Economic complexity and international market: how do they matter in the national dynamics?

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To my family

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Introduction

This thesis contributes to the international economics by considering how the openness of an economy as well as the linkages with other countries matter for the local economic growth. This dissertation consists of three independent articles and the different topics covered in each of them are: the imports of intermediates and the exchange rate, the multinationals and the industry proximity, the labor polarization and the economic complexity.

The aim of this thesis is threefold: (1) to analyze how a change in the value of the Swiss currency impacts on the imports of Swiss intermediates; (2) to identify if the presence of multinationals attracts other multinationals; (3) to examine if the economic complexity matters in determining the demand of low-skilled service jobs and the consequent polarization in the Italian provinces.

In the last decades, a process of global and radical transformation has increasingly modified the process of production (Frenken et al. 2015), with consequences both in the international market and in the local economy. The production process is stretched among many countries and the domestic value chain is progressively being substituted by the global one. More in detail, developed economies are pursuing offshoring strategies for the initial stages of the production process and are more involved in producing and exporting finished and sophisticated products. The more a country has rare resources, skills, and knowledge, the more it is able to produce complex goods and to differentiate from other. The result is a higher competitive advantage in the international market since it is difficult for the other countries to imitate the range of its products and services.

The flows of products, especially of intermediates, the flows of firms (multinationals) or the job demand are some of the several consequences of this structural change.

The purpose of this thesis is to enrich the current debate on the increasing importance of the global value chain and of the openness of the border giving relevance to the interconnection between the international market and the local dimension. What are the consequences of this phenomenon on the local labor market or on the attractiveness of new firms? How a country can be strong against external shock? The attempt to answer to these questions has been done investigating not only the national dynamics but also the regional ones. The high level of heterogeneity of a country, the disparities shown among the smaller territorial units or the different specializations has driven the idea to conduct a local level analysis.

Moreover, high relevance has been given to the key role of linkages among countries: in a global economy, it is not any more realistic and even strategic focusing exclusively on the own knowledge. Complementarity and synergy between local and global are the engine for the economic growth and for an increase in the competitiveness in the international market. An economy able to create

interaction between local resources and external knowledge is able to be competitive, to be innovative and to be a pioneer in the market.

Focus of two out of the three papers of this thesis is Switzerland. It is characterized by a great availability of knowledge, skills and technology that allow to offer a wide range of sophisticated and complex goods. Moreover, the strategic position in the middle of Europe is a source of advantage for its linkages with other countries. The strong interest in understanding the drivers of its success in the international market and its economic stability was the starting point for this research.

In the last paper, instead, the aim is to investigate the local heterogeneity in another context. The attention has been reserved to a bigger country: Italy. It is an interesting country to be studied because of its heterogeneity in terms of specializations, availability of skills and labor composition. The North and the South, as a matter of fact, show disparities in the development process as well as in their level of competitiveness in the international market.

More in detail, the structure of the thesis is as follows. The first chapter aims to empirically show if the Swiss trade is strong and stable against external shocks. It has been investigated what happens to the Swiss intermediate imports after a change in the value of the Swiss Franc. The objective is to understand if the Swiss trade is driven only by exports or if the economy can gain advantage from a currency appreciation and from the relative cheaper imports.

The relevance of keeping an economy open, as well as being attractive in the international market were the engine of the second chapter. With the aim to analyze another aspect of an open reality, it has been deeper investigated the phenomenon of multinational firms at the cantonal level. Do foreign firms attract other firms in similar sectors?

Finally, it has been investigated another geographical context: Italy. In the third chapter, the analysis focused whether the local economic specializations (measured by the economic complexity index) are key drivers in the process of employment polarization and in predicting the corresponding demand at the local level for low-skill service jobs.

These three chapters link the level of competitiveness and economic stability of a country to the concept of economic complexity. It is an innovative approach introduced by Hausmann and Hidalgo (2011) with the aim to capture the level of capabilities available in a country. Each country is seen as a system of knowledge accumulation, and its prosperity depends upon whether it can make even more information grow (Hidalgo 2015): some kinds of knowledge are more difficult to develop or to replicate, becoming a key factor for the economic growth and for the competitiveness of a country.

The economic complexity is the *fil rouge* of this thesis, since it has been proposed as an evaluation measure of the different factors that characterized an open economy. It allows to identify the branches that, for their embedded knowledge, are strategic in an economy for its growth and its evolution. This measure is also a good way to capture the level of innovation available in the goods produced and traded internationally and therefore it allows to catch the level of the investment in R&D in a certain economy.

The three chapters of this dissertation are shortly introduced below.

In the first chapter it has been investigated the inflow of intermediates in the Swiss economy. Switzerland, exploiting a high level of knowledge and innovation, has a larger competitive advantage in the last stages of the value chain. As a result, it tends to import intermediates and to export finished products, leading to a high level of openness. In the existing literature, it has been frequently highlighted that currency appreciation deteriorates competitiveness in the export flows, but the expectation on the import would be opposite since the inflow of goods become relatively cheaper.

Even if the effect of the current exchange rate on trade seems to be well defined, it is strongly influenced by the income level of the trading partners and by the typology of the traded products (Rauch, 1999; Feenstra, Markusen and Rose, 2001; Evans 2003; Saito, 2004; Baldwin, Skudelny and Taglioni, 2005; Anderson, Milot and Yotov, 2014). Focusing on the Swiss economy, Thorbecke and Kato (2018) found that the exchange rate does not affect the volume of exports for more sophisticated sectors (watches and pharmaceuticals), since they are valued for their specifications and hence face limited price competition. Other research (Martinez-Zarzoso and Johannsen, 2016; Badinger and Türkcan, 2014) demonstrates how categories of products react differently to the introduction of a common currency. Combining the literature on the gravity model with intermediates and the direct effect of exchange rate on different categories of goods, it has been measured how intermediates imports react to a change in the value of the domestic currency (Swiss Franc).

The novelty with respect to previous research lies in the focus on imports rather than on exports (Auer and Saurè, 2012; Kohler and Ferjani, 2018; Thorbecke and Kato, 2018), on the use of monthly data regarding the real exchange rate and imports, and in the classification of goods according to the final use. It has been considered also the country of origin of the inputs to investigate the presence of any heterogeneity due to partner market. The vast bulk of intermediates trade is among developed countries (Miroudot, R. and al. 2009; Bergstrand and Egger, 2010) and, in the Swiss case, on average, 73.4% of intermediates imports come from high per-capita income economies, especially from Euro countries.

Using a panel-gravity approach, it has been found that intermediate imports negatively reacts to a Swiss Franc appreciation; this could be mainly due to a decrease in the foreign demand for Swiss goods. Disentangling the entire bundle and focusing on the branches in which the Swiss economy is higher specialized (chemical and metal goods, watches), it has been found a positive relationship between the real exchange rate and inputs used in more complex industries (pharmaceutical and watch). Considering partner countries, it has been found that imports of intermediates from non-Euro countries react less to a change in the value of the Swiss currency. The key success factor for the Swiss economy, as well as the ability to be competitive even with a strong currency, lies in the diversification and in the high specialization of the goods traded in the international market.

In the second chapter, it is addressed another key aspect of the globalization: the flow of companies. Firms set their activities in multiple countries, leading to an increase in the global investment flows. Combining this phenomenon to the relevance of agglomeration and linkages among sectors, it has been investigated if the presence of multinationals (MNEs) in Switzerland in year *t-1* attracts other foreign companies in year *t*.

In the existing literature, a lot of attention has been devoted to the analysis of multinational effects on host economies (Narula and Dunning 2000; Fu, Pietrobelli and Soete 2011; Javorcik 2013, Perri, A.; Peruffo, E., 2016). It is widely recognized that the presence of foreign companies positively affects the local economy, in terms of the level of technologies and innovation, as well as on the linkages with other firms or countries in the international market.

For these reasons, the level of attractiveness of a country is relevant, but what are the drivers in the MNEs location choice process? Empirical research suggests that both external and internal firm factors matter (Bloningen, 2005), but agglomeration and specialization in the same sectors plays a key role in the location choice. Another branch in literature, instead, emphasized the importance of externalities coming from firms located in the same area but active in different sectors (Jacobs, 1969); according to this stream, variety is more important than being specialized only in few sectors.

This paper wants to add a different perspective to the debate, combining these two fields of research and investigating the role of externalities in the location choice of foreign companies. More in detail it has been investigated the linkages among manufacturing and services, among firms active in the same sector and in related ones.

The relevance of services in developed countries is increasing year over year (Kuznets, 1966; Jorgenson and Timmer, 2011; Alvares-Cuardrado and Long, 2011) and the gap in existing literature in exploring the linkages among firms in different sectors, drove the focus in

understanding if the presence of MNEs in manufacturing in time *t-1* attracts foreign firms in services.

Secondly, to have a general overview of the phenomenon, it has been studied the attractiveness of MNEs in year *t-1* toward new foreign companies active in the same sectors or in related ones. The concept of industry relatedness has been exploited to analyze linkages among different sectors. Differently from the input/output relations, this relatedness measure between economic activities considers all the technologies and the skills required during the production process, giving a more exhaustive measure of the industrial distance.

Exploiting cantonal data on multinational firms disaggregated at 2-digit, the empirical analysis investigates if, during the years of economic recovery after the global crisis (2014-2018), the number of multinationals active in a canton was affected by the number of multinationals in the same canton during the previous year. Results confirm the hypothesis that the level of internationalization has a key role in the location process of multinationals firms. It is not enough for a canton to be specialized in a certain branch: what matters is the right level of complementarity, between local and global resources.

Finally, the third chapter investigates another aspect of the structural change that many countries are facing: the change in the labor composition. From 1980s, the European labor markets have undergone a process of radical transformation (Autor, 2015; Goos et al., 2014; Goos et al., 2009, Acemoglu and Restrepo 2019). countries are adopting offshoring strategies, leading the production process to be stretched among different economies and concentrating complex activities in developed countries. At the same time, in the labor market, developed economies are facing the so-called *job polarization* (Autor et al. 2003), with a simultaneous growth of high-skill and low-skill service occupations. The advance in automation and in ICT has led to the substitution of routine tasks labor, since these activities are easily codifiable, repetitive, and follow a well-defined set of procedures (Goos et al. 2014; Michaels et al., 2014).

This context of change has been for different countries an opportunity to introduce new products, processes, and services into their economic systems, increasing the diversification and the complexity of their goods and services. It has been used the economic complexity index (Hausmann and Hidalgo, 2011) as a valuable proxy for the capabilities available in a country, as well as a measure for the country level of income and the national economic growth.

The expectation is that countries specialized in complex goods are at the frontier of technological progress and, as a consequence, would face a larger demand for high skills occupations, such as professional and managerial ones. Therefore, a higher share of such workers might create demand for more services and, in turn, might dampen demand for low-skill occupations. Starting from these

considerations, it has been analyzed how economic complexity matters in the change of employment share of low-skill service jobs, which is one of the main aspects that characterizes the phenomenon of job polarization. Since the characteristics of both employment polarization (Boschma and Fritsch 2009; Moretti 2014; Berger and Frey 2016; Barzotto and De Propris 2018) and economic complexity (Reynolds et al. 2018; Benedikt et al. 2018) differ considerably at the subnational level, the focus of our research is based on Italian provinces.

The empirical analysis focused on the variation in employment shares of low-skill service occupations between 2010 and 2018. Focusing on the years after the Global Recession, the aim is to discover whether the polarization registered during the previous decade (Olivieri 2012) was still at work and if the level of complexity registered in each province is a driver of this phenomenon. The main results indicate that the economic complexity index is a significant driver of the change in the share of low-skill service occupations, being robust to all the local confounding factors. The more a province is able to produce sophisticated goods and is at the frontier of technological progress, the more it requires a large share of service workers, as a result of the large share of high-skilled occupations. More in detail, the positive effect of the ECI seems to be largely due to workers aged between 36 and 65 years, while no significant impact has been found for young workers. The degree of local sophistication captured by the local ECI seems to dampen the demand for low-skill service occupations, contributing to the process of employment polarization observed in the last decades. To sum up, local economic complexity associated with tradable sectors increases employment in the low-skill service sectors as higher local wages will further increase local demand for the non-tradable goods and services.

In general, the results from this thesis confirm the relevance that the linkages a country creates with other economies in the international market have a key role also for its local growth. From the analysis it has been found that complexity is a synonym of stability and of high level of available knowledge. Analyzing the flow of goods, in fact, it has been found that sophisticated products are stable against eternal shock. In the study of the labor market, instead, provinces with a high level of complexity are the ones on the frontier of innovation; as result, they are the ones that have faced a larger increase of low-skill services workers. Looking at the level of attractiveness of foreign firms, MNEs active in high knowledge manufacturing sectors positively influence the number of firms in services in time *t*, even if the magnitude of the coefficient is smaller than in the entire sample of foreign companies.

In conclusion, this thesis demonstrates the importance of being competitive in the international market producing sophisticated products but, at the same time, of being integrated in the global value chain and of having connections with other countries. The complementarity between the local

skills and the global knowledge (available in each country through the MNEs spillovers) are the key drivers for the domestic growth in these years of structural changes.

In the rest of this thesis, each chapter is dedicated to the study of a specific aspect of the openness of the border. The next chapter is dedicated to the analysis of the flows of Swiss intermediates and how they react to a change in the value of the currency. The second chapter, instead, investigates if the level of internationalization of a canton is one of the main drivers in the foreign firms location choice. Focus of the third chapter is the change in the labor market in response to the global value chain. Finally, a conclusion chapter draws results and highlight main findings of this dissertation.

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Chapter 1: The role of the Swiss Franc in the imports of intermediate goods

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Abstract

The Swiss economy is characterized by a high degree of openness; the growing importance of the "global value chain" results in the production process being stretched across many countries. Given this, and the fact that Switzerland is considered a fiscal haven and the Swiss Franc a safe currency exposed to appreciation pressure, we analyze how intermediate imports react to a change in the value of the Swiss Franc. This is highly relevant for an open economy like Switzerland, which imports semi-finished products and exports finished goods.

Modifying the traditional gravity approach to account for intermediates, we provide evidence on how different categories react to an appreciation of the Swiss Franc. We found that semi-finished products used to produce sophisticated and complex goods (e.g., pharmaceuticals and watches) are imported in greater quantities in periods of currency appreciation.

Trade in intermediates takes place mostly among European countries, while during the last years imports from non-Euro members are that with a larger growth: it has been investigated if there is any heterogeneity in the reaction to the Swiss Franc according to these classification of trade partners.

We consider a panel of the 46 most important Swiss partners from 1999 to 2016; data for both imports and real exchange rate are collected on a monthly basis with the aim of providing estimations that are more accurate.

Keywords: intermediate goods imports, complex sectors, real exchange rate, gravity model, Euro currency, peg exchange rate

1.1 Introduction

It has been frequently highlighted that currency appreciation deteriorates competitiveness in export flows, but we expect an opposite situation regarding the inflow of goods as this renders them cheaper.

Switzerland is defined by a high degree of openness; in 2016, the share of imports and exports over GDP was equal to 1.20[1]. The Swiss economy has one of the highest indexes, preceded by only a few countries. A high openness index value is quite common for small economies as intra-regional flows of goods are scarce and countries are forced to open their borders.

During the economic crisis in 2009, Switzerland faced increasing pressure from capital inflows leading to a strong appreciation of the Swiss Franc. The real exchange rate index appreciated by 25% in the Euro market during the years after the global financial crisis. In September 2011, the Swiss National Bank (SNB) decided to introduce a 1.20 Swiss Franc floor against the Euro, leading to a depreciation of the national currency. This exchange rate peg was relaxed in January 2015. How do these changes affect the Swiss imports?

While different studies (Auer and Saurè, 2011; Auer and Saurè, 2012; Kohler and Ferjani, 2018; Thorbecke and Kato, 2018) have analyzed how exports reacted to the appreciation of the Swiss currency, it is also interesting to investigate how changes in the value of the Swiss currency affect imports in general, and in particular, imports of intermediate products.

The analysis of these categories is relevant in a context of global transformation of the production process. Switzerland is not extraneous to this phenomenon and to the increasing importance of the so-called global value chain (GVC): the production process stretches across many countries and each region tends to specialize in a particular stage of the value chain, thus increasing the ties among countries and the amount of international trade. Since Switzerland is an advanced economy with high technology and sophisticated competencies, it creates value—added during the last stages of the production process—importing intermediated goods and exporting finished products. This means that Switzerland is more involved in the GVC via intermediates imports embodied in exports (backward linkages) than in forward linkages (24.6% vs 17.2%, respectively[2]). This ability to produce and export products that require specific knowledge, and that are difficult for other countries to replicate, makes Switzerland an interesting context for analysis. Analyzing exports according to their degree of economic complexity, Thorbecke and Kato (2018) found that exchange rates do not affect the volume of exports from most advanced sectors. This is mainly due to the fact that technologically sophisticated items are valued for their specifications and hence face limited price competition, as also highlighted by the International Monetary Fund (2013).

The Swiss exports bundle, in its variety of goods, is characterized by a strong presence of high-technology products (in 2016, 32% of exported goods[3] are chemical and pharmaceutical, 7% watches). The followed trend is different according to the type of product and to its level of complexity. Especially in the years after the global crisis (2010-2016), in fact, products that require a higher level of knowledge (chemical, pharmaceutical and watches among them) faced an increase in their exports, while less complex goods (paper or metals) have found a reduction in the foreign demand. If the Swiss economy appears to resist the currency appreciation well regarding exports of complex goods, it is interesting to investigate how the Swiss imports react to a change in the local currency. How do imports of inputs react? Does currency appreciation lead to an increase in the volumes of imported goods? The heterogeneity registered in the Swiss exports makes of particular interest the analysis not only of the overall trend of Swiss imports, but also of the different economic branches.

We analyze how intermediate imports reacted to the Swiss Franc appreciation from 1999 to 2016. During this period, imports of intermediates represent, on average, 24% of the total Swiss inflows of goods. In line with the sectors with a higher specialization index, the two categories that have the greatest importance in the import bundle are chemical- and metal-based intermediates (28% and 20% on average, respectively). With high standards in terms of quality, precision, and reliability, these sectors are internationally competitive and generate large value added in the domestic economy.

Another key sector in the Swiss economy is that of watches. Imports of watch components represent, on average, 4% of total intermediates imports in the considered years. Swiss watches are world-renowned and exports of this category continued to be strong despite the recent currency appreciation.

After considering the composition of the imports bundle, we examine the exporter countries. The vast bulk of intermediates trade is among developed countries (Miroudot et al., 2009; Bergstrand and Egger, 2010) and, in the Swiss case, with Euro countries; on average, 73.4% of imports of intermediates come from high per-capita income economies. Neighboring countries (Germany, Italy, and France), followed by Ireland, are the most important Swiss trade partners.

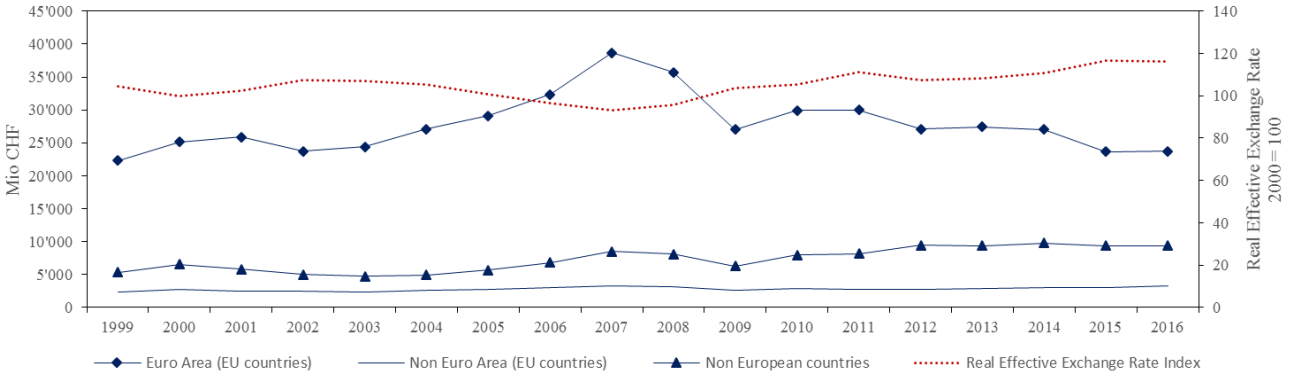
Despite the significant weight of these economies in the Swiss flows, during the period considered, imports of intermediates from non-Euro countries faced more significant average growth than other economies (4.4% vs 0.9%. respectively). Specifically, after the economic crisis in 2009, the imports from non-European countries faced significant growth, equal to 18% (from 2010 to 2016), which corresponded to a decrease in the inflows of intermediates from the Eurozone (-20% in the same years).

Table 1.1: Decomposition of imports of intermediates

	EU28-Euro	EU28-Non Euro	Non EU28
Distribution	73.4%	7.4%	19.1%
Average Annual Growth	0.9%	1.8%	4.4%

While we do not observe a relevant change in the composition of the import bundle, the share of inputs from non-European countries has been increasing (Figure 1.1).

Figure 1.1: Intermediates imports (1990 -2016), disaggregated by the countries of origin



We investigate how an appreciation of the local currency affects the volume of the imports of intermediates and determine the elasticity of the most important categories, both in terms of complexity and volume of goods traded (chemical, metal, and watches). Using a panel-gravity approach, we find that the aggregate inflow of inputs reacts negatively to an appreciation of the Swiss Franc. A change in the value of the local currency causes a reduction in foreign demand for Swiss goods, leading to a fall in intermediate Swiss imports. Since more complex and sophisticated products are less sensitive to price, we also investigate how exchange rates affect individual sectors. We find that exchange rate positively affects the imports of intermediates that are used to produce complex products (pharmaceuticals and watches), while imports of metal intermediates are negatively affected by currency appreciation.

Given the relevance of the Euro countries and the continuous growth of linkages with non-European markets, we analyze how imports from Euro and non-Euro countries react to the exchange rate. Using static panel data, we find that non-Euro countries are less sensitive to the currency appreciation than the partners that have introduced Euro as local currency.

We found that the short-run exchange rate elasticity of Swiss intermediates imports is between -0.4 and -0.7, associated with a high heterogeneity among the considered classification. To

complete our analysis, we estimated a dynamic panel data model to control for the lagged effects and the robustness of the previous results[3].

While previous research focused mainly on exports, this study aims to shed light on the elasticity of intermediates imports with respect to currency appreciation. Does the increase in the value of the local currency lead to a decline in national competitiveness? For many countries, currency appreciation erodes international competitiveness, leading to a trade deficit. However, thanks to their brands and specific characteristics, the outflows of Swiss products face limited price competition and suffer little because of currency appreciation. In the analysis of a country's competitiveness, it is relevant to investigate not only the exports, but also the reaction of imports to a change in the value of the local currency. We want to clarify whether an increase in the value of the Swiss currency leads to an increment in the volume of imported intermediates.

According to the economic theory, the effect of the current exchange rate on trade appears to be unambiguous; an appreciation of country j's currency leads to an increase in the trade flow from country i to j. Regarding the import of intermediates, the effect is not so clearly defined. On one hand, semi-finished products become cheaper, but on the other hand, the exports of finished goods using these intermediates become more expensive.

Specifically, we want to ascertain if cheaper intermediates represent an opportunity to import more and therefore to produce more final and sophisticated goods or if they are driven by the export trend.

The novelty with respect to previous research lies in the use of monthly data regarding the real exchange rate and imports, and in the classification of goods. Rather than considering the traditional classification, imports are classified according to their final use, focusing on the intermediates.

The remainder of the paper is organized as follows. In the next section, we consider previous research applying gravity models to international trade, with focus on the exchange rate and intermediates. Section 1.3 outlines the data and the econometric approach. We then present results in section 1.4 with some robustness checks, while concluding remarks are provided in section 1.5.

1.2 Literature Review

The gravity model emerged in the 1960s (Tinbergen, 1962) with the aim of analyzing bilateral flows among countries. The standard gravity equation is derived from a consumer expenditure equation with the relative price eliminated using a general equilibrium constraint (Anderson, 1979; Bergstrand, 1985). Anderson and van Wincoop (2003) used Anderson's (1979) theory to develop appropriate econometric techniques; in equilibrium, trade from country *i* to *j* is defined as:

$$x_{ij} = \frac{Y_i}{\Omega_i}\left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} Y_j \qquad (1.1)$$

Where x_{ij} are exports from country *i* to *j*, Y_i and Y_j are GDP of country *i* and country *j*, respectively; $P_j$is the consumer price index in *j* and t_{ij} are the iceberg costs.

Moreover:

$$\Omega_i = \sum_j \left(t_{ij}/P_j\right)^{1-\sigma} Y_j \qquad (1.2)$$

The aim of Ω_i is to consider not only the pair of trading countries in the gravity equation, but also the GDP and the consumer price index of all countries *j* that purchase goods from *i.*

The rise in global supply chains is transforming international trade patterns as trade in intermediates becomes increasingly important. countries no longer purchase goods only to satisfy internal demand and the production process is stretched among many economies, which requires a reformulation of the standard gravity model proposed in the existing literature.

The traditional literature on gravity relies on the assumption that the products exported from country *i* to *j* are entirely produced in *i.* Under vertical specialization, the exported volume of goods is much higher than the amount of domestic value due to the import contents of exports; each country imports intermediates and, after processing, export finished goods. Similarly, the traditional model assumed that the demand of country *j* is for its final consumption, meaning that *j'*s expenditure is its total income and it is measured by its GDP. If consumer trade dominates, the GDP of the destination country is a good proxy for the demand while that of the exporter country is for its total supply; differently, when intermediates dominate international trade, the use of GDP is less appropriate.

In the gravity literature, the studies of Bergstrand and Egger (2010), and Baldwin and Taglioni (2011) are particularly relevant for the consideration of intermediate goods. Baldwin and Taglioni (2011) argue that the traditional gravity equation can be used when the pattern of trade in intermediates is proportional to the trade in final goods. However, GDP fails to be a good proxy when the trade in intermediates is dominant (as in our case).

The key difference between the traditional gravity model and that for intermediates is in the definition of the economic "mass" variables since purchases are no longer exclusively driven by consumer demand, but also by intermediates demand. For this reason, Baldwin and Taglioni (2011) formally derived the gravity equation with intermediate goods using gross output as the mass variable, rather than the traditional value-added component. Other studies (Harrigan, 1996; Feenstra, 2004; Anderson and van Wincoop, 2003) employ estimators that control for the mass variables with fixed effects, hence avoiding misspecification.

As well as the change in the production process, the exchange rate is a macroeconomic factor that influences international trade. In the existing literature, it is possible to distinguish among research that considers the volatility of the currency and that which examines the direct effect of the exchange rate (Bergstand, 1985; Dell'Ariccia, 1999). We want to contribute to the latter field of literature.

The effect of the current exchange rate on trade seems to be well defined; as a consequence of currency appreciation, we expect an increase in the inflows of goods. However, the effect may differ according to the type of product traded. Previous studies demonstrated that the elasticity of trade (in terms of output, trade costs, or exchange rate volatility) varies according to the typology of the products (Rauch, 1999; Feenstra, Markusen and Rose, 2001; Evans, 2003; Saito, 2004; Baldwin et al., 2005; Anderson et al., 2014). In particular, with the Swiss economy as the country of interest, Thorbecke and Kato (2018) found that the exchange rate does not affect the volume of exports for more sophisticated sectors (watches and pharmaceuticals). Other research (Martinez-Zarzoso and Johannsen, 2016; Badinger and Türkcan, 2014) demonstrates how categories of products react differently to the introduction of a common currency.

Combining the literature on the gravity model with intermediates and the direct effect of exchange rate on different categories of goods, we aim to measure how intermediates imports react to a change in the value of the domestic currency (Swiss Franc).

1.3 Data and Empirical Approach

We use a panel of monthly data on Swiss imports for the period 1999–2016, covering 46 countries (see Appendix 1.1). As they represent more than 90% of the total imports in Switzerland, these markets have been chosen according to the importance of their trading partnership with Switzerland.

Countries that are not relevant trade partners for Switzerland have not been considered since import trends are determined by other factors.

Total imports have been decomposed into final (consumer and capital) goods and intermediates, with the aim of capturing the final use of imported products. In our analysis, we focus only on this second category. Data on the volume of intermediates inflows have been collected on a monthly basis from the Federal Customs Administration database (Swiss-Impex). Intermediates are recorded under the Broad Economic Classification 01.2.1 – 01.2.4 (see Appendix 1.2 for details). Imports have been used in quantity. Especially in the short run, an appreciation of the currency could lead to a reduction in the value of imports because of a fall in prices, while quantities may not react because of the long-term contract with suppliers (*J effect)*. Since the aim of

the paper is to capture the effective change in the Swiss trade, the use of quantity has been preferred to the values as a measure of the imported goods.

Changes in the value of the Swiss Franc relative to the official currencies of the exporter countries are measured by the real effective exchange rate index (REER). The real exchange rate is defined as (NER x P)/P*, where NER is the nominal exchange rate between the Swiss Franc and the exporter country currency, while P and P* denote the domestic and the foreign producer price index, respectively. Instead of considering the consumer price index, which is the price of a basket of goods and services in Switzerland relative to the price of the same basket in the exporter country, we consider the producer price index (PPI). In fact, in our case, it is better to measure the sensitivity of imports to the exchange rate in terms of the cost of production; the PPI measures the price development of products and services, which are produced (and sold) by enterprises operating within Switzerland or the exporter country.

Specifically, the REER is an average of the bilateral RER between Switzerland and the considered country, weighted by the respective trade shares of each partner (Catao, 2007). Since the exchange rate defines the external value of the Swiss Franc against the trading partner currency, an increase in the exchange rate means that there is an appreciation of the Swiss Franc (and vice versa). Data on the bilateral exchange rate index come from the SNB.

As previously mentioned, we do not consider the GDP of the exporters as a proxy for supply since it would be biased information. Fixed effects control for both the mass variable and multilateral trade resistance.

Our gravity model includes the bilateral real exchange rate, which is our variable of interest, other specific controls, and bilateral time variant controls. All the variables are used in a logarithmic form.

Aim of the model is to capture if the Swiss imports from country *i* in a certain intermediates category *s* at month *m* depends on the current exchange rate between the exporter currency and the Swiss Franc. The empirical model that we analyze is:

$$lnImp_{s,iCH,m} = \alpha + \beta_1 lnREER_{iCH,m} + \gamma_i + \gamma_s + \gamma_t + \varepsilon_{ist} \quad (1.3)$$

The dependent variable is the monthly Swiss imports of intermediates disaggregated according to the Broad Economic Categories (BEC) classification. Bilateral real exchange rate is represented by $REER_{iCH,m}$; β_1 is our interest coefficient. It could be interpreted as a short-run elasticity of imports of intermediates with respect to a change in the value of the Swiss Franc against the trade partner currency.

γ_i, γ_s and γ_t indicate exporters, product and year fixed effects, respectively. The error term ε_{ist} is assumed to be i.i.d.

As well as the Ordinary Least Squares model (OLS), we estimate a Poisson pseudo-maximum likelihood model (PPML) to consider the trade flows that are equal to zero.

We estimate the following model:

$$Imp_{s,iCH,m} = \exp\{\alpha + \beta_1 lnREER_{iCH,m} + \gamma_i + \gamma_s + \gamma_t\} + \varepsilon_{ist} \quad (1.4)$$

where $Imp_{s,iCH,m}$ are the Swiss imports in intermediates, expressed in levels.

Since results between the two models are similar, we augment the OLS model to control for heterogeneity both in sectors and supplier's currency.

Firstly, we include in Equation (1.3) a combined effect of the country characteristics and dummies to control for years of crisis or peg exchange rate. Formally:

$$lnImp_{s,iCH,m} = \alpha + \beta_1 lnREER_{iCH,m} + \beta_2 X_{CHi,t} + \beta_3 Crisis + \beta_4\, Peg + \gamma_{it} + \gamma_{st} + \varepsilon_{ist} \quad (1.5)$$

With $X_{CHi,t}$, we capture bilateral time variant controls, considering the presence of some agreement between Switzerland and the partner countries (free trade agreements, FTA), or the country's membership of the European Union (EU). Considering FTAs, we attempt to capture if the presence of some specific agreement has a positive impact on flows of intermediates goods. We also control for EU membership as a proxy for the closest countries.

$Crisis$ is a dummy for 2009, the year of the global economic crisis. Despite the contraction in international trade as consequence of the global recession, there was a strong appreciation of the Swiss currency in this year.

With the main to investigate the effect of the Swiss Franc 1.20 floor against the Euro in September 2011, the PEG variable has been introduced in the model. It is a dummy equal to 1 during the months of the peg exchange rate against the Euro (September 2011 - December 2014).

We also include country-year and product-year fixed effects to control for the countries mass and the multilateral trade resistance on one side, and for specific product trends, on the other side.

As a second step, we investigate how imports of intermediates from Euro and non-Euro countries react differently to an appreciation or depreciation of the Swiss Franc. Imports from non-Euro countries have registered a higher annual growth while inflows from Euro members accounts for the largest share: to capture heterogeneity in the behavior of the trade partner, the Equation (1.5) has been estimated separately.

Because the sensitivity to exchange rate variation is different according the typology of intermediates imported, we investigate individual categories. For this purpose, we insert the interactions in Equation (1.5) to control how chemical, metal, and watch intermediates behave. We estimate the following equation:

$$lnImp_{s,iCH,m} = \beta_1 lnREER_{CHi,m} + \beta_2 Goods\ category * lnREER_{CHi,m} +$$
$$\beta_3 Goods\ category_s + + \beta_4 X_{CHi,t} + \beta_5 Crisis + \gamma_{it} + \gamma_{st} + \varepsilon_{ist} \quad (1.6)$$

where *goods category* indicates the classification of the intermediates imported (chemical, metal, and watches, respectively). Considering the growing importance and complexity of the pharmaceutical and watch sectors in the Swiss economy, it is relevant to clarify if a strong currency fosters the growth of this branch, allowing firms to purchase intermediates at a relatively cheaper price.

1.4 Empirical Results

As stated in the previous section, we first provide evidence of how the aggregate imports in intermediates react to a change in the value of the local currency. Using a static panel model, we estimate the model both with the OLS fixed effects and the PPML method. Table 1.2 reports the results: in Column (1), the model is estimated using OLS with country, product and year fixed effects. Column (2) shows the results from PPML estimation (in this case the dependent variable is not in log form, but simply in levels). From Columns (3)–(6), we add some controls and interactions to analyze how different categories of goods or how the currency of the exporter influence the volume of imported intermediates. In these specifications, we use country-year and product-year to control both for the countries mass and the product trends.

Results are presented in Table 1.2.

Table 1.2: Static panel data models

			OLS			
	OLS	PPML	*All*	*Euro coun.*	*Non-Euro co.*	*All*
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
ln REER	-0.498**	-0.543**	-0.440***	-0.647**	-0.406***	-0.695***
	(0.197)	(0.223)	(0.135)	(0.319)	(0.147)	(0.221)
European Union			3.205***		3.773***	3.260***
			(0.806)		(0.957)	(0.785)
FTA			1.958**		1.829**	2.006**
			(0.875)		(0.879)	(0.861)
Economic crisis (2009)			-3.287***	-0.0200	-3.441***	-3.257***
			(0.768)	(0.328)	(0.805)	(0.774)
Peg months (Sep.2011-2014)			-0.0753**			
			(0.0379)			
Chemical intermediates						-9.819*
						(5.500)
Chemical * ln REER						2.245*
						(1.177)
Metal based intermediates						10.27**
						(4.204)
Metal * ln REER						-2.085**
						(0.891)
Watch intermediates						-32.79***
						(8.947)
Watch * ln REER						5.436***
						(1.958)
Exporter FE	Yes	Yes				
Product FE	Yes	Yes				
Year FE	Yes	Yes				
Exporter - Year FE			Yes	Yes	Yes	Yes
Product - Year FE			Yes	Yes	Yes	Yes
Observations	131,579	133,687	131,579	49,058	82,521	131,579
R-squared	0.693	0.914	0.693	0.825	0.602	0.698

Clustered standard errors in parentheses (by country and product)

*** p<0.01, ** p<0.05, * p<0.1

The dependent variable is the volume of imports of intermediates in log levels (OLS) and in levels (PPML).

Comparing the first two columns, we note that, using different econometric techniques, the results are similar. The imports of intermediates are sensitive to exchange rate; an appreciation of the domestic currency leads to a decrease in the volumes of imports. The increase in the price of finished goods and the contraction in the aggregate flows of exports generate a negative effect that dominates the imports of intermediates.

In Column (1), we run the model controlling for exporter, product and year fixed effects, aiming to control for the mass variable of each exporter country and for the trend registered by each product category. In Column (2), we estimate the model using PPML, including observations containing zeros; in this case, there is not a significant change compared to the coefficients shown in the other columns. Since we have considered only the main Swiss trade partners, there are few zero flows in our data and these do not significantly modify the results. For this reason, we use the OLS model for the other estimations.

In the other columns ((3) – (5)), we include some controls and some interactions to investigate the effect of a change in the value of the Swiss Franc in more depth.

Considering the control variables (Column (3)), the high level of significance of the real exchange rate is not affected. In particular, Swiss intermediates imports are positively associated with EU countries, meaning that distance continues to be a factor in international trade, as well as with the presence of an FTA between Switzerland and the exporter country.

We also control for the peg years due to the strong depreciation of the Swiss Franc against the Euro. Peg is a dummy equal to 1 during the months of the peg exchange rate against the Euro (i.e., 2012-2014). The SNB's decision to introduce a 1.20 Swiss Franc floor against the Euro has been negatively associated with the inflows: the peg exchange rate curbed the imports of intermediates.

Due to the key role of Euro countries in Swiss trade and the more significant growth of non-Euro countries during the considered year, we disaggregate the imports of intermediates according to their origin. In Column (4) and (5), we attempt to determine if non-Euro countries are more sensitive to the exchange rate than others. In Column (4) we run the model only for the countries that introduced the Euro as local currency, while in Column (5) it has been considered all the other economies.

Results reveal that imports of intermediates from Euro countries react more to a change in the value of the local currency. The short-run exchange rate elasticity of imports from non-Euro countries is -0.406, while that of Euro countries is higher (in absolute term).

With the aim of capturing the role of the local currency in imports in the key sectors of the Swiss economy, we investigate how inflows from chemical, metal, and watch industries react (Column (6)). While chemical and watch intermediates are positively affected by an increase in REER, metal imports are negatively influenced by an appreciation of the currency. This result is in line with the previous literature (Thorbecke and Kato, 2018); industries that export complex products are not price sensitive and do not suffer because of the appreciation of the Swiss Franc. Chemical and watch intermediates are used in the pharmaceutical and watch industries, which are considered the most sophisticated branches of the Swiss economy. Furthermore, considering the

consistent growth of these industries, and the high degree of Swiss specialization in these branches, the purchase of intermediates at a relative lower price allows for greater competitiveness in the international market.

1.4.1 Robustness checks

To test whether the previous results are sensitive to the specific investigated trends or to the used measures of the inflows of goods, we perform some robustness checks (Table 1.3).

In columns (1) and (2), we estimate the model using the values of the imported semi-finished products, instead of the volumes. As expected, the significance of the real exchange rate on the inflows is confirmed, but the magnitude of the coefficient is larger. This is due to the prices fall, as a consequence of the Swiss Franc appreciation. Quantities, instead, in the short-run, tend to react less since contracts with suppliers are fixed for a certain amount of time.

Also the heterogeneity in terms of product categories has been confirmed: more complex products are less sensitive to price and, an appreciation of the local currency, does not lead to a decrease in the imports.

In columns (3) and (4), the model has been estimated using yearly data. The aim is to verify that the effect of the exchange rate on intermediate imports is not present only in the short run. In the general model, the real exchange rate has not a significant impact on the intermediate imports. Nevertheless, investigating the effect according to the different products, the dynamics observed in the short-run have been confirmed.

Finally, in columns (5) and (6), quarter fixed effects have been included in the model to control for seasonable trends. In this case, both the models with controls and that with the interactions with specific product categories confirm the results from the previous model. The real exchange rate, in general, has a negative and significant effect on the Swiss intermediate imports, while the semi-finished that are used in the production of more complex goods positively react to an appreciation of the Swiss Franc.

Table 1.3: Robustness checks

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
ln REER	-0.731***	-1.087***	-1.844	-2.468	-0.599**	-0.838***
	(0.113)	(0.184)	(5.404)	(5.360)	(0.264)	(0.313)
European Union	2.709***	2.775***	0.380	0.271	2.745**	2.760**
	(0.652)	(0.618)	(2.517)	(2.504)	(1.072)	(1.073)
FTA	1.907***	1.967***	-0.296	-0.367	0.932	0.901
	(0.681)	(0.656)	(2.564)	(2.552)	(1.236)	(1.234)
Economic crisis (2009)	-2.040***	-2.233***	-1.042	-0.978	-3.162***	-3.230***
	(0.488)	(0.556)	(2.659)	(2.643)	(0.961)	(1.019)
Peg years	-0.0385		-0.151		-0.0312	
	(0.0304)		(3.505)		(0.0660)	
Chemical intermediates		-9.742**		-9.027*		-10.13*
		(4.615)		(4.742)		(5.687)
Chemical * ln REER		2.254**		2.146**		2.250*
		(0.992)		(1.016)		(1.204)
Metal based intermediates		6.443**		8.329**		10.45**
		(3.033)		(3.631)		(4.304)
Metal * ln REER		-1.260**		-1.648**		-2.109**
		(0.634)		(0.770)		(0.907)
Watch intermediates		-27.58***		-33.86***		-33.28***
		(6.780)		(7.705)		(9.225)
Watch * ln REER		5.375***		5.451***		5.492***
		(1.479)		(1.687)		-2.003
Exporter - Year FE	YES	YES	YES	YES		
Product - Year FE	YES	YES	YES	YES		
Exporter - Quarter FE					YES	YES
Product - Quarter FE					YES	YES
Observations	133,686	133,686	12,771	12,771	131,579	131,579
R-squared	0.620	0.628	0.775	0.780	0.697	0.702

Clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1.5 Conclusion

Since the so called “regional value chain” is making way for the “global value chain,” in terms of the national economy, it is relevant to understand which factors drive the trade and the linkages between countries. This study attempts to capture how a change in the value of the Swiss Franc affects the imports of intermediates, disaggregating these goods according to both the category and the currency of the origin country. Switzerland is an interesting economy due to its high degree of openness and the fact that the Swiss Franc is seen as a safe currency.

Presenting previous research, we demonstrate how to apply the general gravity model to the intermediates trade. Furthermore, particular attention has been given to the real exchange rate as our variable of interest as it helps to explain trade variations.

Our analysis has been structured in two main blocks: first, we investigate the impact of the real exchange rate on the aggregate inflow of intermediates. Second, we augment the general model considering the main categories of intermediates and the currency of the exporter country.

In terms of the aggregate imports of semi-finished products, we found a negative relationship between imports and real exchange rate; this could be viewed as a consequence of the decrease in the foreign demand for Swiss goods. In a more thorough analysis, we investigate the behavior of the different categories of intermediates. We decide to focus on the categories that have a higher weight in the Swiss bundle and also on watches due the complexity and the relevance of this sector in the international market.

Semi-finished products used in industries that are more complex (pharmaceutical and watch) react positively to a change in the value of the Swiss Franc. Currency appreciation is not always associated with a fall in exports and could also lead to an increase in the inflow of goods. Since the most complex goods are not price sensitive, the outflow of these products continues to be strong in the international market, leading to a growth in the demand for intermediates. This is the case for chemical and watch intermediates, which are used in sophisticated industries. If exports continue to be strong, Switzerland continues to import intermediates, gaining advantages because of the lower relative price. Other countries purchase chemical and pharmaceutical products, and watches because of their quality, specifications, and their complexity, and give less relevance to their price. The main goal of these industries is not to offer the cheapest product, but the most innovative and complex goods that are difficult for other economies that do not have such skills and knowledge to replicate. This is the key to being competitive in the international market even when there is an increase in the value of the Swiss Franc.

Starting from the considerations that non-Euro countries have a higher growth rate during the years considered, and that the majority of imports come from the developed countries that are close to Switzerland, we analyze how these two groups of countries react differently to an appreciation of the Swiss Franc. Classifying exporters between Euro and non-Euro countries, we found that the latter react less to a change in the local currency.

Currency appreciation does not always lead to a decrease in the international competitiveness of the Swiss economy. Industries that are more complex continue to be strong in the market because of the high-knowledge and the quality of their products, which generates an increase in the demand for intermediates.

From our results, we can see how the effects of a change in the value of the Swiss Franc is heterogeneous among both countries and economic branches. The key success factor for the Swiss economy, as well as the ability to be competitive even with a strong currency, lies in the diversification and high specialization of the goods traded in the international market.

Endnotes

[1]Data from *The World Bank* database.

[2]Data from the OECD database, 2015.

[3]Data from Swiss Federal Customs Administration.

[4]The results between the static and the dynamics models were very similar. For this reason, we focus our attention on the static model.

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Appendix 1.1: List of considered countries

EU 28	**Other countries**
Euro currency	
Austria	Argentina
Belgium - Luxembourg	Australia
Cyprus	Brazil
Estonia	Canada
Finland	China
France	Hong Kong
Germany	India
Greece	Japan
Ireland	Korea, Rep.
Italy	Malaysia
Latvia	Mexico
Lithuania	New Zealand
Malta	Norway
Netherlands	Russian Federation
Portugal	Singapore
Slovak Republic	South Africa
Slovenia	Thailand
Spain	Turkey
	United States
Non-Euro Currency	
Bulgaria	
Croatia	
Czech Republic	
Denmark	
Hungary	
Poland	
Romania	
Sweden	
United Kingdom	

Appendix 1.2: Broad economic categories

Semi-finished and intermediate products

	Semi-finished and intermediate products for the food industry
01.2.1.01	Semi-finished and intermediate products for food production
01.2.1.02	Semi-finished products and intermediate products for animal-feed production
	Semi-finished and intermediate products for the remainder of industry and manufacturing
01.2.2.01	Semi-finished and intermediate products from the textile and clothing industry
01.2.2.02	Semi-finished and intermediate products made of paper
01.2.2.03	Semi-finished and intermediate products made from leather and pelts
01.2.2.04	Semi-finished and intermediate products made from wood and cork
01.2.2.05	Plastic semi-finished products and intermediate products
01.2.2.06	Semi-finished and intermediate products made of rubber
01.2.2.07	Chemical semi-finished and intermediate products
01.2.2.08	Semi-finished and intermediate products for construction, made from glass and ceramics
01.2.2.09	Metal-based semi-finished and intermediate products
01.2.2.10	Electrical and electronic semi-finished and intermediate products
01.2.2.11	Semi-finished and intermediate products for machines and appliances
01.2.2.12	Watch components
01.2.2.13	Semi-finished and intermediate products for vehicle construction
01.2.3	Precious-metal goods
01.2.4	Goods for public services

Chapter 2: Do multinationals attract other multinationals? Evidence from the Swiss cantons

Federica Maggi

Abstract

It is widely recognized that the presence of MNEs in a region is a source of advantage in terms of innovation and technologies, as well as of information on the international market. The attractiveness of a country for MNEs stems both in local factor and in its level of internationalization. Focusing on Switzerland because of its importance in attracting MNEs, it has been investigated if the presence of MNEs in year t-1 attracts other MNEs. Using cantonal data disaggregated at NOGA 2-digit, it has been found that the MNEs tend to localize in a canton where other MNEs are localized.

Giving the high relevance of the tertiary sector, it has been investigated if MNEs active in manufacturing attract multinationals in services. The sample has been disentangled to investigate the heterogeneity in terms of sector and canton.

Furthermore, to have a general overview of the phenomenon, I studied the attractiveness of MNEs toward other MNEs active in the same sectors or in related ones.

From the results, the existence of international agglomeration is confirmed among same sectors, but also among related ones.

In the location choice, not only the local characteristics matter: the linkages among MNEs are, as a matter of fact, one of the key drivers in the firm decision.

Keywords: Multinational firms, location choice, international agglomeration, related sectors, servitization of manufacturing, sectoral and local heterogeneity

2.1 Introduction

Fragmentation of activities along the value chain is making multinationals increasingly important. Domestic value chains have progressively been replaced by the global ones, stretching the production process in different economies. Firms, in fact, set their activities in multiple countries, leading to an increase in the global investment flows. This is a very dynamic phenomenon, which, along years, knew a change in the destination markets, but also in the economic branches.

Multinationals (MNEs) decide to enter in a new economy for different reasons: some firms are looking for a reduction in transportation costs and for an exploration of new resources, while others are more oriented towards the exploitation of the differential costs. The reason behind the location choice is, as a matter of fact, strongly influenced by the economic development of the host country (Le, 2017; Tsang and Yip, 2007). For the MNE, a larger technological gap between the home and the host country entails greater investment and risk, making also the learning process of the used technologies more complex (Javorcik et al., 2018). For the host countries side, a high level of development allows domestic firms to easily "absorb" MNEs knowledge and benefit from their spillovers and linkages (Narula and Dunning, 2000). As a result, developing and developed economies differently react to the entrance of foreign companies.

Host country benefits from the presence of MNEs since they provide a large and growing contribution to the local economy in terms of employment, investment, taxes and impact on trade balance. MNEs, especially when involved in knowledge intensive and innovative activities, are often seen as a powerful channel of technology transfer with beneficial effect on domestic firms both in terms of productivity and innovation.

Foreign firms can encourage domestic firms in investing in R&D and, moreover, they stimulate local innovation. Furthermore, MNEs offer new insights on the foreign market opportunities and new information on preferences of potential customers. The combination of these aspects is a key factor of success for an economy: innovating and creating new linkages in the international market are main drivers to gain competitive advantage over other countries.

While a lot of attention has been reserved to the MNEs location choice or on the impact of foreign firms on the domestic ones, this paper wants to offer a new perspective. It investigates if sectoral linkages, as well as agglomeration among foreign companies, influence the location choice of new MNEs. Are the presence of high educated workers, the index of specialization or the infrastructure available in a certain region the only drivers for the MNE location choice? Or do foreign firms prefer to locate in an area with a high level of internationalization?

This field of analysis is still under-explored, despite the positive consequences that the presence of MNEs has on the domestic economy and on its competitiveness. Our analysis is based on the number of MNEs in each Swiss canton during the years 2014-2018. I firstly examine if the presence of MNEs in manufacturing sectors in time *t-1* attracts services foreign companies. Secondly, in a more general perspective, it has been investigated if a MNE in a certain sector attracts MNEs in the same industry or in the related ones.

Switzerland is a suitable setting for the analysis. It has been widely recognized that Switzerland attracts a high level of inward foreign investment if compared to other European countries and it has been registered a significant increase in the inflows of FDI year over year.

The innovative aspect of the analysis relies on the study at the local level, investigating the heterogeneity of this phenomenon both in terms of sectors and of cantons.

To explore linkages and heterogeneity among economic branches, a proximity matrix has been implemented to capture the relatedness among different sectors. Differently from the input/output relations, the proximity index offers a more complex and complete tool to evaluate when two sectors can be considered close or not.

This relatedness measure, in fact, considers all the technologies and the skills required during the production process, giving a more exhaustive measure of the industrial distance. Existing literature (Lo Turco and Maggioni, 2019; Zhu et al., 2017; Boschma and Iammarino, 2009) has shown that industrial proximity is playing an important role in terms of employment, production of new products in the economy as well as diversification. The idea of industrial relatedness is not considering only vertical linkages, but also the connections existing among economic branches that are involved in similar technologies or require similar skills.

Furthermore, the local level analysis offers a relevant added value to the investigation of the phenomenon. It allows to exploit the heterogeneity in terms of industry composition and allows to highlight how the different cantons have reacted to the global value chain and to the market entry of foreign companies. The magnitude of the attraction of new MNEs is different according to the local area. Even if Switzerland is a small country, the high level of autonomy and the various specializations, as well as the industry mix, makes relevant the study of MNEs at the cantonal level. In the analysis, it has been deeply investigated the behavior of cantons with a lower number of MNEs in 2014, but that registered a higher growth during the considered years.

Additionally, this study gives relevance to the behavior of foreign firms active in knowledge intensive services sectors. A canton faces less competition in the international market as far as it is able to support what the manufacturing firms produce and export with knowledge intensive services. Furthermore, spillovers from knowledge intensive industries are expected to largely

impact productivity and innovation of the domestic economy. While the role and the impact of foreign companies and their technologies on the local economy have been largely studied, little attention has been reserved to the sectoral composition and to the effect of complex skills among MNEs.

The empirical results show that, although each canton has a different level of attractiveness and a different industrial fabric, the presence of foreign firms is an important driver for attracting other multinationals. Location choice of multinationals is not only driven by the cantonal performance or by the available infrastructures, but also by its level of internationalization.
Manufacturing MNEs attract other services MNEs, especially in cantons in which, in 2014, the number of foreign firms was lower than the Swiss average.
In the general investigation of the phenomenon, the presence of MNEs in year *t-1* (computed as the ratio among MNEs and the total number of firms in the canton) positively affects the number of foreign companies in the same sector and in the same canton. Moreover, with the introduction of the proximity matrix in the equation, I found that the number of foreign companies from related industries in the previous year appears to significantly impact the number of foreign companies in year *t.*

This article is structured as follows: Section 2.2 shows a review of the literature on the relevance of agglomeration and externalities among firms, as well as on the increasing importance of services in developed economies. Section 2.3 shows in detail the stylized fact concerning the Swiss economy and its trend in attracting MNEs, Data and methodology used are shown in Section 2.4, giving particular relevance to the proximity matrix and its computation. Section 2.5 shows the empirical models, while Section 2.6 the results. The final Section concludes, highlighting why MNEs are important for the local competitiveness.

2.2 Review of the literature

Empirical research on the location choice of foreign activities suggests that both external (taxes, exchange rate, trade) and internal firm specific factors matter (for a comprehensive survey see Bloningen, 2005). Nevertheless, there is high evidence that agglomeration plays a key role in the location decision of MNEs.

Starting from Marshall in 1920, the economic literature has highlighted how the sharing of the same location positively influences the industry activities. Externalities coming from surrounding companies generate benefits that can be grouped in three main areas: (i) knowledge spillover and spread of new ideas and of innovation, (ii) the labor pooling (availability of skilled

workers) and (iii) the input sharing, namely the backward and forward linkages to the local market (Fujita et al, 2001).

In addition to these externalities, economic literature has emphasized the presence of externalities among firms located in the same area but active in different sectors: Jacobs externalities (Jacobs, 1969). According to this stream of research, the overall variety of an economy fosters growth more than being specialized in one industry. The strength of these regions is the ability to produce many and differentiate goods, and not the acquisition of a high level of sophistication in one specific branch.

Agglomeration and externalities are widely recognized to play a central role in firm activities and in their profits. Generally, studies on geographic agglomeration focused more on domestic firms, but it is relevant to explore this phenomenon also for foreign companies. As other firms, MNEs are assumed to maximize their profits. As a consequence, a MNE will choose the location that is able to guarantee the highest profits, under the assumption that it transfers its technology and operates with the same production process in any location (Stöllinger, 2015). It follows that the level of profits would change according to the local specific factors, such as agglomeration.

From the empirical literature, there are some evidences on the positive effect of agglomeration economies among foreign companies. For what concerns European countries, Crozet et al. (2004), for example, found very strong evidence of positive spillovers between firms, especially in certain sectors. Other studies of this phenomenon have been done by Guimarães et al. (2000) for Portugal, by Basile (2004) for Italy, by Boudier-Bensebaa (2005) for Hungary or Barrios et al. (2006) for Ireland.

Despite the empirical evidence on the role of companies active in the same economic sectors, the role played by linkages among MNEs active in different sectors has been largely unexplored, leaving unanswered the question whether foreign companies in services are attracted by the presence of MNEs in manufacturing.

This gap in the literature, combined with the increasing relevance of services in developed economies (Kuznets, 1966; Jorgenson and Timmer, 2011; Alvares-Cuardrado and Long, 2011), has drove me to focus on the linkages between manufacturing and services. Generally, literature focuses on the gap between manufacturing and service or on the growing importance of services in creating added value. Instead, I focus on another empirical fact: the linkages between manufacturing and services, highlighting how the tertiary sector is becoming part of the manufacturing value chain. While existing literature analyzes servitization of firms (Crozet and Milet, 2014) or the impact of this shift from manufacturing to services on economic growth (Doytch and Uctum, 2011),

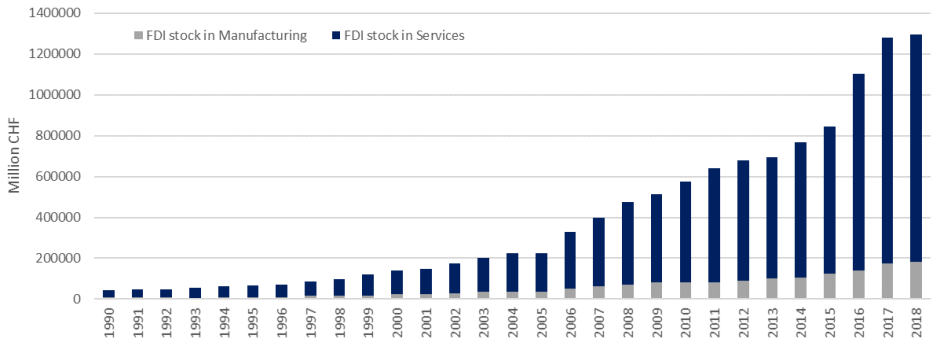
contribution of this study is to understand how manufacturing activities have contributed to attract services activities in the same area.

This is, to the best of my knowledge, the first attempt to study how agglomeration economy matters in the location choice of MNEs in Switzerland, giving relevance to linkages not only among the same sector.

2.3 Background and Swiss evidence

Switzerland is an attractive country for many foreign investments. The different cantons, for various reasons, are chosen as destination market for MNEs. This leadership in attracting companies has deeps roots in the Swiss history and shows a significant growth year over year, as shown in Figure 2.1.

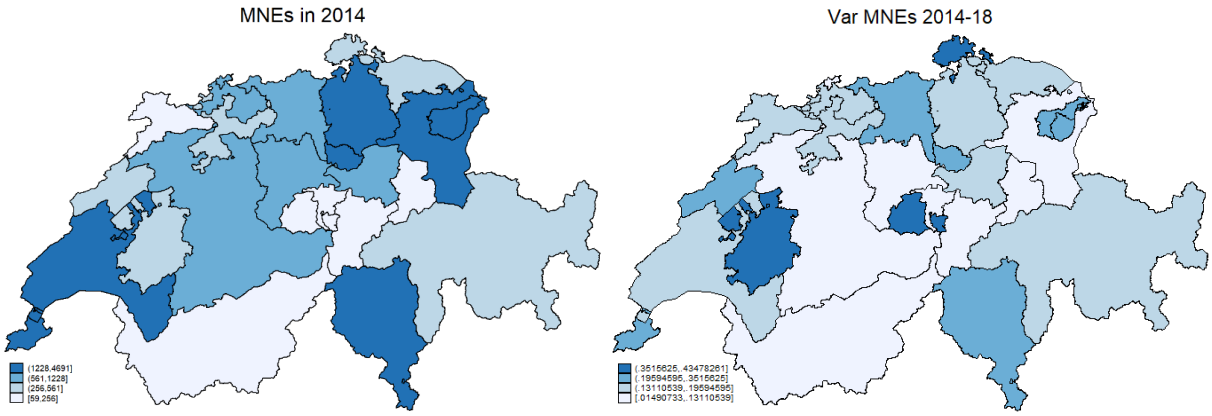
Figure 2.1: **Foreign direct investment in Switzerland (Stock)**



There are several reasons behind this high level of attractiveness. First, Switzerland is a small economy and it is located in a strategic position, in the middle of Europe. International trade, combined with its knowledge and skills, is one of the key drivers of its economic power. Switzerland, in fact, is specialized in the last stages of the production process, importing intermediate products and exporting the finished ones. This strong integration in the international reality is confirmed also by the attractiveness of foreign firms, which positively impact on the economic growth. Another important reason that draws MNEs is the so-called *Swiss made label*: in collective mind, it is a synonymous of high quality and precision that can be easily exploited by firms locates in the country.

Even if Switzerland is a small country, this phenomenon is not equally distributed and there is a high level of heterogeneity among cantons. Figure 2.2 shows, on the left, the number of MNEs in 2014 (first year of the analysis) in each canton and, on the right, the variation in the number of foreign companies during the considered years.

Figure 2.2: Number of MNEs in each canton in 2014 and variation 2014-2018



The distribution of foreign companies is concentrated in some areas, especially in the North-East and in the South-West of the country. Zurich and Zugo on one side, Geneva and Vaud on the other, hosted, in 2014, almost 50% of the MNEs that have decided to set a branch in Switzerland. Another Canton relevant in term of attractiveness of foreign companies is Ticino: located in the South part of Switzerland, it is strongly connected with Italy and hosted 11% of the total amount of MNEs.

It is interesting to note that the cantons with a MNEs number, in 2014, lower than the average Swiss value have registered a more significant growth during the years 2014-2018. Because of their larger increase, in this study I deeply investigate this sub-sample of Cantons and any differences from other Cantons, trying to understand the drivers of their higher growth in terms of foreign companies.

Analyzing the MNEs characteristics, in the Cantons with an initial lower number of foreign companies, firms operating in high-intensity sectors have faced a lower average increase than the total bundle of foreign companies. In 2014, in fact, the 59% of MNEs were active in complex sectors, while in 2018 the 58%. Nevertheless, these shares are higher than the ones registered in the cantons with a higher level of internationalization (56% on average).

As it is common in all developed economies, the larger share of foreign companies is active in services (80% on average in 2014). Furthermore, this category is the one with the larger increase: from 2014 to 2018 the number of MNEs active in services have registered an increase equal to 20% on average, while, in the same period, the MNEs active in manufacturing have face a growth of 15%. Switzerland follows the global trend and confirms to be an attractive location both for production and for services.

2.4 Data and methodology

In the first part of this Section it is presented the variables considered and their source. Because of the innovative approach and the relevance in the model, in the second part of the Section it is explained how the proximity matrix has been computed.

2.4.1 Data sources

Our study covers all the MNEs[1] operating in Switzerland during the years 2014 – 2018. Data come from the Swiss Federal Office (STAGRE) and are disaggregated by the 26 cantons and by 77 economic activities (Noga08 2 digit) [2].

The number of MNE firms is the dependent variable: differently from the number of employees, it allows to precisely analyze the inflow of foreign entities in each canton. If the growth in terms of workers can be due to the hiring of a specific company, while the decrease to the firing, the number of firms is not affected by any specific dynamic within the company. Specifically, in the first model I focused only on the MNEs that are active in services, while in the second one on all the MNEs located in Switzerland. In order not to get biased results, besides the number of MNEs, it has been used the share of MNEs over the total number of firms in a canton.

Since the main goal of the study is to understand the linkages among MNEs active in different sectors and how this influences the location choice, the main variables of interest in the analysis are two. I firstly consider if the number of MNEs active in the manufacturing sectors and in the same canton in year *t-1* affects the number of MNEs in services in year *t*.

Secondly, in a more general perspective, it has been investigated the impact that the share of MNEs, over the total firms in the canton, in *t-1,* has on the current share of MNEs in the same sector or in the related ones. Before going into the details of the empirical strategy and the results, the next Section will cover in detail the computation of the relatedness index among sectors and the construction of the weight matrix. This matrix has been used to compute the distance among sectors in order to understand which ones are more similar in terms of needed resources or workers, as well as target market.

Both the models include a set of control variables. More in detail, it has been considered the specialization level (LQ) of the canton in each specific sector with the aim to capture the agglomeration effect. The location quotient is a good way to understand if the choice to localize in one canton instead of in another is also due to the cantonal competitive advantage in a certain economic activity. For the same reason, as well as to control for the economic size of the section[3], the added value (in CHF at current price) has been included.

Furthermore, the change in GDP over the previous year, in current price, has been considered. This information captures the growth of each canton, helping in identifying if the growth in the number of MNEs is due to the general growth of the area or to the other MNEs.

Since the presence of high-skilled workers could be seen as an important aspect in the location choice of firms involved in technology intensity and complex activities, it has been considered also the share of high educated employees over the total cantonal working age population. High skilled workers are a source of competitive advantage for firms, allowing them to differentiate both in terms of innovation and of level of sophistication of the produced goods. Strictly connected to this aspect, I control also for the expenses in R&D supported by private firms disaggregated by macro region and by economic division. Investments in R&D are, in fact, key driver as well as the engine of the innovation undertaken by the companies.

Variables are summarized in Table 2.1.

Table 2.1: Descriptive statistics

Variable	Definition	Obs.	Mean	Std. Dev.
ln MNE Firms	Number of MNE firms in each canton disaggregated by NOGA08 2 digit	5'738	1.75	1.47
Gdp change	Change in cantonal GDP over the previous year, in % (current price)	5'738	1.56	1.98
ln Added value	Added value of each economic section in each canton (in Mio CHF)	5'738	8.33	1.12
Share of High Educated workers	Share of high educated workers in each sector over the total working age of the canton	5'738	0.18	0.26
ln R&D	Expenses (in Mio CHF) covered by private firms by macro-region and by economic section	5'738	5.16	1.20
LQ	Location quotient (Specialization level of each canton in each sector)	5'738	1.28	2.00

All the data come from the Swiss Federal Office

2.4.2 Measuring the proximity between sectors

The economic distance among sectors has been computed starting from the concept of relatedness proposed by Hidalgo et al. (2007). The idea is to compute the similarities among sectors, considering how many regions are specialized in both sectors. As far as this co-occurrence increases, the two economic branches are similar.

To compute the proximity matrix, I used data on sectoral employment in Switzerland in 2012 to avoid any endogeneity problem. This information is disaggregated by canton and by sectors (NOGA08 2 digit) and, as for the MNEs, I did not consider data on the primary sectors.

Firstly, I computed the location quotient[4] and I defined the sectors *s* in which each canton *c* is specialized ($LQ_{sc} > 1$). Sector *s* and *j* are considered related when many cantons are specialized in both, meaning that the co-occurrence is high. Formally, the proximity among two sectors has been computed as follows:

$$\varphi_{sj} = \frac{c_{sj}}{\left[\left(\frac{s_s}{T}\right)*\left(\frac{s_j}{T-s_s}\right)+\left(\frac{s_j}{T}\right)*\left(\frac{s_s}{T-s_j}\right)\right]*\left(\frac{T}{2}\right)} \quad (2.1)$$

where c_{sj} stands for the number of cantons specialized both in *s* and *j*, s_s and s_j are respectively the number of cantons specialized in *s* or in *j* while *T* is the total number of occurrence of any sector. Instead of following the standard procedure for the proximity measurement, following Van Eck and Waltman (2009) and Cortinovis et al. (2020), it has been introduced a random benchmark. The denominator, in fact, shows the number of co-occurrences under the assumption that *s* and *j* are independent.

Computing the proximity index among each pair of sectors, a weighted matrix (W) with *n* rows and *n* columns has been computed, where *n* is the total number of considered sectors. Since I am interested in sectors with stronger relatedness, cells with a proximity lower than 1 has been set equal to zero, as well as the main diagonal of the weighted matrix. Values have been normalized to make them range between 0 and 1.

Finally, to control for the presence of MNEs not only in the same sectors, but also in related ones, the number of MNEs has been weighted by the proximity index:

$$MNE\_prox_{sct} = \sum_{s \neq j} \varphi_{sj} * MNE_{jct} \quad (2.2)$$

With this measure, the idea is to understand how much the presence of MNEs in a certain sector is exposed to the presence of MNEs in related sectors. The higher is the proximity index, the higher is the weight of companies active in that sector compared to other sectors.

This indicator is relevant also in understanding the role of spillovers. Companies in close industries can benefit from the presence of other firms in related sectors both in terms of knowledge, skills and technology, but also in terms of information on the international market.

2.5 Empirical strategy

This paper investigates if the presence of MNEs in a certain sector in time *t-1* has a consequence on the MNEs active in time *t.* This effect has been investigated using different econometric models. Firstly, to understand the impact of services companies on manufacturing, a

fixed effect model is used (Section 2.5.1). Second, a GMM model has been adopted to generally study linkages among the MNEs located in Switzerland.

2.5.1 The fixed effect model

For what concerns the first model, a fixed effects model has been implemented, controlling for sector/canton specific characteristics. All the independent variables are used one year lagged. The number of MNEs in a certain service sector *i* at time *t* has been modelled as the result from the number of MNEs in manufacturing in the same canton in the previous year and a combined effect of sector/canton variables. The empirical model is as follows:

$$lnMNEservices_{ict} = \beta_1 lnMNEmanufacturing_{c,t-1} + \beta_3 Control_{sc,t-1} + \alpha_t + \gamma_{ic} + \varepsilon_{ict} \quad (2.3)$$

where $lnMNEservices_{ict}$ is the number of MNEs disaggregated by the *i* sectors in services (in log), while $lnMNEmanufacturing_{c,t-1}$ is the number of MNEs in manufacturing (in log). The model includes also a set of canton/sector control as well as yearly (α_t) and canton/sector (γ_{ic}) fixed effects. The set of controls covers the added value of each section in the considered canton (in log), the expenses in R&D covered by private firms (in log), the share of workers with a high education, the cantonal growth and the location quotient.

Considering a sub-sample of the baseline model, two different specifications have been estimated: the first one focusing only on the more complex sectors (Appendix 2.1) and the second one considering only the cantons that, in 2014, had a number of MNEs lower than the Swiss average (Appendix 2.2).

More in detail, following the Eurostat classification, sectors have been classified according to the level of knowledge embodied in their activities. The analysis has been conducted considering only branches (both manufacturing and services) that require high technology, that are more active in R&D or that show a larger number of patents: these are the industries able to offer more diversified and sophisticated services or goods. MNEs active in these sectors are supposed to generate lager spillovers for the local economy.

The aim of differentiating the sample is to investigate the heterogeneity both in term of sectors and in terms of cantons.

As further robustness check of this analysis, the model has been estimated using the share of MNEs over the total number of firms active in the canton. In this way, it is possible to normalize the variable of interest, capturing if the growth in MNEs is due to the overall increase in the firms of the canton, or if it is specifically for the MNEs.

2.5.2 The GMM model

To detect the effect that, in general, the MNEs in the same industry and in related ones have on the MNEs active in time *t*, some econometric challenges have been faced. The OLS estimation fails to control for potential endogeneity and autocorrelation problems. The common alternative (especially in case of a dataset with short time dimension and larger id dimension) is to use a panel GMM estimators. Instrumenting the dependent variables of interest, it is possible to control for simultaneity bias that emerges from the existence of endogenous explanatory variables of interest through the use of internal instruments.

The dependent variable of the model if the $Ratio\ MNEs$, computed as the number of MNEs in a certain sector and canton over the total number of firms in the canton. In this way it is possible to normalize the variable and to identify if the effect is driven by a general growth of the canton or it is specific for the MNEs.

As shown in the Equation below, the fraction of MNEs in each canton in each sector is a function of the share of MNEs hosted by the same canton in the same sector in the previous year. The empirical model is as follows:

$$Ratio\ MNEs_{sct} = \beta_1\ ratio\ MNEs_{sc,t-1} + \beta_2 Control_{sc,t-1} + \alpha_t + \varepsilon_{sct} \quad (2.4)$$

As in Equation (2.3), the model includes also a set of canton/sector controls as well as yearly dummies (α_t).

To investigate if the presence of MNEs in related sectors in time *t*-1 matters in the share of MNEs in time *t*, the variable $ratio\ MNEs_{sc,t}$ has been interacted with the proximity matrix (W).

$$Ratio\ MNEs_{sct} = \beta_1\ W * ratio\ MNEs_{sc,t-1} + \beta_2 Control_{sc,t-1} + \alpha_t + \varepsilon_{sct} \quad (2.5)$$

Introducing the weight matrix, it is possible to control for the effect played by firms in related sectors. The more two sectors are close, the more one is exposed to the spillovers from the other and can benefit not only from the internationalization of its specific sectors, but also from the closest branches.

The model has been estimated in differences, since it performs better than the system; furthermore, the two step option has been used because of its higher efficiency. The dependent variable of interest has been instrumented up to two lags.

2.6 Results

This section is structured as follows. Firstly, it has been presented results on the impact of manufacturing MNEs on services MNEs. Models have been estimated for the entire sample, but

also focusing only on sub-samples to better investigate the heterogeneity both in terms of cantons and sectors.

The second part, instead, gave relevance to the interactions among sectors, both within the same economic branches and in related ones.

2.6.1 Service and Manufacturing linkages

Results from estimates are presented in Table 2.2. In Column (1) and (2), the model has been run considering all the foreign firms active in services, while in Column (3) only complex sectors have been taken into account. Column (4) shows the results for the cantons that in 2014 had a number of MNEs lower than the Swiss average, while Columns (5) and (6) show the results using the share of MNEs over the total number of firms in the canton instead of the number of MNEs in logarithmic form.

Table 2.2: Service and manufacturing linkages

	All sample		*Complex sec.*	*Low MNEs*	*All sample (MNEs/tot. Firms)*	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
LAG lnMNE_man	0.242**	0.261**	0.236***	0.385***		
	(0.103)	(0.104)	(0.0735)	(0.120)		
LAG MNEs man/ Tot. firms (canton)					0.0891***	0.0919***
					(0.0255)	(0.0251)
Gdp change		-0.00174	-0.00624	0.00864		0.000007
		(0.00330)	(0.00424)	(0.00539)		(0.000004)
lnVAt1		0.556***	0.655***	1.118***		0.0003
		(0.185)	(0.217)	(0.330)		(0.0002)
% Em_High t1		4.242	2.007	3.686		0.007
		(3.124)	(3.320)	(3.200)		(0.008)
lnR&Dt1		-0.0121	0.0407	-0.0509		-0.00005
		(0.0361)	(0.0468)	(0.0470)		(0.00004)
QLt1		-0.0321	-0.0988	-0.0783		0.00006
		(0.0836)	(0.0907)	(0.118)		(0.0001)
Observations	2,552	2,552	1,504	1,393	2,552	2,552
R-squared	0.072	0.079	0.083	0.083	0.057	0.064
Number of id	696	696	411	392	696	696
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Canton_sector FE	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In the baseline model, the variable of interest is significant, even after the introduction of controls. The presence of MNEs in manufacturing in time *t-1* has a positive impact on the MNEs in

services. Confirming what recent literature has found, manufacturing industries need the support of services in order to offer a final good that is competitive in the international market. Furthermore, the positive effect can be explained by the growing need of services by workers employed by MNEs.

Investigating heterogeneity in terms of sectors, it has been found that the location choice of services classified as technology intensive is influenced by manufacturing companies active in high-knowledge intensive sectors. Nevertheless, the magnitude of the coefficient is lower than the full sample considered in Column (1) and (2). These MNEs are affected more by the economic size of the sector in the canton than by the presence of other MNEs in the previous year.

Column (4) show the results for the cantons that, in 2014, shown a number of MNEs lower than the Swiss value, but that have registered a larger growth during the considered years. In this case, the coefficients show the same trend and significance of the baseline model, but the magnitude is larger. The level of internationalization is confirmed to be one of the key drivers in attracting new companies, without showing a big heterogeneity in terms of sectors or cantons.

For what concerns MNEs in complex sectors (Column (3)), the results are in line with the baseline model, without highlighting any difference in the behavior of these companies.

Finally, Column (5) and (6) show the model with the share of MNEs instead of the number of MNEs. Also in this case, the results are consistent with what has been found in the other specifications. The share of MNEs in manufacturing (over the total number of firms in the canton) has a positive and significant impact on the share of MNEs in services.

2.6.2 The sectoral linkages (GMM model)

The results from GMM Model are reported in Table 2.3.

In Column (1) and in Column (3) the model has been run without any controls to better understand the relevance of the variable of interest as determinant of the share of MNEs in each canton. In the other Columns (2 and 4), the set of controls is included.

Table 2.3: GMM Model

VARIABLES	(1)	(2)	(3)	(4)
LAG MNEs ratio	0.759***	0.761***		
	(0.103)	(0.100)		
LAG MNEs ratio weighted			0.0414**	0.0402**
			(0.0205)	(0.0203)
Gdp change		0.0000004		0.0000022
		(0.00000227)		(0.00000252)
lnVAt1		0.0001		0.000185
		(0.000112)		(0.000141)
% Em_High t1		-0.0001		-0.000384
		(0.00354)		(0.00551)
lnR&Dt1		-0.0000292**		-0.0000297*
		(0.0000134)		(0.000018)
QLt1		-0.0001		-0.0000108
		(0.0000376)		(0.0000379)
Year dummies	Yes	Yes	Yes	Yes
Observations	3,220	3,220	3,220	3,220
AR(2)	0.634	0.623	0.438	0.443
Hansen test	0.181	0.179	0.197	0.214

Standard errors in parentheses - *** p<0.01, ** p<0.05, * p<0.1

Both the tests of Arellano-Bond indicate that there is no serial autocorrelation of order 1 or order 2 for all the equations. The validity of instruments used for estimations has been not rejected by the Hansen and the Sargan test. For these reasons, the coefficients from the estimates can be trusted.

The estimates of the whole sample shown that the presence of MNE companies in time *t-1* is positively associate with the share of MNEs in the same sector. The effect has been confirmed also with the introduction of the control variables.

More in detail, the coefficient of the variable of interest (*ratio MNEs* in time *t-1*) is positive and significative: the presence of MNEs in the same sector could be seen as a driver in the location choice of MNEs.

In Column (3) and (4), it has been given relevance to the MNEs in related sectors. As in the previous results, the significance of the variables of interests is confirmed also after the introduction of control variables.

The presence of MNEs in close industries is another relevant factor in the location choice of MNEs, even if the magnitude of the coefficient is lower compared to the firms within the same economic branches. Spillovers from related sectors matter in the location choice. Not only specialization and internationalization in the same industry, but also linkages with MNEs in sectors with high proximity level are seen as helpful and beneficial.

The formulated hypotheses have found support in the results from the model. The presence of foreign firms, both within the same industry and in related ones is a driver in the location choice of MNEs. Companies prefer to locate in cantons where the level of internationalization is already high and where the sectoral skills and knowledge of local workers are already specialized and competitive.

2.7 Conclusion

As consequence of the structural change that is characterizing the current economy situation, the domestic value chain has been replace by the global one. The production process is not anymore focused in one place, but the activities are set in multiple countries. The presence of MNEs is not an isolated phenomenon and its relevance is increasing over years.

It is widely recognized that MNEs are a source of advantage for the domestic economy: given that multinationals tend to be more productive and innovative than local firms, their presence in a region could be see an engine for the growth both of domestic firms and for the local economy. Furthermore, in small economy with a high level of openness, this kind of firms are an opportunity to enter and to get information on new markets.

Many studies have investigated which are the determinants in the location choice, which factors have a higher weight than others. In this paper it has been investigated if the presence of other MNEs matters in the location choice. Focus of the study is Switzerland, being a highly competitive economy in the international market and having received a large inflow of foreign investments. The analysis is undertaken at cantonal level, using data on the number of MNEs disaggregated at NOGA 2 digit. This information allows a deep analysis of existing heterogeneity both in term of cantons and in term of sectors.

The aim of the paper is twofold: first is to explore the linkages between manufacturing and services, second to generally investigate the agglomeration economy between MNEs. The innovative contributions of the paper rely in the study of an unexplored country (Switzerland) and in the study of agglomeration effects not only within the same industry but also in related ones. To reach this goal, it has been computed a proximity matrix that considers all the technologies and the

skills required during the production process, giving a more exhaustive measure of the industrial distance.

The results give support to the hypothesis that agglomeration economies attract MNEs. Coefficients from the econometric models have shown that the presence of MNEs active in manufacturing attract MNEs in services. To offer goods that are highly competitive in the international market, manufacturing firms need the support from services.

Disentangling the effect by sectors and cantons, it has been found support to the baseline model. Considering the more complex sectors, the presence of manufacturing still matters, but the magnitude of the coefficient is lower than for the full sample. Cantons that, in 2014, registered a lower number of MNEs than the average Swiss value, instead, has shown a stronger linkage among manufacturing and services companies.

In the second part of the paper, it has generally investigated the agglomeration effect. More in detail, I analyzed if the presence of MNEs in a certain sector attracts MNEs in the same sector and in the same canton. Results confirm that the possibility of having a large pool of skilled workers and of benefiting of high-level knowledge in the same area is a pull factor for new foreign activities. Deeply investigating the phenomenon, it has been considered also the role played by related sectors. The more exposed the sector is, the larger the spillover effects from the other MNEs active in the canton. Even this case has confirmed a significant and positive effects on the attraction on MNES.

This study, in all its parties, highlights how the synergies existing among MNEs are one of the main drivers in the location choice. What is relevant for MNEs is not only the local characteristics but also the level of internationalization of the region. Benefits coming from agglomeration are significant not only for companies active in the same sectors, but also for firms active in different sectors.

The complementarity of activities is a dimension with a large weight in a global economy. As a matter of fact, MNEs do not consider only MNEs active in the same sector, but also MNEs active in related and in connected sectors. To be competitive in the international market and to offer diversified products, an economy should be specialized not only in one specific area, but also in the related economic branches.

The obtained results depend to some extent on the country that I investigate: Switzerland is a highly competitive country, able to offer complex and sophisticated products thanks to availability of knowledge and innovative technologies. As seen from results, location choice is the results and the combination of different factors: from one side the high level of internationalization, on the other side the economic size or the specification level of certain sectors.

This consideration underlines the relevance of networks in the present economy: global value chains have led to more interaction among countries and also within the same country. If it is true that MNEs prefer to choose a location with other MNEs, it is equally true that, to be competitive in the international market, local dynamics matter. Complementarity among local industrial fabric and multinational collaboration is the key factor of success in the global economy.

Endnotes

[1] By definition, a multinational corporation has facilities and other assets in more than one country. Its control consists in holding a majority share in the capital of the group (over 50% of the votes in general meeting of shareholders).

[2] Data on agriculture, forestry and fishing, as well as that concerning mining and quarrying have been dropped.

[3] Data are not available disaggregated at NOGA08 2 digit level, but are aggregated by economic section.

[4] The location quotient is defined as: $LQ_{sc} = \left(\frac{Number\ Employees_{sc}/Number\ Employees_{c}}{Number\ Employees_{sCH}/Number\ Employees_{CH}}\right)$

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Appendix 2.1

List of high and low knowledge sectors

High knowledge sectors		***Low knowledge sectors***	
20	78	10	45
21	80	11	46
26	84	12	47
27	85	13	49
28	86	14	52
29	87	15	53
30	88	16	55
50	90	17	56
51	91	18	68
58	92	19	77
59	93	22	79
60		23	81
61		24	82
62		25	94
63		31	95
64		32	96
65		33	
66		35	
69		36	
70		37	
71		38	
72		39	
73		41	
74		42	
75		43	

Appendix 2.2

List of cantons by Number of foreign companies in 2014

Canton code	Canton name	Num MNEs in 2014
UR	Uri	59
AI	Appenzell Innerrhoden	64
JU	Jura	77
GL	Glarus	84
AR	Appenzell Ausserrhoden	151
OW	Obwalden	158
NW	Nidwalden	167
VS	Valais / Wallis	256
NE	Neuchâtel	313
SH	Schaffhausen	346
GR	Graubünden / Grigioni	389
SO	Solothurn	440
TG	Thurgau	518
FR	Fribourg / Freiburg	561
SZ	Schwyz	575
BL	Basel-Landschaft	616
LU	Luzern	695
BS	Basel-Stadt	740
AG	Aargau	1056
BE	Bern / Berne	1228
SG	St. Gallen	1353
VD	Vaud	1475
GE	Genève	2031
TI	Ticino	2482
ZG	Zug	2819
ZH	Zürich	4691
	Average number of MNEs in 2014	*898*

Chapter 3: Economic complexity and the demand for low-skill service jobs. Evidence from the Italian provinces.

Giulio Bosio, Anna Maria Falzoni, Federica Maggi

Abstract

From 1980s, a process of radical transformation has changed labor markets in developed countries, both in terms of the nature of jobs and of the production process. The sophistication of products has led both to the creation and destruction of jobs, concentrating demand of workers at the opposite ends of occupational skill distribution. The economic complexity index (ECI) is a good measure of this structural change, capturing the knowledge intensity of a country. Because of the relevant heterogeneity at the local level, we investigate how polarization affects Italian provinces during the years after the Great Recession (2010–2018). We investigate to what extent local economic complexity (measured by the ECI) matters in the change of shares in low-skill service occupations. Our empirical analysis indicates that the ECI is a significant driver of the change in the share of low-skill service jobs as it is robust to all specifications: The more a province is able to produce sophisticated goods, the more it requires a larger share of high-skilled workers and, as a consequence, of low-skill service workers. To test the robustness of our results, we implemented an IV and a spatial model that have confirmed our results.

Keywords: Economic complexity, local labor market, job polarization, heterogeneity in the Italian market, structural and technological change

3.1 Introduction

The European labor markets have undergone a process of radical transformation that is still under way and has changed dramatically the nature of jobs (Autor 2015; Goos et al. 2009, 2014). This process of structural change, characterized by a progressive deindustrialization, has increasingly modified the process of production (Frenken et al. 2015), as well as the creation and destruction of jobs. European countries have experienced an intense reorganization of manufacturing industries that has been largely driven by offshoring strategies and global competition. Consequently, the production process has been stretched among different economies: Highly complex activities tend to be controlled by developed countries, that have also faced opportunities to introduce new products, processes, and services into their economic systems. This product sophistication has effect on the employment, through the reduction of employment in some sectors (thanks to machine and robots) and the creation of new opportunities in others (ICT). A rich body of researchers (starting with the work of Autor et al. 2003) has identified this phenomenon as job polarization, with a simultaneous growth of high-skill conceptual and low-skill service occupations, accompanied by a corresponding reduction in middle-skill routine occupations.

The Economic Complexity index (Hidalgo and Hausmann, 2009) has been identified as a good measure for explaining this structural transformation, exploiting the knowledge intensity embodied in the exported products. When countries produce and export more complex products, they have a large amount of capabilities, requiring a large share of high skill workers and, as consequence, of services. This index, as a matter of fact, is a good instrument for the foreign demand shock: as far as trade partners become richer, they would demand more complex and sophisticated products. As consequence, the country that produces these goods tend to maximize the efficiency and to innovate its production processes, reallocating the available labor force.

Arguably, empirical studies have emphasized how labor demand is becoming more concentrated at the opposite ends of occupational skill distribution. The main theoretical explanation for employment polarization is based on routine biased technological change (RBTC), known also as the routinization hypothesis that is innovative with respect to the previous theories on the effects of technological progress (Acemoglu and Autor 2011). Ideally, RBTC maintains that the advance in automation and in ICT has asymmetrically affected the employment trends by increasing demand for high-skill non-routine tasks[1] and substituting labor in routine tasks, where activities are easily codifiable, repetitive, and follow a well-defined set of procedures (Goos et al. 2014; Michael et al. 2014). Rather importantly, the evolution of manual occupations is not only related to ICT technologies but also to alternative drivers, such as consumption externalities or a higher demand

for personal services related to population aging, as discussed in the literature (Mazzolari and Ragusa 2013; Moreno-Galbis and Sopraseuth 2014). Other potential sources contributing to job polarization and recognized by scholars are offshoring and outsourcing, i.e., the capability to relocate many middle-skill production jobs to low-income countries (Blinder 2009). Such changes in the employment structure have generated an increasing number of skill mismatches in developed countries (Feenstra 2010), causing an erosion of manufacturing jobs both at national and local levels and partially threatening to lower the job opportunities and innovation capabilities of these economies (Kemeny and Rigby 2012).

The production process requires various sets of tasks, according to the sophistication level of goods. countries with a comparative advantage in complex goods and with a specialization in high-skill tasks would have a higher demand for professional and managerial occupations. As a consequence, a higher share of such workers might create demand for more services and, in turn, might dampen demand for low-skill service occupations. In this perspective, the level of economic complexity of a country might acts as a driver for polarization in the labor market.

The characteristics of both employment polarization and economic complexity differ considerably if we extend the analysis to the subnational and local levels, which represent the ideal units of analysis in economic geography. Indeed, the spatial dynamics in the evolution of labor market outcomes might reflect local variations in institutional specificities, trade exposure, labor supply and other social factors (Ciarli et al. 2018; Charnoz and Orand 2017). In the empirical literature on the RBTC, the relevance of geographic dimension has become popular in attempting to uncover whether the local occupational mix dampens the economic performance of regions and local areas (Boschma and Fritsch 2009; Moretti 2014; Berger and Frey 2016; Barzotto and De Propris 2018) and in capturing whether there is heterogeneity in the degree of polarization[2]. In a similar vein, there are several attempts to compute economic complexity in regional or subnational productive structures by relying on two alternative approaches. The first one, exploiting national trade data, identifies the value of local complexity by employing weighted averages of the local industry structure (Reynolds et al. 2018). The second approach calculates the local ECI, exploiting data on exports for each geographical unit (e.g., Benedikt et al. 2018 for the US metropolitan areas).

In this paper, we contribute to the strands of literature both on job polarization and economic complexity by adopting a local approach in line with the recent studies in economic geography. In particular, we analyze how local economic complexity matters in the change in employment share of low-skill service jobs, an aspect that characterizes the polarization of labour markets. More precisely, the focus of our research is based on Italian provinces, exploiting the heterogeneity in the

ECI indicator at the NUTS 3 level to explain the change in the demand for low-skill service occupations during the years after the Great Recession.

Italian provinces are specialized in various economic branches: The national economy is highly heterogeneous among the areas, showing relevant disparities in development between the North and South. In turn, different provinces can be considered as small economies within the same institutional setting but with local peculiarities in terms of exposure to trade, industry specialization, labor force composition, and economic culture. During the years before the global crisis, a generalized growth and convergence in production sophistication across the Italian provinces was evident (Coniglio et al. 2016), but it has been halted by the crisis. In this context, we uncover how the local labor market reacted to this Great Recession, discovering whether the polarization registered in the previous decade (e.g., Olivieri 2012) was still at work in the period 2010–2018 and the extent to which local economic complexity (ECI), measured at the provincial level, was a driving force in this process.

The lack of previous studies investigating the relationship between local ECI and change in employment shares of low-skill service jobs, on the one hand, and the peculiarities of the Italian context on the other make our contribution potentially relevant from a policy perspective. We articulate the role of ECI at the local level as a determinant of task-biased labor demand in an economic geography approach and, at the same time, we ascertain whether other structural and demographic characteristics of the local labor market can influence the relationship of interest.

Matching data at the provincial level (NUTS 3) for exports (ISTAT - COEWEB) and the Italian labor force survey (ILFS), we aggregate data at the provincial level from 2010 to 2018. Each cell identifies a certain local labor market with specific structural characteristics related to workforce composition, industry specialization, dimension of credit market, entrepreneurial activities, and presence of immigrants. Our hypothesis is that higher levels of the local ECI, implying more sophistication in the production process and higher demand for highly educated workers, are likely to affect the demand for low-skill service jobs and, in turn, the variation in employment shares for this group of workers. Using this analytical structure, we investigate the existence of a relationship between the ECI at the subnational level and the growth in low-skill service occupations.

Our preliminary results indicate that the ECI indicator matters as a potential driver of employment polarization and of the demand for non-routine low-skill service jobs at the local level. Through a deep investigation, we find that adult workers (35 to 65 years) show stronger coefficients. This effect is detectable even after controlling for potentially confounding factors related to the demographic composition of the provincial labor market (e.g., gender, college, and

immigrants' share) and to other local economic contexts (e.g., self-employment rate, dimension of credit market, number of firms active, unemployment rate, patents, and value added per capita). Furthermore, empirical findings emphasize how this effect is robust to several robustness checks, such as the exclusion of the public sector from our estimating sample and the use of an alternative indicator for the degree of economic complexity at the provincial level.

To deal with potential bias due to simultaneity issues and spatial dependence in our relationship of interest, we implement both an IV strategy and spatial models. Concerning the IV specification, we use as an instrument a measure of social capital, i.e., the share of employed individuals in cooperative firms at the provincial level in 2001 (e.g., Cortinovis et al. 2017; Neffke et al. 2011). The findings support our previous results and suggest how the lack of control for endogeneity bias might underestimate the true impact of the local ECI on the growth in the share of low-skill service jobs. We also adopt a spatial model to account for the existence of potential spillover effects among provinces and to disentangle the influence of surrounding provinces. Controlling for spatial interdependence, estimated parameters are substantially unchanged with respect to the standard OLS model, confirming that the degree of local sophistication might represent a significant driver in the polarization of local labor markets.

The remainder of the paper is structured as follows. In the next section, we outline data and descriptive evidence on the Italian labor market as well as a discussion on the local ECI. Section 3.3 describes the empirical strategy. In Section 3.4, we present the main results from econometric analysis, while in Section 3.5 we conclude.

3.2 Data and measurement index

3.2.1 Data sources and sample

In our empirical analysis, we use data relative to the period 2010–2018. With the aim of studying heterogeneity at the local level, the narrowest territorial unit available is the Italian province. Since some of them were created in 2005 and then deleted in 2016, we aggregated these provinces in order to have the same (and minimum) sample size for all considered years. In particular, we aggregate Monza with Milano, Fermo with Ascoli-Piceno, and Barletta with Bari, thus having a dataset of 103 provinces.

The analysis is based on several sources. Data on the labor market are taken from the Italian Labour Force Survey (ILFS), a household survey conducted by ISTAT[2] as well as the principal source of information on the Italian labor market. ILFS provides a database on the employment statuses of a large sample of the Italian population (e.g., Ceccarelli 2007), their occupational categories and other information concerning both the job and the individual socio-demographic

characteristics. To compute our outcome variable, the share of low-skill service workers, we selected the workforce aged 15 to 65 years and we split the various occupations into three groups (following the OECD 2017 scheme): manual, routine, and abstract workers. These classifications come from the mean wages of employees and the different tasks each worker is expected to perform (see Appendix 3.1).

We measure Italian provincial specialization and complexity using information on exports. Data, classified according to the 3-digit level ATECO taxonomy[3,] come from the ISTAT international trade data (COEWEB Section). Due to data restrictions, trade of services was not considered. Even if the last few years faced a consistent growth in service exports, in 2010, exports in manufacturing accounted for 75%[4] of the total exports, thus occupying a central role in the Italian international market. Variables and data sources are summarized in Table 3.1.

Table 3.1: Definitions of Variables, Mean, and Standard Deviation

	Definition	Mean	s.d.	obs.
Share of low-skill service occupations	Share of workers employed in manual occupations (i.e., ISCO08 1-digit major groups 5 and 8) over total employment for each province-year cell	0.111	0.036	1040
Local ECI	Economic complexity index calculated for each province-year cell that provides a measure for the level of sophistication of production	0.003	0.993	1040
Share of female workers	Share of female workers over total employment for each province-year cell	0.428	0.040	1040
Share of college workers	Share of workers with at least a college degree over total employment for each province-year cell	0.178	0.037	1040
Share of migrants	Share of non-EU citizens over total population for each province-year cell	0.058	0.031	1040
Self-employment rate	Share of self-employed people over total employment for each province-year cell	0.251	0.040	1040

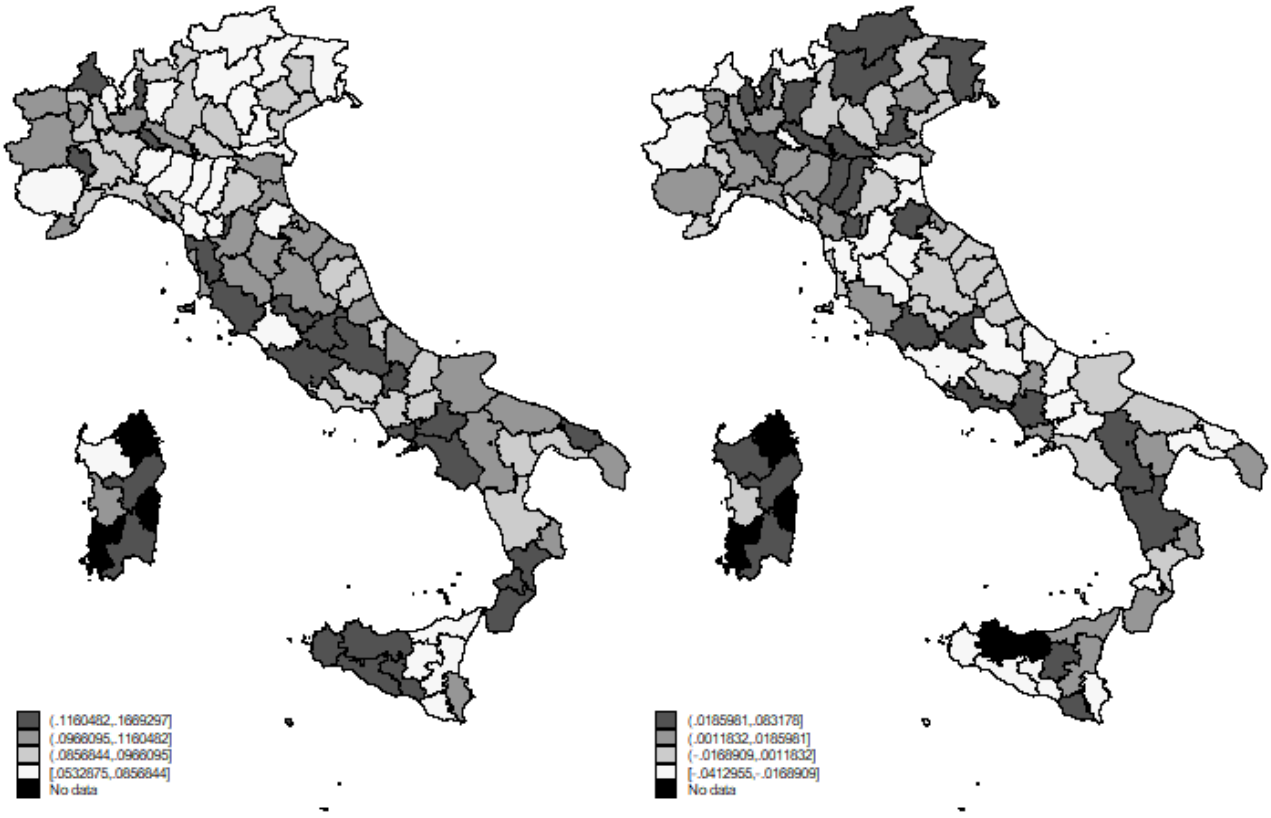
3.2.2 Labor market polarization in Italy: stylized facts

When most industrialized European countries have been affected by the labor market polarization (OECD 2017), Italy has registered a shift towards high-skill occupations, experiencing a substantial upgrading in the 1990s and 2000s. This phenomenon has been driven by a change in the labor demand as well as in the demographic composition.

In the last decade, after the growth in highly qualified workers, Italy experienced an increase in the share of low-skill service occupations. After the economic crisis, the Italian labor market shifted from the so-called upgrading phenomenon to polarization. More in detail, in 2010 (the first year of the analysis), the 57% of Italian workers were employed in routine occupations, while the remaining were distributed among abstract (33%) and low-skills service (10%) occupations (the non-routine ones). At the aggregate level, the weight of each category does not face a significant change, but at the local level the polarization was more pronounced. The behavior of low-skills service jobs has been deeply investigated as indicator of the phenomenon: the presence of abstract workers require more services, leading to an increase of low-skills service jobs and a decrease in the manual workers.

Figure 3.1 compares the employment share of low-skill service occupations in the Italian provinces in 2010 and the change registered in this share between 2010 and 2018 at the provincial level. As expected, there is a high level of heterogeneity in the composition of the local labor market, given the traditional socio-economics disparities between the North and the South and across the Italian local labor markets.

Figure 3.1: Share of low-skill service occupations (2010) -left hand side- and their changes (2010–18) -right hand side- in the Italian provinces.

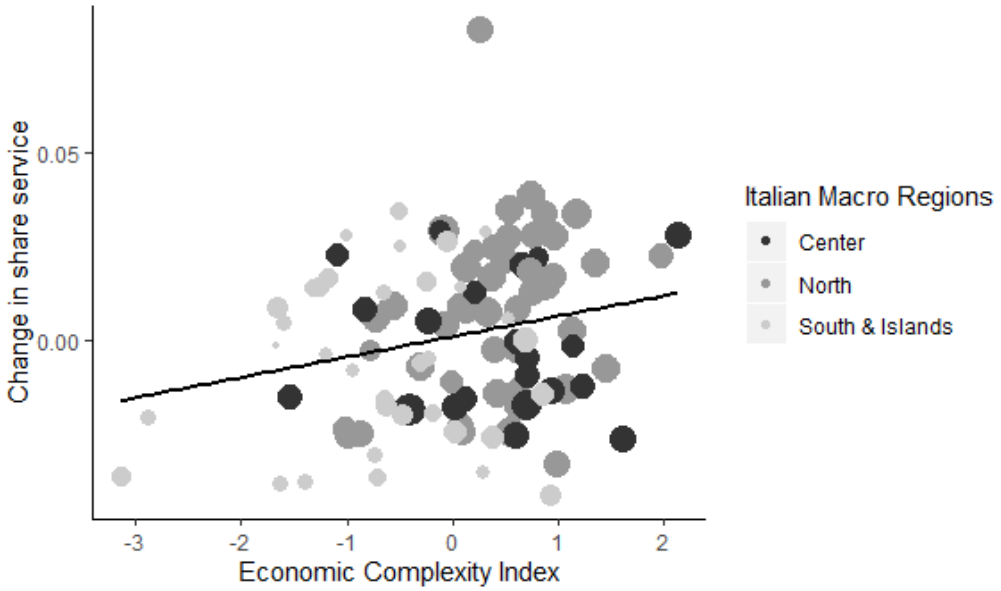


In 2010, the share of people employed in low-skill service occupations was higher in the Southern provinces compared to the Northern provinces in Italy. Given the different industry specializations and the heterogeneity in economic prosperity across local areas, the magnitude of the expansion in low-skill service jobs increases from the southern to the northern provinces. The polarization process, therefore, is not symmetrical across regions in Italy: The richer and the more industrialized provinces had a greater change in labor demand.

The high level of heterogeneity in the local labor market emphasizes the need to unveil the potential key drivers of employment polarization at the local level, with the aim of understanding the peculiarities in the local structures.

Considering the different level of products sophistication one of the main cause of labor demand, Figure 3.2 shows that the correlation between the change in low-skill service jobs share and the ECI of each province: As long as a province produces more complex good, it is more competitive in the international market and experiences a larger increase in low-skill services.

Figure 3.2: ECI and change in low-skill service occupations in the Italian provinces.



The dimension of the dots shows the added values per capita registered by each province, while the color represents the macro Italian regions.

3.2.3 The Economic Complexity Index

The Economic Complexity Index (ECI) is an innovative approach proposed by Hausmann and Hidalgo (2011) to measure the competitiveness of a country. The main idea is to capture the capabilities existing in a country: the available skills strongly influence the production process and the sophistication of the products. Each country is seen as a system of knowledge accumulation, and its prosperity depends upon whether it can make even more information grow (Hidalgo 2015): Some kinds of knowledge are more difficult to develop or replicate than others, becoming one of the key drivers of the long-run economic growth of a country.

According to the capabilities available and their combination among individuals, one country is able to produce a certain good instead of another one. Different combinations of skills and knowledge lead to the production of goods with a different level of competitiveness in the international market. What matters is not only the amount of knowledge available in a specific place but also how individuals and organizations combine the various chunks of knowledge: goods produced by a country depend on the combination of all these factors.

Hidalgo and Hausmann (2009) started from the assumption that there is a tripartite network: It links countries to the capabilities they have and products to the capabilities they require in the production process. Out of the entire bundle of produced goods, a country exports the products with a competitive advantage in the international market and with a well-developed production process. Such goods occupy a greater share in the country's exports basket compared to the share of the

same products in the world market, meaning that the Revealed Comparative Advantage Index (RCA)[5] is greater than 1. Considering only the economic branches with an RCA ≥ 1, results are binarized to 1 and 0 respectively and inserted into a matrix M_{cp}. Using these data, it is possible to define the diversity of a country and the ubiquity of the exported products. By diversification, we are considering the number of products a country produces and exports with comparative advantage in the international market. The intuition behind the ubiquity, instead, is that the more knowledge/know-how is available in a country, the more it can produce complex products and the less other countries can replicate those goods. The less economies can produce a certain good, the more it is competitive in the international market.

Diversity and ubiquity are formally defined as:

$$\text{Diversity} = k_{c,0} = \sum_p M_{cp} \tag{3.1}$$

$$\text{Ubiquity} = k_{p,0} = \sum_c M_{cp} \tag{3.2}$$

To get a more accurate measure of the level of sophistication in a country, it is necessary to correct the ubiquity by the diversity and vice versa. Applying the *Method of reflection,* we calculate iteratively the average value of the measure computed in the preceding iteration. After *n* iteration, we get the complexity of a country:

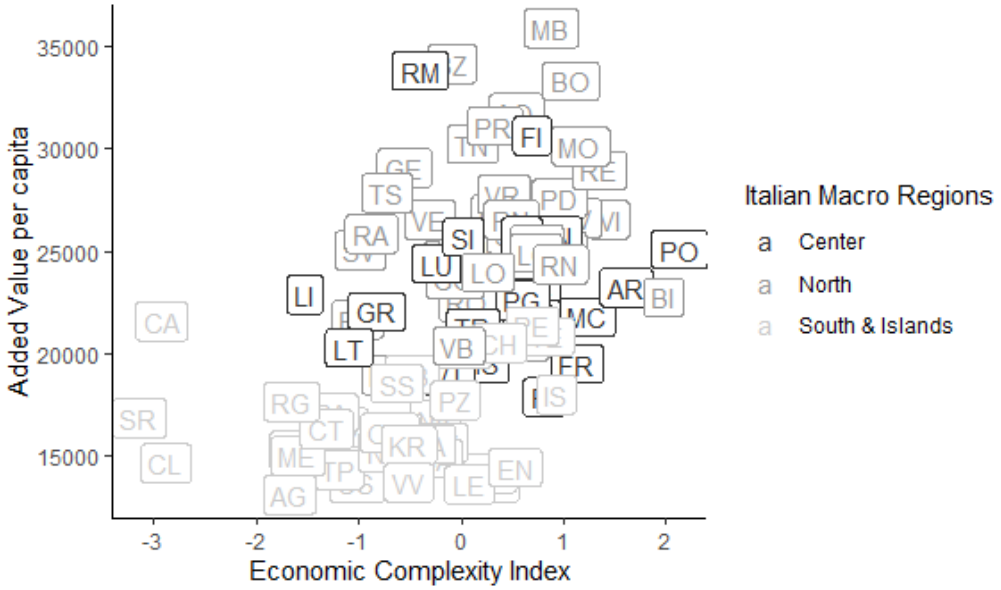
$$k_{c,\mathrm{n}} = \frac{1}{k_{c,0}} \sum_p M_{c\mathrm{p}}\, K_{\mathrm{p,n-1}} \tag{3.3}$$

Following this intuition, complex countries are the ones that export a larger number of less ubiquitous goods. As highlighted by Hausmann and Hidalgo (2011), there is a strong and positive correlation between the economic complexity index and the added value per capita: Richer countries tend to have a higher indicator and to be more competitive in the international market.

In Italy, the North provinces are the most developed ones (higher added value per capita) and, having a richer bundle of skills and knowledge, produce a wide range of sophisticated goods. The South area, on the other hand, is not very diversified and tends to produce products that are highly ubiquitous.

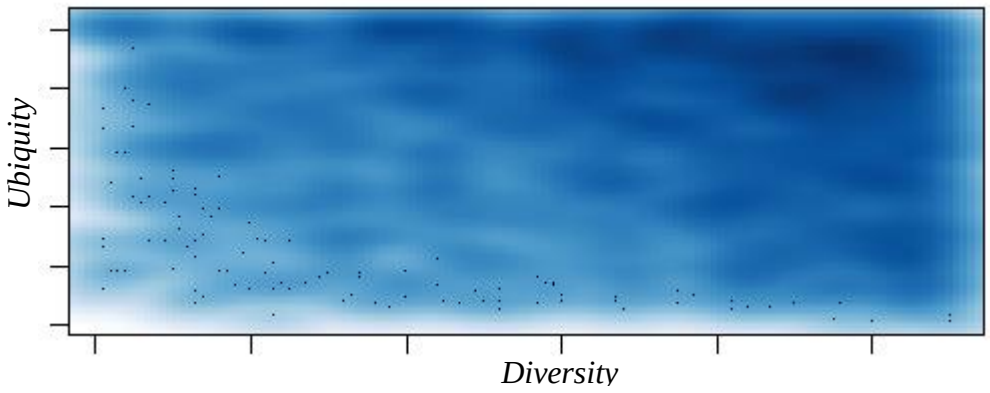
Central areas, however, are distinguished by an indicator above the average, meaning that even though they are not the most developed regions, they have demonstrated significant growth during the last few years. Prato, Biella, Arezzo, and Vicenza are the provinces with the highest ECI, while the island provinces (Sicilia and Sardegna) and others of South Italy (Taranto, Brindisi, or Reggio Calabria) are located at the bottom of the ranking (Appendix 3.2). Figure 3.3 shows the ECI registered by the Italian provinces in 2010 (first year of our analysis) and the added value per capita.

Figure 3.3: ECI and per capita added value in the Italian provinces in 2010



Combining the diversity of the Italian provinces and the ubiquity of goods, it comes out that the most ubiquitous products are present in all regions, and the most diversified provinces are more specialized in the production of more (if not all) products. Provinces with a lower diversity have an RCA ≥ 1 only in economic branches with a higher ubiquity. In Figure 3.4, we show the graphical representation of the locations of products across the Italian provinces and products in 2010, the first year of our analysis. Provinces are sorted from left to right by diversity, and products are sorted from bottom to top by ubiquity.

Figure 3.4: Input Matrix, ubiquity vs. diversity (2010)



As expected, the plot has a triangular structure: the most ubiquitous products are present in all regions, and the most diversified provinces are more specialized in the production of more (if not all) products.

3.3 Empirical strategy

Starting with the novelties introduced by Autor and Dorn (2013) and replicated by Consoli and Sànchez-Barrioluengo (2019) in the measurement of the job polarization process, we investigate which factors influenced the changes in the low-skill service jobs during the last decades. This category identifies the manual non-routine occupations, which are hard to automate (Autor and Dorn 2013; Bárány and Siegel 2018).

Our research question concerns whether the variation in the employment shares of low-skill service jobs is related to the level of local sophistication captured by the ECI. To delve further into this relationship, we account for a broad spectrum of potential factors that might influence the occupational structure, such as human capital stock, demographic characteristics, the entrepreneurial culture.

Formally, we estimate a pooled OLS regression model as follows:

$$\Delta\, service_{pr\,(t_1-t_0)} = \alpha + \beta_1 ECI_{pt_0} + \beta_2 X_{pt_0} + \gamma_r + \varepsilon_{prt} \qquad (3.4)$$

where the dependent variable, $\Delta\, service_{pr\,(t_1-t_0)}$, is the change in employment shares of low-skill service occupations in a given province p and region r between 2010 and 2018. Our main variable of interest, ECI_{pt_0} captures the degree of sophistication associated with each Italian province at the beginning of the period examined; higher values of this index are characteristic of a province able to exploit existing knowledge in producing complex goods. The vector X_{pt_0} includes a set of province controls at the beginning of the period. We insert standard controls to capture the demographic structure of population at the provincial level (such as the shares of females, of college degree, of young people). We also include the share of non-UE citizens over total population, the population density as a measure of agglomeration externalities, the self-employment rate, the share of people employed in manufacturing industries, the unemployment rate, the value-added per capita, the number of patents, the number of active firms as registered at the Chamber of Commerce, and the number of bank branches. In addition, γ_r identifies regional fixed effects, while ε_{prt} is the standard idiosyncratic error term. Our standard errors are robust to heteroscedasticity and clustered at the provincial level.

The underlying hypothesis in our OLS specification is that once we account for a rich set of province-specific observables, the residual variation in the ECI across local labor markets is

exogenous. The nature of this indicator might generate an endogeneity issue in the relationship of interest and, hence, a potential problem of reverse causality. To test the robustness of our results, we exploit a lagged measure of the ECI for up to four years, as Adam et al. (2019) did. We also implemented an IV strategy, relying on an instrument inspired by prior literature on the potential role of social capital (Cortinovis et al. 2017; Neffke et al. 2011; Acemoglu and Johnson 2005). The intuition is that formal and informal institutions at the local level might play a crucial role in fostering regional innovation, economic specialization and the process of structural change (Rodrìguez-Pose and Di Cataldo 2014; Rodrìguez-Pose 2013). Prior studies have shown that social capital does not have a clear-cut effect on economic activities at the local level. If on one side it reflects a beneficial social feature that enhances trust and cooperation among local actors, stimulating investments and innovation (Echebarria and Barrutia 2013; Antonietti and Boschma 2018); on the other side, it might also reduce the propensity to innovate (conformity bias) (Portes and Landolt 1996). As an indicator of local social capital, we use the lagged information on the share of people employed in cooperative firms at the provincial level for 2001[6]. In sum, we estimate a two-stage IV model to account for potential bias in our OLS estimates.

Further attention will be devoted to accounting for possible spillovers among provinces in the relationship of interest and, in turn, the presence of spatial dependence. Formally, we estimate a SARAR model (Kelèjian and Prucha 1998; Anselin and Florax, 1995; Anselin, 1988) which simultaneously controls for both spatially autoregressive error terms (SEM model) and spatially lagged outcome variables (SLM model). The spatial dependence is specified on the basis of a spatial weight matrix, defined according to a set of rules based on the spatial links between provinces.

Hence, our spatial specification is defined as:

$$\Delta\, service_{pr\,(t_1-t_0)} = \alpha + \beta_1 ECI_{pt_0} + \beta_2 X_{pt_0} + \lambda \sum w_{pj}\, \Delta\, service_{jr\,(t_1-t_0)} + \gamma_r + \varepsilon_{prt} \qquad (3.5)$$

$$\varepsilon_{prt} = \rho \sum w_{pj}\, \varepsilon_{pt} + u_{prt}$$

where $W = \sum w_{pj} (p = 1, \dots N,\ j = 1, \dots, N)$ is the connectivity NxN matrix, with N corresponding to the number of provinces considered (i.e., our spatial units). To capture the intensity of the relationship between pairs of provinces, the specification of the connectivity matrix follows a 0/1 rule where w_{pj} is equal to 1 if both p and j are contiguous and 0 otherwise. Alternatively, we identify k-nearest neighbors with k = 7. The weight matrix is row-standardized so that the row sum is 1. In addition, it is used for the error terms and modified to generate a spatial lag by calculating the average of neighboring provinces. Finally, we obtain the coefficients from a SARAR approach by a generalized two-step model using a maximum likelihood estimator.

3.4 Main results

Firstly, we present the baseline OLS models for the entire working population and by cohorts. Secondly, we provide a battery of robustness checks in order to test the sensitivity of our results, exploiting alternative model specifications as well as a different procedure to calculate the degree of local sophistication. Thirdly, we resort to an IV approach in order to tackle endogeneity and simultaneity bias between the local current ECI and contemporaneous labor market outcomes. Finally, we estimate several spatial models which account for potential spatial dependence in the relation of interest.

3.4.1 OLS models

Results summarized in Table 3.2 report the OLS estimates concerning the impact of the local ECI on the change between 2010 and 2018 in the employment share of low-skill service occupations for each Italian province. All models control for regional fixed effects and are clustered by provinces in order to account for potential serial correlation of the residuals. Models are also weighted by the province employment share at the beginning of the period with respect to the national workforce[7].

Panel A provides results concerning all working populations, while Panel B that of young workers (less than 35 years) and Panel C that of adults (35-65 years).

In Column (1), we present our baseline specification, including only regional fixed effects, while in the other columns we control for additional variables that are critical in understanding the dynamics of the Italian labor market. In Column (2), we include the demographic composition factors within cells. We control for gender, education, age composition, and for an indicator of population aging represented by the local share of population with more than 55 years and of foreign non-EU population. Indeed, a growing share of immigrants might have a displacement effect on native-born workers (Lin 2019) in terms of employment prospects and/or wage outcomes, especially in some occupations such as those in the service industries.

In Column (3), we add a control for population density to capture potential agglomeration externalities. Local networks, in fact, allow firms to exploit complementary skills and are a key driver in economic growth and innovation (Eriksson and Lengyel 2019; Villamil 2010).

In Column (4), we include the local self-employment rate and the unemployment rate, with the aim of controlling for local dynamics and the entrepreneurial structure of the market. Finally, in order to further check the sensitivity of our estimates, we introduce a battery of confounding factors to capture the local economic context. Specifically, we add information about the value added per capita at the provincial level, the number of patents, and the number of active firms registered at the

Chamber of Commerce. Moreover, we add an indicator capturing the relevance of credit markets at the provincial level, i.e., the number of local bank branches. As shown by Barone et al. (2018), during the Great Recession, negative credit supply shocks might importantly reduce real value added at the local level, with the effect being strongly heterogeneous across industries[8].

Table 3.2: Baseline OLS model

VARIABLES	(1)	(2)	(3)	(4)	(5)
			Panel A – all sample		
Local ECI	0.008**	0.008**	0.008**	0.007**	0.008***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Constant	-0.025**	0.068	0.074	0.031	0.023
	(0.010)	(0.053)	(0.061)	(0.059)	(0.340)
R2	0.42	0.47	0.48	0.52	0.63
N	102	102	102	102	102
			Panel B – young workers aged 15 to 35		
Local ECI	0.003	0.005	0.006	0.007	0.005
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)
Constant	-0.047*	-0.027	-0.004	0.032	0.050
	(0.025)	(0.099)	(0.104)	(0.103)	(0.544)
R2	0.26	0.29	0.30	0.33	0.45
N	102	102	102	102	102
			Panel C – adult workers aged 36 to 65		
Local ECI	0.010**	0.010*	0.010*	0.009**	0.011**
	(0.005)	(0.006)	(0.006)	(0.004)	(0.004)
Constant	-0.018***	0.095	0.105	0.003	-0.068
	(0.006)	(0.061)	(0.083)	(0.073)	(0.433)
R2	0.43	0.47	0.47	0.55	0.60
N	102	102	102	102	102
Regional FE	Yes	Yes	Yes	Yes	Yes
Local demographic controls	No	Yes	Yes	Yes	Yes
Agglomeration controls	No	No	Yes	Yes	Yes
Local labor market controls	No	No	No	Yes	Yes
Local economic indicators	No	No	No	No	Yes

Robust standard errors in brackets
**** p < 0.01, ** p < 0.05, * p < 0.1*

Our variable of interest, the economic complexity index, shows a positive and statistically significant coefficient that is robust to all specifications. It indicates that an increase in the degree of provincial specialization (measured by the ECI) positively impacts the change in employment share of low-skill service jobs. The magnitude of the coefficient, ranging between 0.007 and 0.008, means that a change in ECI of one standard deviation on average increases the change in low-skill service occupations by 0.7–0.8%.

Our results show that the degree of local sophistication captured by the local ECI seems to dampen the demand for low-skill occupations in service industries, contributing to the process of employment polarization observed in the last decades. In sum, the local economic complexity associated with tradable sectors increases employment in the service sectors as higher local wage will further boost local demand for the non-tradable goods and services.

Furthermore, replicating the same specification by cohorts, the estimates in Panels B and C indicate that, on average, the impact of local specialization on the change in the employment shares of low-skill service jobs is larger and statistically significant only in case of adult people (aged 36 to 65). The magnitude of the coefficient (0.010 on average) is even larger than when considering the total sample. This can be due to several reasons. On the one hand, the rise in university enrollment has produced a natural upgrading in the educational level of young people who now enter in the labor market with higher aspirations in terms of career prospects and remuneration; therefore, they select medium-high job profiles in the occupational distribution. On the other hand, the natural process of the aging working population and the consistent reshuffling from routine to low-skill service occupations has involved largely the adult working population who traditionally work in the industrial sector.

3.4.2 Robustness checks

We now perform several robustness checks (Table 3.3) to test whether previous results are sensitive to the empirical approach adopted.

In Column (1), we estimate the same saturated model as in column (5) of Table 3.2 by replacing the control for firms' turnover with the local share of people employed in manufacturing industries. Provinces with a higher share of high-skilled workers in manufacturing tend to be more productive than other provinces because they are able to generate positive spillovers in terms of employment growth and wage outcomes (Moretti 2004). To be exact, the presence of high-skilled workers might generate, through consumption spillovers (e.g., Mazzolari and Ragusa 2013; Moreno-Galbis and Sopraseuth 2014), an additional demand for personal services and, in turn, a growth in low-skill service jobs.

In Column (2), we split our sample period into two four-year intervals, respectively 2010–2014 and 2014–2018, replicating the specification in column (5) of Table 3.2. The goal of these estimates is twofold: to capture potential cyclical differences and, secondly, to test whether the results hold in the short-term. We introduce period-fixed effects in the specification to account for the presence of different time trends in local labor demand. Even if smaller in size, the estimates in column (2) show that the degree of local specialization positively impacts the demand for low-skill service occupations. The intuition is that this effect is weaker when we consider a shorter time period, given its nature of structural change, but it is still at work.

As a further robustness check, we define our dependent variable differently: We exclude from the initial sample of workers all individuals working in the educational sector (classified as high-skill occupations). Since in Italy this economic branch is largely dominated by the public sector, we expect that it has a trend more related to the public budget and fiscal policies introduced by the central government. The coefficient in column (3) shows that by excluding this segment of workers from our sample, there is an increase in the impact of the local ECI on the change in the shares of low-skill service jobs at the provincial level. Being statistically significant at the 1% level, a change in the ECI of one standard deviation on average increases the change in low-skill service occupations by 1%.

Finally, we investigate to what extent the relationship between local economic specialization and trends in labor demand is sensitive to alternative sophistication indicators proposed by the literature. In Column (4), we replace our complexity measure with another indicator called EXPY (Huber 2018; Coniglio et al. 2016; Javorcik et al. 2017), and it confirms our main conclusions. This indicator is computed by considering the complexity of the exported products for each province (PRODY), weighted by the share of that specific economic branch in the province's total exports (Appendix 3.3). Overall, EXPY positively affects the change in the share of low-skill service occupations, strengthening the results from the previous estimates. The more a province is competitive in the international market, the more it experiences an increase in low-skill service occupations.

Table 3.3: Robustness checks

VARIABLES	(1)	(2)	(3)	(4)
Local ECI	0.007**	0.004**	0.010***	-
	(0.003)	(0.002)	(0.003)	
Constant	0.046	-0.027	-0.013	0.096
	(0.323)	(0.208)	(0.365)	(0.305)
Local Expy	-	-		0.008**
				(0.003)
Regional FE	Yes	Yes	Yes	Yes
Local demographic controls	Yes	Yes	Yes	Yes
Agglomeration controls	Yes	No	Yes	Yes
Local labor market controls	Yes	No	No	Yes
Local economic indicators	Yes	No	No	No
R2	0.64	0.19	0.61	0.62
N.	102	205	102	102

Robust standard errors in brackets
**** p < 0.01, ** p < 0.05, * p < 0.1*

3.4.3 Simultaneity bias and spatial dependence

The major concerns for the causal interpretation of our estimates are the potential endogeneity in the level of local specialization related to a simultaneity bias with the labor market outcomes in the same area and the presence of spatial dependence in the relationship of interest.

Even when controlling for regional fixed effects and province-specific confounding factors, OLS estimates may still be biased due to unobservable demand shocks correlated with the degree of local specialization. For this reason, we rely on the IV estimates reported in Table 3.4, where the exclusion restriction is the local share of employees in cooperative firms in 2001. The instrument represents an indicator of social capital at the local level; it has been shown to consistently influence the degree of sophistication and the capability of each province to specialize in the production of certain goods (Cortinovis et al. 2017; Neffke et al. 2011).

The estimated coefficients clearly indicate a positive and significant effect of the local ECI on the change in employment shares of low-skill service jobs. This is even slightly larger in size than that reported in our basic OLS specifications. The point estimates for the saturated model in column (4) is 0.012. This means that the correction for simultaneity bias further emphasizes the

positive impact of local economic specialization on the demand for low-skill service occupations at the provincial level.

In order to test the sensitivity of our IV estimates with the choice of instrument, we replicate the same estimation strategy but exploiting as an additional instrument a dummy variable indicating whether the province had a tradition of political autonomy prior to the Unification of Italy. This instrument might capture how a tradition of political autonomy dampens local economic specialization by affecting culture and, in turn, the efficiency of local institutions. In practice, this additional instrument is a proxy of the quality of public government at the provincial level. Indeed, as shown by Di Liberto and Sideri (2015), past historical political institutions matter with respect to both current local public administration efficiency and local economic specialization. Arguably, past political traditions might introduce cultural differences across areas and, in turn, influence how formal institutions currently interact with economic development in the local labor market (Tabellini 2008). Using both instruments does not change our main results. Indeed, the estimates are quantitatively the same, approximately 0.012, as shown in column (5).

Table 3.4: IV Model

VARIABLES	(1)	(2)	(3)	(4)	(5)
Local ECI	0.012	0.013	0.013*	0.012*	0.012**
	(0.009)	(0.009)	(0.008)	(0.006)	(0.008)
Constant	0.056	0.062	0.020	0.024	0.043
	(0.057)	(0.061)	(0.057)	(0.281)	(0.059)
Partial R2	0.115	0.114	0.116	0.141	0.198
F test					
R2	0.46	0.46	0.50	0.62	0.62
N	102	102	102	102	102
Regional FE	Yes	Yes	Yes	Yes	Yes
Local demographic controls	Yes	Yes	Yes	Yes	Yes
Agglomeration controls	No	Yes	Yes	Yes	Yes
Local labor markets controls	No	No	Yes	Yes	Yes
Local economic indicators	No	No	No	Yes	Yes

Robust standard errors in brackets Column (5) with 2 instruments
****p < 0.01, **p < 0.05, *p < 0.1*

Given the insights on the existence of potential spillover effects among provinces (i.e., the presence of so-called spatial dependence), we test the robustness of our main results by implementing a spatial analysis. Previous models rely on the strong assumption that there are no spillover effects across neighboring areas. However, technological and knowledge spillovers as well as migration and capital flows are likely to increase interdependencies in economic performance between neighboring provinces (Janikas and Rey 2005): local areas are not isolated and that economic growth at the local level is often influenced by the same process in neighboring areas (Le Gallo and Ertur 2003).

The results of the graphical analysis reported both in the Data section (e.g., Figures 3.1 and 3.2) are supported by the Moran's I test (1950) which indicates the presence of a positive global spatial autocorrelation between provinces[9]. Even if the diagnostic tests on the OLS residual do not seem to confirm graphical and descriptive evidence, we replicate our saturated specification by estimating spatial models described in Section 3.3. Estimation results in Table 3.5 report SLM, SEM, and SARAR, respectively. The estimates illustrate a magnitude of the impact of the local ECI on the change in shares of low-skill service jobs of approximately 0.007–0.008, which is coherent with the indications of diagnostic tests from OLS residuals. On the other hand, both lambda (capturing the spatial lag component) and rho (capturing the spatial autocorrelation in the error term component) are significant in the SARAR model, suggesting that this model is more appropriate with respect to SLM or SEM models for accounting for potential spatial dependence.

In sum, the spatial analysis seems to reveal that spatial interdependencies do not change our main results significantly and, hence, the bias is almost negligible in this case. A potential explanation is that we include a rich battery of controls at the provincial level that could help to mitigate this possible source of bias in our analysis. However, once accounting for simultaneity bias by an IV approach, the relationship of interest is larger and statistically significant. In this case, a standard OLS approach might underestimate the long-term process and, in particular, the impact of local specialization on local labor demand.

Table 3.5: Spatial Model

VARIABLES	(1) SLM	(2) SEM	(3) SARAR
Local ECI	0.007***	0.007***	0.008***
	(0.002)	(0.002)	(0.002)
Constant	-0.003	-0.003	0.057
	(0.243)	(0.251)	(0.261)
Lambda	-0.106		0.460***
	(0.183)		(0.175)
Sigma	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Rho		-0.312	-1.402***
		(0.349)	(0.487)
Regional FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Local demographic controls	Yes	Yes	Yes
Agglomeration controls	Yes	Yes	Yes
Local labor markets controls	Yes	Yes	Yes
Local economic indicators	Yes	Yes	Yes
N.	102	102	102

Robust standard errors in brackets
**** p < 0.01, ** p < 0.05, * p < 0.1*

3.5 Discussion and Conclusions

During the last decades, the employment structure of the labor markets in many OECD countries underwent a process of radical transformation that modified the nature of jobs as well as the production process (Autor and Dorn 2013; Acemoglu and Restrepo 2019; Goos et al. 2014). This revolution has been due to a growing adoption of new technologies, mainly ICT-based, and to the diffusion of offshoring strategies and the increasing importance of the so-called global value chain.

New technologies (Autor et al. 2003) as well as this globalization process (Blinder 2009) have impacted demand in the labor markets in developed economies, especially in the US and European countries. Workers in routine tasks, who were involved in codified and repetitive activities, have been replaced by machines, while high-skill abstract jobs and low-skill service jobs have had an increase in demand. In this framework, the Italian labor market traditionally has been

an exception. As described in Olivieri (2012), until the mid-2000s, the employment structure did not provide a polarization pattern but an occupational upgrading, with a consistent rise in high-skill abstract jobs and no evidence of a corresponding growth in low-skill service jobs. On the contrary, the last decade has shown a change in the trend of the Italian labor market: Along with a decline in routine occupations, there was a complementary rise in low-pay and manual occupations (Basso 2019). With these considerations, we can assert that during the years after the global crisis, the polarization phenomenon affected the Italian employment structure.

This process of structural and technological change has systematically modified the way in which traditional industries operate in the global markets and the goods in which they are specialized. Different economies, in fact, were able to launch new products in their economic systems, increasing their diversification and the complexity of the goods. The level of sophistication as well as the level of knowledge embedded in the production structure can be measured through the economic complexity index (ECI). Different ways in which the various types of knowledge or skills are combined by organizations or individuals distinguish the battery of products that a country (or an area) can produce and its level of competitiveness in the international market. Even in a context of general deindustrialization, the ECI has been validated as a predictive indicator of future economic growth and, hence, it may be a potentially relevant tool for uncovering how the process of structural transformation shapes the evolution in employment trends.

However, it has been noted that there is a relevant heterogeneity in the degree of labor market polarization at the local level. According to this intuition, a complementary branch of literature has started to examine local polarization and to what extent local economic specialization matters in stimulating a reshuffling from routine to abstract and low-skill service jobs.

Combining the existing literature on job polarization, the economic complexity index, and the studies of these phenomena at the local level, the goals of this paper were to make a first attempt at estimating whether the local economic specializations (measured by the ECI) are key drivers in the process of employment polarization and to predict the corresponding demand at the local level for low-skill service jobs after the Great Recession. In particular, exploiting employment data from the Italian LFS and exports information provided by ISTAT at the provincial level, our empirical analysis focused on the variation in employment shares of low-skill service occupations between 2010 and 2018. The richness of the database allowed us to control for many potential confounding factors at the provincial level that may be correlated with both the degree of local specialization and demand for specific low-skill jobs.

Our main results indicate that the economic complexity index is a significant driver of the change in the share of low-skill service occupations, since it is robust to all specifications. The more

a province is able to produce sophisticated goods and is at the frontier of technological progress, the more it requires a large share of high-skilled workers and, as consequence, of low-skill service workers. Through a more in- depth investigation, it appears that the positive effect of the ECI is almost entirely related to workers aged between 36 and 65 years, while no significant impact has been found for young workers. This pattern might be consistent with the long-term path of deindustrialization that has characterized the process of structural change in advanced economies and, in particular, of manufacturing-intensive local areas in Italy (e.g., Consoli and Sánchez-Barrioluengo 2018 for the Spanish case).

To test the robustness of our results and to recover a causal interpretation, we implemented an IV strategy, and we controlled for spatial dependence in the relationship of interest.

To tackle the possible endogeneity of the local ECI, we used as an instrument a proxy of social capital at the local level, i.e., the share of people employed in cooperative firms. The estimates indicate a larger effect than that shown in the standard OLS specification, suggesting that without controlling for potential endogeneity, we might underestimate the true parameters of interest. With the aim of considering potential spillovers among provinces, we ran spatial models. They reveal that spatial interdependencies do not change our results in a significant way, confirming the positive and significant coefficient of the ECI in explaining the change in the share of low-skill service occupations.

In sum, this study examines how local specializations and sophistication matter in explaining the change in the demands of the labor market. We identify economic complexity as an explanatory variable for the increasing share of low-skill service occupations during the years after the Great Recession. An interesting way to provide further evidence on this topic might be to also consider service sophistication as a route for economic growth and, as a consequence, a driver of job polarization. Today, the level of competitiveness of a country and its GDP are not exclusively defined by its ability to produce goods but also services. Future research might also take into account the different levels of sophistication in the services offered in each local area in order to uncover how the combined local specialization in goods and services influences economic performance at the local level and, in turn, the evolution in employment polarization.

Endnotes

[1] In addition, the improvement in new technologies has also generated a market reduction in the process of computer, further dampening the complementarity between ICT and high-skill conceptual occupations (e.g., Jerbashian 2019)

[2] The survey is conducted quarterly through a two-stage sample design with stratification: About 1,300 municipalities were sampled in the first stage and about 70,000 households in the second one. The ILFS follows a rotating scheme according to which each household is interviewed for two successive quarters and then again for two other consecutive waves after two quarters of interruption.

[3] ATECO is the Italian equivalent of the European NACE classification of economic activities.

[4] Source: OECD STAN database.

[5] The RCA (Balassa 1965) is defined as: $RCA = \frac{X_{cp}/\sum_p X_{cp}}{\sum_c X_{cp}/\sum_{cp} X_{cp}}$ where X_{cp} represents the total exports of a country *c* in a specific product *p*.

[6] We take a lagged value for this variable in order to reduce potential simultaneity related to the current labor market outcomes and, in this perspective, we use the first year available provided by ISTAT.

[7] In addition, we replicate our OLS models using as weights the provincial number of employed individuals. The estimated coefficients are consistently the same and available upon request.

[8] We also estimate a model in which we include as a control the number of cooperative credit banks that are traditionally more connected with the entrepreneurial activities at the local level. The results, available upon request, are substantially unchanged for both indicators.

[9] The value of the test is 0.113 (p-value = 0.011).

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Appendix 3.1: Occupation classifications

Following the OECD 2017 scheme, 1-digit occupations have been classified into three broad categories: manual, abstract, and routine. The first group includes workers from ISCO88 group 8; in routine occupations, there are ISCO88 groups 4, 5, 6, and 7; and lastly, abstract occupations include ISCO88 groups 1, 2, and 3.

	ISCO88 occupations (1-digit)	Task classification
1	Managers	Abstract
2	Professionals	Abstract
3	Technicians and associate professionals	Abstract
4	Clerical support workers	Routine
5	Service and sales workers	Routine
6	Craft and related trades workers	Routine
7	Plant and machine operators and assemblers	Routine
8	Elementary occupations	Manual

Appendix 3.2: Economic complexity index by provinces in 2010

Province code	Province	Region	ECI in 2010	Macro Region
PO	Prato	Toscana	2.13	Center
BI	Biella	Piemonte	1.98	North
AR	Arezzo	Toscana	1.61	Center
VI	Vicenza	Veneto	1.45	North
RE	Reggio-Emilia	Emilia Romagna	1.35	North
MC	Macerata	Marche	1.23	Center
MO	Modena	Emilia Romagna	1.17	North
TV	Treviso	Veneto	1.13	North
FR	Frosinone	Lazio	1.13	Center
BO	Bologna	Emilia Romagna	1.07	North
RN	Rimini	Emilia Romagna	0.97	North
PD	Padova	Veneto	0.96	North
PC	Piacenza	Emilia Romagna	0.95	North
AN	Ancona	Marche	0.93	Center
IS	Isernia	Molise	0.93	South & Islands
MB	Monza-Brianza	Lombardia	0.88	North
MN	Mantova	Lombardia	0.86	North
TE	Teramo	Abruzzo	0.85	South & Islands
RI	Rieti	Lazio	0.81	Center
CO	Como	Lombardia	0.75	North
VA	Varese	Lombardia	0.75	North
PN	Pordenone	Friuli Venezia	0.74	North

		Giulia		
LC	Lecco	Lombardia	0.73	North
PS	#N/D	Marche	0.72	Center
FM	Fermo	Marche	0.71	Center
PE	Pescara	Abruzzo	0.70	South & Islands
FI	Firenze	Toscana	0.69	Center
PT	Pistoia	Toscana	0.66	Center
TO	Torino	Piemonte	0.62	North
AT	Asti	Piemonte	0.61	North
VC	Vercelli	Piemonte	0.61	North
BS	Brescia	Lombardia	0.61	North
PG	Perugia	Umbria	0.60	Center
PI	Pisa	Toscana	0.59	Center
BG	Bergamo	Lombardia	0.54	North
AO	Aosta	Valle d'Aosta	0.54	North
EN	Enna	Sicilia	0.53	South & Islands
UD	Udine	Friuli Venezia Giulia	0.52	North
RN	Rimini	Emilia Romagna	0.49	North
VR	Verona	Veneto	0.42	North
BL	Belluno	Veneto	0.40	North
CR	Cremona	Lombardia	0.38	North
CH	Chieti	Abruzzo	0.37	South & Islands
CN	Cuneo	Piemonte	0.37	North

PR	Parma	Emilia Romagna	0.33	North
CE	Caserta	Campania	0.30	South & Islands
BN	Benevento	Campania	0.28	South & Islands
LO	Lodi	Lombardia	0.26	North
MS	Massa-Carrara	Toscana	0.20	Center
PV	Pavia	Lombardia	0.20	North
AL	Alessandria	Piemonte	0.12	North
TR	Terni	Umbria	0.12	Center
TN	Trento	Trentino Alto Adige	0.11	North
SP	La-Spezia	Liguria	0.08	North
LE	Lecce	Puglia	0.08	South & Islands
RO	Rovigo	Veneto	0.07	North
SO	Sondrio	Lombardia	0.06	North
AQ	L'Aquila	Abruzzo	0.02	South & Islands
SI	Siena	Toscana	0.02	Center
VB	Verbania	Piemonte	-0.02	North
PZ	Potenza	Basilicata	-0.06	South & Islands
GO	Gorizia	Friuli Venezia Giulia	-0.06	North
NO	Novara	Piemonte	-0.09	North
BZ	Bolzano	Trentino Alto Adige	-0.09	North
VT	Viterbo	Lazio	-0.11	Center
AV	Avellino	Campania	-0.18	South & Islands

LU	Lucca	Toscana	-0.24	Center
SA	Salerno	Campania	-0.24	South & Islands
NA	Napoli	Campania	-0.25	South & Islands
BA	Bari	Puglia	-0.30	South & Islands
VE	Venezia	Veneto	-0.31	North
RM	#N/D	Lazio	-0.40	Center
CB	Campobasso	Molise	-0.48	South & Islands
KR	Crotone	Calabria	-0.51	South & Islands
VV	Vibo-Valentia	Calabria	-0.51	South & Islands
GE	Genova	Liguria	-0.55	North
SS	Sassari	Sardegna	-0.63	South & Islands
CZ	Catanzaro	Calabria	-0.63	South & Islands
MT	Matera	Basilicata	-0.65	South & Islands
OR	Oristano	Sardegna	-0.70	South & Islands
TS	Trieste	Friuli Venezia Giulia	-0.72	North
NU	Nuoro	Sardegna	-0.75	South & Islands
IM	Imperia	Liguria	-0.77	North
GR	Grosseto	Toscana	-0.83	Center
RA	Ravenna	Emilia Romagna	-0.88	North
FG	Foggia	Puglia	-0.95	South & Islands
SV	Savona	Liguria	-0.99	North
FE	Ferrara	Emilia Romagna	-1.01	North
CS	Cosenza	Calabria	-1.02	South & Islands

LT	Latina	Lazio	-1.09	Center
RC	Reggio-Calabria	Calabria	-1.19	South & Islands
TP	Trapani	Sicilia	-1.20	South & Islands
PA	Palermo	Sicilia	-1.26	South & Islands
CT	Catania	Sicilia	-1.31	South & Islands
BR	Brindisi	Puglia	-1.41	South & Islands
LI	Livorno	Toscana	-1.53	Center
ME	Messina	Sicilia	-1.60	South & Islands
TA	Taranto	Puglia	-1.63	South & Islands
RG	Ragusa	Sicilia	-1.66	South & Islands
AG	Agrigento	Sicilia	-1.68	South & Islands
CL	Caltanissetta	Sicilia	-2.88	South & Islands
CA	Cagliari	Sardegna	-2.93	South & Islands
SR	Siracusa	Sicilia	-3.14	South & Islands

Appendix 3.3: Definition of EXPY

EXPY is another indicator of the level of sophistication of a certain economy. It was proposed by Hausmann, Hwang, and Rodrik (2007), and it is computed from the PRODY index. This indicator weights the added value of each province with the RCA index of each product in that province. Formally, we have:

$$PRODY_p = \sum_c \frac{X_{cp} / \sum_p X_{cp}}{\sum_c X_{cp} / \sum_{cp} X_{cp}} Y_c$$

where X_{cp} represents the total exports of a province c in a specific product p, while Y_c is the per capita added value registered by the province in that specific year.

The level of sophistication of a good is proxied by the average per capita added value of the provinces that have an RCA in that good.

Once PRODY is computed, it is possible to define the level of complexity of each province through EXPY, which can be defined as:

$$EXPY_c = \sum_p \frac{X_{cp}}{X_c} PRODY_p$$

The level of sophistication of each local area is computed as the complexity of each product weighted by the share of exports of that good in that specific province.

Conclusion

The global value chain and the stretching of production process among many countries are becoming common characteristics in a globalized economy. Consequently, linkages and connections among different Nations are invaluable source of advantage for the local economic growth. The interest in deepening these aspects, as well as in analyzing them from the new perspective of the economic complexity have been the starting point for this thesis.

Developed economies are facing a structural change; they tend to be more focused on the last stage of the production process and on the trade of complex and sophisticated goods. As a result, the need of labor force is changing, the importance of imports of intermediates is increasing and the level of attractiveness of a specific area towards new foreign companies is getting higher relevance. These are only three out of the several aspects of the entire globalization process, but giving their importance in understanding this phenomenon and their strategic role, they have been deeply investigated in the three essays of this thesis.

The *fil rouge* of this study as well as one of its strengths is the use of the economic complexity as a measure to identify the strategic sectors and the branches that generate larger spillovers and benefits to the economy. This measure captures the capabilities and the knowledge needed to produce certain goods or available in a certain area: as far as these skills are rare, the product is considered sophisticated or the economy competitive, having an advantage towards other countries or products. The more a product or a geographical area is complex, the more it is innovative and the more it shows sophisticated knowledge.

The analysis of specific factors of globalization through this indicator allows to deeper investigate the phenomenon and to identify the branches that are able to generate larger benefits to the local economic growth.

In fact, even if the existing literature is giving high relevance to the investigation of the different faces of the globalization and its changes, these papers offer new points of view on aspects partially studied but that still need more attention. Furthermore, to provide more insights to the research and a detailed analysis, it has been considered not only country level data, but also the local aspects. Giving relevance to the subnational dimension allows a better understanding of the various dynamics as well as of the heterogeneity existing in the same country.

More in detail, the focus of two out of three papers is Switzerland for its strategic position in the middle of Europe and for its peculiarities. In the last paper the analysis has been conducted on Italy with the aim to investigate another country, with a bigger and more heterogenous reality. The North

and South, in fact, show disparities in the development process as well as in the level of knowledge and skills available.

The first chapter of this thesis looks at the impact of a change in the value of the local currency on the Swiss imports of intermediates. The analysis of intermediates flows is strategic for a high developed economy, as Switzerland, that is specialized in the creation of added value during the last stages of the production process. It is commonly recognized that an appreciation of the Swiss Franc negatively affects the exports, but it should work in the opposite direction with the imports. Using a gravity approach, it has been found that the effects of a change in the value of the Swiss Franc is heterogeneous among partner countries as well as economic branches.

At the aggregate level, the empirical results show a negative relationship between imports and real exchange rate. This could be viewed as a consequence of the decrease in the foreign demand for Swiss goods. Focusing, instead, on the intermediates used in the branches with a higher level of specialization and of economic complexity, it has been found a positive reaction to a change in the value of the local currency. This means that, despite a strong currency, exports are little sensitive to price and Switzerland continues to invest in linkages with other countries and to be competitive in the international market.

Disentangling the bundle by partner countries, it has been found that non-Euro economies react less to a change in the value of the local currency than Euro-countries.

The proposed empirical analysis confirms that being specialized in complex sectors is synonymous of stability for the local economy, as well as one of the strengths in case of external shock. The key success factors for the Swiss economy, as well as the ability to be competitive even with a strong currency, lie in the diversification and in the high specialization in goods rarely available in the international market.

After the investigation on the flow of goods, the second chapter of the thesis focuses on another aspect that characterizes an open economy: the flow of multinational firms. It has been widely recognized that the presence of MNEs generates positive spillovers to the local economy, in terms of innovation and information on the international market. Giving their importance, it is strategic to understand which factors have a key role in the location choice process. Do MNEs attract other MNEs?

Exploiting data at cantonal level to keep into account local heterogeneity, it has been found that foreign firms attract other foreign firms. Previous studies have highlighted how the presence of other firms in the same area positively influence the industry activities thanks to the presence of positive externalities (for example in terms of workforce, information). There are some attempts to

study this phenomenon among multinational firms, but there are still some fields under-explored. This paper aims to add new perspectives of analysis in this direction.

To be competitive in the international market, manufacturing firms need to integrate the produced goods with high value-added services, fostering the creation of linkages with this branch of activities. The models have confirmed that the presence of MNEs in the secondary sector attracts MNEs in services. Disentangling the effect by cantons and by complex sectors, the coefficients continue to be positive and significant, underlining the robustness of the results. Cantons that, in 2014 had a number of MNEs lower than the Swiss average, are the category with a larger magnitude of the linkage between manufacturing and services.

In the general investigation of the phenomenon, the model has confirmed that the agglomeration matters also among foreign companies: the presence of MNEs in a certain canton attracts other foreign firms in the same sectors. Using a proximity matrix, it has also been investigated the effect of MNEs in close sectors. Even this case has confirmed a significant and positive effects on the attraction on foreign firms.

This analysis shows that, in addition to the local characteristics, the level of internationalization is one of the main drivers in the MNEs location choice. A good specialization level combined with a high presence of MNEs appear to be the right setting for a MNE choice.

Finally, the third paper investigates another element characterizing the structural change in developed economy: the shift in the labor demand. The analysis has been conducted in a bigger geographical reality, characterized by a high heterogeneity at the local level: Italy.

Combining the existing literature on job polarization, on the economic complexity index as well as the studies of these phenomena at the local level, this paper is a first attempt to bring some findings on how the different levels of economic complexity of a province matters in explaining the labor demand.

Exploiting data at the narrowest territorial unit (province), the empirical analysis shows that local specializations are significant drivers of the change in the share of low-kills service occupations. Focusing on the years after the global recession (2010-2018), it has been found that the provinces with a higher innovation and technological level, as well as a large bundle of skills, registered a larger increase in the demand of low-skilled service jobs. This growth is one of the main aspects that characterizes the job polarization. With a larger share of skilled workers, the demand for services increases and, consequently, also for workers in that economic branch.

Through a deeper investigation, adult workers aged 35 to 65 years have shown larger coefficients: the workforce coming from this cohort is more exposed than the younger to the effect of local specialization. The significance of the economic complexity has been confirmed even after

controlling for potentially confounding factors related to the demographic composition of the provincial labor market (e.g., gender, college, and immigrants' share) and to other local economic contexts (e.g., self-employment rate, unemployment rate, patents).

These empirical findings have been validated also by several robustness checks that have been done to deal with simultaneity issue and spatial dependence.

This study has highlighted that the more a province is able to produce sophisticated goods, the more it requires a larger share of high-skilled workers and, consequently, of low-skilled service workers. The provinces that are more competitive in the international market and are able to produce sophisticated goods are more exposed to the polarization phenomenon and to the replacement of the middle skills workers by innovative machines.

In conclusion, these papers propose an innovative way to analyze international dynamics that characterize both the open economy and the structural change that is affecting developed countries. The local level analysis, moreover, adds a different perspective to the debate: it is not enough to evaluate the phenomenon at the country level, but each local area is reacting in a different way to the global challenges.

Another strength of this analysis lies in combining the global changes to the local industrial fabric. To be successful, the opening of borders needs to be combined with local specializations and knowledge. The increasing flows of intermediates, the shift in labor demand or the presence of multinationals should not be seen only as a natural consequence to what is happening in the world: they are a resource, an engine for the growth of an economy and for the competitiveness in the international market. A country, to be successful, should be able to get advantages from the changes of the world economy and connections with other countries, as well as to combine the external inputs with the local skills and knowledge. The complementarity between these two dimensions, in fact, allows a country to be both on the frontier of technological progress and, to get information on new opportunities in the international market. Hence the right balance between specialization in complex goods and linkages with other countries is the strategic view to follow to be competitive in the international market and to foster the local growth.

An interesting direction for future research is to extend the focus of the analysis to a developing country. Other level of development leads an economy to differently react to the same phenomenon, swinging from the complementarity among resources to their development and their growth.

Continuing the investigation proposed in the first chapter of this thesis, it would be relevant to understand what happens in the surrounding economies and how a common currency could

impact on the intermediate flows of goods or, more generally, on the linkages in the global value chain.

Looking at the flow of companies, instead, it would be interesting to cover a larger period: do the growth began in some cantons continue or will it stop in favor of the most important ones? Furthermore, future research could compare the behavior of domestic and multinational companies and investigate heterogeneity in terms of industry.

Regarding the third chapter, future research might also take into account the different levels of sophistication in the services offered in each local area: it would be so possible to uncover how the combined local specialization in goods and services influences economic performance and, as a consequence, the evolution in employment polarization.