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INNOVATION AND GROWTH.
EVIDENCES FROM ITALIAN REGIONAL SYSTEMS

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ABSTRACT

The role of innovations for a global competition, as well as their influence upon the economic growth, has gradually increased the interest for this subject, both from an economic and from a political point of view. Basing on the existing literature, this paper aims at measuring and describing the innovative capability of Italian regional systems, so as to improve the comprehension of this phenomenon as well as of its effects.

Plenty of input, output and context conditions are considered, since the systemic nature of innovation requires a simultaneous analysis of all possible variables, actors and relationships involved. About a hundred of indicators are selected and used to create synthetic measures about innovation and regional economic development. Best practices are pointed out, paying attention to their score, internal composition and sustainability.

Not only the intensity but also the nature of the relationship between innovation input and output and between innovation and economic growth is studied by means of independence and interdependence indicators, as well as through the application of regression models.

KEYWORDS: local development, regional innovation systems, statistical regressions
JEL: C43, O18, O39, R11

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Introduction

Technological progress, wider and more integrated markets and a greater attention for quality and immaterial goods have gradually changed competition paradigms, giving innovation a strategic importance. Many evidences are offered by the international literature about its crucial role for firms – and economic systems – survival and growth. They also point out the existence of very different solutions, since different kinds of innovation exist, as well as plenty of determinants and possible effects.

Starting from this assumption, a great attention will be paid to those variables which innovation is concerned with, trying to consider the widest range of factors, even if not directly connected with its origin or diffusion. The aim is to describe their features, as well as their contribution to innovation processes, so as to assess what kind of relation exits between innovation inputs and outputs. Moreover, the paper will examine the influence of innovative behaviours on social and economic growth, trying to verify the presence of a concrete link and to define its nature and intensity. As innovation features and results can change according to the context (thought as a specific mix of natural, social, economic, cultural, institutional and organizational elements) where they take place, we have chosen regions as spatial units of investigation, since – on the base of existing datasets – no similar and well detailed information exist for lower territorial levels.

Referring to Italian regional systems, about a hundred of static and dynamic indicators, concerning with innovation and economic development and divided into several thematic areas, have been estimated. They have been summed up in order to create aggregate measures of innovation input, output and context conditions; two synthetic indicators of regional innovative character (RI) and socio-economic performance (RP) have been created, too. Basing on these measures, a short description of regional differences about innovation systems has been realized; they have been also used to compare innovative efforts and economic outcomes, by means of statistical association, dependence and interdependence indices.

Contents have been organized as follows: section 1 outlines the theoretical background, focusing on variables that contribute to the innovation process, and specifies the analysis methodology, describing indicators and aggregation rules. Section 2 reports about regional performance, pointing out the presence of differences – best and worst performers – and explaining them. Moreover, it summarizes the relationship between innovation determinants and outcomes, as well as between the development of higher innovative capabilities and the achievement of better economic outcomes. Conclusions are collected in section 3.

1. Theoretical framework and methodological approach

The mainstream of the international literature about innovation acknowledges its systemic nature as one of the most important achievement in this field. Heterogeneous and dynamic phenomenon, it comes from different interacting phases and subjects, revealing a techno-economic character, as well as relevant social and cultural conditionings: it's the context where innovations take place, with its features and restraints, which define the destiny of the innovation process, creating its assumptions and influencing its development (Hauknes, 1999). As a consequence, the concept of innovation seems to enrich of new meanings, suggesting new questions and asking for a wider and more articulated analysis. Simpler theories, focused on research and development activities and based on a linear vision of the sequence of phases (Bush, 1945; Smith, 1992), are gradually displaced by more sophisticated ones, where the number of actors and dimensions increases (including all kind of elements, directly o indirectly connected with the production and diffusion of new knowledge[1], but also anyway able to influence innovation processes[2]) and relationships become more and more interactive, pointing out the importance of the dialogue among different moments and actors (Kline e Rosenberg, 1986; Lundvall, 1992; Nelson, 1993; Porter, 1990).

Starting from these considerations it is clear that plenty of variables can condition the innovation process, so that it gets very difficult not only to quantify but also to identify them. The qualitative character of some factors, together with the sometimes absence of direct statistical indicators, makes measuring very hard and reduces its effectiveness, forcing to use proxies which can grasp – at least partially – the intensity of the investigated phenomena. Moreover, a lot of doubts still exist about the nature of the link between decisive factors and innovation outcomes, as well as about the contribution of innovations to the economic growth[3]. For these reasons, the quality of our results will be unavoidably limited from the beginning, suggesting a partially reduction of this problem by using a wide range of variables, so as to obtain an analysis that is as much complete as possible.

1.1 Indicators selection

Given these considerations and limits, we have chosen to analyse the innovation process by means of three different groups of variables: inputs, outputs and context conditions. The

[1] Customers, suppliers, competitors, research centres, universities, support agencies, transferrring centres, technological parks, Pubblic Administrations, firm associations, Chambers of Commerce, and so on.
[2] Financial system, educational system, market structure, relational networks, infrastructural resources, ecc.
[3] Think about the debate innovation-firm dimension or about contrasting effects on the labour market.

first one sums up factors directly connected with the production, acquisition and use of knowledge; the second one considers results of innovation processes, from different point of view, while the last one is a sort of residual category, which includes all remaining elements that are able to influence origin chances and diffusion modalities of an innovation.

Both inputs and context conditions are considered as possible sources and conditionings of the innovation process. Going into details, the ***Input*** group (A) is concerned with:

- *Research and development activity* (A1): the acknowledgement of the plurality of elements involved has reduced the role of this factor in comparison with neoclassical models, although its importance still remains as one of the main sources of innovations. For this reason, some indicators have been selected to study the amount of human and financial resources devoted to the creation, exploitation and diffusion of new knowledge, starting from R&D expenditure and personnel.
- *Human Capital* (A2): it investigates about the availability of human resources from a quanti-qualitative point of view. People with higher education levels and/or endowed with particular technical and scientific expertise, in fact, can have a great influence on the system growth in a knowledge-based economy. At the same time, the participation in training initiatives is evaluated too, recognizing as very important the constant updating of labour forces skills to face technological progress and market changes. In this case, our indicators try to evaluate the average educational qualification of the labour force, the importance of S&T degrees and the enrolments in training courses.
- *Foreign trade* (a3): innovations usually originate in knowledge existing or produced within the system, but they can also be conditioned by information coming from the outside, for example through the foreign exchange of goods, services and technologies. For this reason, we have included among innovation inputs the total expenditure of the Technological Balance of Payments[4], as well as the value of hi-tech imports[5].

Focusing on possible results, the ***Output*** group (B) is dealt with:

- *Patents* (B1): Apart from its possible limitations[6], it measures the inventive activity of a territory, offering a wide sectorial detail; for this reason, we have decided to study not only

[4] It measures the total value of patents, licenses, know-how, ecc acquired from foreign nations.

[5] Even if usually it is considered as a measure of international dependence (and so it has a negative meaning, revealing a low competitiveness in the hi-tech field) here it becomes a positive element, since it represents a possible source of knowledge. For a definition of hi tech sectors, see note D of table 1.

[6] Think, for example, about the discrepancy sometimes existing between the titular of the patent and the real inventor, which creates some problems for the assignment of the region of pertinence; moreover, patents only grasp a small part of total innovations introduced in a system, since a lot of them are informal and incremental ones, so that they are not registered. Finally, it is difficult – sometimes impossible – to define the social and economical value of patents, so we can only sum up their number.

the total amount of patents registered but also the share of patents referred to hi-tech sectors[7]

• *Innovation diffusion* (B2): in order to study the presence of innovations within the system, we have referred to firms and families behaviours, also trying to evaluate the importance of hi tech activities by considering their level of employment.

• *Technological advantage* (B3): it is possible that new technologies are used outside the system where they are produced, as a consequence of the purchasing from foreign subjects, so generating international flows that are a clear sign of the competitive advantage which local knowledge benefits of. These aspects have been underlined by referring to the Technological Balance of Payments proceeds, as well as to the value of hi-tech exports[8].

Basing on a systemic vision, the third and last group collects other decisive factors, which are able to condition the innovation process, relating to the ***Context*** (C) where it takes shape:

• *Financial system* (C1): financing innovations is a rather risky business, since it requires high investments, offering uncertain and delayed returns. This gives a great relevance to the credit system, which is supposed to be reliable and accessible, and has also to plan specific solutions for funding innovative firms. The attention is paid here to the spatial diffusion of bank counters, as well as to the level of investments and delays in settling.

• *Educational system* (C2): it's considered a decisive factor because of its influence upon the quality of the human capital; from this point of view, not only the availability and accessibility of its structures, but also their variety, is important. The presence of technical and scientific institutes, in fact, can stimulate the diffusion of this kind of competences, while the heterogeneity of specializations can foster a cross-fertilization process, suggesting new ideas and applications. Three aspects have been considered: the diffusion of universities and the cover degree[9] of universities and upper secondary schools.

• *Firm structure* (C3): a lot of elements can influence the innovative behaviour of a firm. Although the range of variables is much more complex[10], both its dimension and its organizational structure can be relevant in so far as; in fact, they are usually linked with the international opening and the R&D activity, so implying a greater incentive to innovation, as well as an higher probability of success (at least for formal innovations). Also important is the entrepreneurial development rate, as a symbol of the economic system dynamism.

[7] The aim is to measure the innovative capability of the system referred to dynamic and research-based sectors.
[8] See notes 5 and 6.
[9] It stands for the share of institute types which is present in the region, compared to the national variety.
[10] Likewise important are managerial culture, inclination to cooperation and internationalisation, market concentration, belonging sector ecc, but not all these factors have been considered, because of the lack of reliable statistics (as for the managerial culture) and of a shared vision of their contribution to the innovation process (for example think about the market concentration: an high level can discourage the search of innovation, implying a low competition, but it could also be the result of a competitive advantage due to the innovation process itself).

• *Relational system* (C4): the attitude towards cooperation and the belonging to productive and/or cognitive networks, also extended at an international level, usually favour innovation processes, by fostering the renovation of competitive advantages and offering new incentives and opportunities through the inclusion in interactive systems where actors constantly compare one another. From this point of view, it's important to assess the regional diffusion of industrial groups and districts, the spatial extent of local labour systems and the international opening of the commerce[11].

• *Social capital* (C5): among different meanings usually ascribed to this concept, we have chosen to underline some specific aspects: participation to the socio-political life, solidarity and respect for the neighbour, level of confidence in other people and institutions. A cooperative attitude, in fact, is an essential element so that firms' innovative activity doesn't turn into a mere mutual competition, causing a waste of resources and energies. Otherwise, by interacting and exchanging information, they foster the accumulation and sharing of knowledge, promoting the achievement and diffusion of innovations.

• *Support structures* (C6): it reveals the presence of specific structures that are able to favour the innovation process, such as S&T parks or interdepartmental research centres[12].

• *Public Administration* (C7): it can influence the innovation process directly and/or indirectly, by creating a favourable context, improving the human capital, fostering research activities, and so on. The engagement in this field usually modifies the administration features, but is also influenced by them: subjects particularly interested in promoting innovation not only devote large amounts to the increase of local innovative capabilities, but are often involved in the modernization of their own structures and operational models. Basing on existing data, the public expenditure for education and training has been considered, as well as the level of informatization of the PA and the attention for e-government projects.

• *Localization* (C8): the territory where innovations occur can be important for many reasons: first of all, because of the singularity of its physical capital (both natural and artificial), which is a strong distinctive element; then, it matters as relational context, so as a space where local and external actors establish their networks; finally, it counts for its geographical position and accessibility. In order to grasp these aspects, the attention has been focused on the presence of neighbouring regions whose GDP has rapidly grown up during last years and on the local infrastructural equipment.

[11] As measures of firms belonging to socio-economical networks, but also of their geographical dimension.
[12] They underline the attitude towards cooperation of university research centres.

Aiming at pointing out not only the static dimension of the above mentioned variables, but also their dynamic evolution, we have calculated both their actual level and their growth rate, usually referring to the period 1981-2001[13]. According to the available statistical information about these topics, 81 indicators have been identified: 18 belonging to the Input group, 16 to the Output group and 47 referred to the Context. A summarizing list of their contents, sources and time references are synthesized in table 1.

In order to assess the socio-economic performance of systems, 17 further indicators have been selected, divided into three specific subgroups: people wellbeing (5), firms' productivity (6) and employment dynamics (6). A list of these indicators, of their sources and time references is included in table 2

All these data have been aggregated to obtain synthetic measures for the comparison of different geographical models, as well as for the study of the relationship between innovation and growth. Every single indicator has been supposed equal to 1 (-1) if its value is at least 10% higher (lower) than the Italian average and equal to zero in all other cases[14]. Adding up these scores by subgroups and groups, more general measures have been obtained, so assessing the innovative character and of the socio-economic performance of every region. This procedure has been also applied to four Italian macro-areas (North West, North, East, Centre and South)[15], always referring to the national average value for the attribution of their score. Aggregation scheme and ranges are shown in table 3.

For every group a concentration index has been calculated, too. Since it is equal to $(X_i/X_{iMAX})^{-1}$, where X_i is the synthetic value of the group, the greater is the concentration level and the lower is the sustainability of the group – and so of the system which it refers to – because it implies the presence of a very small number of "excellent" factors[16].

The analysis of the relation between innovation determinants (ID) and outcomes (B), as well as between regional innovative character (RI) and socio-economic performance (RP), has been based on a three step process: first of all, the existence of a statistical association has been verified by means of the Pearson χ^2 index; then, we have tried to define the nature of this link, by estimating different regression functions (from the first to the sixth degree)

[13] For exceptions, see table 1.
[14] Since we consider that variables (number of crimes and delays in settling excepted) have positive effects for the system innovativeness, we have chosen these limits so as to advantage virtuous regions and penalize the weakest ones, in order to point out the "moments of excellence" within and among different regions.
[15] On the base of Istat definition, we have considered the following division: North West (Piemonte, Valle d'Aosta, Lombardia and Liguria), North East (Trentino Alto Adige, Veneto, Friuli Venezia Giulia and Emilia Romagna), Centre (Toscana, Umbria, Marche and Lazio) and South (Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna).
[16] The situation is worse for negative measures, as they imply that weak points are greater than excellence ones.

and testing their explanatory capability through the calculation of the determination coefficient (R^2) and of the mean absolute spread (MAS). Finally, we have verified the interdependence hypothesis, by means of the Bravais-Pearson correlation coefficient (ρ_{xy}), so assuming that variables can influence one each other.

2. Overview of results

2.1 Regional performance

By comparing group indicators (tables 4 and 5) it is possible to note that innovation determinants (ID), and especially context conditions (C) [17], have a great influence on the definition of regional innovative characters (RI), certainly because of their numerical consistency but also owing to difficulties that characterize the implementation of innovation inputs (A) and which are stated by the presence of many negative values (often very near to the minimum score). Rather more favourable is the situation for innovation outputs (B), where some more positive indicators (despite of the presence of several negative scores) and a somewhat relevant contribution to the determination of RI (just as for the Veneto region) can be found. Finally, a positive judgment is related to the socio-economic performance indicator (RP), since its value is usually better than other ones.

Taken as a whole, both innovation and growth measures, even when positive, usually reach a small portion of their maximum score, so proving that, for the most part, regions have gained a limited number of advantages over the national average.

Different regional models can be found within these areas, pointing out the existence of plenty of feasible solutions, characterized by different internal composition and score of synthetic indices. North East (NE) mainly obtain better results than other areas, with the exception of B and RP groups, whose values are exceeded by North West (NW) ones. Also Centre regions achieve positive scores, even if lower than the northern ones, while South displays a critical situation evidenced by the general presence of negative results. Lombardia, Valle d'Aosta and Emilia Romagna obtain the best scores, both from an innovative and a socio-economic point of view, while the worst performance is concerned with Campania, Calabria and Sicilia systems.

Going into details, the NW model has a relative advantage in B, due to the international competitiveness of its technologies (despite of its negative evolution) and to a wide diffusion

[17] From this point of view, Piemonte, Lazio and Abruzzo are important exceptions, since A counts more than C within ID.

of innovative firms and hi tech activities. Rather limited are strong points in A, only concerning with the level of S&T degrees and of the enrolment in training courses, as well as with the increase of medium-high certificates, while some problems rise from the decreasing trend of R&D activities. In the C group favourable conditions come out with regard to the financial system (whose score is near the 67% of the maximum one) and to the relational system, which benefits of the diffusion of industrial groups and districts, as well as of inter-provincial labour systems. At a regional level, positive performance of Valle d'Aosta and Lombardia contrast with the frequent presence of negative indicators in Piemonte and Liguria.

The NE model reveals higher scores, especially for determinants, thanks to a solid financial system and to a well-developed relational system, based on the diffusion of associations and industrial districts but also open to the international trade and to neighbouring regions. A fair presence of support structure can be observed, as well as of a good infrastructural equipment[18]. Also high investments in R&D activities have a positive influence on the innovative character of this area, although they have been reducing during last fifteen years. Further contributions come from the human capital quality, too (and particularly from the constant attention paid to constant updating of labour force skills) whereas payments of TBP and imports of hi tech goods and services settle into values under the national average. On the other hand, innovative outcomes are granted by the increasing accumulation of patents, by the presence of innovative firms and by the growth of hi tech employees. Best results are concerned with Emilia Romagna and Friuli Venezia Giulia (whose RI value is positive although very low), even if all regions benefit of a certain advantage in comparison with other areas.

So as previous models, the Centre system is positively influenced by the presence of a stimulating context although incentives here derive from different factors. In this case, in fact, educational system (which shows a wide diffusion and good cover degrees) and innovative efforts of public administrations have a central role, granting regions a competitive advantage. Moreover, benefits coming from context conditions are, on the whole, lower than northern ones, given the presence of weak points concerning with the social capital but also with the decrease of medium-large firms, of industrial groups and of the spatial extension of labour systems. Positive results also mark the input group, even if problems related with the human capital[19] roughly nullify the good position reached in R&D activities and foreign trade. With regard to the B group, a positive value can be found mainly thanks to patents

[18] This aspect is common both to the NW and NE area.
[19] From this point of view, a critical situation seems to characterize the Lazio region.

accumulation and to the international sale of domestic technologies. By comparing the four central regions, only one (Toscana) has an advantage both from the innovation and from the socio-economic point of view, while others usually couple positive RP and negative IR.

In the South model almost every variable confirm a difficult situation, since both input, output and context scores have a negative sign, so implying that critical elements are greater than advantage ones. No regions have a positive synthetic index (just referring to RI and RP) and sometimes their values equal – or exceed – the 33% of the minimum score. Only few positive factors can be found, mainly related with the trend of R&D activities and foreign trade (which counterbalance the inadequacy of actual levels) and with the good level of hi tech exports.

Referring to concentration coefficients (table 6) we can argue that innovation models are generally less sustainable than socio-economic ones, since RI values always exceed RP ones. For the same reason, local choices about B can be usually considered more sustainable than A and C ones, although in this case a greater variability characterizes regional behaviours[20]. At a macro-area level, concentration data essentially confirm previous considerations about synthetic indicators: NE proves to be the most sustainable innovation system, basing its results on an higher number of strong elements; NO points out its supremacy with regard to socio-economic performance, while Centre and South systems reveal rather more problematic situations, especially referred to the improvement of innovation inputs. As best performers we find Emilia Romagna (RI, ID and C), Veneto (B), Trentino Alto Adige (A) and Lombardia (RP) whereas worst results are concerned with Piemonte (ID), Valle d'Aosta and Lombardia (A), Liguria, Trentino and Toscana (B), Marche (RI-A) and Abruzzo (RP-C).

By grouping data on the base of their temporal nature (table 7) it is possible to note that static indicators mainly determine value and sign of synthetic measures, as well as that they usually imply better performance than dynamic components. Nevertheless, also in this case a certain variability exists. In the NW and South this situation is confirmed whit the exception of the negative sign of southern static indicators, which confers them a decisive but penalizing role, while in the NE and Centre dynamic elements predominate, respectively, in A-B-RI and C-RP groups. This means that today's problems and advantages are due to the actual level of indicators above all, but also that policies realized during last twenty years haven't had a positive impact on local innovative and economic performance, sometimes causing a deterioration of their relative position.

[20] In Liguria, Trentino Alto Adige, Umbria and Abruzzo input coefficients are better than output ones, while Friuli Venezia Giulia, Emilia Romagna, Toscana and Marche find their best results in the context group.

From this point of view, positive signals come from northern and central regions, where systems like Valle d'Aosta, Trentino Alto Adige and Marche have succeeded in improving their innovative structure, so achieving better performance. Also encouraging is the presence of positive dynamic indicators in some southern regions (referred to context conditions above all), as sign of an increasing effort for leaving their technological backwardness. On the contrary, what is worring is the presence of highly negative dynamic indicators in northwestern regions, as symbols of a leadership that is failing. Despite of some positive results, also the southern situation remains very critical, since for the most part dynamic group indicators have negative signs, which worsen static problems.

2.2 Innovation and growth: an analysis of links

One of the basic hypotheses of this paper is that a concrete and positive link exist between the development of good innovative capabilities and the achievement of higher socio-economic performance, so that innovative efforts of a system should turn into an increase of firms' efficiency and people wellbeing, also implying a possible rise of employment levels (at least for high skilled workers). Moreover, we suppose that the amount and quality of inputs that get into the process, as well as the presence of favourable conditions, can influence origins and diffusion of innovations. So as to verify these assumptions, basing on available statistics and on previous synthetic indicators, we have analysed the relationship existing between two couple of indices: ID-B and RI-RP. In order to distinguish innovation consequences on people living conditions from firms and employment effects, we have also repeated the analysis comparing RI with three RP subgroups: RPwel (RP1), RPpro (RP2) and Rpemp (RP3)[21]. A synthesis of most important results is reported in table 8 and figure 1.

By calculating the Pearson χ^2 index it has been possible to test the existence of a significant statistic link between these variables. So as to simplify the comparison among different level of association, we have used the normalized index[22], whose range is included between 0 and 1. Since we have that χ^2_{norm} values always exceed (or at least equal) 80%, we can avoid the hypothesis of the independence of characters, especially for the couple RI-RPwel, whose score is 0,947.

Rather more doubts still exist about the nature of these links. Supposing that ID and RP (and its subgroups) are dependent variables and that B and RI are the independent ones, by

[21] For an explanation of their contents, see table 1.
[22] It can be obtained by dividing χ^2 for its maximum value, whose formula is: N * min (n° rows -1; n° columns -1). N is the number of observations.

applying the minimum squares methodology we have estimated intercepts and regression coefficients of every couple of variables, so obtaining different interpolating functions (from the first to the sixth degree). Referring to their level of adaptation (measured by R^2 and MAS coefficients), we have chosen those functions that assure both rather simply expressions and high correspondence with the distribution of real values.

Basing on these results, it seem to be acceptable the idea of the existence of a positive link between innovation and socio-economic performance, which can be expressed by the equation $RP = 6{,}064 + 0{,}114RI - 0{,}008RI^2 + 0{,}001RI^3 + 0{,}00003RI^4$, since its determination coefficient is 0,835, although the presence of a rather significant absolute spread (2,634). Also regressions concerning with RPwel and RPemp seem to be reliable, as their R^2 index is 0,757 and 0,818 (with a MAS even lower than 1,5), while rather more uncertain is the link between RI and RPpro, since interpolating functions only reach low R^2 values (from 0,365 to 0,492). Likewise, a positive relation seems to characterize ID and B, which can be approximated by the equation: $B = 0{,}643 - 0{,}153ID - 0{,}040ID^2 + 0{,}005ID^3 + 0{,}0002ID^4 - 1{,}478E\text{-}05ID^5 - 5{,}455E\text{-}07ID^6$ and whose determination level is 0,603.

Given the possibility that economic and innovation variables – as well as innovation determinants and outcomes – influence each other, we have finally tried to measure the intensity of their links assuming that no dependent elements exist, just wanting to compare the effectiveness of this hypothesis whit the previous one. The linear correlation index by Bravais-Pearson has been assessed, so underlining better results with reference to RI-RP (and especially to RPben ad RPlav) and lower values for ID-B. Like the regression methodology, we find the confirmation of the stronger link that exist between innovative investments and economic performance, but also of the importance of inputs and context conditions for the improvement of innovative results. However, as the interdependence hypothesis seems to fit better than the dependence one, it is also possible to expect that innovation processes are fostered by the economic growth of the system.

3. Conclusions

On the base of our estimations it is possible to outline a rather precise description of innovative characters of Italian regions, which points out the existence of relative advantages for North East systems, due to the creation of a favourable context as well as to the improvement of input factors and innovation outcomes. The dynamism of this area contrast with the static condition of the North West, whose strong points mainly come from the actual

level of indicators, so advantaging of a leadership that has been reached during past years but that is now vanishing (as proved by the presence of negative dynamic indicators). On the whole, a positive judgment can be expressed about Centre regions, as synthetic measure generally reveal a positive sign, despite of a low intensity, whereas a critical situation seems to characterize southern regions, so as evidenced by the wide presence of negative scores, both from a static and from a dynamic point of view.

As a consequence, the gap between North and South Italy gradually increases, only showing an alternation between eastern and western regions at the top of the list.

On the other hand, the analysis of the relationship between innovation determinants and outputs, as well as between innovative behaviours and socio-economic performance, seems to confirm the presence of a positive significant link, so suggesting that increasing investments in innovation could foster regional growth, promoting employment and people wellbeing but also raising firms productivity.

Starting from these considerations, regional policies should focus on the improvement of innovative capabilities for relaunching local development, especially considering the central role that innovations have for the international competition. A reasonable solution could be just to start from the removal of the weakest points, so as to line up at least with the average national level. From this point of view, possible interventions should be concerned with:

- North West (especially Valle d'Aosta and Liguria): investments in R&D activities (expenditure and personnel) and for the acquisition of foreign knowledge (so as to better last trends); creation of support structures
- North East: improvement of the social capital (partecipation in the political life and trust in institutions, especially for Friuli Venezia Giulia); creation of support structures (Trentino Alto Adige)
- Centre: increase of the expenditure in education and professional training (Toscana), of the presence of companies and partnerships and of the growth rate of the infrastructural equipment (Lazio)
- South: human capital stock and financial system (Basilicata and Calabria); acquisition of foreign knowledge (Sicilia); HT patents accumulation (Molise) and exports (Basilicata); international opening (Calabria); educational provision; social capital stock; presence of medium-large firms and industrial groups (Calabria) as well as of support structures (Basilicata).

Tables

Table 1. Innovative performance indicators

Groups	*Subgroups*	*Indicators*	*Sources*
(A) INPUT	(A1) R&D activity	• R&D expenditure/GDP in 2001 • Total per cent variation in 1982-2001 • R&D employees/Total employees in 2001 • Total per cent variation in 1986-2001	Istat
	(A2) Human capital	• Average education level of labour forces in 2001(a) • Total per cent variation in 1981-2001 • People with higher certificates (b)/Total labour forces in 2001 • Total per cent variation in 1981-2001 • S&T degrees (c) /Total degrees in 2001 • Total per cent variation in 1981-2001 • Enrolments in training course/ Total labour forces in 1997 • Total per cent variation in 1981-1997 • Employees (age 25-64) enrolled in training courses/Total employee (25-64) in 2001 • Total per cent variation in 1995-2001	Istat and Euro-stat
	(A3) Foreign trade	• Technological Balance of Payments Expenditure /GDP in 2001 • Total per cent variation in 1997-2001 • Hi tech (d) Imports /Total imports in 2001 • Total per cent variation in 1991-2001	Istat, ICE and UIC
(B) OUTPUT	(B1) Patents	• N° of patents cumulated till 2001 • Total per cent variation in 1981-1999 • N° hi-tech (e) patents/Total patents in the period 1996-1998 • Total per cent variation compared with the period 1989-1991	Ueb-Cespri
	(B2) Innovation diffusion	• N° of innovative firms/Total firms in the period 1990-1992 • Total per cent variation compared with the period 1984-1985 • N° diversified innovators (f)/ Total innovators in the period 1990-1992 • Total per cent variation compared with the period 1984-1985 • N° of families with an Internet access/Total families in 2001 • Total per cent variation in 1997-2001 • Hi-tech (d) employment/Total employment in 2001 • Total per cent variation in 1981-2001	Istat
	(B3) Technological advantage	• Technological Balance of Payments proceeds/GDP in 2001 • Total per cent variation in 1997-2001 • Hi tech (d) Export /Total Export in 2001 • Total per cent variation in 1991-2001	Istat, ICE and UIC
(C) CONTEXT CONDI-TIONS	(C1) Financial system	• N° of bank counters/Thousands of population in 2001 • Total per cent variation in 1991-2001 • Investments/GDP in 2001 • Total per cent variation in 1991-2001 • Delays in settling/Loans in 2001(g) • Total per cent variation in 1997-2001	Bank of Italy
	(C2) Educational system	• N° of faculties/Millions of people in 2003 • Total per cent variation in 1981-2003 • Cover degree of upper secondary schools in 1997 (h) • Cover degree of universities in 1997 (h)	Istat and MIUR

C) CONTEXT CONDITIONS	(C3) Firm structure	• Firms with at least 200 employees/Total firms in 2001 • Total per cent variation in 1981-2001 • Companies and partnerships/Total firms in 2001 • Total per cent variation in 1981-2001 • Entrepreneurial development rate (i) in 2001 • Total per cent variation in 1995-2001	Istat and Union-camere
	(C4) Relational system	• Companies belonging to industrial groups/Total companies in 2000 • Total per cent variation in 1999-2000 • Associated firms/Total firms in 1991 • Districts' industrial employment/Total industrial employment in 1998 • Total per cent variation in 1996-1998 • N° of inter-provincial and inter-regional Local Labour Systems/Total LLS in 1991 • Total per cent variation compared with 1981 • System opening degree in 2001(l) • Total per cent variation in 1985-2001	Istat, ICE and Union-camere
	(C5) Social capital	• Crimes/Thousands of people in 2001(g) • Total per cent variation in 1982-2001 • Voters for regional elections/Electors in 1999 • Total per cent variation in 1981-1999 • AVIS members/Population in 2001 • Total per cent variation in 1981-2001 • Voluntary workers in 1990 • People interested in politics /Total population in 1990 • People who trust in neighbours/Total population in 1990 • People who trust in institutions/Total population in 1990	Istat, AVIS and EVS
	(C6) Support structures	• Scientific and technological parks/Population in 2001 • Inter-departmental research centres/Universities in 2002	MIUR
	(C7) Public Ad-ministration	• Education and professional training expenditure/Total public expenditure in 2000 • Total per cent variation in 1981-2000 • Level of informatization of the PA (m) in 2001 • Total per cent variation in 1998-2001 • E-government investments (n) in 2002	Istat, MIT
	(C8) Localization	• N° of neighbouring regions whit a GDP growth rate in 1996-2001 higher than the Italian average /Total regions • Total per cent variation compared to the period 1991-1996 • Infrastructural equipment in 1997 • Total per cent variation in 1995-1997 • Broad band diffusion (o) in 2002	Istat, MIT

NOTES:

(a) Calculated by multiplying the number of people, belonging to the labour force, with a certain education certificate (primary-school, lower secondary school, upper secondary school, college degree) by the number of years usually necessary to obtain such certificate (five years for primary-school, eight for lower secondary school, thirteen for upper secondary school and seventeen for the college degree).
(b) Upper secondary school and college degree
(c) Basing on Istat classification, we include among Science & Technology faculties: Engineering; Medicine; Veterinary sciences; Agriculture; Mathematical, physical and natural sciences; Pharmacy; Industrial chemistry.
(d) Referring to Ferrari et al (2002), we consider as hi tech activities having codes 24.1, 24.4, 24.6, 24.7, 30, 32, 33 e 35.3 of the ATECO 91classification.
(e) Referring to Ueb-Cespri classification (Ferrari et al, 2002), hi tech category includes: Pharmaceutics; Plastics, elastomers and fibres; Fine Chemicals; Industrial automation; Office machinery; Consumer electronics goods; Telecommunications; Electromedical equipments; Electronic components; Aerospace; Precision instruments, measurement and control devices; Optical instruments and materials.
(f) Firms that introduce both product/process and organizational innovations.

(g) Scores assigned to this indicator have an opposite sign compared to other ones, since the higher is its value and the lower is its contribution to the innovation process.
(h) It represents the number of typologies existing in the region compared to the national value.
(i) Calculated as: (new registrations – strikings off)/firms registered the year before.
(l) Calculated as: (Imports+Exports)/GDP.
(m) Given by the number of people living in towns whose register office is connected to the SAIA (the Italian information system for registry access and exchange).
(n) Measured by the average value of projects presented for the e-government announcement of the April 2002.
(o) Measured by means of the cover degree of backbone, MAN and ADSL infrastructures (CRC, 2003).

Table 2. Socio-economic performance indicators

Subgroups	***Indicators***	***Sources***
(RP1) People wellbeing	• GDP/Total population in 2001 • Total per cent variation in 1981-2001 • Final domestic consumptions/Total population in 2001 • Total per cent variation in 1981 –2001 • N° of poor families/Total families in 2002	Istat
(RP2) Firms' productivity	• GDP/Total labour units in 2001 • Total per cent variation in 1981-2001 • Regional Return on Investments (ROI) in 2000 • Total per cent variation in 1996-2000 • Value Added/N° of employees in 2000 (for medium and small firms) • Total per cent variation in 1998-2000	Istat, Medio-banca, Union-camere
(RP3) Employment dynamics	• N° of employees/Population over 14 in 2001 • Total per cent variation in 1981-2001 • Employees age 15-24/People age 15-24 in 2001 • Total per cent variation in 1991-2001 • Female employees/Total female population over 14 in 2001 • Total per cent variation in 1991-2001	Istat

Table 3. Indicators' range and aggregation structure

Subgroups	***Groups***	***Synthetic measures***	
(A1) R&D activity [-4, 4] (A2) Human capital [-10, 10] (A3) Foreign trade [-4, 4]	(A) INPUTS [-18, 18]	(ID) INNOVATION DETERMINANTS [-65, 65]	(RI) REGIONAL INNOVATIVE CHARACTER [-81, 81]
(C1) Financial system [-6, 6] (C2) Educational system [-4, 4] (C3) Firms' structure [-6, 6] (C4) Relational system [-9, 9] (C5) Social capital [-10, 10] (C6) Support structure [-2, 2] (C7) Public Administration [-5, 5] (C8) Localization [-5, 5]	(C) CONTEXT CONDITIONS [-47, 47]		
(B1) Patents [-4, 4] (B2) Innovation diffusion [-8, 8] (B3) Technological advantage [-4, 4]	(B) OUTPUTS [-18, 18]		

Subgroups	***Groups***
(RP1) People wellbeing [-5, 5] (RP2) Firms' productivity [-6, 6] (RP3) Employment dynamics [-6, 6]	(RP) SOCIO-ECONOMIC REGIONAL PERFOR-MANCE [-17, 17]

Table 4. Innovation and socio-economic performance indicators, by subgroups and groups, regions and macro-areas

	A1	A2	A3	**A**	B1	B2	B3	**B**	C1	C2	C3	C4	C5	C6	C7	C8	**C**	**ID**	**RI**	RP1	RP2	RP3	**RP**
Piemonte	0	-1	-1	**-2**	-1	3	-2	**0**	1	1	-2	-1	-2	0	2	0	**-1**	**-3**	**-3**	1	2	5	**8**
Valle d'Aosta	-2	5	-4	**-1**	0	6	-4	**2**	3	0	2	1	3	-2	3	2	**12**	**11**	**13**	2	3	5	**10**
Lombardia	-1	0	0	**-1**	-1	3	0	**2**	5	0	1	2	-1	0	-3	1	**5**	**4**	**6**	3	2	6	**11**
Liguria	-2	-2	-2	**-6**	-3	2	0	**-1**	-1	0	-3	-3	-4	-2	-1	2	**-12**	**-18**	**-19**	3	1	3	**7**
Trentino Alto Adige	0	4	-2	**2**	-1	4	-4	**-1**	4	-1	-2	1	5	-2	-2	-1	**2**	**4**	**3**	2	-3	5	**4**
Veneto	-4	-1	-4	**-9**	1	7	-2	**6**	6	0	-1	2	1	0	-1	0	**7**	**-2**	**4**	3	0	4	**7**
Friuli Venezia Giulia	0	1	-1	**0**	-2	0	-1	**-3**	3	2	-1	1	-1	0	-1	1	**4**	**4**	**1**	2	3	5	**10**
Emilia Romagna	0	1	0	**1**	1	1	-4	**-2**	5	0	0	5	-2	2	4	1	**15**	**16**	**14**	3	0	6	**9**
Toscana	0	1	-1	**0**	0	1	-2	**-1**	3	0	1	4	-1	2	-2	1	**8**	**8**	**7**	2	-2	4	**4**
Umbria	1	5	-4	**2**	1	1	-4	**-2**	3	-1	-2	-2	-2	0	-3	-1	**-8**	**-6**	**-8**	1	0	4	**5**
Marche	-3	0	2	**-1**	-1	-1	0	**-2**	5	1	-3	0	2	0	-3	-1	**1**	**0**	**-2**	1	1	3	**5**
Lazio	0	-7	2	**-5**	0	2	2	**4**	3	1	0	-4	-6	-2	3	3	**-2**	**-7**	**-3**	2	0	-2	**0**
Abruzzo	0	-7	0	**-7**	-3	-5	2	**-6**	-2	0	-1	3	-2	-2	2	1	**-1**	**-8**	**-14**	-3	1	-2	**-4**
Molise	0	-4	-3	**-7**	-2	-5	-3	**-10**	-2	0	-3	-4	6	-2	-1	-1	**-7**	**-14**	**-24**	-2	-3	-5	**-10**
Campania	0	-7	0	**-7**	-3	0	-2	**-5**	-6	1	-2	-5	-6	0	-1	1	**-18**	**-25**	**-30**	-4	-5	-6	**-15**
Puglia	-2	-5	0	**-7**	-2	-2	-3	**-7**	-6	2	-6	-5	-1	0	-1	0	**-17**	**-24**	**-31**	-3	1	-6	**-8**
Basilicata	-4	-1	-2	**-7**	-2	-6	-2	**-10**	-6	0	2	-2	4	-2	-2	-1	**-7**	**-14**	**-24**	-2	-1	-4	**-7**
Calabria	0	-7	0	**-7**	-3	-8	1	**-10**	-5	-2	0	-5	-1	-1	-3	-3	**-20**	**-27**	**-37**	-2	-4	-5	**-11**
Sicilia	2	-4	-4	**-6**	-2	-6	-1	**-9**	-6	-2	-3	-1	-2	0	-2	-3	**-19**	**-25**	**-34**	-4	-5	-4	**-13**
Sardegna	-2	-2	-2	**-6**	-2	-4	-1	**-7**	-4	-1	-2	-4	-6	2	3	-3	**-15**	**-21**	**-28**	-3	-3	-4	**-10**
NO	*-1*	*3*	*0*	***2***	*-1*	*3*	*2*	***4***	*4*	*0*	*0*	*2*	*-1*	*1*	*-1*	*1*	***6***	***8***	***12***	*2*	*1*	*6*	***9***
NE	*1*	*5*	*-3*	***3***	*3*	*-1*	*0*	***2***	*2*	*0*	*1*	*3*	*0*	*1*	*0*	*1*	***8***	***11***	***13***	*3*	*-1*	*6*	***8***
C	*2*	*-3*	*2*	***1***	*1*	*-1*	*2*	***2***	*0*	*2*	*0*	*1*	*-2*	*1*	*2*	*0*	***4***	***5***	*7*	*1*	*1*	*2*	***4***
S	*0*	*-3*	*0*	***-3***	*-3*	*-5*	*1*	***-7***	*-6*	*0*	*-1*	*-3*	*-4*	*-2*	*0*	*-1*	***-17***	***-20***	***-27***	*-4*	*-3*	*-6*	***-13***
MIN	*-4*	*-10*	*-4*	***-18***	*-4*	*-8*	*-4*	***-16***	*-6*	*-4*	*-6*	*-9*	*-10*	*-2*	*-5*	*-5*	***-47***	***-65***	***-81***	*-5*	*-6*	*-6*	***-17***
MAX	*4*	*10*	*4*	***18***	*4*	*8*	*4*	***16***	*6*	*4*	*6*	*9*	*10*	*2*	*5*	*5*	***47***	***65***	***81***	*5*	*6*	*6*	***17***

Table 6. Concentration coefficients, by groups, regions and macro-areas.

	A	B	C	ID	RI	RP
Piemonte	-9,0	--	--	-21,7	-27,0	2,1
Valle d'Aosta	-18,0	8,0	3,9	5,9	6,2	1,7
Lombardia	-18,0	8,0	9,4	16,3	13,5	1,5
Liguria	-3,0	-16,0	-3,9	-3,6	-4,3	2,4
Trentino Alto Adige	9,0	-16,0	23,5	16,3	27,0	4,3
Veneto	-2,0	2,7	6,7	--	20,3	2,4
Friuli Venezia Giulia	--	-5,3	11,8	16,3	81,0	1,7
Emilia Romagna	18,0	-8,0	3,1	4,1	5,8	1,9
Toscana	--	-16,0	5,9	8,1	11,6	4,3
Umbria	9,0	-8,0	-5,9	-10,8	-10,1	3,4
Marche	-18,0	-8,0	47,0	--	-40,5	3,4
Lazio	-3,6	4,0	-23,5	-9,3	-27,0	--
Abruzzo	-2,6	-2,7	-47,0	-8,1	-5,8	-4,3
Molise	-2,6	-1,6	-6,7	-4,6	-3,4	-1,7
Campania	-2,6	-3,2	-2,6	-2,6	-2,7	-1,1
Puglia	-2,6	-2,3	-2,8	-2,7	-2,6	-2,1
Basilicata	-2,6	-1,6	-6,7	-4,6	-3,4	-2,4
Calabria	-2,6	-1,6	-2,4	-2,4	-2,2	-1,5
Sicilia	-3,0	-1,8	-2,5	-2,6	-2,4	-1,3
Sardegna	-3,0	-2,3	-3,1	-3,1	-2,9	-1,7
NW	***9,0***	***4,0***	***7,8***	***8,1***	***6,8***	***1,9***
NE	***6,0***	***8,0***	***5,9***	***5,9***	***6,2***	***2,1***
C	***18,0***	***8,0***	***11,8***	***13,0***	***11,6***	***4,3***
S	***-6,0***	***-2,3***	***-2,8***	***-3,3***	***-3,0***	***-1,3***

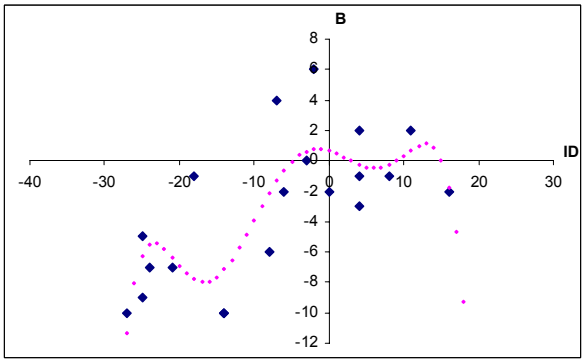
Table 7. Static and dynamic indicators, by groups, regions and macro-areas.

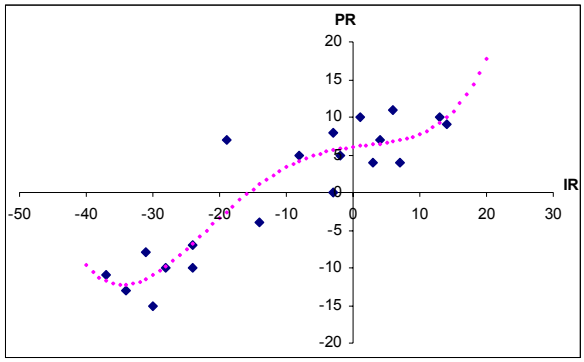
	Static						Dynamic					
	A	B	C	ID	RI	RP	A	B	C	ID	RI	RP
Piemonte	3	4	4	7	11	6	-5	-4	-5	-10	-14	2
Valle d'Aosta	-1	1	3	2	3	8	0	1	9	9	10	2
Lombardia	4	6	10	14	20	8	-5	-4	-5	-10	-14	3
Liguria	1	3	-5	-4	-1	5	-7	-4	-7	-14	-18	2
Trentino Alto Adige	-1	-1	4	3	2	6	3	0	-2	1	1	-2
Veneto	-4	3	9	5	8	7	-5	3	-2	-7	-4	0
Friuli Venezia Giulia	3	0	8	11	11	6	-3	-3	-4	-7	-10	4
Emilia Romagna	4	0	13	17	17	8	-3	-2	2	-1	-3	1
Toscana	2	-2	9	11	9	5	-2	1	-1	-3	-2	-1
Umbria	2	-3	-2	0	-3	2	0	1	-6	-6	-5	3
Marche	-5	-4	5	0	-4	3	4	2	-4	0	2	2
Lazio	2	6	0	2	8	1	-7	-2	-2	-9	-11	-1
Abruzzo	-3	-2	-5	-8	-10	-3	-4	-4	4	0	-4	-1
Molise	-6	-6	-13	-19	-25	-7	-1	-4	6	5	1	-3
Campania	-1	-1	-11	-12	-13	-9	-6	-4	-7	-13	-17	-6
Puglia	-8	-6	-10	-18	-24	-7	1	-1	-7	-6	-7	-1
Basilicata	-3	-7	-11	-14	-21	-8	-4	-3	4	0	-3	1
Calabria	-6	-5	-16	-22	-27	-9	-1	-5	-4	-5	-10	-2
Sicilia	-4	-4	-13	-17	-21	-8	-2	-5	-6	-8	-13	-5
Sardegna	-5	-4	-10	-15	-19	-8	-1	-3	-5	-6	-9	-2
NW	*5*	*6*	*12*	*17*	*23*	*6*	*-3*	*-2*	*-6*	*-9*	*-11*	*3*
NE	*-1*	*-2*	*9*	*8*	*6*	*6*	*4*	*4*	*-1*	*3*	*7*	*2*
C	*2*	*2*	*1*	*3*	*5*	*1*	*-1*	*0*	*3*	*2*	*2*	*3*
S	*-6*	*-4*	*-15*	*-21*	*-25*	*-9*	*3*	*-3*	*-2*	*1*	*-2*	*-4*

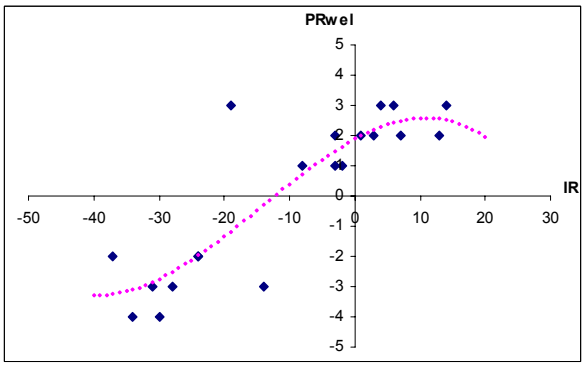
Table 8. Link indicators: χ^2, ρ_{xy}, regression functions, R^2 and MAS.

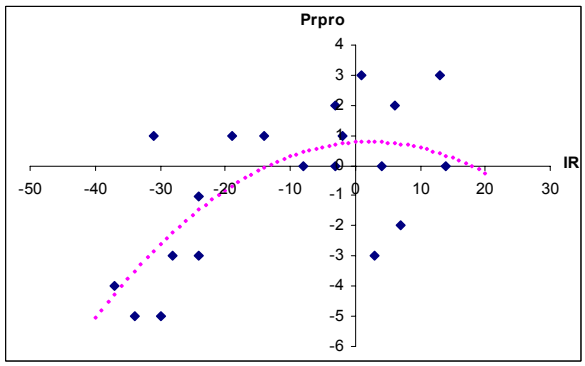
	X^2_{norm}	ρ_{xy}	Regressions	R^2	MAS
ID-B	0,798	0,648	$B = 0{,}643 - 0{,}153ID - 0{,}040ID^2 + 0{,}005ID^3 + 0{,}0002ID^4 - 1{,}478E\text{-}05ID^5 - 5{,}455E\text{-}07ID^6$	0,603	2,353
RI-RP	0,817	0,895	$RP = 6{,}064 + 0{,}114RI - 0{,}008RI^2 + 0{,}001RI^3 + 0{,}00003RI^4$	0,835	2,634
RI-RP$_{wel}$	0,947	0,859	$RP_{ben} = 1{,}891 + 0{,}119RI - 0{,}004RI^2 - 9{,}32E\text{-}05RI^3$	0,757	0,793
RI-RP$_{pro}$	0,911	0,604	$RP_{prod} = 0{,}775 + 0{,}015RI - 0{,}003RI^2$	0,438	1,495
RI-RP$_{emp}$	0,887	0,896	$RP_{lav} = 3{,}804 + 0{,}231RI - 0{,}006RI^2 - 0{,}0002RI^3$	0,818	1,432

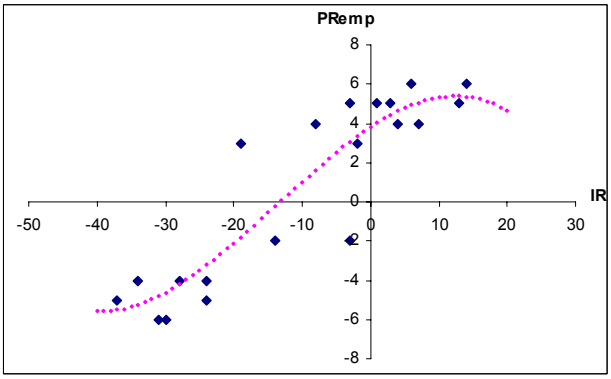
Figure 1. Regression functions











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