weight of the economic sectors (see the table, we can make an initial horizontal analysis, highlighting the sectors that affect the greatest number of chains. This provides confirmation that the production system is concentrated in certain areas: commerce, chemicals, rubber and plastics, metal products,

8 Each company is placed in just one category; where a company has more characteristics than those selected on the scale of internationalisation, it is placed in the higher category. This means that, for example, the Italian Multinationals or Foreign Multinationals categories contain companies belonging to multinational groups (Italian and foreign respectively) which export and/or import.

machinery, specialist construction, storage and support for transport, software production, staff selection and recruitment, architecture and engineering studies. Now if we if we proceed with a vertical reading, it is possible to consider the length of the supply chains. More economic sectors are involved in a supply chain, the longer it is. The data reveal that the longest supply chains in terms of value added, are agro-food, road transport, clothing, industrial plant and appliances, energy and construction. While the shorter supply chains are: air and sea transport infrastructure and services, precious stones, audio and audiovisual content, education and professional training.

2.3 Conclusions

In recent years, the increasing importance of interpreting the production system through the lens of supply chains, and its implications in terms of both analysis and policy, have demanded greater commitment to the production of statistics, and official data in particular.

Prototype studies and analyses carried out on sub-samples of the electronic invoicing database on the one hand, and the addition of a section on supply chains to the ISTAT census questionnaire on the other, are a demonstration of that commitment.

In the short term it is expected that the main source of information will continue to be the census, making full use of the extensive information collected by the survey which, as we know, consists of 9 sections.

Although data from surveys are valuable, they have limits; in particular, they are based on pre-determined supply chains and the self-classification of enterprises. In this sense, on the one hand we have a pre-determined view of the production system (the 28 supply chains are defined upstream) and on the other, a possible statistical distortion due to well-known issues of errors in measure, typical of surveys.

These issues can be overcome with the use of electronic invoicing, since the definition of networks is not based on a definitive theoretical framework, but rather on direct relationships between customers and suppliers.

While the prospect of data from electronic invoicing opens extremely interesting avenues for study, it is also true that issues around the availability of data and the methodology to be adopted currently constitute an obstacle, with the consequence that at this stage it is not possible to give an exact idea about when the first results from this key source will be forthcoming.