International specialization and the export resilience of local economies: Italian provinces in the aftermath of the global crisis

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Abstract

This paper aims at better understanding the export performance of local economies during the global crisis, characterized by a slowdown of international trade and more intense competitive pressures.

After discussing the main concepts and statistical indicators regarding the relationship between industrial structure and export performance, the paper presents empirical evidence on Italian provinces, based on a detailed analysis of their international specialization patterns.

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1. Introduction

Motivation

Better understanding the relationship between international economic integration, risk and resilience at the local level

Initial assumptions

- Open local economies are exposed to higher risks of external shocks
- Under certain conditions, international economic integration reinforces the resilience of local economies, by spreading knowledge and improving their productive structure

The global crisis initiated in 2008 offers an important benchmark to assess the different resilience of local economies to a common external shock

Export performance after the 2009 trade collapse can be used to gauge the dynamic resilience of open local economies

Research questions

- Understanding why the resilience to the global crisis has been so different across local economies in Italy
- Exploring the linkages between international specialization and export performance after the crisis

Relevant literature

- Regional economic resilience (Fingleton et al., 2012; Augustin et al., 2013; Martin and Sunley, 2015; Brown and Greenbaum, 2016)
- Dynamic efficiency of international specialization patterns (Krugman, 1989; Thirlwall, 2011)

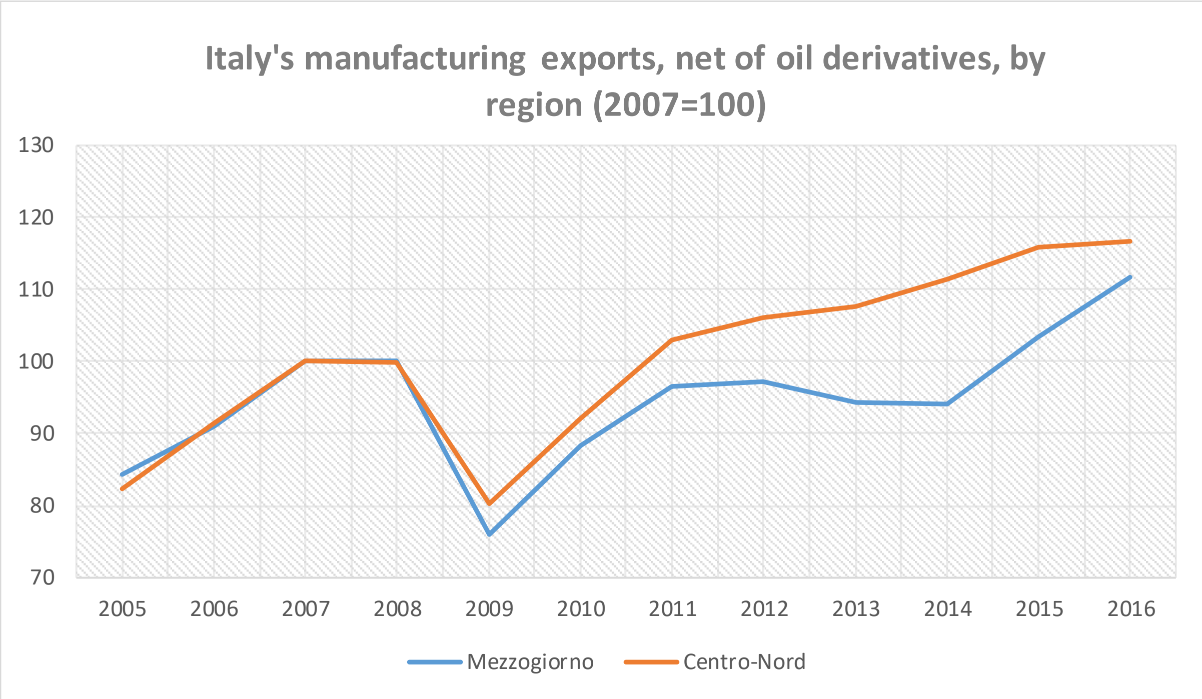
- Trade performance and specialization (Fagerberg and Sollie, 1987; Coughlin and Pollard, 2001; Memedovic and Iapadre, 2010)
- Structural diversification and regional growth (Boschma and Iammarino, 2009; Kemeny and Storper, 2015)
- International production and local development (Barba Navaretti and Venables, 2004; Giunta et al. 2012; Iammarino and McCann, 2013)

2. Export resilience and specialization patterns of local economies in Italy

2.1. Defining and measuring export resilience

The resilience of local economies to external shocks can be defined in two main ways. On one hand, it can be seen as their robustness against external disturbances (*static* resilience). Given a common exogenous shock, regions that are more resilient will suffer less for its negative impact. On the other hand, *dynamic* resilience can be defined as the reactivity of the local economy after the shock, i.e. the speed at which it returns to its previous activity levels.

The global economic crisis, which started in 2008, offers an important opportunity to assess the resilience of local economies to external shocks. The financial crisis originated in the US generated negative effects on economic activity, which spread simultaneously all over the world, bringing about an unprecedented collapse in international trade. According to IMF (2016), the volume of world trade in goods and services decelerated from a growth rate of 8 per cent in 2007 to 3 per cent in 2008 and fell by 10.5 per cent in 2009. The impact of the trade collapse was huge in almost every country, but was felt more heavily in more vulnerable economies, where the macro-economic shock compounded with the problems created by a long-standing exposure to the competitive pressure of international integration. This is particularly true in Italy, where the Mezzogiorno area was hurt more severely than the rest of the country (fig. 1). Local economies within each of the main Italian macro-regions have recorded different performances, and this paper is aimed at better understanding the determinants of this divergence, focussing on the role of structural factors, as revealed by export specialization patterns.



Source: Istat.

To this purpose, we measure static resilience as the change in each province's shares of Italian exports between 2007 and 2009, which shows the short-term impact of the crisis, and dynamic resilience as their change between 2009 and 2016, which measures their ability to recover from the crisis. Our data refers to manufacturing exports of Italian provinces at current prices, net of oil derivatives[1].

Figure 1 shows clearly that Mezzogiorno's export performance has been worse than that of the rest of Italy, both in terms of static and above all of dynamic resilience. The initial impact of the crisis was more severe in the Mezzogiorno and the subsequent recovery was slower. Indeed, the second wave of the recession, prompted by the sovereign debt crisis, translated into a fall of Mezzogiorno exports, so that in 2014 their value was still below its pre-crisis level. The quick recovery of the last two years, as we will see, is almost exclusively the result of automotive exports.

2.2. Trade performance and specialization: the dynamic efficiency of export specialization patterns

The analysis of trade performance is generally conducted only in macroeconomic terms. From an accounting perspective, the current account balance is equivalent to the difference between saving and investment (or between income and domestic demand). Its behaviour may thus be understood as the outcome of factors determining real wealth accumulation in the economy. Even when the analysis is concentrated on the trade balance, the dynamics of export and import volumes is often presented only as a function of other aggregate variables, such as real exchange rates and foreign or domestic income.

In many cases, however, models considering only macroeconomic fundamentals are inadequate to explain trade performances. These models overlook important, but difficult to quantify, underlying factors of international trade performance, such as product quality, shifts in consumer tastes, changes in international trade rules and a whole range of other structural factors defining foreign trade distribution by product or by country. For instance, assuming the growth of world demand and all other circumstances being equal, the dynamics of a country's exports will be influenced by the concordance between its international specialization pattern and changes in the product composition of world imports. In other words, if foreign

[1] Exports of oil derivatives have been detracted from total manufacturing exports, because of the high volatility of their relative prices.

demand grows more rapidly in products in which the country enjoys comparative advantages, the aggregate income elasticity of its exports will be higher and the external constraint to growth will be looser. In this case we may speak of *macroeconomic* or *dynamic efficiency* of a country's international specialization pattern.

The influence of these structural factors is more relevant than commonly understood and may sometimes override the effect of aggregate variables, such as price competitiveness. Differences in foreign trade structures between countries are therefore important determinants of their growth rates: international specialization patterns affect the income elasticity of exports and imports and so the intensity of the external constraint to growth. [2]

At the local level, the balance-of-payments constraint is not binding, as any trade deficit can easily be financed by surpluses in other regions of the same country. Yet, the dynamic efficiency of local specialization patterns is an important determinant of their export performance, as well as of their resilience to external shocks.

The relative importance of structural and competitiveness factors in determining trade performances can be established with the help of a statistical decomposition technique, known as 'constant-market-share analysis'. Several different specifications of this method have been experimented in the literature.[3] Here we use a simple formula, which allows to split the change of each province's aggregate share of Italian exports into three effects:

1) *Competitiveness effect (CE)*: it is the weighted average of the changes recorded by each province's share in each of the 86 sectors of the Italian export market. The weights are given by the relative size of each sector in the value of total Italian exports in the initial year. The term 'competitiveness' should be understood in a broad sense, encompassing the set of factors that may explain the relative success of the province's products in international markets. Therefore, CE is not an *ex ante* measure of their possible competitive advantage in terms of relative prices, but only a summary *ex post* measure of their relative export performance. While leaving open the question of identifying the factors that led to these results, this indicator gives better information than that offered by the simple change of the aggregate market share, because it cleans it from the influence of structural effects.

2) *Sector structure effect (SE)*: it is related to the interaction between the characteristics of the province's specialization pattern and changes in the sector distribution of Italian exports. In other words, it measures the change in the aggregate export market share which would result, if all the sector market shares remained unchanged (hence the name 'constant-market-share' analysis). Other things being equal, provinces that are specialized in relatively dynamic products will enjoy a higher SE (and a better trade performance) than provinces whose comparative advantages are concentrated in slow-growth products. So, this term can be interpreted as a measure of the dynamic efficiency of the province's export specialization pattern.

3) *Adaptation effect (AE)*: it is related to the interaction between changes in the province's sector market shares and changes of sector weights in Italian exports. This effect reveals the extent to which the province's specialization pattern adapts over time to structural changes in the market.

The formula used is as follows:

[2] The link between the income-elasticity of trade flows and the growth rate of an open economy was highlighted by Thirlwall (1979) and, with a different approach, by Krugman (1989). The hypothesis that international differences in such elasticity are essentially attributable to differences in the structure of foreign trade was advanced, among others, by Goldstein and Khan (1985).

[3] A survey of this literature is offered in Memedovic and Iapadre (2010), who propose a new specification and study the role of structural factors for trade performances. An interesting application to international trade data at sub-national level can be found in Coughlin and Pollard (2001).

$S^t – S^0 = CE + SE + AE$

$$= \sum_k \left(s_k^t - s_k^0\right) w_k^0 + \sum_k \left(w_k^t - w_k^0\right) s_k^0 + \sum_k \left(w_k^t - w_k^0\right)\left(s_k^t - s_k^0\right)$$

where:

S: province *i*'s market share of total Italian exports;
s_k: province *i*'s market share of Italian exports in sector *k;*
w_k: sector *k*'s weight on Italian exports;
and superscripts *0* and *t* refer respectively to the initial and final year chosen for the analysis.

The role played by structural factors in determining export performance may be better understood by further decomposing the CE effect, in the following way:[4]

$$SE = r_{SC} \sqrt{\sum_k \left(s_k^0 - \mu_s^0\right)^2} \sqrt{\sum_k \left(w_k^t - w_k^0\right)^2} \qquad [2]$$

in which: r_{SC} = linear correlation coefficient between a province's initial export market shares in each sector and the changes of sector weights in Italian exports;
s_k^0 = a province's initial export market share in sector *k*;
μ_s^0 = unweighted arithmetic mean of a province's initial sector market shares;
w_k^t = product *k*'s weight on Italian exports.

Equation [2] shows the sector structure effect as the product of three factors:

a) The degree of correlation between the sector structure of a province's market shares, which defines its specialization pattern, and the changes in the sector structure of Italian export demand.
b) An indicator of the variability of sector market shares around their mean or, in other terms, of the degree of *polarization* of the specialization pattern.
c) An indicator of the intensity of change in the structure of demand, as measured by the variation of sector weights in Italian exports.

Since the third factor is common to all exporting provinces, it is the first two that are decisive for differentiating each province's SE. More precisely, the sign of SE is established by the coefficient of correlation, while its size relative to other countries, depends on the intensity of the correlation and on the coefficient of comparative advantage polarization. In other words, for any given degree of correlation between the provinces' specialization patterns and the changes in the structure of export demand, the highest positive (or negative) SEs are recorded by those provinces whose specialization patterns are more differentiated between strong and weak points: the polarization of the specialization pattern amplifies the magnitude of the structure effect.
This index should not be confused with an indicator of concentration. Even provinces with a richly diversified export structure can have a relatively polarised specialization pattern, if the average intensity of their comparative advantages and disadvantages is high. On the other hand, a province with an export supply concentrated in a few number of products might show a low degree of polarization, if the product distribution of its comparative advantage indices does not show much variability. In general, however, relative polarization is negatively associated with the size of the province, as measured by its aggregate exports.

[4] See Memedovic and Iapadre (2010), who adapt to CSE an approach similar to that proposed by Fagerberg and Sollie (1987) for another term generated by the CMS decomposition.

2.3 CMS analysis of export resilience of Italian provinces (2009-16)

In this section, we present the results obtained from applying the CMS analysis described in section 2.2 to the study of Italian provinces' exports in the period 2009-16. The analysis is based on Istat data, classified by sector.[5] Table 1 refers to the first 15 provinces in terms of export value in 2009, which are all located in the Centre-North of Italy. Table 2 is limited to the first 15 exporting provinces in the Mezzogiorno.

Table 1 - The top 15 exporting provinces in Italy

Constant-market-share analysis of export performance (percentages at current prices)						
Provinces	**Market shares**		**Relative changes**	**Competitiveness (CE)**	**Sector structure (SE)**	**Adaptation (AE)**
	2009	**2016**	**2016-2009**			
Milano e Monza	13,20	11,89	-9,95	-9,88	-0,66	0,59
Torino	5,28	5,39	2,18	-2,70	5,63	-0,76
Vicenza	4,14	4,25	2,72	2,23	1,69	-1,19
Bergamo	3,61	3,62	0,43	4,08	-4,22	0,57
Brescia	3,59	3,65	1,73	4,58	-1,85	-1,01
Treviso	3,32	3,10	-6,66	-0,28	-5,00	-1,38
Bologna	3,06	3,26	6,37	6,38	0,10	-0,10
Modena	2,99	3,03	1,37	-4,32	6,37	-0,69
Varese	2,87	2,42	-15,46	-11,37	-4,80	0,71
Firenze	2,55	2,78	9,09	3,99	3,19	1,91
Verona	2,44	2,47	1,31	1,73	1,49	-1,91
Reggio Emilia	2,39	2,44	1,78	8,35	-4,52	-2,05
Padova	2,09	2,28	9,43	11,82	-1,85	-0,54
Cuneo	1,84	1,68	-8,86	-11,60	1,98	0,76
Roma	1,67	1,91	13,87	9,26	6,70	-2,09

Table 2 - The top 15 exporting provinces in the Mezzogiorno

Constant-market-share analysis of export performance (percentages at current prices)						
Provinces	**Market shares**		**Relative change**	**Competitiveness (CE)**	**Sector structure (SE)**	**Adaptation (AE)**
	2009	**2016**	**2016-2009**			
Napoli	1,50	1,30	-13,42	-12,00	3,27	-4,70
Chieti	1,21	1,49	22,91	0,98	15,74	6,19
Bari Foggia BAT	1,06	1,15	8,44	3,33	4,34	0,77
Salerno	0,66	0,55	-17,35	-13,31	-3,98	-0,05
Taranto	0,50	0,28	-44,74	-42,03	-8,32	5,62
Potenza	0,46	1,04	125,19	59,72	42,27	23,19
Caserta	0,33	0,27	-18,46	-17,12	-5,21	3,87
Teramo	0,31	0,31	-1,52	1,07	-2,68	0,09
Sardegna	0,29	0,18	-40,16	-39,99	-1,12	0,94
Avellino	0,29	0,26	-8,86	-8,22	11,72	-12,36
L'Aquila	0,26	0,14	-47,82	-44,91	0,07	-2,98

[5] We consider 86 sectors at the three-digit level of the national ATECO classification.

Brindisi	0,24	0,24	-0,92	1,30	-2,05	-0,16
Catania	0,17	0,23	32,35	35,60	-4,85	1,60
Siracusa	0,16	0,15	-9,89	-10,42	-0,26	0,79
Pescara	0,15	0,14	-5,14	-6,89	-0,11	1,86
	7,60	7,71				

Broadly speaking, it can be said that differences in export resilience do not follow strictly the divide between Centre-North and Southern Italy (Mezzogiorno), which emerges from figure 1. Although most of the provinces that enlarged their shares of Italian exports are located in the Centre-North, there are some relevant exceptions, such as Chieti, Bari-Foggia-BAT, Potenza and Catania. On the other hand, several important Centre-North provinces rank among the worst performing Italian provinces, including Milan-Monza, whose share of Italian exports fell from 13.2 to 11.9 per cent.

Constant-market-shares analysis confirms that these market share changes are strongly influenced by competitiveness factors. Their sign coincides with the sign of the *competitiveness effect* (CE) in 90 out of 99 provinces[6], and CE makes up for a very high percentage of the total share variations (126 per cent on average, expressed in their absolute value). However, the structure and adaptation effects amount respectively to 77 and 28 per cent of the average share variations. So, the prevalence of CE is also due to the contrasting signs of the other terms.

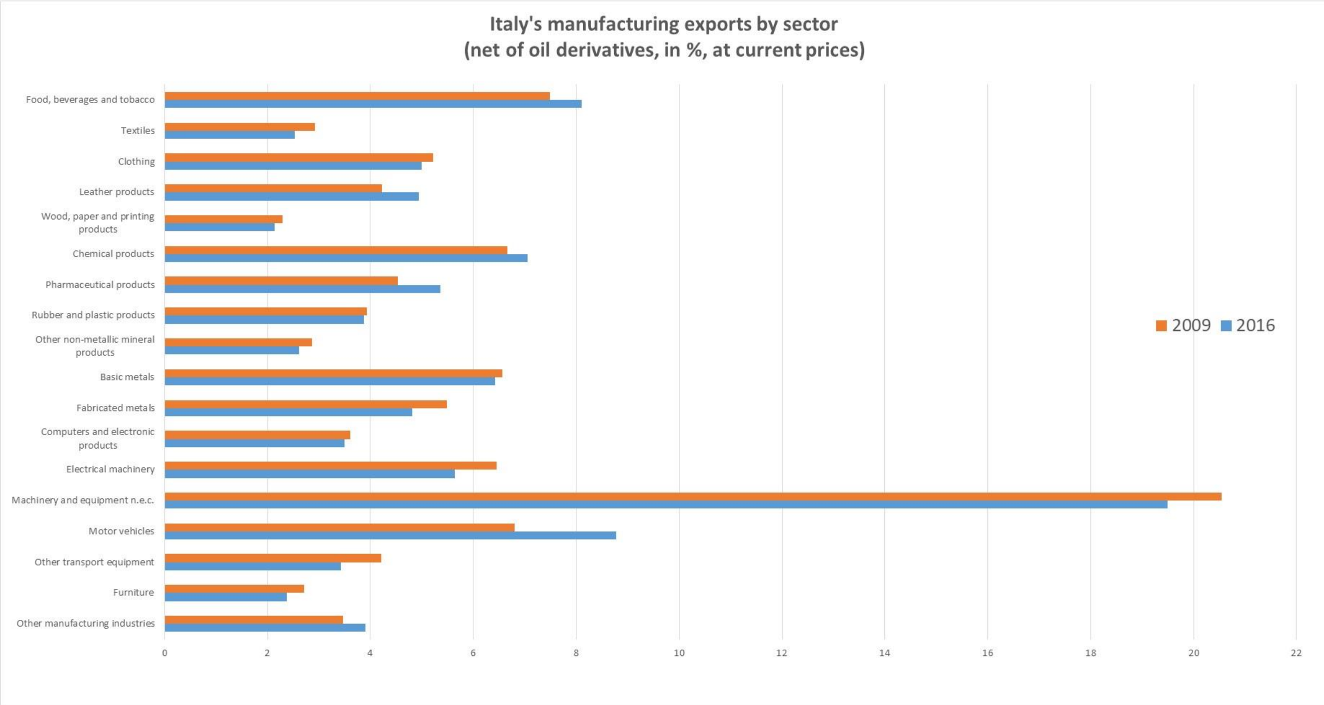
As argued earlier, CE is not an *ex-ante* measure of a country's export competitive capacity, but an *ex-post* indicator of its competitive performance at the disaggregated level. CE measures what would have been the change of the country's aggregate export share, in the absence of composition effects, that is under the assumption that the distribution of Italian export demand had remained unchanged. In other words, CE allows measuring to what extent changes in a province's aggregate export market share reflect its average competitive performance in each sector. This can be the result not only of *ex-ante* competitiveness variables, such as price and quality, but also of other factors affecting export performance, such as the province's capacity to attract FDI or participate in international production fragmentation.

Besides CE, the *sector structure effect* plays an important and sometimes decisive role in provincial market share behaviour. In some cases, it substantially strengthens a CE of the same sign, such as for the gains of Florence and Rome, or of Bari, Chieti and Potenza, as well as for the losses of Treviso and Varese, or of Caserta, Salerno and Taranto. In other cases such as Brescia and Reggio Emilia, or Naples, it lessens considerably its influence. There are even cases, such as Turin and Modena, or Teramo and Brindisi, in which the size of the structure effect is so large to overturn the CE, showing thus to be determinant for the evolution of export market shares.

As already argued, the *sector structure effect* (SE) measures the effect on aggregate market share changes of the correlation between a province's export specialization pattern and trends in the sector structure of Italian export demand. Provinces whose comparative advantages are concentrated in products in which Italian exports grow more rapidly would be favoured by this effect, even if their market shares remained constant over time for every sector. This is what we mean by 'dynamic efficiency' of the export specialization pattern.

To interpret this term, the evolution of Italian exports structure by commodity must be looked at. To this purpose, we converted and aggregated the product level data by industries, according to the two-digit ATECO classification. Figure 2 portrays the main results. It is clear that the structural evolution of Italian exports has changed significantly during the crisis. The most dynamic sectors have been motor vehicles and the pharmaceutical industry, that is two sectors which do not belong to the set of traditional comparative advantage productions of the Italian economy. On the other hand, the machinery industry and most of the *Made in Italy* consumption good productions (with the exceptions of the food industry and leather products) have undergone a decline in their relative importance.

[6] For lack of comparable data over time, some provinces have been aggregated into larger areas (Ascoli-Fermo, Bari-Foggia-Barletta-Andria-Trani, Milano-Monza, Sardinia).



This general picture is useful to understand the different results recorded by Italian provinces in terms of sector structure effect. Using as a threshold a minimum level of 10 per cent for the ratio between *SE* and the initial market share (in 2009), eight provinces emerge (Potenza, Frosinone, Chieti, Siena, Latina, Avellino, Arezzo, Belluno). With the exception of the latter one, they are all located in Central or Southern Italy. Most of them are specialized in the automotive and/or in the pharmaceutical industries, which have been the most dynamic sectors of Italian exports during the crisis.

As shown in section 2.2, given the variation in the structure of foreign demand, the dynamic efficiency of the export specialization pattern, measured by *SE*, is the product of two factors, namely the correlation between a province's export specialization pattern and changes in the composition of demand (r_{SC}) and the degree of *polarization* of the specialization pattern (*POL*). The data show that the first factor is dominant (the correlation between *SE* and r_{SC} is equal to 0.92).

Table 3 – Dynamic efficiency of specialization patterns in the top 15 exporting provinces in Italy

Determinants of the sector structure effect, 2009-2016 (percentages at current prices)				
Provinces	**Average market share 2009**	**Relative SE**	**Correlation between specialization and structural change**	**Relative polarization**
Milano e Monza	13,20	-0,66	-3,74	6,91
Torino	5,28	5,63	23,58	9,33
Vicenza	4,14	1,69	5,91	11,14
Bergamo	3,61	-4,22	-13,12	12,58
Brescia	3,59	-1,85	-7,05	10,23
Treviso	3,32	-5,00	-14,19	13,76
Bologna	3,06	0,10	0,50	7,46
Modena	2,99	6,37	12,78	19,49
Varese	2,87	-4,80	-10,48	17,92
Firenze	2,55	3,19	8,87	14,07
Verona	2,44	1,49	2,58	22,60
Reggio Emilia	2,39	-4,52	-13,61	13,00
Padova	2,09	-1,85	-10,19	7,10
Cuneo	1,84	1,98	3,55	21,82
Roma	1,67	6,70	14,20	18,46

Table 4 - Dynamic efficiency of specialization patterns in the top 15 exporting provinces in Mezzogiorno

Determinants of the sector structure effect, 2009-2016 (percentages at current prices)				
Provinces	**Average market share 2009**	**Relative SE**	**Correlation between specialization and structural change**	**Relative polarization**
Napoli	1,50	3,27	9,53	13,42
Chieti	1,21	15,74	37,03	16,62
Bari Foggia Bat	1,06	4,34	16,00	11,44
Salerno	0,66	-3,98	-2,74	56,89
Taranto	0,50	-8,32	-12,00	27,11
Potenza	0,46	42,27	69,82	23,67
Caserta	0,33	-5,21	-6,23	32,68
Teramo	0,31	-2,68	-4,72	22,22
Sardegna	0,29	-1,12	-1,45	29,96
Avellino	0,29	11,72	16,29	28,13
L'Aquila	0,26	0,07	0,05	55,51
Brindisi	0,24	-2,05	-4,19	19,16
Catania	0,17	-4,85	-2,58	73,44
Siracusa	0,16	-0,26	-0,20	49,59
Pescara	0,15	-0,11	-0,38	10,97

The polarization coefficient acts as a multiplier of correlation. So, for example, Belluno and Florence share a similar level of r_{SC} (respectively 0.089 and 0.085), but Belluno's specialization pattern is much more polarized than that of Florence and, as a result, its relative *SE* (10 per cent of the initial share) is much larger than in Florence (3 per cent). Normally, the polarization of specialization is inversely correlated with the size of the province, as measured e.g. by total employment (the correlation coefficient is -0.3). Smaller provinces tend to have more intense comparative advantages and disadvantages, as their export structure is less diversified.

As already argued, although significant, *SE* has played a relatively minor role in export performance of Italian provinces. There are only 21 provinces out of 99, in which the relative size of *SE* has been larger than the competitiveness effect (both taken in their absolute value). So, the rest of this paper will focus on other structural factors that can help understand differences in export performances across Italian provinces.

3. Export competitiveness and specialization of Italian provinces

In the previous section, we have shown that differences in export performance across Italian provinces during the global crisis have mostly been the result of the set of macroeconomic and structural factors affecting their competitiveness, even if the dynamic efficiency of their specialization pattern has played a significant role.

By definition, macroeconomic factors, such as the real exchange rate, tend to affect all local economies and cannot be used to explain their relative performances. On the other hand, differences in the structural features of local specialization patterns can be an important determinant of export performances, and help understand differences in local resilience to external shocks.

In order to investigate this relationship, we start from defining a new indicator of revealed comparative advantages (RCA) in exports, overcoming the main statistical limitations of the well-known Balassa RCA index. We then discuss the main indicators used to measure several relevant features defining the quality of export specialization.

Finally, we apply these indices to the exports of Italian provinces, in order to check if differences in their resilience after the global crisis can be related to the quality of their specialization.

3.1. A new measure of revealed comparative advantages

We explore the relationship between trade resilience and some structural features of local economies, as revealed by their export specialization patterns.

In order to perform our analysis, we adopt an indicator of export specialization, which is based on the Balassa (1965) index of revealed comparative advantages, but overcomes its statistical problems[7]. Since our interest is in understanding the structural determinants of local trade resilience, we use our indicator to measure export specialization of each Italian province with respect to the rest of the country.

In its simplest form, the Balassa RCA index of province *i* in product k (RCA_{ik}) is equal to the ratio between the product's share of province *i*'s exports (S_{ik}) and the product's share of Italian exports (W_{ik}):

$$RCA_{ik} = S_{ik}/W_{ik} = (x_{ik}/x_{i.})/(x_{.k}/x_{..}) \qquad [\ 1\ ]$$

where:

x_{ik} : province *i*'s exports of product k.

$x_{i.}$: province *i*'s total exports.

$x_{.k}$: Italian exports of product k.

$x_{..}$: Italian total exports

This index is equal to one if the province does not reveal a comparative advantage, nor a disadvantage, in product k (product neutrality). On the contrary, if a province's RCA index is higher than one, it can be said that its exports are 'specialized', i.e. relatively more oriented, in product k.

The traditional Balassa RCA index is characterized by at least three uncomfortable features, which limit its interpretability and usefulness:

a) *range variability*: the maximum value of the index is not invariant across provinces and products;
b) *range asymmetry* with respect to the threshold value of one;
c) *dynamic ambiguity*: possible sign concordance between the changes of the index across products.

The next sub-sections will be devoted to the analysis of these problems, and point to a possible solution for each of them.

a) Range variability

Looking at [1], it is easy to see that the actual range of values assumed by the RCA index is influenced by the size of the statistical unit, as measured by the total value of the province's exports, as well as by the value of Italian exports of product k. In fact, whilst in the extreme case of no export flows the RCA index is equal to zero for any province and product, its maximum value, which is reached in the opposite case, when all Italian exports of product k are concentrated in one province, which does not export any other product, is not invariant across provinces and products. More precisely, it can be shown that:

$$Max\ (RCA_{ik}) = Min\ \{(X_{..}/X_{.k}),\ (X_{..}/X_{i.})\} \qquad [\ 2\ ]$$

In other words, the RCA index ranges from zero (no provincial exports of product k) to a maximum value (all exports are concentrated in product k, which is not exported by any other province), which is the higher, the smaller the province's total exports and Italian exports of product k. This range variability problem implies

[7] Our RCA index is conceptually equivalent to the index of revealed trade preferences proposed in Iapadre and Tironi (2009) in order to analyse the geographic distribution of trade.

that indices computed for different provinces and/or products are not easily comparable among each other, nor over time.[8]
A possible solution for this problem consists in changing the denominator of the RCA index, by substituting the product's weight in Italian exports with the product's weight in the trade of the *rest* of Italy (V_{ik}), which is equal to zero in the limiting case of a province being the only exporter of product k. The result could be called *homogeneous index of RCA* ($HRCA_{ik}$):

$$HRCA_{ik} = S_{ik}/V_{ik} = (x_{ik}/x_{i.})/[(x_{.k} - x_{ik})/ (x_{..} - x_{i.})] \qquad [3]$$

The threshold value of this index, in the case of product neutrality, is equal to one, not differently from its traditional Balassa formulation, but its range goes now from zero (no provincial exports of product k) to infinity (province *i* is the only exporter of product k), independently of the province's and of the product's size.

b) Range asymmetry

The second problem of the RCA index, in both the formulations discussed so far, is that its range is not symmetric around the product neutrality threshold. More precisely, in the case of comparative disadvantage, the RCA index ranges only from zero to one, whilst it goes from one to infinity in the homogeneous formulation, and from one to a number which is normally much higher than two in the traditional Balassa formulation, in the case of comparative advantage.
This problem may give rise to biased assessments of the index changes, depending on whether they occur above or below the neutrality threshold. In addition, it may create problems in econometric estimates involving the index.
One possible solution for the asymmetry problem consists in applying to the homogeneous index the transformation proposed by Dalum, Laursen and Villumsen (1998) for the Balassa index, which yields the following *symmetric index of RCA* ($SRCA_{ik}$):

$$SRCA_{ik} = (HRCA_{ik} – 1) / (HRCA_{ik} + 1) = (S_{ik} – V_{ik}) / (S_{ik} + V_{ik}) \qquad [4]$$

This index ranges from minus one (no exports) to one (export monopoly), and is equal to zero in the case of neutrality.[9] It is therefore a standardized transformation of the RCA index, which allows proper cross-province comparisons.

c) Dynamic ambiguity

The concept of specialization implies a transfer of production factors from comparative disadvantage to comparative advantage sectors, so that, in a two-good model, specialization in product 1 implies comparative disadvantage in product 2, and a rise in an index of specialization in product 1 is equivalent to a fall of the same index in product 2.
In a two-good framework, we can define the complementary indicators of the three intensity indices discussed in the previous sub-sections as follows:

$$RCA_{i2} = (1 – S_{i1}) /(1 – W_{i1}) \qquad [5]$$
$$HRCA_{i2} = (1 – S_{i1}) /(1 – V_{i1}) \qquad [6]$$
$$SRCA_{i2} = (HRCA_{i2} – 1) /(HRCA_{i2} + 1) \qquad [7]$$

[8] At first sight, the solution for this problem could appear to divide the RCA index by its maximum value. However, the result of this normalization would simply be equal to the product's weight in provincial exports, or to the province's share of product k's Italian exports, depending on which is the binding constraint in equation [2].
[9] Similar properties are shown by the hyperbolic tangent of the natural logarithm of the RCA index, proposed by Jungmittag, Grupp and Hullmann (1998) as a substitute for the Balassa formulation.

Unfortunately, all the three couples of RCA indices are afflicted by a common problem: the change of the RCA index in product 1, although having usually opposite sign than that in product 2, does sometimes take the same sign, which makes it difficult to interpret the dynamics of the indicators.
More precisely, it can be shown that, if $RCA_{i1} \neq RCA_{i2}$, i.e. if comparative advantage exists, and if the ratio between the changes of S_{i1} and W_{i1} lies in the interval between RCA_{i1} and RCA_{i2}, the two complementary indices change in the same direction (*condition of sign concordance*). For example, assuming that province *i* has a comparative advantage in product 1:

If: $RCA_{i2} < \Delta S_{i1}/\Delta W_{i1} < RCA_{i1}$, [8]
then: $\Delta RCA_{i1} \cdot \Delta RCA_{i2} > 0$

and, more precisely, if the sign concordance condition holds, and $\Delta W_{i1} > 0$, then $\Delta RCA_{i1} < 0$ and $\Delta RCA_{i2} < 0$; on the contrary, if under the same condition, $\Delta W_{i1} < 0$, then $\Delta RCA_{i1} > 0$ and $\Delta RCA_{i2} > 0$.
In other words, under condition [8], if product 1's exports are relatively dynamic, in the sense that their weight in Italian exports increases, RCA indices decrease for both products. On the contrary, if product 1's foreign demand is relatively slow, the two complementary RCA indices increase. For example, with reference to the latter case, the increase of RCA_{i1} is due to the fact that the product's weight in provincial exports (S_{i1}) falls at a lower rate than its weight in Italian exports (W_{i1}), whilst the increase of RCA_{i2} results from a rise of (S_{i2}) which is relatively larger than the increase of W_{i2}.
These results hold also for the homogeneous and symmetric versions of the RCA index. It should be noted that the range of values of $\Delta S_{i1}/\Delta W_{i1}$ for which the complementary indices change in the same direction is equal to the difference between their levels, which means that, other things being equal, the probability of obtaining results that are dynamically ambiguous is higher when RCA is either very high or very low. When both the RCA indices show a simultaneous increase (or fall), it is in any case difficult to interpret the data, because the first index seems to contradict the second, and vice versa.[10]

d) A new relative RCA index

In order to solve the dynamic ambiguity problem, one could make use of the ratio between the two complementary RCA indices, which shows synthetically if RCA in product 1 is growing more or less rapidly than in product 2. However, the resulting indicators of *relative* RCA would suffer from the same problems of range variability and asymmetry discussed for their absolute versions.
A comprehensive solution of the three problems affecting the Balassa index can be given by a *relative export specialization index* (*RXS*), defined as follows:

$$RXS_{ik} = (HRCA_{ik} - HRCA_{i(-k)})/(HRCA_{ik} + HRCA_{i(-k)}) \quad [9]$$

where $HRCA_{i(-k)}$ is the homogeneous complementary RCA index computed for the aggregate of all products except *k.*
It is easy to see that our *RXS* index is homogeneous and symmetric, since it ranges from minus one to one, passing through the neutrality threshold of zero. Moreover, it is not affected by the dynamic ambiguity problem, because, by definition, $RXS_{ik} = - RXS_{i(-k)}$.
Of course, our *RXS* index, similarly to the Balassa RCA index, can give only an *ex-post* evaluation of the intensity of export specialization, without pretending to give any *ex-ante* assessment of the underlying comparative advantages.

[10] The problem of dynamic ambiguity can emerge even when the number of products is higher than 2, leading to a simultaneous increase (or decrease) of specialization in every product. More generally, it can emerge for any number of products, if the RCA index in product k is compared to the complementary RCA index computed for the aggregate of all products except *k.*

3.2. The quality of export specialization

We now discuss some structural characteristics of export specialization patterns, which can affect export competitiveness and performance at the local level, focussing on the main statistical indicators used to measure such qualitative properties of specialization.

In this paper, we consider several aspects defining the quality of local specialization, including:

- Concentration and polarization
- Related variety
- Product complexity
- Technological intensity
- Presence of multinational enterprises

3.2.1. Concentration and polarization

If the structure of a local economy relies heavily on a limited number of products, this concentration can increase its vulnerability to external shocks.

This theme has often been raised in the debate about the integration of developing countries into the world trading system. In particular, countries that are strongly specialized in the production of raw materials are exposed to the high volatility of their prices.

More generally, if an economy's productive structure is concentrated in few sectors, its reactivity to changes in the composition of external demand will be higher. The aggregate impact of a sector shock will be stronger, the more important the sector is for the local economy.

This theme has been discussed in the debate on international monetary integration. Kenen (1969) pointed out that the costs of monetary integration, as highlighted by the theory of optimum currency areas, are lower for countries characterised by a more diversified export structure, because this reduces the probability of an adverse asymmetric shock and dampens its impact.

We measure the concentration of local specialization patterns in several ways:

1) Number of comparative advantage sectors, i.e. the number of sectors in which our RXS index is positive

2) Export concentration

In the empirical trade literature the concentration of exports across different products or markets is generally measured through the Herfindahl-Hirschmann index (H_i):

$$H_i = \sqrt{\sum_k \left(x_{ik} / \sum_k x_{ik} \right)^2} \qquad [10]$$

This index is dependent on the number of products considered in the distribution More precisely, H_i is equal to 1/n when all the *n* products have the same weight in terms of export value, reaching a maximum level of 1 if exports are concentrated in only one product. So, we prefer its normalised version, which is as follows:

$$NH_i = (H_i - 1/n)/(1 - 1/n) \qquad [11]$$

$$0 \leq NH_i \leq 1$$

3) Export dissimilarity

Both variants of the Herfindahl-Hirschmann index are based on a comparison between the actual distribution of data and an abstract benchmark of equi-distribution across the statistical units of observation. This benchmark can be reasonable, when the index is applied to individual families or firms, but may be

questioned when the index is used to study the concentration of a distribution across statistical units that are inherently different in terms of size, such as sectors or partner countries. Given that sector boundaries in trade classifications are not aimed at identifying units of comparable size, there is no a priori reason to expect that exports of a large sector, such as automobiles, have the same weight than those of a small sector, such as musical instruments.

An alternative approach, which does not refer to the equi-distribution benchmark, is based on the linkage between the concepts of concentration and specialization. Local economies tend to concentrate their productive resources in their sectors of comparative advantage, so that their export structure tends to differentiate from the average of other localities.

This view can also be discerned in the debate on optimum currency areas, where the Kenen criterion can be interpreted in a slightly different way than in the previous sub-section. An economy's vulnerability to external shocks can be related not so much to the absolute degree of concentration of its productive structure, as to its degree of dissimilarity with respect to the partner economies. For any given level of concentration, a sector shock will affect mostly those local economies that are specialized in the sector hit by the shock. So, if productive structures are similar across regions, any sector shock will not be asymmetric, as it will hurt all local economies in a similar way. On the contrary, a strong dissimilarity with respect to the rest of the country exposes the local economy to higher risks of idiosyncratic shocks.

A simple way to measure the dissimilarity of export structures across provinces is offered by the Finger-Kreinin index (FK_i), which is as follows:

$$FK_i = ½ \Sigma_k \, |(x_{ik} / x_{i.}) – [(x_{.k} - x_{ik})/(x_{..} - x_{i.})]| \qquad [12]$$

$$0 \leq FK_i \leq 1$$

This index is null if a province's export structure by products is exactly equal to the national average and ranges up to a maximum of one, which is reached when a given product is the only export item of only one province in the country (perfect concentration *and* dissimilarity).

4) RCA polarization

In section 2, we showed that the dynamic efficiency of export specialization patterns, as measured by the commodity-structure effect identified by CMS analysis, depends on three different factors, including an index of export polarization, given by the dispersion of each province's market shares across products.

A similar index of polarization can be defined also for export specialization patterns. With reference to our new RCA indicators, the corresponding polarization index is as follows:

$$POL_i = \Sigma_k \, |RXS_{ik} \, (x_{ik} / x_{i.})| \qquad [13]$$

In other words, polarization is measured as the weighted average of RCA indices, taken in their absolute value.

As already underlined, this index should not be confused with a measure of concentration. Rather, it can be seen as a measure of the average intensity of comparative advantages and disadvantages. Two provinces with the same degree of export concentration can have different degrees of polarization, if they differ in their degree of specialization across products. However, the two concepts are interrelated and the corresponding indicators tend to be strongly correlated between each other.

3.2.2. Related and unrelated variety

The concept of variety has been recently used in many studies aimed at investigating the determinants of growth differences across different territories. The underlying idea is that innovation and growth can be favoured by technological and cognitive externalities among sectors (so-called Jacobs externalities). So, other

things being equal, an economy characterized by a relatively large presence of *related* sectors grows more rapidly than a strongly specialised economy, as well as than a diversified economy, which however is oriented towards reciprocally *unrelated* sectors.

This concept is difficult to operationalize. In principle, assessing linkages among sectors would require detailed information about their production functions. Even the use of input-output tables would not be enough to ascertain the presence of cognitive spillovers, which often go beyond supply-and-use linkages.

A widely used indicator is based on the concept of entropy (Theil, 1972), and has been applied to the study of specialization patterns by Frenken et al. (2007). The driving idea is that Jacobs externalities emerge more easily among related productions *within* each sector, rather than *between* different and unrelated sectors.

So, unrelated variety is measured by the Theil entropy index between different sectors (k):

$$UV = \Sigma_k w_k \log_2(1/w_k) \qquad [14]$$

On the other hand, related variety is measured by a similar index computed between different products (p) within each sector, and its aggregate measure for each economy is given by the weighted average of the sector indicators:

$$RV = \Sigma_k w_k V_k$$

where: $V_k = \Sigma_p w_{pk} \log_2(1/w_{pk})$ [15]

$w_{pk} = x_{ip}/x_{ik}$

$w_k = x_{ik}/x_{i.}$

The properties of the Theil entropy index ensure that total variety across products is equal to the sum of related and unrelated variety.

The heuristic power of these indices is strongly affected by the quality of the available statistical classification, and particularly by the reliability of the distinction between products and sectors.

Leaving this problem aside, it should be stressed that, by construction, the entropy index is a measure of diversification. So, it is an inverse function of the degree of concentration and its maximum corresponds to the case in which all the statistical units (products or sectors) have the same weight (equi-distribution). As already argued in our discussion of the Herfindahl-Hirschmann index, the equi-distribution benchmark appears as unreasonable when the size of the statistical units of observation is intrinsically different.

So, like in the case of concentration, a different approach could be useful also to study diversification. The starting point could be, even in this case, a comparison between each province's export distribution and their average. If a province's within-sector entropy is higher than the national average, this gap can be used to detect and measure related variety. So, our relative measures of related and unrelated variety are as follows:

$$RUV_i = (UV_i - UV^*)/(UV_i + UV^*) \qquad [16]$$

$$RRV_i = (RV_i - RV^*)/(RV_i + RV^*) \qquad [17]$$

where the * refers to the arithmetic mean of the two indicators across provinces.

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3.3. Export specialization patterns of Italian provinces

We present here the results obtained by applying some of the descriptive indicators discussed in section 3.2 to the export specialization patterns of Italian provinces. The next step of our research project will be an econometric exercise, aimed at assessing to what extent the different features of export specialization can explain the trade performance of Italian provinces, as measured by the competitiveness effect identified by the CMS analysis presented in section 2.

Table 5 abd 6 refer to the top 15 exporting provinces in Italy and in the Mezzogiorno and show six indicators measuring different, although interrelated, properties of their patterns of specialization.

The first one is the number of revealed comparative advantage sectors, i.e. the number of sectors in which the RCA index of equation [9] is positive. This can be seen as a simple measure of diversification, which however does not consider the intensity of specialization. It is positively correlated (0.51) with the size of the province, expressed in terms of export value.

The average intensity of comparative advantages and disadvantages is measured by the index of RCA polarization (equation [13]), which is negatively correlated (-0.88) with the previous indicator, as normally the intensity of specialization can be high only if it is concentrated in a relatively low number of sectors.

A related but distinct concept is the concentration of the export distribution across sectors, as measured by the Herfindahl-Hirschmann index (equation [11]), which is also negatively related to the size of the province (-0.31), but positively to the polarization of the model (0.79).

Concentrated and/or polarized export structures at the local level tend also to be dissimilar from each other, as well as from the national average. The Finger-Kreinin dissimilarity index (equation [12]) is therefore positively correlated to the two previous ones and negatively (-0.57) to the size of the province.

The last two columns refer to our particular specification of unrelated and related variety indices, in terms of relative differences with respect to their average across provinces. By construction, the underlying entropy indices tend to fall with the degree of concentration of the corresponding between- and within-sector distributions. So, both indicators are positively correlated (respectively 0.27 and 0.37) with the province’s size.

Table 5 – Export specialization in the top 15 exporting provinces in Italy

Structural features of export specialization							
Province	Market share 2009	Number of RCA sectors	Polarization of RCA indices	Normalized Herfindahl-Hirschmann index	Finger-Kreinin dissimilarity from national average	Relative unrelated variety	Relative related variety
Milano-Monza	13,200	38	0,224	0,020	0,230	0,108	0,221
Torino	5,279	21	0,439	0,078	0,430	0,020	0,129
Vicenza	4,137	24	0,355	0,036	0,349	0,064	0,205
Bergamo	3,606	30	0,338	0,031	0,366	0,097	0,163
Brescia	3,592	21	0,388	0,049	0,390	0,044	0,194
Treviso	3,320	25	0,427	0,044	0,442	0,084	0,140
Bologna	3,061	21	0,316	0,058	0,338	0,056	0,134
Modena	2,986	16	0,481	0,077	0,480	0,073	-0,003
Varese	2,867	25	0,351	0,037	0,349	0,107	0,078
Firenze	2,551	22	0,507	0,075	0,486	-0,002	0,087
Verona	2,439	28	0,377	0,026	0,356	0,105	0,190
Reggio Emilia	2,393	20	0,445	0,059	0,461	0,052	0,105
Padova	2,088	27	0,268	0,038	0,297	0,094	0,173
Cuneo	1,839	31	0,483	0,037	0,483	0,061	0,166
Roma	1,673	25	0,475	0,046	0,450	0,074	0,159

Table 5 – Export specialization in the top 15 exporting provinces in the Mezzogiorno

Structural features of export specialization							
Province	Market share 2009	Number of RCA sectors	Polarization of RCA indices	Normalized Herfindahl-Hirschmann index	Finger-Kreinin dissimilarity from national average	Relative unrelated variety	Relative related variety
Napoli	1,503	21	0,562	0,070	0,551	0,090	0,051
Chieti	1,211	10	0,653	0,269	0,610	-0,015	-0,092
Bari Foggia BAT	1,063	21	0,453	0,062	0,463	0,086	-0,081
Salerno	0,660	13	0,644	0,193	0,601	-0,073	-0,221
Taranto	0,501	4	0,867	0,410	0,814	-0,252	-0,262
Potenza	0,464	5	0,884	0,703	0,834	-0,538	-0,656
Caserta	0,329	12	0,686	0,158	0,668	0,097	-0,149
Teramo	0,313	31	0,447	0,036	0,489	0,123	0,114
Sardegna	0,293	12	0,732	0,230	0,708	0,014	-0,152
Avellino	0,285	19	0,638	0,170	0,622	0,075	-0,002
L'Aquila	0,259	13	0,757	0,186	0,752	-0,008	-0,431
Brindisi	0,244	13	0,752	0,235	0,720	0,012	-0,386
Catania	0,171	13	0,791	0,285	0,762	-0,085	-0,078
Siracusa	0,164	5	0,921	0,425	0,908	-0,502	-0,215
Pescara	0,146	22	0,460	0,097	0,460	0,082	0,012

We have started our exploration of the linkages between export resilience during the global crisis at the province level and the structural features of their specialization, by regressing the competitiveness effect generated by our CMS analysis against each of the indicators shown in the previous two tables. In each estimate, we have controlled for the effect of province size, as measured by the total number of employees.

All the indicators have been normalized by dividing their difference with respect to their minimum level by the range between the maximum and the minimum. At this stage, we have performed simple cross-section OLS regressions for our 99 provinces, without addressing the problems of spatial autocorrelation.

The estimates are significant at the 5% level only for the polarization of comparative advantages, which seems to affect negatively export performance, and for the dissimilarity from the national average, which seems to exert a positive influence. Related variety also appears to sustain export competitive performance, but its coefficient is significant only at the 10% level. In all regression, as expected, the coefficient for the size of the province is negative and significant.

NORMDRES	Coef.	Std. Err.	t	P>|t|
NORMEMPL	-.4729762	.0833084	-5.68	0.000
NORMRPOL	-.133056	.0515637	-2.58	0.011
_cons	.9200786	.0350421	26.26	0.000

NORMDRES	Coef.	Std. Err.	t	P>|t|
NORMEMPL	-.4787313	.0851474	-5.62	0.000
NORMFK	.1420016	.05575	2.55	0.012
_cons	.7824834	.0239755	32.64	0.000

NORMDRES	Coef.	Std. Err.	t	P>|t|
NORMEMPL	-.4030907	.0750702	-5.37	0.000
NORMRRV2	.0924979	.0506982	1.82	0.071
_cons	.7758918	.0347556	22.32	0.000

Clearly this is only a preliminary step of our exploration, and we still need to address the problem of a sound specification of our estimates.

4. Conclusions

Future research

- Econometric estimates of the relationships between international specialization and export performance at the local level
- Controlling for other local conditions, e.g.:
  - Industrial districts
  - Urban systems
  - Social capital
  - Infrastructures
- Controlling for inter-regional effects

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