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Related variety and regional growth in Italy[^]

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Abstract
This paper makes an attempt to estimate the impact of agglomeration economies on regional economic growth by means of detailed export and import data by Italian province (NUTS 3) by sector (3-digit) by country of destination/origin for the period 1995-2003. The first objective is to assess the impact of different types of variety (e.g. related and unrelated variety) on regional growth. More in particular, we investigate whether provinces endowed with sectors that are complementary in terms of shared competences (i.e. having related variety) perform better. The second objective of the paper is to assess the effects of the breadth and relatedness of international trade linkages on regional growth. We test whether the presence of extra-regional linkages, as embodied in a diversified and complementary set of trade linkages, generates additional regional economic growth, as it may bring new and related variety respectively into the region.

Keywords: agglomeration economies, related variety, regional growth.
JEL Classification: R11, R12, O18

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1. Introduction

Since the seminal contribution of Glaeser et al. (1992), a debate has been taken place on the impact of different types of agglomeration economies on innovation and economic growth. Some proponents stress the positive role of localisation economies, arguing that the sectoral specialisation of a region is a positive factor because firms are expected to learn mainly from other local firms in the same industry. Others claim that the more diversified a regional economy is (i.e. Jacob's externalities), the more knowledge spillovers will occur, because firms get new and better ideas through other local firms that are active in different industries. In this paper, our aim is to extend this type of analysis into two new directions.

First of all, we argue that it is not accurate to assume that Jacob's externalities necessarily result in knowledge spillovers. Knowledge will spill over effectively between sectors when complementarities exist among sectors in terms of shared competences. Such complementarities are captured by the notion of related variety. Therefore, it is essential to make an analytical distinction between agglomeration economies based on related variety, and agglomeration economies based on unrelated variety (Frenken et al., 2007). In contrast to regions characterised by related variety, knowledge spillovers are not expected to occur in regions where unrelated variety prevails. In these latter contexts, instead, portfolio effects are more likely to occur, as sector-specific shocks can be absorbed more easily when industries are unrelated.

Secondly, the agglomeration literature does not account for inter-sectoral linkages among regions, overlooking the fact that new variety may be brought into the region through the establishment of extra-local linkages, such as a diversified set of trade partners. Increasing attention has been paid to the fact that regions may become locked in or inward looking, and therefore need to establish extra-regional linkages (Bathelt et al., 2004). However, this literature does not specify what kind of extra-regional linkages may be crucial: what might be important is to have relationships that bring new knowledge in the region through a wide range of sectors located elsewhere (Boschma, 2004). Thus, sectoral lock-in at the regional level may be counterbalanced by the inflow of a high variety of knowledge through inter-regional connections. However, what might be even more important is that these knowledge flows are related to, but not the same as, the sectoral specialisation of the region. If the external knowledge is unrelated, the industrial base in the region cannot absorb it, and is unlikely to benefit from it. When the external knowledge is the same (i.e. it originates from sectors the region is already specialised in), firms can easily absorb it, but the new knowledge will not add to the existing knowledge base of the region, and will not lead to major renewal. In other words, we expect that a region will especially benefit from extra-regional knowledge when the latter originates from industries that are related to those in the region.

In this paper we test these theoretical statements by means of a database on exports and imports by Italian province, by sector and by country of destination/origin for the period 1995-2003. The paper has two objectives. The first objective is to estimate the impact of related and unrelated variety and other types of agglomeration economies on the economic growth of Italian provinces in the period considered. The second objective is to assess whether also the breadth and the relatedness of international trade linkages of each province affects its economic growth.

The structure of the paper is as follows. In Section 2, we set out the main theoretical arguments. Section 3 first presents the research design and the indicators used, followed by the results of our estimation model. Section 4 reports some conclusive remarks and future research directions.

2. Agglomeration economies, related variety and regional growth

There is a huge literature on the impact of different types of agglomeration economies on innovation and economic growth (e.g. Glaeser et al., 1992; Henderson et al., 1995). In a nutshell, the debate focuses on the question of whether regional specialisation (localisation economies) or regional diversification (Jacobs' externalities) induce knowledge spillovers and, therefore, regional growth.

However, this literature tends to overlook two issues. The first issue is that it is hard to understand what the precise meaning of Jacobs' externalities is. Following Frenken et al. (2007), we argue that it is not a matter of having a diversified economy, but an economy that encompasses related activities in terms of competences that induce knowledge spillovers. It is therefore essential to distinguish between related and unrelated variety. The second issue is that non-local linkages may be crucial in bringing new knowledge into the region (Asheim and Isaksen, 2002). The importance of extra-local linkages has been completely overlooked by the Glaeser-related literature, which is predominantly preoccupied by the composition of the industrial structure at the local level (Boschma, 2005; Wetering, 2005).

Yet, the inflow of extra-regional knowledge is not *per se* a sufficient condition for ensuring economic growth: regional absorptive capacity is needed in order to understand and transform it into regional growth. In organisational studies and in the economics of technical change, it has long been recognized that the ability of a firm to understand and absorb external knowledge is dependent on its own knowledge base (e.g. Cohen and Levinthal, 1990). Being able to build new competences quickly involves the ability to establish links at all levels, from the 'global' to the 'local': the extent to which a region attracts innovative resources from outside – i.e. spurring its external integration – depends first and foremost upon its extant knowledge base (e.g. Cantwell and Iammarino, 2003; Simmie, 2003). Again, the notion of related variety is crucial, because inflows of extra-local knowledge that are related or complementary to existing competences in the region may particularly enhance interactive learning. Also from a historical perspective, absorptive capacity depends significantly on diversity and complementarity: innovation occurs where there is a diverse (technological, social, economic) culture, and the most dynamic capabilities lie in the combination of both exploration and exploitation of new and existing assets (e.g. Rantisi, 2002; Iammarino, 2005).

2.1 Jacobs' externalities: related and unrelated variety

Much of the literature is dealing with the question whether a specific composition of sectors in a region further enhances knowledge diffusion and innovation. It basically concerns the question whether firms learn more from local firms in the same industry, or from local firms in other industries. Or, to put it differently, are specialised regions more conducive to innovation and growth, or are regions with diversified sectoral structures the most innovative and fast-growing?

Agglomeration externalities based on regional specialisation may arise from a thick and specialised labour market, local access to specialised suppliers and large markets, and the presence of local knowledge spillovers. The idea of localisation economies was strongly embedded in Keynesian thinking in the 1970s, but dates back to Marshall's ideas on industrial districts developed in the early twentieth century (Marshall, 1920). Recent studies suggest that inter-industry spillovers may be more important than intra-industry spillovers in explaining economic growth (Martin and Ottaviano, 1999), although intra-industry effects may dominate some manufacturing activities (Henderson et al., 1995). There is a huge literature that appraises the virtues of diversified economies or Jacobs' externalities (e.g. Glaeser et al., 1992). They argue that the more diversified the regional structure, the higher the local growth, because diversity triggers new ideas, induces knowledge spillovers, and provides valuable resources required for innovation to take place.[1]

However, the literature on Jacobs' externalities suffers from two shortcomings. First of all, one can question whether knowledge spillovers are expected to take place between sectors that are unrelated. For example, it is unclear what a pig farmer can learn from a microchip company despite the fact that they are neighbours. Knowledge will only spill over between two sectors when the cognitive distance is not too large (Nooteboom, 2000; Morone, 2006).[2] Indeed, most approaches to agglomeration economies, in line with the orthodox economic tradition, tend to be largely unconcerned with the interplay between industries, technology and geographical locations: they are mainly engaged in identifying localised knowledge spillovers, irrespective of the characteristics of any functional dimension of knowledge processes, which depend on the type of industry structure and spatial configuration (Iammarino and McCann, 2006). Secondly, a diversified economy may also act as an absorber of sector-specific or asymmetric shocks, as stressed in the economic integration literature (Artis and Lee, 1997). Accordingly, and quite confusingly, the notion of Jacobs' externalities covers two different effects at the same time (i.e. knowledge spillover and portfolio effects), but they have not been separated analytically (Frenken et al., 2007).

[1] More in particular, Glaeser et al. (1992) find that city-industries tend to grow faster if the local industrial structure is relatively diversified (i.e. Jacobs externalities) and if the degree of competition is relatively diversified (so-called Porter externalities). For a thorough review of the literature see Mameli (2007).

[2] Some contributions have also shown that the inter-firm spillover arguments implicit in typical models of industrial clustering are not always applicable to oligopolistic or multinational-dominated types of spatial agglomerations (Arita and McCann, 2002a,b), where the dominant innovative behaviours act against the diffusion of knowledge in the local environment (Iammarino and McCann, 2008).

As a consequence, it is essential to distinguish between different forms of regional variety, because they involve different economic effects. Knowledge will only spill over from one sector to another when they are complementary in terms of shared competences. Hence, related variety is needed in order to enable effective connections. We define related variety as industrial sectors that are related in terms of shared or complementary competences (cognitive-based definition).[3] In other words, there is some degree of cognitive proximity required to ensure that effective communication and interactive learning take place, though not too extreme, in order to avoid cognitive lock-in (Nooteboom, 2000). Thus, it is neither regional diversity (which may involve too large cognitive distance) nor regional specialisation *per se* (resulting in excessive cognitive proximity) that stimulate innovation, but rather local specialisation in related variety that is more likely to induce effective interactive learning and innovation (Boschma, 2005). As such, the concept of related variety goes beyond the traditional dichotomy of localisation economies and Jacobs' externalities.

The idea of innovation founded on related variety comes close to the definition of innovation proposed by Schumpeter, in which real innovations stem from the recombination of existing pieces of knowledge in entirely new ways. Such a view leaves behind a traditional, narrow sectoral perspective. Instead, it is argued that innovation is driven by interaction and feedback mechanisms that cross industry boundaries (Kline and Rosenberg, 1986; Robertson and Langlois, 1995). Thus, major innovations are more likely to occur when knowledge spills over between sectors, rather than within the same sector, but only as long as the sectors are related in terms of shared competences. In a dynamic perspective, diversity in complementary sets of competences and knowledge has been argued to be advantageous when interdependent pieces of knowledge have to be integrated and recombined to sustain innovation rates (e.g. Arora and Gambardella, 1994; Feldman, 1999). Building on related variety might then be an effective way to start up new growth paths (Martin and Sunley, 2006).

As is argued above, the knowledge spillover effect based on related variety must be distinguished from another form of variety, that is, unrelated variety, which covers sectors that do not share complementary competences. When defined in economic terms (which is different from the cognitive-based definition), unrelated variety concerns sectors that have no substantial economic input-output linkages. In this case, a broad range of unrelated sectors in a region may be beneficial for regional growth because unrelated variety spreads risks. In other words, when a sector-specific shock occurs, it is unlikely to disturb the regional economy as a whole as no substantial input-output linkages exist. Thus, unrelated variety dampens down industry-specific shocks and stabilises regional economies in the longer term (Essletzbichler, 2005).

Frenken et al. (2007) have demonstrated the empirical relevance of related and unrelated variety at the regional level in the Netherlands. As expected, the outcome of the study was that regions with related variety showed the highest employment

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[3] Related variety is thus not defined in terms of sectors having input-output linkages. It is relevant to make this distinction between the cognitive and economic dimension, because business networks are not necessarily the same as knowledge networks (see, for example, Giuliani, 2005).

growth rates in the Netherlands in the period 1996-2002. These results tend to suggest the importance of knowledge spillovers across related sectors at the regional level. Regions with unrelated variety, instead, showed the most favourable unemployment rates, suggesting, as expected, a portfolio-effect.

The notion of related variety has much in common with concepts like technological systems developed in the 1980s and 1990s (e.g. Rosenberg and Frischtak, 1983; Roobeek, 1988; Carlsson and Stankiewicz, 1991). Such technological systems account for strong inter-industry technological linkages and interdependencies, resulting in interactive learning and innovation processes in related industries. Boschma (1999) used these concepts to identify clusters of innovative industries during the industrial epoch, which were connected through dynamic processes of transfer and feedback of technology criss-crossing among a set of industries during a particular period. Different types of mechanisms through which industries may be related technically emerged from the analysis. These mechanisms give insights on how related variety enhances knowledge spillovers and radical innovations, how new sectors come into existence, and how regional economies diversify in new directions now and then. This also implies that the effects of related variety will be particularly strong in key-sectors that lead economic changes brought about by a new technological paradigm, and that provide the main sources of knowledge of new technological trajectories. Such key-sectors (currently, for example, microelectronics and ICT) are characterised by high pervasiveness, horizontal effects and inter-industry cross-fertilisation among emerging technologies (Dosi, 1982; Freeman and Perez, 1989; Bussolati et al., 1995).

Economic history gives evidence of many new sectors that grow out of existing ones, such as the television industry branched out of the radio sector (Klepper and Simons, 2000). This is an example of how the economic relevance of related variety shows up over time: new sectors emerge out of related industries, on which they build and expand. The economic significance of related variety goes far beyond these empirical observations: it is not only shown in old sectors giving birth to new sectors, but also, and even more so, it increases the probability of survival of the new industry. By conducting an industrial dynamics analysis, Klepper (2002) could demonstrate empirically that prior experience in related industries (like coach and cycle making) increased the life chances of new firms in the new US automobile sector. Boschma and Wenting (2007) showed empirically that new automobile firms in the UK had a higher survival rate during the first stage of the life cycle of the new industry when the entrepreneur had a background in these related sectors, and when the firm had been established in a region that was well endowed with these related sectors. Thus, when diversifying into the new automobile industry, such new entrants could exploit and benefit from related competences and skills in their location, which improved their life chances to a considerable degree, as compared to start-ups lacking those related competences and skills.

In sum, the basic line of argument is that neither regional diversity nor regional specialisation stimulates innovation. Instead, related variety in a regional economy is more likely to induce effective interactive learning and innovation, because it enables regions to diversify into new fields while building on their existing knowledge base.

2.2 Extra-local linkages and related variety

Section 2.1 was concerned with what occurs at the regional level, and to what extent a particular industry structure in a region is more beneficial for economic growth. While emphasising intra- and inter-sectoral spillover effects at the geographical scale, the agglomeration economies literature largely overlooked the importance of intra- or inter-sectoral linkages among regions. In doing so, this literature neglected the fact that new variety and new knowledge can be brought into the region through the establishment of extra-local linkages. Recent studies have pointed out that regions may become locked in or inward looking, and, therefore, it is crucial to bring new knowledge into the region (e.g. Asheim and Isaksen, 2002; Cantwell and Piscitello, 2002). Being connected to extra-local knowledge networks is now regarded as a precondition for cluster firms to survive. Too much reliance on local knowledge sources may be harmful for interactive learning and innovation: when local firms become too much inward looking, their learning ability may be weakened to such an extent that they lose their innovative capacity and are unable to respond to new developments. This type of lock-in may be solved or avoided by establishing extra-local networks, providing access to the outside world (Camagni, 1991). Empirical studies show that local and non-local relationships are both important sources for interactive learning (Kaufmann and Tödtling, 2002). There is increasing awareness that the two go together: local relations may become more beneficial when they are supplemented by non-local relations that bring new ideas into the local system (Bathelt et al., 2004).

However, little attention has been devoted to specifying what kind of extra-local linkages are crucial for knowledge flows across regions. Following a logic similar to Jacobs' externalities, one could argue that it is crucial for regions to establish extra-regional connections that bring new knowledge into the region from a wide range of sectors located elsewhere. In this way, sectoral lock-in at the regional level may be counterbalanced by the inflow of a high degree of variety of knowledge through inter-regional relationships. Hence, the more the region is connected to other regions, and the wider the range of knowledge that flows into the region, the higher the benefit in terms of local economic growth.

Yet, in the case of Jacobs' externalities, it is not just a matter of being connected with a diversified set of regions or sectors. One needs local absorptive capacity to understand and transform external knowledge into economic growth. In the cluster literature, this idea is increasingly understood (e.g. Giuliani, 2005): leading firms may function as hubs or gatekeepers in a cluster, who search for and absorb non-local knowledge that may, or may not, diffuse to the other firms in the cluster, depending on their absorptive capacity (Owen-Smith and Powell, 2004).

What might be even more important is that these flows of extra-regional knowledge are related to, but not the same as the sectoral specialisation of the region. In other words, we claim that related variety in extra-regional connections is required to ensure that the knowledge flows will spark of learning and innovation *in situ*. If the external knowledge is unrelated, the sectors in the region cannot understand and absorb it, and are unlikely to benefit from it. When the external knowledge is the same (i.e. it originates from sectors the region is already specialised in), the sectors in the region can absorb it, but the new knowledge will not add to the existing local knowledge base, and will not lead to breakthrough innovations and economic renewal. Thus, we expect that a region will especially benefit from extra-regional knowledge when it originates from sectors that are related, but not similar to the sectors present in the region. In these circumstances, cognitive proximity between the extra-regional knowledge and the knowledge base of the region would neither be too small (avoiding lock-in in localised learning process), nor too large (enabling the absorption of the extra-regional knowledge).

Thus, it is not sufficient to attract large inflows of extra-regional knowledge: local absorptive capacity is needed in order to understand external knowledge and transform it into economic growth. Again, related variety may turn out to be crucial: inflows of extra-regional knowledge that are related or close, but not quite similar to existing competences in the region may particularly enhance interactive learning and regional growth. In what follows, we make an attempt to estimate this effect of related variety in inter-regional linkages through the import profile of Italian provinces.

3. The empirical analysis: the case of the Italian provinces 1995-2003

In this paper we test some of the theoretical statements discussed above by means of a database on exports and imports by Italian regions for the period 1995-2003. This dataset consists of trade data that are specified for 103 Italian provinces (NUTS 3 level). In addition, the export and import data are specified for 121 three-digit sectors (ATECO-3 level), and it provides detailed information on the country of destination as far as exports are concerned, and on the country of origin in the case of imports.[4] The source of data is the Italian National Institute of Statistics (ISTAT). In section 3.1 we introduce the main variables, while section 3.2 presents the main results.

3.1 The analytical framework

As explained in Section 1, we aim to estimate the impact of different types of agglomeration economies and different types of extra-regional linkages on economic growth at the provincial level. We use three dependent variables: (1) employment growth by province 1995-2003; (2) value added growth by province 1995-2003; and (3) labour productivity growth by province 1995-2003, as measured by valued added divided by labour units. In order to assess the impact of different types of agglomeration economies, we have constructed three specific variables.

Firstly, we assess the impact of diversified economies, or Jacobs' externalities, on regional growth. In other words, we test the extent to which diversified provinces provide evidence of a higher growth due to knowledge spillovers, among other factors. As a proxy for diversified economies, we employ the variable VARIETY that

[4] The trade database covers the period 1991-2003. However, our statistical analyses consider only the shorter period 1995-2003 because of a break in the time series at the provincial level.

measures the degree of export diversification in 1995 by means of an entropy measure at the three-digit level. The value of the entropy indicator increases the more diversified the export profile of a province is. The entropy at the three-digit level in each region is given by (where p_i stands for the share of three-digit sector i):

$$VARIETY = \sum_{i=1}^{N} p_i \log_2 \left(\frac{1}{p_i} \right) \quad (1)$$

Secondly, we built two variables to measure the effect of related variety and unrelated variety respectively. Following Frenken et al. (2007), we make use of the entropy measure to indicate both types of variety at different levels of sectoral aggregation, based on the existing classification of sectors. Again, we use the export profile of each province, that is, the set of export industries in each province. We measure the degree of related variety in each province through the weighted sum of the entropy indicator at the three-digit level within each two-digit class. As such, the variable related variety (RELVAR) measures the degree of variety within each of the two-digit classes in 1995: the higher the variety of sectors, the more knowledge spillovers we expect at the level of the province, and the higher its economic growth.[5] By contrast, the degree of unrelated variety in each province (UNRELVAR) is measured through the entropy of the one-digit distribution in 1995. Consequently, this indicator measures the extent to which a province is characterised by very different types of sectors. In doing so, UNRELVAR measures the portfolio-effect of variety, as explained in section 2.1.

The variable RELVAR is measured as follows. All three-digit sectors i fall under a two-digit sector S_g, where $g=1,\ldots,G$. We can derive the two digit shares P_g by summing the three-digit shares p_i :

$$P_g = \sum_{i \in S_g} p_i \quad (2)$$

Related variety (RELVAR) is then defined as the weighted sum of entropy within each two-digit sector, which is given by:

$$RELVAR = \sum_{g=1}^{G} P_g H_g \quad (3)$$

where:

$$H_g = \sum_{i \in S_g} \frac{p_i}{P_g} \log_2 \left(\frac{1}{p_i / P_g} \right) \quad (4)$$

The entropy at the one-digit level, or unrelated variety (UNRELVAR), is given by:

$$UNRELVAR = \sum_{j=1}^{N} P_j \log_2 \left(\frac{1}{P_j} \right) \qquad (5)$$

where p_j stands for the share of one-digit sector *j*.

We also tested whether urbanisation economies mattered, that is, to what extent more densely populated provinces show a higher growth. As a proxy for urbanisation economies, we took the population density of each province by calculating the number of inhabitants per squared kilometre in 1995 on a logarithmic scale. In all our estimations this variable turned out to be insignificant, so we decided to leave it out. Such a result might be interpreted in the light of the 'scarcely urban' and relatively 'low technology-intensive' nature of the development of the Italian production and export model in the last decade (Viesti, 2006). The two aspects are rather interdependent: Italy has recently failed to build strong comparative advantages in industries with cutting-edge and general-purpose technological content, whose locations in many industrialised economies are prevalently urban.

As explained above, we used export data by sector by province to measure the effect of various types of agglomeration economies.[6] Obviously, not all industries are export sectors, so the export profile of a province might not exactly reflect the sectoral composition of the local economy. Having said that, we expect export sectors to be the strongest amongst all sectors in the province. Therefore, we expect related variety (localised knowledge spillovers effect) and unrelated variety (portfolio-effect) to matter most among export sectors. In addition, we assume the export profile of a province to be rather stable over time. If this was not the case, the export profile could not accurately reflect the sectoral composition of a province. This assumption is supported by the literature (e.g. Krugman, 1987; Dosi et al., 1990): trade profiles tend to be cumulative in nature, because each location continues to do what it did in the past, due to increasing returns to scale at the industry level, and due to non-transferable tacit knowledge accumulated in production and technology. Recent contributions confirm the persistence in the Italian national and regional export patterns over time (Amendola et al., 1998; Guerrieri and Iammarino, 2007).

Besides the effect of agglomeration economies, we aim to assess the impact of the breadth and nature of international linkages on economic growth at the provincial level, because these may bring new variety into the region. In section 2.2, we explained the need to differentiate between types of extra-regional relationships,

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[5] It should be acknowledged that we lack a variable to measure directly technological complementarity between sectors at the level of sectoral and geographical breakdown used in our analysis.

[6] It could have been interesting to use production or employment data by sector by province, but these more direct indicators are either not available or difficult to obtain at a detailed geographical level. On the other hand, trade indicators have been traditionally very important in assessing knowledge flows in open economic systems, particularly when there is an emphasis on extra-local linkages, as it is in the case of this paper.

because these bring different types of variety into the region, with diverse effects on regional growth. We have constructed three variables to measure their impacts.

First, we test the effects of extra-local linkages that bring a high degree of knowledge variety into the region through a diversified set of import sectors. Our database provides trade data by province and by sector specified for country of origin as imports are concerned, and for country of export destination. We estimate this effect of variety in extra-regional linkages through the import profile of each Italian province. As a proxy for import variety, we employ the variable IMPVAR that measures the degree of import diversification in 1995 by means of an entropy measure at the three-digit level. The value of the entropy indicator increases the more diversified the import profile of a province is. We assume that the wider the spectrum of import sectors, the more diversified should be the knowledge flows that enter the province through its trade linkages. The entropy at the three-digit level in each province is given by (where p_i stands for the share of three-digit sector i):

$$IMPVAR = \sum_{i=1}^{N} p_i \log_2 \left(\frac{1}{p_i} \right) \qquad (6)$$

As set out in section 2.2, we expect a region to benefit particularly from extra-regional knowledge when it originates from sectors that are related, but not too similar, to the sectors that are present in the region. We developed an indicator that relates the import profile (at the three-digit level) of the region to its existing sectoral structure, as proxied by its export profile (at the three-digit level). It takes the import profile (i.e. the sectoral distribution of imports in a province) as a starting point, and then determines the extent to which the import profile is related to the export profile of the province. When identifying the degree of related variety between imports and exports, it is important for two reasons to exclude pure intra-sectoral trade at the 3 digit level, meaning import and export in the same 3 digit sector. Firstly, this might concern mere transit flows from country A to country C through the province in country B. Secondly, as explained in section 2.2, there is too much cognitive proximity involved, which implies no substantial interactive learning is expected to take place: the knowledge that is brought into the province through import flows is unlikely to add to the provincial knowledge base.

Thus, we expect the more related and complementary (but not similar) the knowledge base of the province and its import profile are, the more it will contribute to growth in the province. To determine the degree of related variety between imports and exports, we constructed the related import variety indicator IMPRELVAR in 1995. It proxies the possible benefits a local economy can derive from learning opportunities in related local industries. It is calculated as follows. For each three-digit export industry, it first multiplies the relative size of that export sector and the entropy of the imports from the other 3-digit industries within the same two-digit class: this is done for all export industries. Then, it sums the products across all three-digit industries in the region. We used export shares in total regional exports for the weighting. Accordingly, this indicator depends on the relative size of the export sector in the local economy and on how that export sector can learn from related (but not similar) imports. Thus, the higher the variety in the related imports the greater the learning opportunities, and the bigger the export sector concerned the more these learning opportunities may contribute to regional growth. Let *1* be a three-digit industry within the 2-digit class *I(i)*, with $i = 1,\ldots n$. Let $OE_3^M(i)$ (where $i \neq 1$) be the import entropy in three-digit industries other than *1*, but within the same two-digit industry *I(i)*. Let $X_3(i)$ be the relative size of the three-digit export industry *1* (with $i = 1,\ldots n$) in the entire local export, then the IMPRELVAR can be defined as:

$$IMPRELVAR = \sum_i OE_3^M(i) * X_3(i) \qquad (7)$$

Finally, we calculated an indicator that accounts for the inflow of extra-regional knowledge that originates from an import sector in which the region is already specialised. As explained in section 2.2, when the external knowledge is from the same sector the region is specialised in, the region (or better, the sector) can absorb it, but the new knowledge will not add substantially to the existing knowledge base of the region. As a result, we do not expect it will lead to additional local growth. We constructed a so-called trade similarity variable (TRADESIM), which is simply calculated as the sum of the products of the absolute sizes of three-digit industry's local exports and imports. This indicator gets its maximum value when a region is specialised in one (and the same) sector in both import and export (i.e. the province is mono-specialised). The value gets lower the more diversified a region is (in both imports and exports), and the less similar the import and export profiles of the region are. Because we take absolute values, we also account for the size of the regions. Let $X_3(i)$ be the absolute size of the three-digit export industry i in the province, and let $M_3(i)$ be the absolute size of the three digit import industry i in the province. TRADESIM is then calculated as the logarithm of:

$$TRADESIM = \sum_i X_3(i) * M_3(i) \qquad (8)$$

Above, we defined extra-regional linkages as the trade linkages Italian provinces have with other countries. There are a number of drawbacks in using this indicator. Firstly, trade flows do not measure directly knowledge flows. In our study, we have assumed that trade flows are accompanied by knowledge flows. Better indicators to measure knowledge flows between regions, are, for instance, co-patenting activity or co-publications (e.g. Leten et al., 2007). The problem is, however, that these do not account for knowledge flows between non-high tech activities, which are especially relevant for the relatively low technology-intensity of a country like Italy. Secondly, extra-regional linkages have been defined as linkages between Italian provinces and other countries. In other words, our analysis does not include linkages with other Italian provinces.[7] For this reason, dummies for macro-regions have been included in

[7] Input-output tables at the NUTS 3 level are not available, so we could not calculate technical input-output links by Italian province.

the model, to account for externalities effects that spill over between adjacent provinces. We have distinguished the typical four major areas in Italy, which are considered to be very different from each other: North West, North East, Centre and South.

We have summarised some basic descriptives in Table 1. The list of dependent and independent variables used in the empirical analysis are reported in Appendix A.1, whilst Appendix A.2 displays the correlation matrix.

Table 1. Descriptive statistics of the variables

Variables	Mean	Std. Dev.	Minimum	Maximum	N
Employment growth	9.61	5.00	-5.44	19.12	103
Value added growth	40.51	6.79	23.01	56.29	103
Productivity growth	31.49	6.29	15.64	57.82	103
Variety	2.70	0.65	1.26	3.87	103
Related variety	0.67	0.29	0.08	1.19	103
Unrelated variety	0.88	0.17	0.28	1.16	103
Import variety	2.90	0.73	0.43	4.00	103
Related import variety	1.05	0.40	0.04	1.72	103
Import/export similarity	37.13	3.34	24.48	44.98	103

3.2 Main results

It should be made clear that we do not estimate a conventional regional growth model. Data such as capital investment and capital/labour ratios are required to do so, but these data are not available at the NUTS 3 level in Italy. Our study only aims to assess the effects of different types of agglomeration economies, and is therefore grounded in that research tradition (e.g. van Oort, 2004). The preliminary estimation results are shown in Table 2, and may be summarised as follows.

Model 1 shows that the variety variables at the regional level have no significant impact on the employment growth of the Italian provinces during the period 1995-2003. What is encouraging, however, is that regional variety as such (or Jacobs' externalities) has a negative sign, while the coefficients of the more specific variables (that is, related and unrelated variety) have a positive sign. When we look at the import variety variables, all expectations tend to be confirmed. It is not so much variety in import, but related import variety that matters: while import variety has even a negative coefficient, related import variety has a positive and significant effect on regional employment growth in Italy during the period 1995-2003. Thus, our data suggests that the more related the knowledge base of the province and its import profile are, the more trade contributes to local employment growth. In addition, import/export similarity has no significant effect on regional employment growth, which tends to be in line with expectations: when a province imports goods from sectors in which it exports, there is not much to be learnt from, and no additional employment growth in the region is expected.

Table 2. Regression results

Variables	Employment growth 1995-2003	Value added growth 1995-2003	Productivity growth 1995-2003
Variety	-1.514 (2.015)	-1.725 (2.525)	-0.356 (2.213)
Related variety	3.584 (3.766)	11.680** (4.719)	7.224* (4.136)
Unrelated variety	5.947 (4.363)	8.818 (5.468)	2.242 (4.792)
Import variety	-1.409 (0.897)	-0.486 (1.124)	1.058 (0.985)
Related import variety	3.290** (1.557)	0.539 (1.952)	-3.462** (1.710)
Import/export similarity	0.126 (0.171)	-0.585*** (0.215)	-0.695*** (0.188)
Northwest	0.618 (1.729)	-9.068*** (2.167)	-7.457*** (1.899)
Northeast	0.710 (1.694)	-6.952*** (2.123)	-5.502*** (1.860)
Centre	2.677* (1.422)	-3.441* (1.782)	-4.622*** (1.561)
R-square	0.171	0.294	0.368
F	2.137 sign. 0.034	4.309 sign. 0.000	6.015 sign. 0.000

Excluded variable: South
n=103
Standard errors in parentheses; *p < 0.10, **p <0.05, ***p<0.01

When we look at the macro-region dummies in model 1, it seems to matter in which Italian macro-region a province is located. As compared to the South of Italy, being located in one of the Northern macro-regions and, particularly, in the Centre of the country impacts positively on employment growth. When controlling for initial employment levels in each province in 1995, these outcomes remain the same. This is also true for varying periods over which regional employment growth is measured.

In model 2, with value added growth as dependent variable, the variety indicators at the regional level show similar results as in model 1, with one exception. Once again, regional variety as such has a negative sign (and not significant), whilst the coefficients of the more specific variables of related and unrelated variety remain positive. What is different now, and in line with expectations, is that the related variety variable has become significant. This result implies that having related sectors in a province impacts positively on value added growth in the period 1995-2003. When we look at the import variety variables, the results are, however, quite different from model 1. Import variety *per se*, once again, has no significant effect, but that is now also true for related import variety. The encouraging result is that import variety still has a negative coefficient, while the coefficient of related import variety is still positive. Import similarity has now turned into a significant and negative effect: apparently, the more similar the import and export profiles of a province are, and the more specialised the province is in the same import and export sectors, the lower the growth of valued added in the province. In addition, it matters where a province is located, as indicated by the significant impact of the macro-region dummies: provinces in the South of Italy perform significantly better as far as value added growth in the period 1995-2003 is concerned.

The outcomes in model 3, where the dependent variable is labour productivity growth, demonstrate similar results as in model 2 with respect to the variety indicators. Jacobs' externalities and unrelated variety do not matter, while related variety has a positive and significant effect on regional labour productivity growth. However, what is surprising now is that related import variety has turned into a significant and negative effect, while the coefficient of import variety has become positive, though it remains insignificant. For the import/export similarity index a negative (and highly significant) effect is confirmed also on labour productivity growth. Thus, the more related (and narrowly specialised) the import and export profiles of the province are, the lower the labour productivity growth in the province. Being located in the South of Italy is again very relevant, increasing labour productivity growth of the provinces in that area as compared to the other Italian macro-regions.

We have checked for possible multicollinearity problems. As the variables variety and related variety display a correlation coefficient higher than 0.7, namely 0.86 (see Appendix A.2), we have also run the regressions excluding the variety variable: all the results were confirmed.

When interpreting these outcomes in the light of the recent Italian experience, one can observe the following. Other empirical studies have pointed to a lack of correlation between localised innovation processes and employment growth in the Italian regions over the 1990s (e.g. Ciciotti and Rizzi, 2003).[8] On the other hand, a positive and significant correlation has been observed at the spatial level between innovation and productivity, due to the restructuring and rationalisation processes undertaken over the 1990s in search of production efficiency and quality increase (Ciciotti and Rizzi, 2003). These findings seem to be consistent with the lack of a positive impact of agglomeration economies on employment growth in model 1 on the one hand, and the positive effect of related variety on value added growth and labour productivity growth of provinces in model 2 and 3 on the other hand.[9] This

[8] Among other contributions investigating the role of agglomeration economies on economic growth in Italy see Cainelli and Leoncini (1999), Usai and Paci (2003), Cingano and Schivardi (2004), Paci and Usai (2005).

[9] Our findings also confirm the sensitivity of the estimation with respect to different dependent variables. In the debate on the impact of agglomeration economies on economic growth, the empirical evidence is based on a variety of research approaches that has produced mixed and hardly comparable results. For a remarkable study on the drawbacks of the empirical literature on the topic, specifically addressing the problems created by the lack of comparability of results, see Mameli (2007). This is a

would be in line also with the strong significance of the dummy South in model 2 and 3: productivity growth and diversification of industrial structures and export patterns in the Italian southern regions have all been, since the middle 1990s, much higher than the national average (ISTAT-ICE, various issues; Barca, 2006).

4. Conclusions

This paper is a first step in the exploration of the linkages between regional growth and different forms of variety, measured at the level of the region and at the level of extra-regional linkages. The results are quite encouraging: we expected related variety to matter most from a theoretical perspective. Indeed, both related variety at the regional level, and related variety through inter-regional trade linkages positively impacted on regional growth, though not in all cases. There were other very consistent results in our study. Variety *per se* does not affect regional growth, no matter how growth is defined. The same result was observed for unrelated variety: it never did have an impact on regional growth. These outcomes tend to put in question the relevance of unspecified Jacobs' externalities, as is done in many studies (see also Frenken et al., 2007, for similar arguments). Our study shows there is a strong need to differentiate between various types of economic variety. There are quite a number of challenges open to further research. Some of them are mentioned below.

A first step is to check whether the impact of related variety differs within some specific industrial groups based on more advanced technological systems and 'general purpose technologies'. This might lead to a differentiation of our results both at the industry and geographical levels. For example, Paci and Usai (1999, 2000), investigating the relationship between agglomeration economies and patent intensity in 292 Italian local systems, seem to confirm that related variety might be crucial: knowledge spillovers were identified at the level of clusters of science-based sectors, supporting the view that knowledge spillovers are dependent on the type of technological system underlying industrial production. Other empirical analyses have shown that inter-industry knowledge spillovers are likely to arise in regional centres of technological excellence, where spillovers seem to operate mainly through exchanges in and around core technological systems (i.e. rooted in 'general purpose technologies' as, for instance, background engineering, mechanical methods and, particularly nowadays, electronics and ICTs), creating linkages between actors in quite separate alternative fields of specialisation. These centres of excellence experience a faster process of convergence between old and new technologies and a potentially greater competitiveness, eventually leading to a process of rise and decline of technological regions or clusters (Cantwell and Iammarino, 2003; Iammarino and McCann, 2006).

As explained before, we only accounted for the impact of extra-local linkages as far as export and import linkages are concerned. So, we did not include the effect of extra-local linkages between provinces within Italy. All we did is to account for the

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very relevant point (see also van Oort, 2004) that we hope to further address in future developments of our analysis.

impact of macro-regions, to include possible spillover effects between provinces at a more aggregated regional level. This is, however, a rough proxy, because inter-provincial linkages are not directly measured as yet. That would require data on trade linkages among Italian provinces which are, unfortunately, not available at the NUTS 3 level. We also considered co-publication and co-patenting data. We did not include these data as they would only account for knowledge flows within the high-tech segment of the Italian economy, whereas the majority of knowledge flows are likely to occur in medium and low-tech industries which constitute the bulk of the country's industrial structure (e.g. Viesti, 2006).

These quantitative analyses at the spatial level should be complemented by more descriptive case studies of regions, in order to get detailed insights on how related variety may be relevant for regional development. In the Italian landscape, a historical example of how related variety may contribute to economic renewal and growth at the regional level is the post-war experience of the Emilia Romagna region. Already for many decades, Emilia Romagna was endowed with a diffuse knowledge base in engineering. After the Second World War, many new sectors emerged out of this pervasive and broad knowledge base, which provided a fertile ground for a wider range of industrial activities. Examples of such new economic and technological applications diffusing across local strengths are found in the packaging industry in Bologna, the ceramic tiles sector in Sassuolo, luxury car manufacturers in the vicinity of Modena (e.g. Maserati, Ferrari), agricultural machinery, and, more recently, robotics and mechatronic. These sectors not only built and expanded on the extensive regional knowledge base, they also renewed and extended it towards the emergent technological paradigm, further boosting the competitiveness of Emilia Romagna up to present (cf. Rapporto ISTAT-ICE, 2006).

A dynamic and historical perspective on sectoral and technological combinations within firms and regions could be extremely useful in order to help provide a sound normative basis for drawing policy implications. Indeed, scholars are increasingly highlighting the need to consider jointly structural and systemic variables, and assess the causal links between policy and industrial structure in both directions. In other words, whilst in the past the focus was almost solely on how policy could affect structure and performance, it has become clear that the role of technological systems – and the crucial importance of system integration, requiring complementary competences for the alignment of old and new technologies (von Tunzelmann, 2003) – in shaping industrial policies should be explicitly acknowledged.

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Appendix A.1 – The variables

Dependent variables:
Employment growth 1995-2003 (EMPLGR)
Value added growth 1995-2003 (VALADGR)
Labour productivity growth (PRODGR)

Independent variables:
Dummy macro-region Northwest (NORTHWES)
Dummy macro-region Northeast (NORTHEAS)
Dummy macro-region Centre (CENTRE)
Dummy macro-region South (SOUTH)
Variety 1995 (VARIETY)
Related variety 1995 (RELVAR)
Unrelated variety 1995 (UNRELVAR)
Variety import 1995 (IMPVAR)
Related import variety 1995 (IMPRELVAR)
Import/export similarity (TRADESIM)

Appendix A.2 – Correlation Matrix

		EMPLGR	VALADGR	PRODGR	NORTHWES	NORTHEAS	CENTRE	SOUTH	VARIETY	RELVAR	UNRELVAR	TRADESIM	IMPVAR	IMPRELVAR
EMPLGR	Pears Corr.	1	,430**	-,456**	,051	,078	,175	-,259**	,193	,227*	,168	,170	,048	,303**
	Sig. 2-tailed	.	,000	,000	,611	,436	,077	,008	,050	,021	,089	,087	,629	,002
VALADGR	Pears Corr.	,430**	1	,570**	-,268**	-,096	-,016	,333**	-,103	-,075	,062	-,350**	-,110	-,029
	Sig. 2-tailed	,000	.	,000	,006	,335	,875	,001	,302	,453	,531	,000	,268	,771
PRODGR	Pears Corr.	-,456**	,570**	1	-,278**	-,123	-,130	,462**	-,235*	-,230*	-,061	-,467**	-,126	-,277**
	Sig. 2-tailed	,000	,000	.	,004	,217	,190	,000	,017	,019	,543	,000	,204	,005
NORTHWES	Pears Corr.	,051	-,268**	-,278**	1	-,287**	-,279**	-,404**	,411**	,471**	,112	,238*	,199*	,216*
	Sig. 2-tailed	,611	,006	,004	.	,003	,004	,000	,000	,000	,259	,016	,044	,028
NORTHEAS	Pears Corr.	,078	-,096	-,123	-,287**	1	-,264**	-,382**	,340**	,331**	,304**	,206*	,333**	,307**
	Sig. 2-tailed	,436	,335	,217	,003	.	,007	,000	,000	,001	,002	,037	,001	,002
CENTRE	Pears Corr.	,175	-,016	-,130	-,279**	-,264**	1	-,371**	-,084	-,114	-,044	,097	-,046	-,051
	Sig. 2-tailed	,077	,875	,190	,004	,007	.	,000	,397	,251	,660	,330	,643	,607
SOUTH	Pears Corr.	-,259**	,333**	,462**	-,404**	-,382**	-,371**	1	-,585**	-,605**	-,324**	-,470**	-,424**	-,413**
	Sig. 2-tailed	,008	,001	,000	,000	,000	,000	.	,000	,000	,001	,000	,000	,000
VARIETY	Pears Corr.	,193	-,103	-,235*	,411**	,340**	-,084	-,585**	1	,855**	,665**	,471**	,668**	,592**
	Sig. 2-tailed	,050	,302	,017	,000	,000	,397	,000	.	,000	,000	,000	,000	,000
RELVAR	Pears Corr.	,227*	-,075	-,230*	,471**	,331**	-,114	-,605**	,855**	1	,409**	,457**	,552**	,620**
	Sig. 2-tailed	,021	,453	,019	,000	,001	,251	,000	,000	.	,000	,000	,000	,000
UNRELVAR	Pears Corr.	,168	,062	-,061	,112	,304**	-,044	-,324**	,665**	,409**	1	,175	,535**	,371**
	Sig. 2-tailed	,089	,531	,543	,259	,002	,660	,001	,000	,000	.	,077	,000	,000
TRADESIM	Pears Corr.	,170	-,350**	-,467**	,238*	,206*	,097	-,470**	,471**	,457**	,175	1	,383**	,312**
	Sig. 2-tailed	,087	,000	,000	,016	,037	,330	,000	,000	,000	,077	.	,000	,001
IMPVAR	Pear Corr.	,048	-,110	-,126	,199*	,333**	-,046	-,424**	,668**	,552**	,535**	,383**	1	,430**
	Sig. 2-tailed	,629	,268	,204	,044	,001	,643	,000	,000	,000	,000	,000	.	,000
IMPRELVAR	Pears Corr.	,303**	-,029	-,277**	,216*	,307**	-,051	-,413**	,592**	,620**	,371**	,312**	,430**	1
	Sig. 2-tailed	,002	,771	,005	,028	,002	,607	,000	,000	,000	,000	,001	,000	.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).