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Abstract:

We adapt the product-space methodological approach of Hausmann and Klinger to the case of Italian provinces and regions in order to examine the extent to which the network connectedness and centrality of a province's exports is related to its economic performance. We construct a new Product Space Position (PSP) index which retains many of the Hausmann-Klinger features but which is also much better suited to handling regional and provincial data. We also compare PSP performance with two other export composition indices. A better positioning in the export-network product space is indeed associated with a better local economic outcomes.

Keywords: relatedness, revealed comparative advantage, product space, regional development.

JEL codes: O11, R11, R12

Introduction

The centrality and positioning of a nation's tradeable sectors within global trade patterns are argued to be critical for a country's growth trajectories (Hausmann and Klinger 2006; Hausmann et al. 2007; Hidalgo et al. 2007; Hidalgo and Hausmann 2009), and similar arguments have also been put forward at the regional scale (Neffke et al. 2011). Following on from these arguments, in this paper we investigate the role played by the positioning and connectedness of a region's export patterns within the overall international trade system in explaining the region's economic development. Using province-level data from Italy, our analysis demonstrates that the existing Hausmann-Hidalgo approaches which are used to examine the performance of countries are much less effective when discussing sub-national regional profiles in advanced economies. We therefore put forward a method for modifying the existing national-level indicators of trade network-relatedness and centrality (Hausmann and Klinger 2006; Hidalgo et al. 2007; Hidalgo and Hausmann 2009 Hausmann and Klinger 2006; Hidalgo et al. 2007; Hidalgo and Hausmann 2009) to produce an index which is place-specific and much better suited to sub-national analyses. This new modified Product Space Position (PSP) index is shown to perform better than the existing Hausmann and Klinger (2006), Hidalgo, Klinger, Barabási, Hausmann (2007), Hausmann, Hwang and Rodrik (2007) indices (henceforth HK, HKBH, HHR), while still maintaining many of the features of the product space method. Importantly, using the new index we find that the original Hausmann, Hidalgo at al. type arguments do hold at the sub-national scale, even after controlling for more traditional regional growth factors.

This paper is structured as follows. Within the product space framework the next section discusses the interconnected ideas of relatedness, centrality and connectedness. We then modify, adapt and extend the methodological approach of Hausmann and Klinger (2006) to a wider context more suitable for addressing regional variations within advanced economies. Our analysis shows that in such a context this modified approach makes much more theoretical and empirical sense than the existing HK, HKBH, HHR indices and these ideas are then applied to data on Italian provinces. We then apply our measure to an analysis of the GDP per capita and innovation performance of Italian provinces. The product space logic implies that a province with a better position in the export product space is likely to be associated with better economic outcomes. We aim to investigate whether this argument holds in the case of Italian provinces, after also controlling for more traditional regional economic characteristics associated with variety, diversity, human capital and density. Our findings demonstrate that a province's good positioning in the export network product space is indeed associated with enhanced regional development, over and above other more traditional regional economic variables.

Product and Technological Relatedness, Network-Centrality

The product and network space arguments of Hausmann and Klinger (2006), Hidalgo et al. (2007) and Hidalgo and Hausmann (2009) suggest that within the overall global networks of trade countries which are represented relatively more in centrally-located export activities are more likely to exhibit stronger growth and developments trajectories than regions which are more represented by the exporting of more peripheral products. The foundations of the Hausmann-Hidalgo approach are twofold.

To begin with, their analysis posits that where two products or services share most of the same requisite production assets and capabilities, countries that export one will also tend to export the other. By the same token, goods or services that do not share many capabilities are less likely to be co-exported. Reflecting the cognitive distance argument of Boschma (2005), greater proximity between products or services - in terms of the common production assets and capabilities required - also offer greater possibilities for mutual technology transfer, learning and knowledge sharing. The product proximity index that Hausmann, Hidalgo and their colleagues propose is therefore a measure of the relatedness between pairs of products using cross-country export data. It is also a measure of the product-space distance between products, and one which avoids any priors as to the relevant dimensions of similarity. The similarity of requisite production assets and capabilities is also revealed by the likelihood that where a country has a revealed comparative advantage (RCA) in the exporting of one good, it will tend to have such an advantage in both goods.

Yet, these relatedness properties are themselves not sufficient to ensure strong development trajectories. Rather, their analysis also posits that countries with a revealed comparative advantage in groups of sectors which are centrally positioned within global trade networks will exhibit higher levels of economic development than those whose revealed comparative advantage is in sectors which are more peripherally positioned. The degree of centrality of a country's related exports in global trade networks is therefore also critical in determining its long term development trajectory, and the more centrally positioned are a country's exports the stronger will be its development trajectory. The Hausmann-Hidalgo approach has been shown to be very effective in capturing the development performance of many low income and small countries, whose revealed comparative advantage exports tends to be restricted to only a small number of sectors or products.

These Hausmann-Hidalgo arguments represent a quite different approach to many of the types of questions than those which have dominated economic geography over recent years. A large body of economic geography literature deriving primarily from urban economics has focused on the role that sectoral composition of a regional economy plays in enhancing the rate of innovation and growth. As a whole the results are inconclusive in that both specialization and diversity can foster regional growth in different contexts (Melo et al 2009; De Groot et al. 2009, 2016; Beaudry and Schiffauerova 2009). Other studies reported evidence of agglomeration externalities by making a sectoral distinction, but they tend to be unconcerned with the role of relatedness among industries. For example, for the Israeli case, Shefer (1998) argued that agglomeration externalities affect the rate of innovation in the high-tech industries positively and significantly, but have a much less pronounced effect on low-tech industries. For the Italian case, Paci and Usai (1999, 2000) demonstrated that both specialization and diversification externalities positively affect regional innovativeness, the latter being more pronounced for high technology sectors. They also found evidence that the distribution of innovative activity tends to follow an explicit spatial pattern. Local systems with high innovation activity are often close with each other and are also more likely to appear around the main metropolitan areas in the North of Italy.

At the same time a smaller but highly persuasive literature suggest that the relatedness (Frenken et al. 2007; Boschma and Frenken 2011) of a region's different sectors is more important than simply its structural composition, with relatedness permitting the inter-sectoral knowledge and skills linkages necessary to foster both diversification and branching (Nygaard Tanner 2014).

This idea is especially important in network-type systems (Boschma and Neffke 2012) and again is heavily based on the cognitive proximity argument of Boschma (2005). Indeed, the related variety literature shares some commonalities with the Hausmann-Hidalgo approach in terms of their conceptual underpinnings, although their empirical specifications are very different to each other.

In this paper, and following the Hausmann-Hidalgo type of logic, we examine the extent to which the export network-structure of a sub-national area or region of an advanced economy is related to its level of development. In order to do this, as we explain below, it is necessary to adapt the existing Hausmann-Hidalgo framework to a form which is more appropriate to discussing diversified regions in advanced economies.

Indices of Export Network-Centrality and Relatedness and the Italian provinces

The index proposed by the arguments of Hausmann and Klinger (2006), Hidalgo et al. (2007) and Hidalgo and Hausmann (2009) is constructed by combining the well-known Balassa (1965) index with an index of proximity. Following Balassa, the RCA index of country c for product i is measured by the product's share in the country's exports in relation to its share in world trade:

$$RCA_{c,i} = (x_{c,i}/X_{c,t})/(x_{w,i}/X_{w,t}) \quad (1)$$

Where $x_{c,i}$ and $x_{w,i}$ are the values of country c's exports of product i and world exports of product i and where $X_{c,t}$ and $X_{w,t}$ refer to the country's total exports and world total exports. In the same way, if we assess other geographical area – like a local economy – saying that a region has revealed comparative advantage in that good, it means that the share of the local economy's exports in that product is greater than the share of the whole country exports in that product. This general logic is also reflected in the well-known employment-based Location Quotient (LQ) framework often used at the regional level. More specifically, if $RCA_{c,j}$ is region c's Balassa or LQ index for industry j and $RCA_{c,j} > 1$, region c is said to have a revealed comparative advantage in industry j, since this industry is more important for region c's exports than for the exports of the reference regions (the other regions belonging to the country Z). For a region to have revealed comparative advantage in an export good it must have the right endowments and capabilities to produce that good and export it successfully. Where two or more products are exported from a region, then if two goods require the same productive factors, this should show up in a higher probability of a country having comparative advantage in both.

Formally, the proximity ϕ between products i and j is the minimum of the pairwise conditional probabilities of having revealed comparative advantage in product i given that the regional economy has revealed comparative advantage in product j. Based on this idea, the proximity between product i and product j at year t is defined as:

$$\phi_{i,j} = min(P(x_i|x_j), P(x_j|x_i)) \tag{2}$$

where for any region or country c:

$$x_{i,c} = \begin{cases} 1 & if\ RCA_{c,i} \geq 1 \\ 0 & otherwise \end{cases} \tag{3}$$

and where the conditional probability is calculated using all regions (or countries).

Since conditional probabilities are not symmetric we take the minimum of the probability of exporting product i given j and the reverse, to make the measure symmetric and more stringent. More details about the concept of proximity and the option value associated with it were covered in the work of Hausmann and Klinger (2006).

Following the methodological approach of Hidalgo et al. (2007), the matrix of revealed proximities between every pair of products is given by the equation above. The Product Space is the network representation of this matrix of proximities, and it allows us to visualize the structure of the full matrix as well as to visualize the relatedness of each regional specialization pattern.

In the case of Italy we use ISTAT international trade data (provided by the ISTAT Coeweb Section), disaggregated according to the Standardized International Trade Code at the three-digit level (SITC-3), providing the regional value share exported to the world for 118 product classes for each Italian province (NUTS 3) relative to the Italian national share. Based on RCA values, we calculate the proximity ϕ between product i and product j at year t, where the conditional probability is calculated using all Italian provinces c. We calculate these probabilities across all the 110 Italian provinces. As already argued, the proximity ϕ between products i and j is the minimum of the pairwise conditional probabilities (see Appendix A) of having revealed comparative advantage in product i given that the province has revealed comparative advantage in product j. We calculate the 118-by-118 matrix of revealed proximities between every pair of products by using the proximity equation. Each row and column of this matrix represents a particular product and each off-diagonal element represents the proximity between a pair of products.

As already mentioned, the network and product-space arguments of Hausmann and Klinger (2006), Hidalgo et al. (2007) and Hidalgo and Hausmann (2009) suggest that countries or regions which are represented relatively more by centrally-located export activities are more likely to exhibit stronger growth and development trajectories than regions which are more represented by peripheral products. The reason is that these products offer greater possibilities for technology transfer, learning and knowledge sharing, and these ideas ought to be especially relevant in the local or regional context, where agglomeration-type arguments are often emphasized.

Hidalgo et al. (2007) compare the localization of the productive structure for different regions of the world, highlighting the products for which the region has an RCA > 1. They do not calculate a place-specific index, instead a network analysis shows that industrialized countries have more products with RCA > 1 in the core than East Asia Pacific, Latin America and Sub-Saharan Africa. One possible concretization of their visual index can be found in the work of Hausmann and Klinger (2006). Firstly they calculate a product i's centrality in the Product Space in time t. A product that is more central in the Product Space will be connected to a greater proportion of the other products j, and therefore will have a higher value for centrality.

$$C_{i,t} = \frac{\sum_j \phi_{i,j,t}}{J} \qquad (4)$$

This measure shows which goods are located in the dense part of the Product Space and which are located in the periphery by simply adding the row for that product in the matrix of proximities, and dividing by the maximum possible number of distance-weighted products J. Secondly Hausmann and Klinger (2006) measure the density of the product space around the areas where different countries have specialized by calculating the average centrality of all products in which the country has comparative advantage. They also graph this variable against GDP per capita showing that in general, rich (poor) countries tend to be specialized in dense (sparse) parts of the product space. For convenience, we will call this index "HK Average Centrality".

FIGURE 1 ABOUT HERE

As we see in Figure 1, applying the Hausmann-Klinger (HK) methodology to the Italian provinces we see that Italian provinces with higher HK AVERAGE CENTRALITY values tend to be higher GDP regions ($\rho = 0.565$, $R^2 = 0.320$). The problem, however, is that the existing Hausmann-Klinger approach relies only on those products with a Balassa index of greater than 1, and this misses much of the granularity of a region's economic fabric, and especially in advanced economies with economically diverse regions and with many different sectors with Balassa values close to or below 1.

Hidalgo et al. (2007) propose a measure to summarize the position of a country in the product space. They adopt a measure based on Hausmann, Hwang, and Rodrik, 2007), which involves a two-stage process. First, to every product, the weighted gross domestic product (GDP) per capita of countries with a comparative advantage in that good, is assigned. This is referred to as PRODY. Effectively, this is the associated income/productivity level for each good. Hidalgo et al. (2007) then average the PRODYs of the top N=50 products that a country has access to. We will call this index HKBH PRODY.

FIGURE 2 ABOUT HERE

As we see in Figure 2, applying the Hidalgo et al. (2007) HKBH PRODY methodology to the Italian provinces yields a weak correlation ($\rho = 0.319$). Furthermore, we see that indeed many Italian provinces with high HKBH PRODY indices are relatively poor provinces like Isernia and, vice versa, the extreme case represented by Milan.

HKBH PRODY is the first step to calculate the well-known export sophistication index called EXPY and developed by Hausmann, Hwang and Rodrik (2007). They find a positive and robust relationship between EXPY (henceforth HHR EXPY), that is the productivity level associated to a country's exports, and subsequent economic growth. HHR EXPY is calculated as a weighted average of each exported commodity's PRODY, where the weights are the shares of each product in the country's total exports.

A shortcoming of the HHR EXPY indicator used by those authors is that it does not take into account the quality differences within exported products across countries (Minondo,2010). In order to overcome this limitation, Minondo (2010) develops a new quality-adjusted EXPY indicator. His work shows that, once quality differences within products are taken into account, there is not a robust relationship between EXPY and subsequent growth even at national level.

FIGURE 3 ABOUT HERE

Yet, as we see in Figure 3, applying the Hausmann-Hwang-Rodrik (HHR EXPY) methodology to the Italian provinces yields results which are rather curious. Using the HHR EXPY index we see that indeed Italian provinces with higher values tend to be higher GDP regions, but the relationships is very weak indeed and were it not for a couple of outliers the relationship would be little different from zero. Moreover, with the HHR EXPY index, many provinces with high HHR EXPY indices are relatively poor provinces. Indeed, the province with the highest HHR EXPY index is Medio Campidano in Sardinia with a value of 10.6, and the province with the minimum value is Cagliari which is also in Sardinia with a value of 3.2, while the mean value for all Italian provinces is 7.8. Yet, both Medio Campidano and Cagliari are low GDP per capita regions with only few productive sectors generating tradeables.

The existing HHR type of approach ranks many poorer southern Italian regions above rich areas such as Milan. As we see in Figure 3, the weak overall relationship ($\rho = 0.226$) between exports and provincial GDP per capita is not what we would expect from the Hausmann-Klinger types of arguments.

In a setting such as Italian provinces a more holistic approach is therefore required which retains the basic HK AVERAGE CENTRALITY logic but which also takes account of the region's products which are both far and close to the well connected core, as well as the products in which the local economy has both high and low RCA values.

In order to do this we calculate the density of the Product Space around the areas where each Italian province is specialized, and this results in a new measure of network relatedness and centrality which we refer to as Product Space Position (PSP).

In order to calculate the Product Space Position (PSP), we first calculate the measure of a product i's centrality in the Product Space in time t, using equation (4). A product that is more central in the Product Space will be connected to a greater proportion of the other products, and therefore will have a higher value for centrality. As mentioned earlier, this measure shows which goods are located in the dense part of the Product Space and which are located on the periphery (Hausmann and Klinger 2006).

Next, we calculate for each province the RCA of each product they export, irrespective of whether the Balassa values are less than or greater than 1, and we use this measure to weight the centrality value of each node/product. The sum of these weighted values is our new measure of related variety or Product Space Position (PSP). Obviously, not all industries are export sectors and specially the relative tradability of most service industries is very low. Having said that, the industrial composition of a region can be approximated by its export structure. In addition, like Boschma and Iammarino (2009), 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 approximate the productive structure of a province. This assumption is supported by the literature (e.g. Krugman, 1987; Dosi et al., 1990). Formally, we therefore define the Product Space Position (PSP) of a local economy p as the sum of product i's centralities in the Product Space in time t weighted with the RCA values of province p for product i.

$$PSP_{p,t} = \sum_i (C_{i,t} * \mathrm{X}RCA_{p,i,t}) \tag{5}$$

This measure uses a RCA index which differs from the traditional index of revealed comparative advantages of Balassa (Balassa, 1965). The traditional Balassa index is affected by a statistical problems that may affect our results. Its range of variation is indeed asymmetrical and not homogeneous, in the sense that it varies between 0 and 1 for the cases of comparative disadvantage, while in the cases of comparative advantage varies between 1 and a very high upper limit, which depends on the size the region, the country and the sector in question. The formula we use is proposed by Iapadre (Iapadre, 2001). It is a variant of the one proposed by Dalum et al. (1998) and solves all statistical problems. The index used is the following (time subscript t suppressed for brevity):

$$XRCA_{p,i} = \frac{(RCA_{p,i} - RCA_{p,j})}{(RCA_{p,i} + RCA_{p,j})} \tag{6}$$

with:

$$RCA_{p,i} = \frac{\left(\frac{X_{p,i}}{X_p}\right)}{\left(\frac{X_{r,i}}{X_r}\right)} \tag{7}$$

and

$$RCA_{p,j} = \frac{\left(\frac{X_{p,j}}{X_p}\right)}{\left(\frac{X_{r,j}}{X_r}\right)} \tag{8}$$

where p = province, i = product, r = total of other provinces and j = total of the other products (net of i). This specialization of the value of exports (X) indicator varies between -1 and 1. Positive (negative) indicate advantages (disadvantages) compared to other Italian regions.

This new PSP index displays several more desirable properties than the existing indices when applied to the Italian provincial data. Firstly, as we see in Figure 4, plotting the provincial PSP index with respect to provincial GDP per capita displays a stronger positive correlation (ρ = 0.653) than the HK AVERAGE CENTRALITY, the HKBH PRODY and the HHR EXPY index. Using the new PSP index we see that the highest provincial PSP value is that of Milan at -0.67 while the minimum value is now that of Ogliastra in Sardinia at -6.27, with an overall mean for Italy of -3.61.

FIGURE 4 ABOUT HERE

Secondly, the PSP index retains the feature that provinces with high RCA values for exports positioned in the core of the global networks are likely to face much better prospects than provinces with a low presence in the core. Thirdly, even if product centrality values are constant for every province, weighting those values with RCA values which are specific to each sector and each province, gives us the weighted position of the industrial composition for each Italian province in the overall Italian Product Space. Likewise, even if the RCA values are the same for different provinces, the centrality weightings produce different results.

As an example, we compare here the HK and HHR positioning with the Product Space Position of two provinces with exactly the same number of sectors with RCA>1. The province of Sassari, in Sardinia, which is a low GDP per capita province, has a very high HHR EXPY score of 8.72 but a low PSP score of -4.18. La Spezia, which is a high GDP per capita province in Northern Italy, has a relatively low HHR EXPY score of 6.79 but a relatively high PSP score of -2.94. HK AVERAGE CENTRALITY scores are very similar for both provinces, still slightly higher for Sassari. As is very clear, the PSP scores make much more theoretical and empirical sense that both the HK AVERAGE CENTRALITY and the HHR EXPY scores.

We are also able to draw here the export network-positioning of the provinces of Sassari and La Spezia using both indices. Figures 5 and 6 depict the network centrality and positioning of both Sassari and La Spezia, respectively, using the Hausmann-Klinger (HK AVERAGE CENTRALITY) approach, Figures 7 and 8 depict their respective positioning using the Hausmann, Hwang and Rodrik (HHR EXPY) method, while Figures 9 and 10 depict their respective positioning using the PSP index.

Because of the density of the networks possible in a 118-118 matrix, the complete network structure for each province looks like a hairball. Therefore, Hidalgo recommend that good rule of thumb is to ensure that the average connectivity is not much more than 4 or 5 links per node (Hidalgo et al. 2007, 2009). In order to simplify the visual images, in each of these cases we therefore only depict those linkages with a cut-off value of at least 0.30. We also added 1 to the XRCA values just to improve the network visualization. Thereby in the Figures 9 and 10, the RCA indicator, represented by the size of nodes, varies between 0 and 2.

FIGURE 5 AND 6 ABOUT HERE

In these figures, the node colors represent the value for HK AVERAGE CENTRALITY.

FIGURE 7 AND 8 ABOUT HERE

Although Sassari and La Spezia are very different provinces in terms of the levels of economic development, these two provinces have exactly the same number of sectors with RCA values greater than 1. Yet, what becomes clear from the visual network structure presented in Figures 5 and 6 and in the Figures 7 and 8 is that it is very difficult using the HK AVERAGE CENTRALITY and HHR EXPY indices to identify differences between these two provinces, even though they are very different economically.

FIGURE 9 AND 10 ABOUT HERE

In contrast, if we depict the network positioning using the PSP index then the picture becomes much clearer. Sassari has far fewer sectors with a major presence in the center of the global trade networks whereas La Spezia has a much greater presence in these central placings, as would be expected from a richer province. Our approach therefore moves beyond the existing approaches because provinces with similar XRCA values but with different network configurations will display different PSP values, and similarly provinces with similar network centrality values but with similar XRCA values, will also display different PSP values. Our findings as a whole also show that in general, richer (poorer) provinces tend to be specialized in dense (sparse) parts of the product space, and therefore display a high (low) value of PSP, as depicted in Figure 4. However, observing these features is of itself not enough to operationalize our index because we still need to examine whether our modified index of network-centrality is in reality largely picking up other more general regional characteristics.

Econometric Model, Data and Variables

In order to identify the extent to which the Product Space Position (*PSP*) of a region's tradeables network structure is related to its overall economic performance we also need to control for other local area characteristics. Using measures of a region's GDP per capita and also its innovative performance we examine the extent to which PSP affects these outcomes over and above the standard indicators on variety, diversity, human capital and agglomerative capacity. In what follows we introduce our data and empirical specification, and we discuss our results followed by a robustness check where we consider alternative specifications of our agglomeration and density control variables.

In our analysis we consider 103 out of a possible 110 NUTS 3 provinces according to the uniform data available from 2006. We excluded the new Italian provinces of Monza della Brianza, Fermo, Barletta-Andria-Trani, Carbonia Iglesias, Ogliastra, Medio Campidano, Olbia-Tempio. Monza della Brianza was officially created by splitting the north-eastern part from the province of Milan on 2004, and became executive in 2009. Fermo is a province in the Marche region of central Italy. It was established in 2004 and became operational in 2009. The Province of Barletta-Andria-Trani is a province of Italy in the Apulia region. The establishment of the province took effect in 2009, and Andria was appointed as its seat of government in 2010. Carbonia Iglesias, Ogliastra, Medio Campidano and Olbia-Tempio are provinces in the autonomous region of Sardinia. The formation of these province was announced in 2001 by the Autonomous Region of Sardinia and it officially became executive in 2005. We employ annual data from 2006-2011. A panel data analysis is carried out since the dataset available in our analysis consisted of both cross-sectional and time dimensions

We use two dependent variables**.** As a proxy for the economic prosperity of each province we use the per capita annual gross domestic product (GDP per capita) derived from the OECD regional database. As a measure of the innovation performance of each province we use patenting activity per capita. In particular, we use the number of patent applications to the European Patent Office (EPO) from 2006 to 2011, classified by inventors' residence.

Even though it is very widely used, the choice of patents as a measure of innovative activity faces some limitations. Patent indicators are not directly equivalent to a measure of innovative output since many patented inventions never become marketable products while many successful products are never patented (Griliches, 1990; Feldman, 1994). Another limitation is that patent data do not measure innovation in services as accurately as in manufacturing goods, but this kind of phenomenon in may cases is difficult to measure. On the other hand, in favor of the use of this indicator for the purposes of our analysis, we can argue that contrary to other patent indicators, applications at EPO provide an effective measure of innovation, taking into account just high quality applications. Patent applications to the European Patent Office (EPO) is an effective indicator for innovation, due to the fact that applying to EPO is difficult, time consuming and expensive. It is also an indicator for both product and process innovations and, therefore, a very comprehensive measure of the innovative provincial output, such that patents continue to be used as a useful measure of the generation of ideas.

For the purposes of this paper the most important independent variable in our model is the Product Space Position index (*PSP*), which represents our new measure of the relatedness and network centrality of the exports of each province. We aim to identify the extent to which this is related to provincial *GDP* per capita and Patents per Capita, over and above other more conventional control variables. As already discussed, in order to draw the product space and build this index at the provincial level, we used ISTAT export data (Coeweb database), in which export data are specified for 118 three-digit sectors (ATECO-3 level). The use of international trade data to construct the indicator has some limitations (Boschma and Iammarino, 2009; Boschma et al., 2012), the most obvious of which is that exports tend to be biased towards manufacturing activities, due to the relatively low tradability of most service industries.

In terms of the other independent variables, as an indicator for the degree of the structural concentration of a local economy we use the reciprocal of the Gini concentration coefficient (*VARIETY*):

$$VARIETY = \frac{1}{2\frac{\sum_{k=1}^{n} kE_k}{(n-1)\sum_{k=1}^{n} E_k} - \frac{n+1}{n-1}} \tag{9}$$

where E_k is the sum of employees (E) for sector k, with sectors listed in increasing order. Given that the Gini coefficient is a measure of concentration, an increase of its reciprocal implies that the levels of provincial sectoral concentration are lower. Employment data are provided by the

ISTAT statistical register ASIA, that is the Statistical Register of Active Enterprises. In particular, we use employment data provided by the business register of local units. A local unit is defined by the Council Regulation on statistical units (N. 696/1993) as 'an enterprise or part thereof (e.g. a workshop, factory, warehouse, office, mine or depot) situated in a geographically identified place'. The ASIA-Local Units register provides information on location of the local unit, economic activity, number of employees.

The measure of provincial specialization and diversity at the local level we use is given by the Duranton and Puga index (*DIVERSITY*). As with Duranton and Puga (2000) and de Vor and de Groot (2010), the degree of variety is measured by summing for each province, over all sectors, the absolute value of the difference between each sector share on local employment and its share on national employment. Formally it leads to:

$$DIVERSITY = \frac{1}{\sum_{p=1}^{118} |s_{k,p} - s_{k,c}|} \tag{10}$$

where:

$$s_{k,p} = \frac{E_{k,p}}{E_p} \text{ and } s_{k,c} = \frac{E_{k,c}}{E_c} \qquad \text{(11) and (12)}$$

and where $E_{k,p}$ is the employment in sector k in province p and E_p is the total employment in province p, $E_{k,c}$ the national sector employment in sector k and E_c is the total national employment. The source of the data is the ASIA-Local Units database.

In the typical regional production function approach, the innovative output of a region is also often argued to depend upon the level of research and development activities within the local economy. We measure the level of research and development activities (*RD*) by the level of provincial R&D employment divided on the total employment of each province (*RD*). The source of the data is the ASIA-Local Units database.

The model also includes a variable which reflects the provincial share of advanced tertiary sector employees relative to all employees of each province. The advanced tertiary sector of the economy includes organizations specialized in IT, marketing, research and development and legal, technical and financial consulting. We calculate this indicator (*ADV_SECT*) after excluding the share of employment on research and development sector, in order to avoid considering the effects twice. Again, the source of the data is the ASIA-Local Units database.

We also include a variable *EDU*, which is the share of the provincial population with a higher education (defined as a bachelor's degree or master's degree) as a proxy for the general quality of human capital. Moreover, we also make a distinction considering the share of the population possessing a degree in a scientific subject - defined as mathematical sciences, engineering and medicine – defined here as *EDU_SC*, in order to focus on technological spillovers as the major engine of innovation. We use data provided by the Italian Ministry of Education, University and Research (MIUR) statistical section, collected considering the location of Universities.

Finally, we test whether urbanization economies matter, that is, to what extent more densely populated provinces show a higher rates of economic prosperity and innovation. To capture urbanization economies we take the population density of each province, that is, the number of inhabitants per squared kilometer (*POP*), as derived from the OECD Regional Demographic

Statistics.

Unstandardized sample statistics are reported in Table 1. We enter all variables in standardized form, so the coefficients should be interpreted in terms of standard deviations.

TABLE 1 ABOUT HERE

Adopting the pooled ordinary least-squares (OLS) model with robust standard errors and period fixed effects, we estimate the following equations for the first model having economic prosperity (*GDP*) as dependent variable:

$$GDP_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_4 PAT_{p,t} + \beta_5 EDU_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon \quad \text{(Reg 1.1)}$$

$$GDP_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_2 VARIETY_{p,t} + \beta_4 PAT_{p,t} + \beta_5 EDU_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon \quad \text{(Reg 1.2)}$$

$$GDP_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_3 DIVERSITY_{p,t} + \beta_4 PAT_{p,t} + \beta_5 EDU_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon \quad \text{(Reg 1.3)}$$

$$GDP_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_2 VARIETY_{p,t} + \beta_3 DIVERSITY_{p,t} + \beta_4 PAT_{p,t} + \beta_5 EDU_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon$$

(Reg 1.4)

and the following equations for the second model having innovation (Pat) as dependent variable:

$$PAT_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_4 GDP_{p,t} + \beta_5 EDU\_SC_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon$$ (Reg 2.1)

$$PAT_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_2 VARIETY_{p,t} + \beta_4 GDP_{p,t} + \beta_5 EDU\_SC_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon$$ (Reg 2.2)

$$PAT_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_3 DIVERSITY_{p,t} + \beta_4 GDP_{p,t} + \beta_5 EDU\_SC_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon$$ (Reg 2.3)

$$PAT_{p,t} = \beta_0 + \beta_1 PSP_{p,t} + \beta_2 VARIETY_{p,t} + \beta_3 DIVERSITY_{p,t} + \beta_4 GDP_{p,t} + \beta_5 EDU\_SC_{p,t} + \beta_6 RD_{p,t} + \beta_7\, ADV\_SECT_{p,t} + \beta_8\, POP_{p,t} + \lambda_1 \mathrm{dt2} + \lambda_2 \mathrm{dt3} + \lambda_3 \mathrm{dt4} + \lambda_4 \mathrm{dt5} + \lambda_5\, \mathrm{dt6} + \varepsilon$$

(Reg 2.4)

where: t denotes 1-year intervals (from 2006 to 2011), p denotes the province, ε denotes the error term, *GDP*, *PAT*, *PSP*, *VARIETY*, *DIVERSITY*, *EDU*, *EDU_SC*, *RD*, *ADV_SECT*, *POP* is the set of variables. We control for period specific unobserved shocks by entering year-dummies, with 2006 the reference year. We tested models with additional province fixed effects. These models were rejected against the single regional intercept models reported in this paper. The results are available upon request.

The estimation results are shown in Table 2 and 3 for the two dependent variables, namely economic prosperity and innovation activity, respectively. All specifications show reasonable to good values for the R-square, and the Durbin-Watson statistics are all within established limits.

In Table 2 we present the main results concerning the dependent variable provincial economic prosperity (*GDP*). In column 1, *PSP* is the sole variety indicator of the model, along a number of the standard controls applied in the literature. The coefficient is significant and positive, indicating that a standard deviation rise in *PSP* is associated with a 0.287 standard deviation increase in *GDP*. In order to investigate the relevance of *PSP* over and above other measures of economic specialization and concentration, in column 2 and 3 we include the *VARIETY* and *DIVERSITY* indices, respectively. *PSP* maintains a positive and significant impact on economic prosperity (*GDP*) in both regressions, with an effect size of similar magnitude. *VARIETY* also affects *GPD* positively and significantly (but lower than *PSP*), whereas *DIVERSITY* is just slightly positive. In column 4 we included all our three variety indicators, finding stable results for *PSP* and *VARIETY*, which present again positive and significant effect on *GDP*, whereas we find a negative and insignificant value for the *DIVERSITY* coefficient.

In Table 3, we turn to the regressions regarding innovative behavior. Once more, in the first regression, model 2.1, we only include *PSP* and we find a significant and positive coefficient. In the next step we include the *VARIETY* index in the model. *PSP* maintains a positive and significant impact on innovation, whilst the coefficient of the *VARIETY* variable is also positive and significant. In model 2.3 we add *DIVERSITY* rather than *VARIETY*. *PSP* maintains again a positive and significant impact on innovation, whilst *DIVERSITY* also displays a significant value. In column 2.4, we include both *VARIETY* and *DIVERSITY*. The complete version of the model shows stable results for *PSP* and *VARIETY*, which again display positive and statistically significant effects on Innovation, whereas we also find a negative and significant value for the *DIVERSITY* coefficient.

Our results suggest that both *PSP* and *VARIETY* matter for economic prosperity at the provincial level. However, the Product Space Position has a much stronger effect on *GDP* than *VARIETY*, confirming that the more related is the productive structure and the knowledge base of the province, the wider the contribution of cognitive proximity to local GDP.

Thus we confirm that regions which are well endowed with sectors that are central and well connected in the product space (i.e., that show related variety) achieve higher economic prosperity and, consequently, achieve higher rates of innovation. This effect is significant and economically relevant over and above standard controls emanating from the literature. These results are very robust and confirm our expectation that ex-post relatedness indicators are suited to capture the economic effects of relatedness across industries, as witnessed by the stable and positive relationship between our new related variety measure (PSP) and economic prosperity.

Focusing on results concerning the dependent variable for provincial innovation (*PAT*), we observe that *PSP* is positively and significantly associated with both innovation and economic prosperity.

Regarding the other control variables, the econometric results show the crucial role of innovation (*PAT*) in the *GDP* model, and also the crucial role of economic prosperity (*GDP*) in the *PAT* model. At the same time, the effect of *ADV_SECT* - that is the share of advanced tertiary sector employees to all employees of each province – is strongly positive and significant on *GDP*, whereas it is negative and significant on innovation, which is not as might be expected. Similarly, the effect of the *RD* variable is not significant on *GDP*, whilst it is slightly negative and significant on innovation output, whereas this might have been expected to be positive. Rather than employment data, a more suitable proxy for R&D inputs may be the total R&D expenditure per capita for each area. Unfortunately, however, R&D expenditure data disaggregated at the level of the Italian provinces do not exist, and are only reported at the much larger spatial units of the Italian regions.

In order to control for regional human capital endowments, we included the variable *EDU* in the *GDP* models, and the variable *EDU_SC* in the *PAT* models, focusing on scientific knowledge as the major engine of innovation. The impact of *EDU* on economic prosperity *GDP* is negative and generally not significant, whereas we find *EDU_SC* to have a positive and statistically significant effect on innovative behavior, as expected. As already said, these education data are collected considering the location of universities, so we also tried our regression model with data collected according to the residence of students. The results were always negative, although this might be related to the south-north migration flows of recent graduates. The presence of local university is very important in attracting long distance migrants (Biagi et al., 2011) and the most relevant migration decision for regional human capital accumulation is made at the moment of choosing the university. Since the large majority of Italian students tend, after graduation, to stay and work where they completed their education, keeping their official residence in their origin province of bird (Ciriaci, 2014), this phenomenon provides a strong bias to human capital index based on residence of students.

We control for population density, which displays a significant and negative coefficient. This implies that, controlling for everything else, both Patents per capita (*PATENTS*) and GDP per capita (*GDP*) are lower in more densely populated areas. This suggests that our model specification has accounted for most of the positive externalities associated with dense areas, and the residual cost-related denominator effects remains. As a robustness check, we replace the population density variable *POP*) with the variable *POPdummy*. *POPdummy* is an alternative urbanization-economy index, defined simply as a value of 1 for population density values greater than 250.000 and 0 for values lower than 250.000. The results of the models 3 including *POPdummy* rather than *POP* are only slightly different from the output of the model framework including *POP*. However, in model 4, *POPdummy* coefficients display positive and statistically significant values, and the adjusted R-squared is also slightly higher. The results are reported in Appendix A, in Tables A1 and A2 respectively.

TABLE 2 and TABLE 3 ABOUT HERE

Concluding remarks

In this paper we have applied the Hausmann-Klinger (HK) type logic in order to examine the extent to which the network-positioning of a sub-national region's exports accounts for its level of economic development. In the case of an advanced economy, we explained using Italian provincial export data why it is necessary to construct a new Product Space Position (PSP) index, which better captures the features of these types of economies than the original HK AVERAGE CENTRALITY index and also the other sophistication export indices, HKBH PRODY and HHR EXPY. The PSP index is shown to be significantly related to a region's GDP per capita and its innovation performance, even after controlling for regional economic characteristics. The PSP index findings suggest that basic insights of Hausmann and Klinger therefore continue to hold even at the sub-national level in an advanced economy. Indeed our results suggest that explanatory power of the PSP approach may be at least as powerful as the more traditional measures typically used in economic geography. In terms of further work, it would be interesting to compare the performance of the PSP index with other measures of related variety, although undertaking this is well beyond the scope of this paper.

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Appendix A Robustness checks

Table A1

Dependent variable: GDP 2006-2011

	Reg (3.1)	Reg (3.2)	Reg (3.3)	Reg (3.4)
Constant	0.201***	0.177**	0.191***	0.176**
	(0.069)	(0.074)	(0.072)	(0.074)
Product Space Position	0.276***	0.207***	0.247***	0.205***
	(0.033)	(0.035)	(0.033)	(0.035)
Variety		0.203***		0.193***
		(0.042)		(0.045)
Diversity			0.078***	0.015
			(0.026)	(0.026)
Pat	0.485***	0.434***	0.483***	0.436***
	(0.052)	(0.053)	(0.051)	(0.052)
Edu	0.020	−0.006	0.001	−0.008
	(0.029)	(0.027)	(0.028)	(0.027)
RD	−0.021	−0.036*	−0.021	−0.035*
	(0.020)	(0.020)	(0.020)	(0.020)
Adv Sect	0.298***	0.260***	0.310***	0.264***
	(0.035)	(0.034)	(0.037)	(0.035)
Pop Dummy	−0.122***	−0.145***	−0.127***	−0.145***
	(0.024)	(0.023)	(0.023)	(0.023)

dt_2	−0.349***	−0.307***	−0.341***	−0.308***
	(0.086)	(0.084)	(0.085)	(0.084)
dt_3	−0.186**	−0.169**	−0.173*	−0.167*
	(0.087)	(0.086)	(0.088)	(0.086)
dt_4	−0.342***	−0.315***	−0.338***	−0.316***
	(0.089)	(0.092)	(0.091)	(0.093)
dt_5	−0.114	−0.038	−0.092	−0.038
	(0.095)	(0.095)	(0.094)	(0.095)
dt_6	−0.217**	−0.232***	−0.200**	−0.228***
	(0.087)	(0.086)	(0.087)	(0.085)
R-square	0.691	0.707	0.696	0.707
Adjusted R-square	0.686	0.701	0.690	0.701
S.E. of regression	0.560	0.546	0.556	0.546
Sum squared resid.	190.266	180.402	187.337	180.318
Log likelihood	−512.882	−496.432	−508.088	−496.288
Durbin-Watson stat	1.483	1.471	1.476	1.469
Akaike info criterion	1049.766	1018.865	1042.177	1020.576
Schwartz criterion	1102.884	1076.410	1099.722	1082.547
F-statistic	182.972	285.965	165.182	258.526
P-value (F-statistic)	2.3e-184	4.5e-240	7.4e-182	1.1e-236

Notes: n=618; Standard errors in parentheses; *p<0.10, **p<0.05; ***p<0.01

Table A2

Dependent variable: Pat 2006-2011

	Reg (4.1)	Reg (4.2)	Reg (4.3)	Reg (4.4)
Constant	0.027	0.017	0.032	0.022
	(0.055)	(0.053)	(0.057)	(0.056)
Product Space Position	0.109***	0.069**	0.129***	0.088***
	(0.025)	(0.028)	(0.029)	(0.030)
Variety		0.128***		0.196***
		(0.029)		(0.034)
Diversity			−0.059	−0.115***
			(0.036)	(0.039)
GDP	0.676***	0.635***	0.683***	0.627***
	(0.029)	(0.030)	(0.031)	(0.029)
Edu Sc	0.094**	0.065*	0.113***	0.088**
	(0.038)	(0.038)	(0.037)	(0.038)
RD	−0.049**	−0.054**	−0.052**	−0.061**
	(0.024)	(0.024)	(0.025)	(0.025)
Adv Sect	−0.128***	−0.138***	−0.141***	−0.169***
	(0.040)	(0.040)	(0.042)	(0.043)
Pop Dummy	0.136***	0.119***	0.140***	0.115***
	(0.019)	(0.019)	(0.019)	(0.018)
dt_2	−0.114*	−0.092	−0.118*	−0.088

	(0.062)	(0.063)	(0.062)	(0.063)
dt_3	−0.042	−0.036	−0.050	−0.048
	(0.071)	(0.071)	(0.073)	(0.073)
dt_4	0.059	0.066	0.060	0.072
	(0.083)	(0.083)	(0.085)	(0.086)
dt_5	−0.028	0.013	−0.040	0.010
	(0.119)	(0.115)	(0.115)	(0.113)
dt_6	−0.037	−0.056	−0.045	−0.081
	(0.093)	(0.089)	(0.093)	(0.089)
R-square	0.567	0.573	0.569	0.581
Adjusted R-square	0.559	0.564	0.561	0.572
S.E. of regression	0.663	0.659	0.662	0.654
Sum squared resid.	267.075	263.435	265.505	258.433
Log likelihood	−617.666	−613.426	−615.844	−607.502
Durbin-Watson stat	1.756	1.749	1.767	1.770
Akaike info criterion	1259.333	1252.852	1257.689	1243.005
Schwartz criterion	1312.451	1310.396	1315.234	1304.976
F-statistic	106.415	109.939	97.274	102.7126
P-value (F-statistic)	1.3e-133	3.3e-143	1.7e-132	2.1e-143

Notes: n=618; Standard errors in parentheses; *p<0.10, **p<0.05; ***p<0.01

Table 1

Sample statistics of the variables, 2006-2011

	Mean	**Median**	**Std. dev.**	**Min**	**Max**
GDP	25,692	25,940	6,905.2	13,934	52,824
Pat	6.9680e-05	5.0600e-05	6.7957e-05	0.0000	0.00049689
PSP	-3.569	-3.510	1.0617	-5.863	-0.371
Variety	1.471	1.477	0.075	1.308	1.707
Diversity	0.026	0.025	0.007	0.012	0.050
Edu	0.385	0.224	0.384	0.000	2.187
Edu Sc	0.141	0.085	0.157	0.000	0.979
RD	0.122	0.086	0.118	0.000	0.938
Adv Sect	14.946	14.527	2.885	10.150	29.589
Pop	246.23	172.53	326.75	38.017	2,597.6

Table 2

Dependent variable: GDP 2006-2011

	Reg (1.1)	Reg (1.2)	Reg (1.3)	Reg (1.4)
Constant	0.190***	0.169**	0.184**	0.169**
	(0.070)	(0.075)	(0.073)	(0.075)
Product Space Position	0.287***	0.224***	0.262***	0.226***
	(0.036)	(0.035)	(0.033)	(0.034)
Variety		0.172***		0.177***
		(0.042)		(0.044)
Diversity			0.054**	−0.008
			(0.025)	(0.024)
Pat	0.450***	0.403***	0.449***	0.402***
	(0.050)	(0.052)	(0.049)	(0.052)
Edu	−0.0343	−0.064**	−0.047*	−0.063**
	(0.029)	(0.026)	(0.027)	(0.025)
RD	0.006	−0.004	0.004	−0.004
	(0.018)	(0.018)	(0.018)	(0.018)
Adv Sect	0.355***	0.327***	0.361***	0.326***
	(0.038)	(0.038)	(0.039)	(0.038)
Pop	−0.108***	−0.110***	−0.097***	−0.112***
	(0.031)	(0.033)	(0.031)	(0.032)
dt_2	−0.373***	−0.341***	−0.367***	−0.341***

	(0.091)	(0.090)	(0.091)	(0.090)
dt_3	−0.148*	−0.127	−0.138	−0.128
	(0.085)	(0.085)	(0.086)	(0.085)
dt_4	−0.289***	−0.265***	−0.291***	−0.264***
	(0.084)	(0.088)	(0.086)	(0.088)
dt_5	−0.131	−0.071	−0.118	−0.071
	(0.098)	(0.097)	(0.098)	(0.097)
dt_6	−0.201**	−0.209**	−0.188**	−0.212**
	(0.087)	(0.087)	(0.088)	(0.087)
R-square	0.687	0.699	0.689	0.699
Adjusted R-square	0.681	0.693	0.683	0.692
S.E. of regression	0.564	0.553	0.562	0.554
Sum squared resid.	192.851	185.553	191.510	185.530
Log likelihood	−517.052	−505.131	−514.897	−505.093
Durbin-Watson stat	1.457	1.428	1.448	1.428
Akaike info criterion	1058.105	1036.264	1055.794	1038.186
Schwartz criterion	1111.223	1093.808	1113.338	1100.157
F-statistic	166.905	175.575	145.588	163.770
P-value (F-statistic)	3.3e-175	5.2e-188	2.1e-169	4.2e-188

Notes: n=618, Standard errors in parentheses; *p<0.10, **p<0.05; ***p<0.01

Table 3

Dependent variable: Pat 2006-2011

	Reg (2.1)	Reg (2.2)	Reg (2.3)	Reg (2.4)
Constant	0.036	0.022	0.042	0.028
	(0.052)	(0.050)	(0.054)	(0.053)
Product Space Position	0.195***	0.136***	0.224***	0.170***
	(0.033)	(0.033)	(0.039)	(0.036)
Variety		0.164***		0.246***
		(0.030)		(0.037)
Diversity			−0.063*	−0.139***
			(0.038)	(0.042)
GDP	0.640***	0.590***	0.644***	0.573***
	(0.031)	(0.031)	(0.031)	(0.032)
Edu Sc	0.140***	0.094***	0.161***	0.118***
	(0.036)	(0.036)	(0.036)	(0.037)
RD	−0.053**	−0.056**	−0.054**	−0.059**
	(0.025)	(0.024)	(0.025)	(0.025)
Adv Sect	−0.119***	−0.128***	−0.128***	−0.154***
	(0.041)	(0.042)	(0.042)	(0.044)
Pop	−0.061***	−0.065***	−0.074***	−0.093***
	(0.023)	(0.022)	(0.025)	(0.025)
dt_2	−0.120*	−0.093	−0.126**	−0.093

	(0.063)	(0.064)	(0.063)	(0.063)
dt_3	−0.095	−0.079	−0.105	−0.093
	(0.068)	(0.066)	(0.070)	(0.069)
dt_4	0.067	0.079	0.072	0.095
	(0.080)	(0.081)	(0.081)	(0.084)
dt_5	0.001	0.049	−0.010	0.046
	(0.118)	(0.116)	(0.114)	(0.113)
dt_6	−0.073	−0.093	−0.084	−0.125
	(0.095)	(0.090)	(0.095)	(0.090)
R-square	0.555	0.565	0.558	0.576
Adjusted R-square	0.547	0.556	0.549	0.567
S.E. of regression	0.672	0.665	0.671	0.657
Sum squared resid.	274.334	268.14	272.575	261.211
Log likelihood	−625.953	−618.904	−623.964	−610.805
Durbin-Watson stat	1.763	1.742	1.776	1.764
Akaike info criterion	1275.906	1263.809	1273.929	1249.612
Schwartz criterion	1329.024	1321.353	1331.474	1311.583
F-statistic	113.797	116.993	104.556	113.362
P-value (F-statistic)	1.9e-139	8.0e-149	9.4e-139	2.2e-152

Notes: n=618, Standard errors in parentheses; *p<0.10, **p<0.05; ***p<0.01

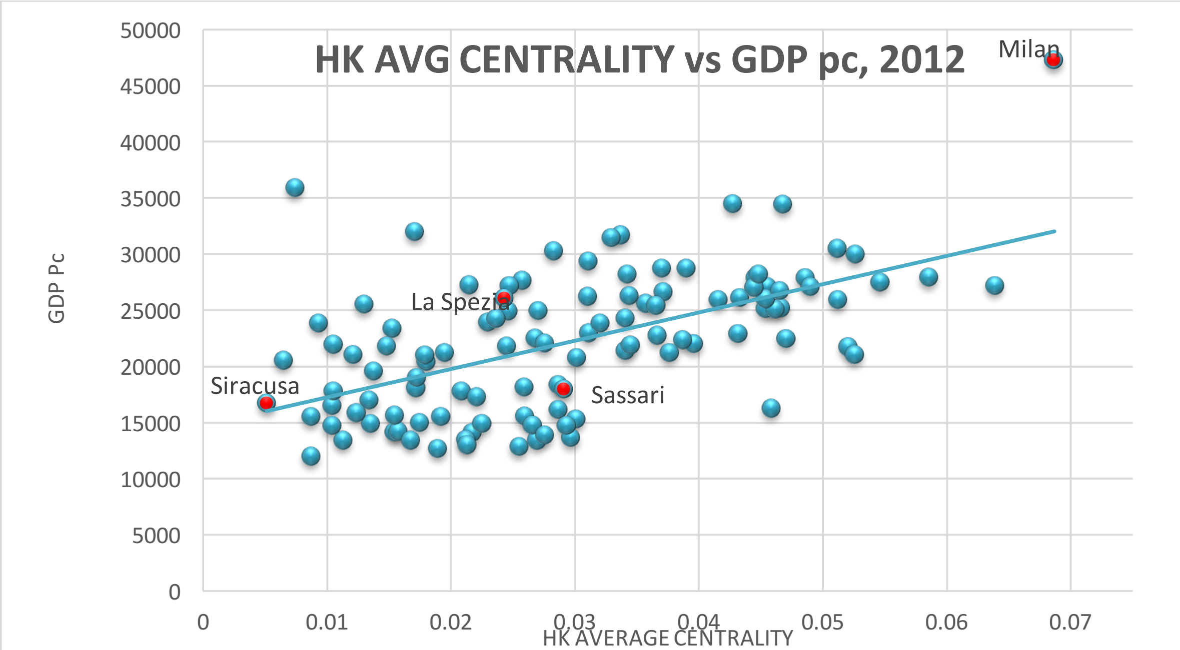

Figure 1. Scatterplot of Provincial GDP per capita and HK Average Centrality Index

Notes: Correlation = 0.565; R^2 = 0.320

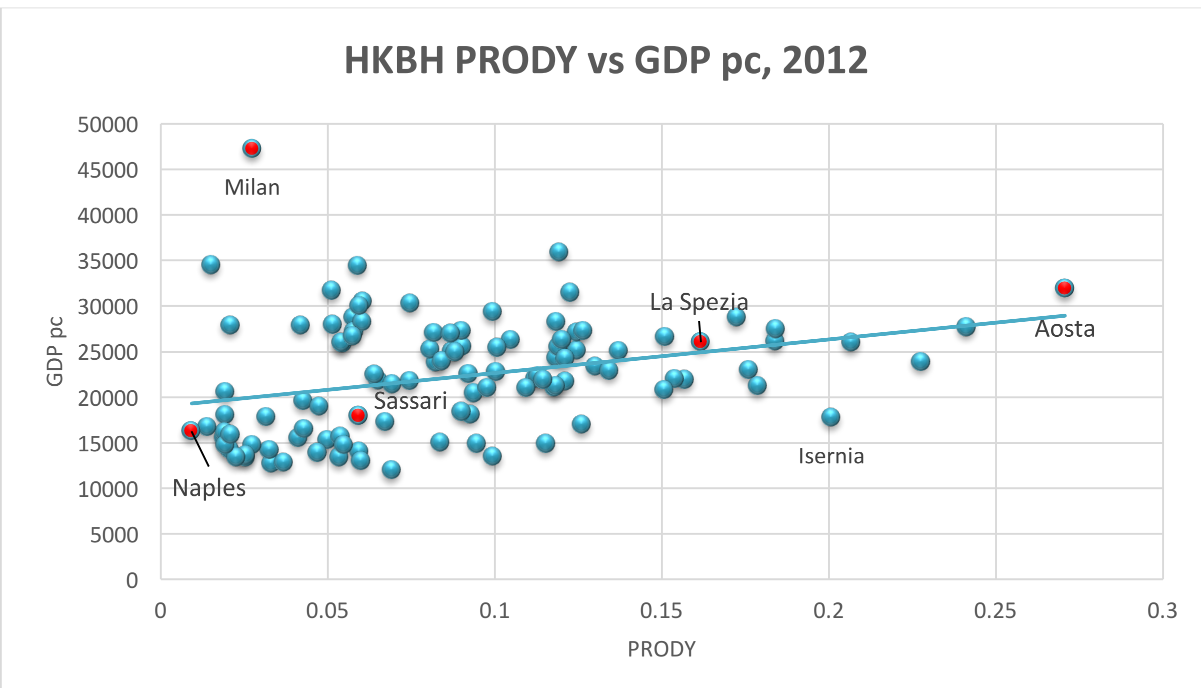

Figure 2. Scatterplot of Provincial GDP per capita and HKBH Prody Index

Notes: Correlation = 0.319; R^2 = 0.102

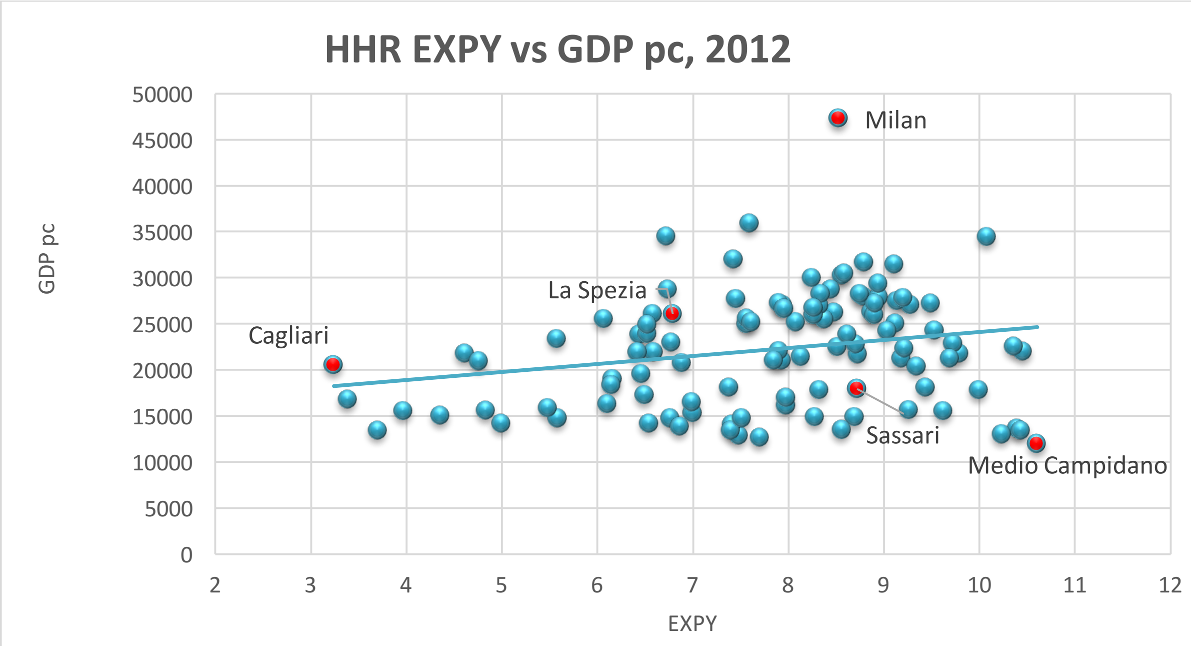

Figure 3. Scatterplot of Provincial GDP per capita and HHR EXPY Index

Notes: Correlation = 0.226; R^2 = 0.051

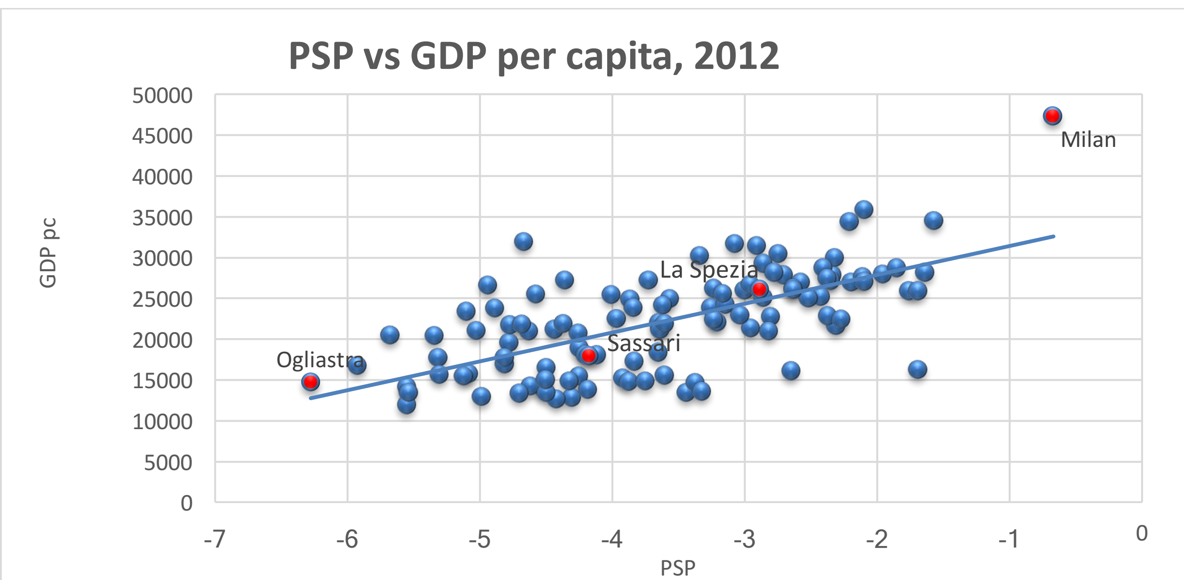

Figure 4: Scatterplot of Provincial GDP per capita and PSP Index 2012

Notes: Correlation = 0.653; R^2 = 0.426

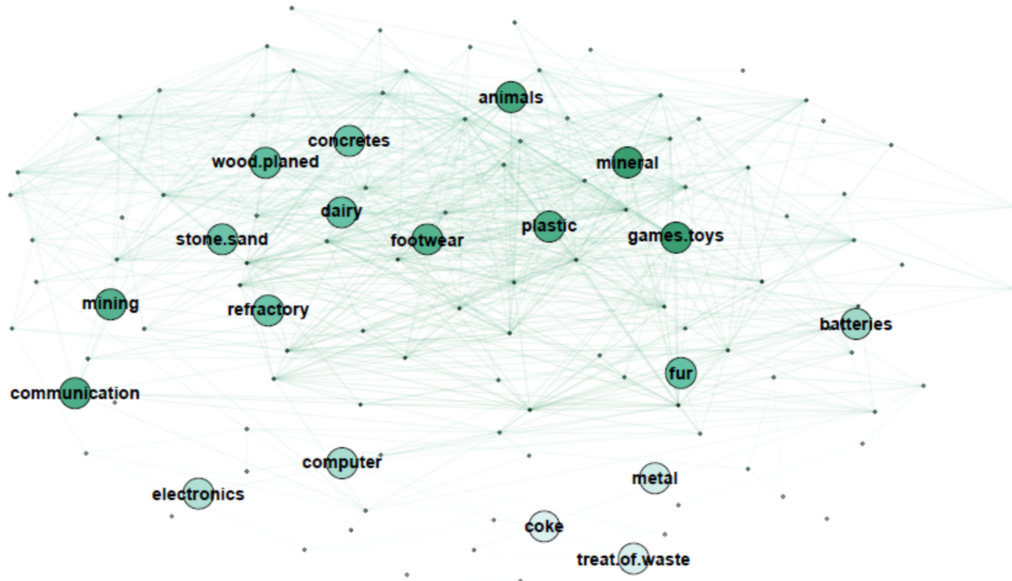

Figure 5. The Network Positioning for Sassari province using the HK AVERAGE CENTRALITY Index

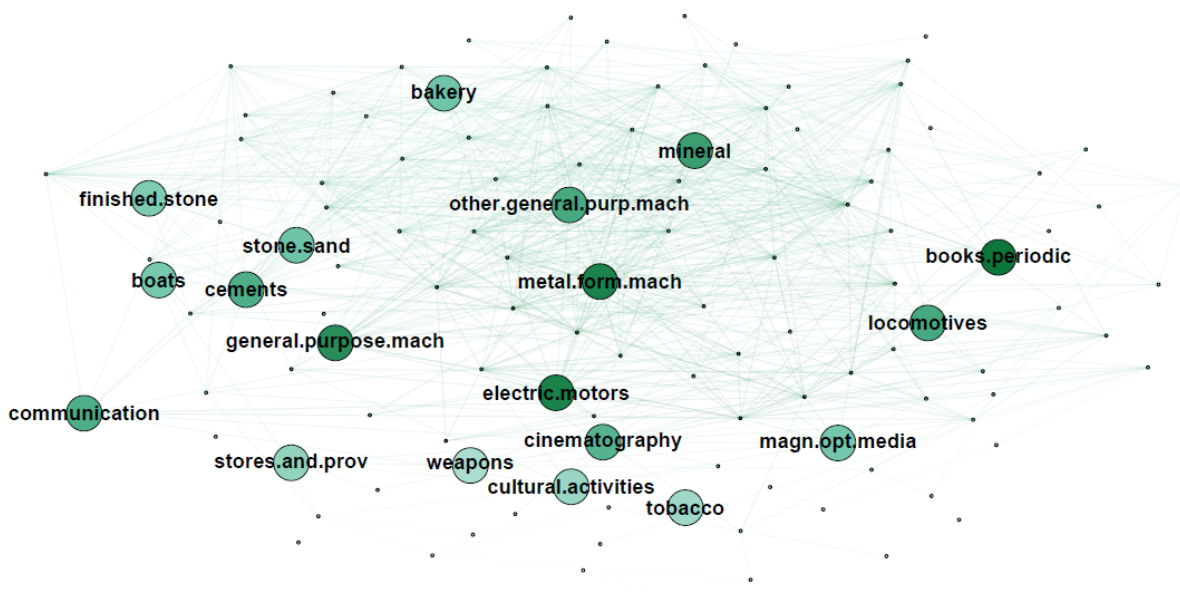

Figure 6.The Network Positioning for La Spezia province using the HK AVERAGE CENTRALITY Index

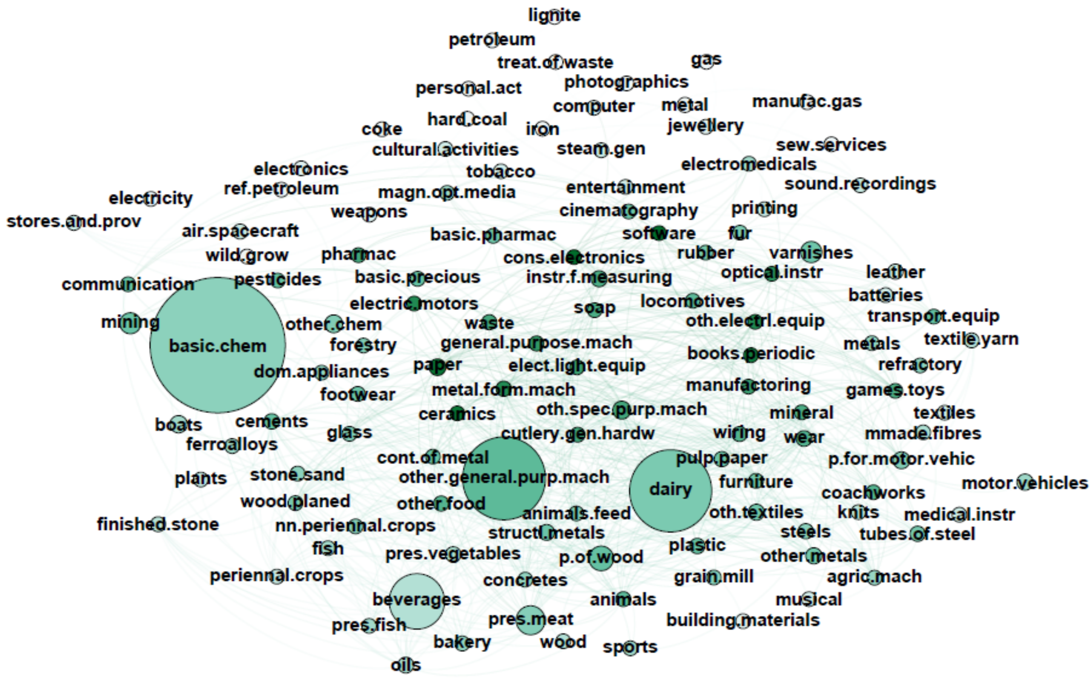

Figure 7. The Network Positioning for Sassari province using the HHR EXPY Index

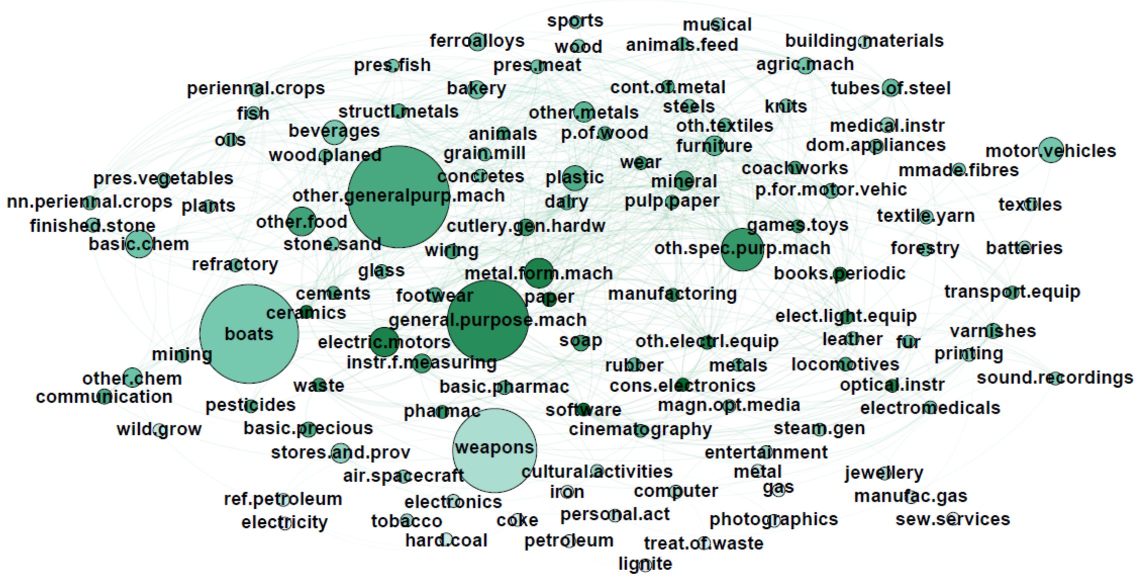

Figure 8: The Network Positioning for La Spezia province using the HHR EXPY Index

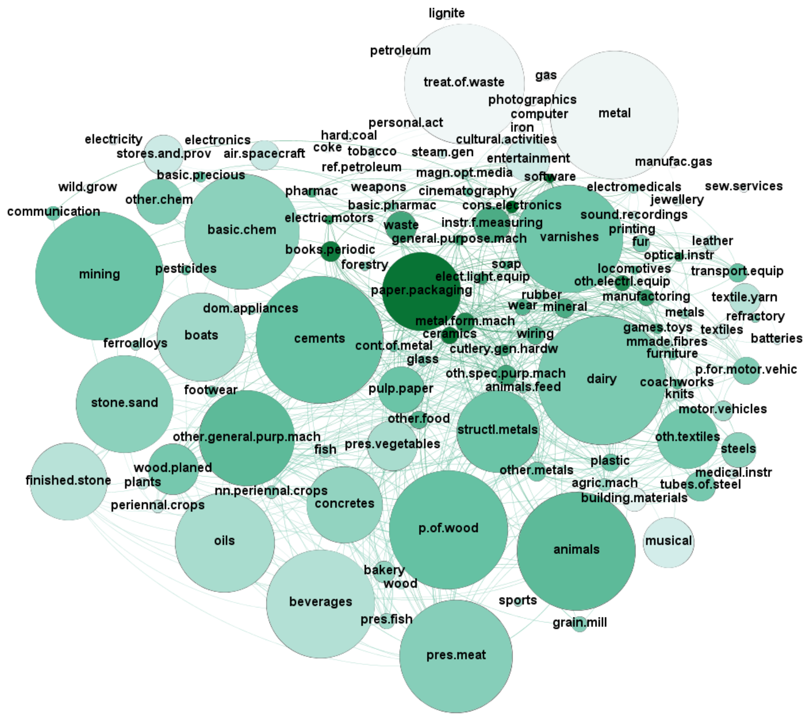

Figure 9. The Network Positioning for Sassari province using the PSP index

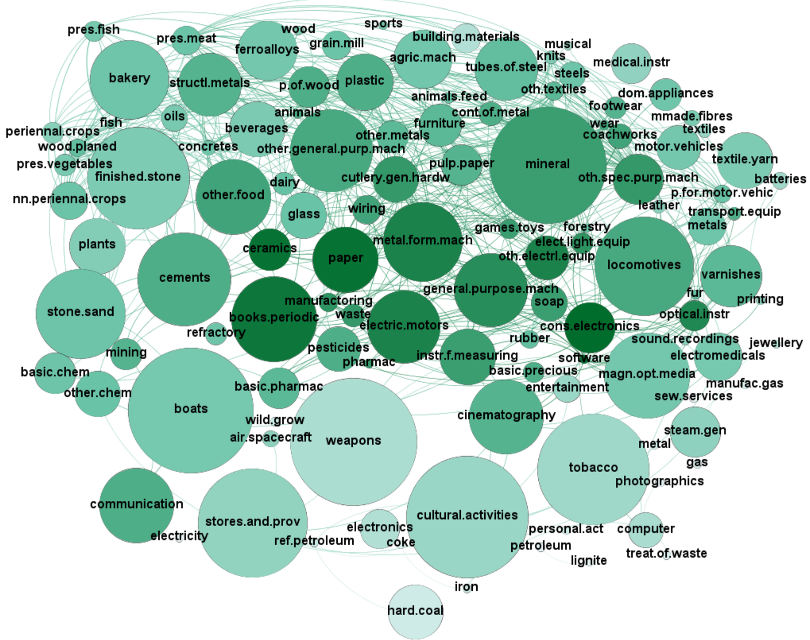

Figure 10. The Network Positioning for La Spezia province using the PSP index