Credit risk and rating evaluation as a tool for industrial innovation policy: an application based on the Industry 2015 projects portfolio

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Abstract

This paper investigates the possibility to exploit credit risk evaluation for the definition of new industrial policy measures devoted to maximize potential credit opportunities for industrial innovation projects. The proposed risk evaluation method brings into the project rating process a more accurate representation of its sectoral and regional structure, contributing to attenuate the strong information asymmetry usually registered between the borrower and the potential lender in the case of industrial innovation project financing. Moreover it could allow the definition of different investment profiles corresponding to increasing levels of risk in the considered project portfolio.

The paper presents a case study based on the Industry 2015 innovation projects portfolio, where the beneficiaries are research organization, large enterprise and SMEs. The projects are focused on Energy efficiency, Sustainable mobility, New technologies for Made in Italy.

Our study presents an approach of technical analysis of the credit risk, based on a rating system which is normally used to assess the investments in stocks, which allows to examine the influence of the technological and regional mix on Industry 2015 projects rating.

In particular for the sectoral analysis a set of financial and economic ratios is analyzed to assess the probability of default using Altman method, based on multiple discriminant statistical methodology.

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For the regional analysis the Wroclaw Method is used, based on an aggregation function, that is an adjusted mean of the regional indicators. The obtained regional index is easily computable, interpretable and comparable over time.

A regions-technologies SWOT matrix is built in order to relate the regional index values with the Industry 2015 technological mix.

A first application of the method to differentiate the risk profiles of the various technological themes defined inside the three technological areas of the Industry 2015 projects is reported.

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1 - Introduction

In the rapidly developing knowledge economy, long-term economic growth, employment, and welfare in countries mainly depends on their capability to generate, and implement new knowledge. In particular the competitiveness of an industrial system mainly relays on the effective exploitation of knowledge upgrade by firms to obtain innovation, in a search for profits and growth opportunities [4].

There is a clear perception that Europe is lagging behind US and other major economies in this knowledge based industrial innovation mechanism. The latest designed European growth strategy “Europe 2020”[5] clearly recognizes this point, keeping as one of its target the 3% of the EU's GDP to be invested in R&D, remarking that the European experienced gap is mainly due insufficient private sector R&I spending.

Access to appropriate forms of finance continues to be one of the most serious constraints on innovation by European firms. The relatively high risks related to investments in research and innovation (R&I), the difficulties of the financial operator to assess the potential of new technologies and the reluctance of financial institutions to lend money without collateral, hamper innovation and the growth of innovative companies.

The financial crisis has made access to finance for innovative companies even more difficult, as banks have become more risk-averse than ever. As a result, risk capital for private investments in R&I is very scarce. In particular, innovative companies with rapid growth potential face enormous difficulties in finding external finance in Europe, but even for established companies working on new technologies in key areas (e.g. energy and climate change, biotechnology), private capital sources are limited.

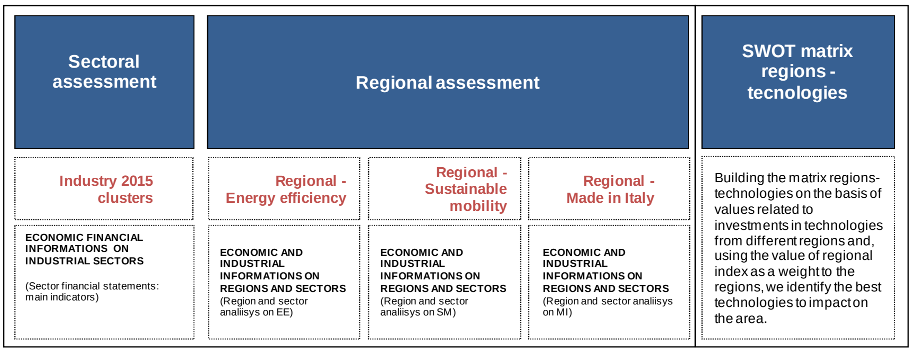
As a consequence, industrial innovation policy should be more risk sharing oriented in order to facilitate access of innovative projects and companies to financial instruments.

This paper investigates the possibility to exploit credit risk evaluation for the definition of such new policy measures, aimed to maximize potential credit opportunities for industrial innovation projects. The proposed risk evaluation method brings into the project rating process a more accurate representation of its sectoral and regional structure, contributing to attenuate the strong information asymmetry usually registered between the borrower and the potential lender in the case of industrial innovation project financing. Moreover it could allow the definition of different investment profiles corresponding to increasing levels of risk in the considered projects portfolio.

Following the lines of the European context in the last years promotion of industrial research and innovation has been the main pillar of the Italian government industrial policy, culminating with the launch in 2008 of the Industry 2015 initiative, mainly based on the realization of the Projects for Industrial Innovation (PII) in the technological areas of Energy efficiency, Sustainable mobility, New technologies for Made in Italy.

The paper presents the application of the proposed risk evaluation to a case study based on the Industry 2015 innovation projects, where the beneficiaries are research organization, large enterprise and SMEs.

The proposed methodology is depicted in the following scheme:



Section 2 describes the sectoral cluster analysis of Industry 2015 related firms; section 3 and 4 contains respectively the evaluation of the relevant sectoral and regional risk; finally section 5 contains the risk ranking of the industry 2015 technologies portfolio and a comparison between the native risk profile of the Industry 2015 projects portfolio and a synthetic risk profile built up with the fifteen lowest risk technologies.

2 - Sectoral and technological cluster analysis of the Industry 2015 projects

For each technological area of the Industry 2015 program, that is Energy efficiency, Sustainable mobility, New technologies for Made in Italy, the frequency distribution of the firms beneficiaries of the projects calls is built, based on sectoral classification Ateco07. This corresponds to identify a proxy of the "sectoral clusters" corresponding to the three areas.

The following figures show the frequency distributions of the three clusters, limited to the sectors assuming the ten highest frequency values.

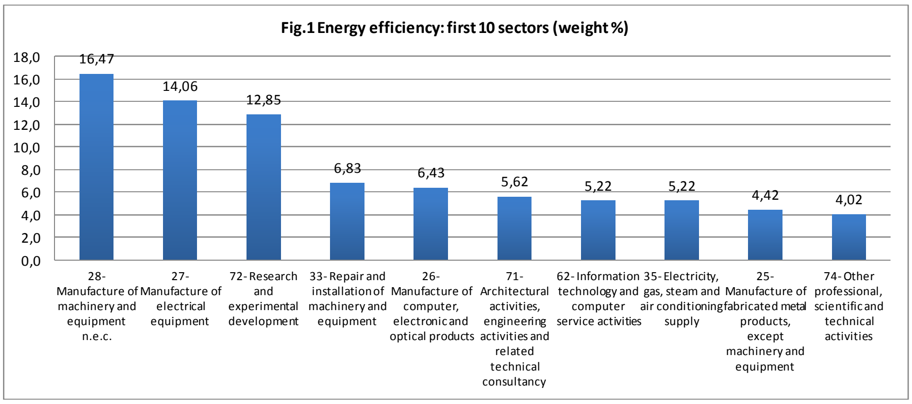


Fig.1 Energy efficiency: first 10 sectors (weight %)

Source: based on Ministry of Economic Development data

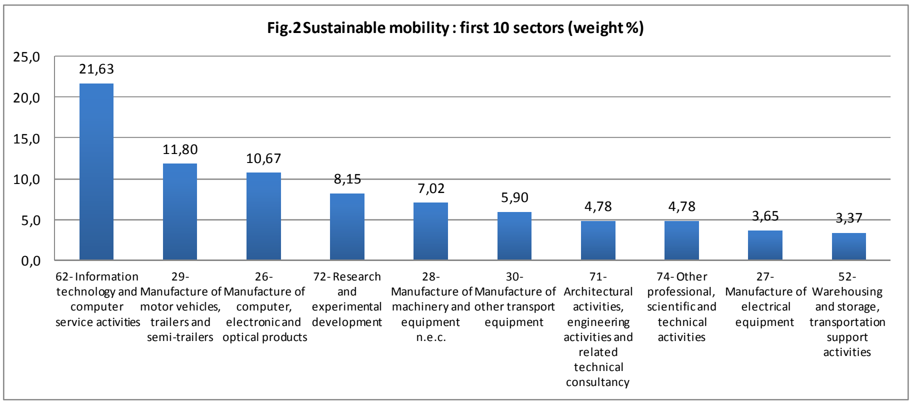


Fig.2 Sustainable mobility : first 10 sectors (weight %)

Source: based on Ministry of Economic Development data

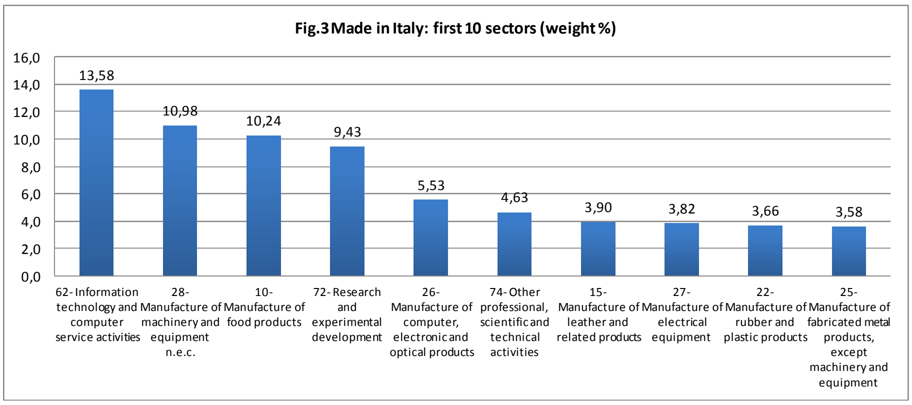


Fig.3 Made in Italy: first 10 sectors (weight %)

Source: based on Ministry of Economic Development data

3 - The measurement of the sectoral risk

For the sectoral risk analysis the Altman credit scoring model is used[1], based on the following discriminant statistical function:

$$\mathbf{EM = 3.25 + 6.56\ X1 + 3.26\ X2 + 6.72\ X3 + 1.05\ X4}$$

- X1 = working capital/total assets
- X2 = retained earnings/ total assets
- X3 = earnings before interest and taxes/ total assets
- X4 = market value of equity/ book value of total liabilities
-

To reproduce the ex ante condition typical of a policy design phase, the financial and economic data, used to build the input to evaluate the EM function for each technological area, are sectoral aggregate data, averaged over the last five years, derived from the Mediobanca database. Before entering in the Altman discriminant function these data are further averaged, weighted with the sectoral relative frequencies coming from the corresponding frequency distribution.

The most important rating agencies use the following scales:

Moody's	S&P	Fitch
Aaa	AAA	AAA
Aa1	AA+	AA+
Aa2	AA	AA
Aa3	AA-	AA-
A1	A+	A+
A2	A	A
A3	A-	A-
Baa1	BBB+	BBB+
Baa2	BBB	BBB
Baa3	BBB-	BBB-
Ba1	BB+	BB+
Ba2	BB	BB
Ba3	BB-	BB-
B1	B+	B+
B2	B	B
B3	B-	B-
Caa1	CCC	CCC

EM-score uses the rating notation like S&P and Fitch, decreases with the increase of the probability of default.

Fig.4 Rating classification	
EM Score	**Rating**
EM ≥ 8.15	AAA
7.60≤EM<8.15	AA+
7.30≤EM<7.60	AA
7.00≤EM<7.30	AA-
6.85≤EM<7.00	A+
6.65≤EM<6.85	A
6.40≤EM<6.65	A-
6.25≤EM<6.40	BBB+
5.85≤EM<6.25	BBB
5.65≤EM<5.85	BBB-
5.25≤EM<5.65	BB+
4.95≤EM<5.25	BB
4.75≤EM<4.95	BB-
4.50≤EM<4.75	B+
4.15≤EM<4.50	B
3.75≤EM<4.15	B-
3.20≤EM<3.75	CCC+
2.50≤EM<3.20	CCC
1.75≤EM<2.50	CCC-
EM<1.75	D

Source: based on In-Depht Data Corp.(over 750 U.S. Corporates with rated debt outstanding: 1995 data)

From the value of EM-score is possible to construct a classification of rating and to estimate the probability of default (PD):

$$PD = p(B|\mathbf{x}_i) = \frac{1}{1+\frac{1-\pi_B}{\pi_B} e^{z_i-\alpha}}$$

cut-off

π_B is equal to the incidence of insolvent companies in the sample

probability to belong to insolvent companies (B)

Tab.1 EM score value 2002-2011

SECTORS	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	av. 2007-2011
industrial company	**4,3**	**4,5**	**4,8**	**4,9**	**4,8**	**4,6**	**4,6**	**4,6**	**4,7**	**4,5**	**4,6**
food	5,0	4,9	4,8	4,8	4,9	4,8	4,7	4,8	4,9	4,8	4,8
textiles	5,4	5,3	5,5	5,7	5,7	5,6	5,0	4,8	5,0	5,0	5,1
wearing apparel	5,0	5,6	5,4	5,5	5,4	5,2	5,1	5,6	5,8	5,7	5,5
leather	4,8	6,0	6,3	6,6	6,9	6,3	6,7	6,5	6,3	6,4	6,4
wood and furniture	5,5	5,2	5,4	5,5	5,5	5,3	5,2	4,8	5,1	5,0	5,1
paper	4,3	4,2	4,2	4,0	4,0	4,2	4,2	4,5	4,3	4,3	4,3
printing	4,7	4,5	4,5	4,7	5,8	5,2	5,1	4,2	4,3	4,4	4,6
coke and refined petroleum	4,1	4,6	5,3	5,1	4,9	4,3	4,6	4,8	4,9	4,6	4,6
chemicals	4,3	4,4	4,6	4,8	5,2	5,2	4,8	4,8	5,2	5,2	5,0
pharmaceuticals	5,9	5,8	5,9	6,1	5,8	5,5	5,5	5,7	5,8	5,7	5,6
rubber and plastic	3,6	3,3	3,8	4,5	4,0	4,2	3,5	3,8	3,9	3,8	3,8
other non-metallic minerals	5,5	5,6	6,2	5,7	5,6	5,6	5,4	5,1	4,9	4,7	5,1
basic and fabricated metals	4,1	4,2	4,9	5,3	5,5	5,8	5,4	4,7	4,7	4,7	5,1
machinery and equipment n.e.c.	4,8	4,8	5,1	5,0	5,0	5,0	4,9	4,7	5,0	5,0	4,9
computer, electronic, optical and electrica	4,7	4,5	5,1	4,9	4,9	4,7	4,8	4,7	4,8	4,4	4,7
transport equipment	3,3	3,6	3,3	4,1	3,9	3,8	3,8	3,5	3,7	3,0	3,6
construction	4,1	3,9	4,0	4,6	4,4	4,6	4,5	4,4	4,3	4,2	4,4
pubblic service	3,5	3,8	4,7	4,4	4,2	4,1	3,6	3,8	3,9	3,5	3,8
other company	4,2	3,9	4,1	4,3	4,5	4,3	4,4	4,2	4,3	3,7	4,2
ENERGY EFFICIENCY	**4,2**	**4,2**	**4,7**	**4,6**	**4,6**	**4,5**	**4,3**	**4,3**	**4,4**	**4,1**	**4,3**
SUSTAINABLE MOBILITY	**3,9**	**3,9**	**4,3**	**4,4**	**4,3**	**4,2**	**4,1**	**4,0**	**4,1**	**3,7**	**4,0**
MADE IN ITALY	**4,4**	**4,3**	**4,6**	**4,6**	**4,7**	**4,6**	**4,5**	**4,4**	**4,5**	**4,2**	**4,4**
INDUSTRY 2015	**4,1**	**4,1**	**4,5**	**4,6**	**4,5**	**4,4**	**4,3**	**4,2**	**4,3**	**4,0**	**4,2**

Source: based on Mediobanca data

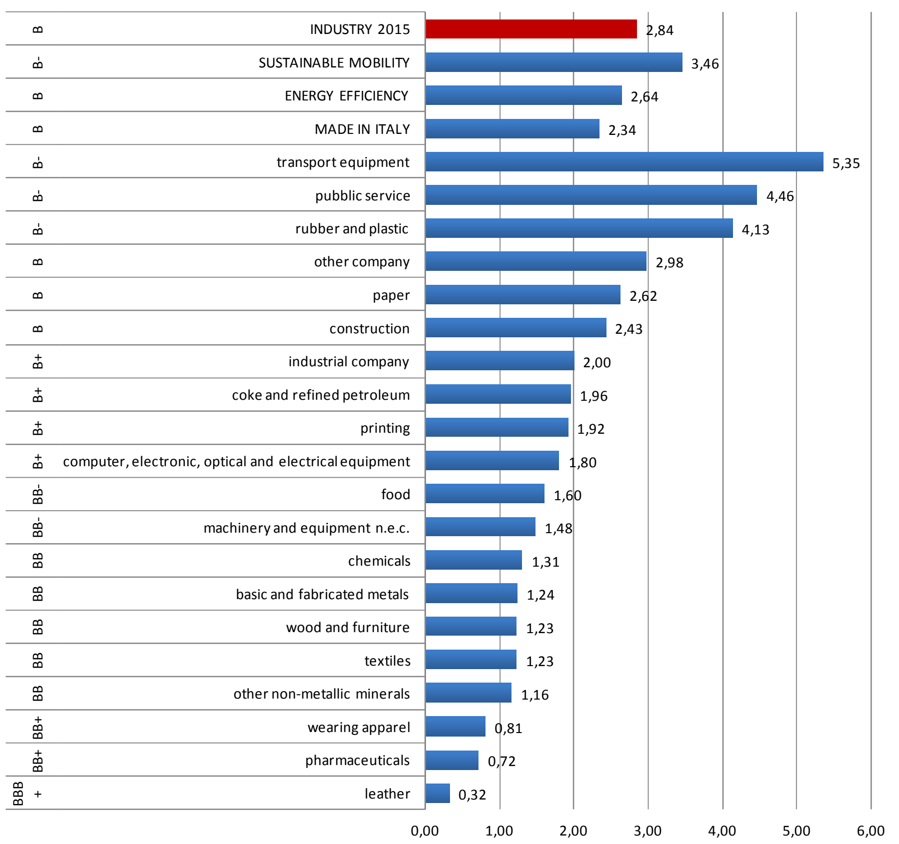


Fig.5 Probability of default (%) and rating (av. 2007-2011)

Source: based on Mediobanca data

4 - The measurement of the regional risk

For the regional analysis the proposed approach, called Wroclaw Method[2], normalizes the indicators by a specific criterion that deletes the unit of measurement and the variability effect and uses, as aggregation function, an adjusted mean by a penalty coefficient that is function, for each unit, of the indicators variability in relation to the mean.

The obtained IR index (Regional Index) is easily computable, interpretable and comparable over time. The variables used are as follows: enterprises, employees, export and social safety nets. The IR index is as follows:

$$IR_i = \frac{\sum_{k=1}^{3} D_{ik}^2 \cdot p_k}{\sum_{k=1}^{3} p_k}, \quad per\_i = 1,2,\ldots 20$$

D_{ik} *is the k- cluster index of the i-region, is equal to the euclidean distance weighted by 1/standard*

0< IR <1

p_k *is the PD value of k-cluster*

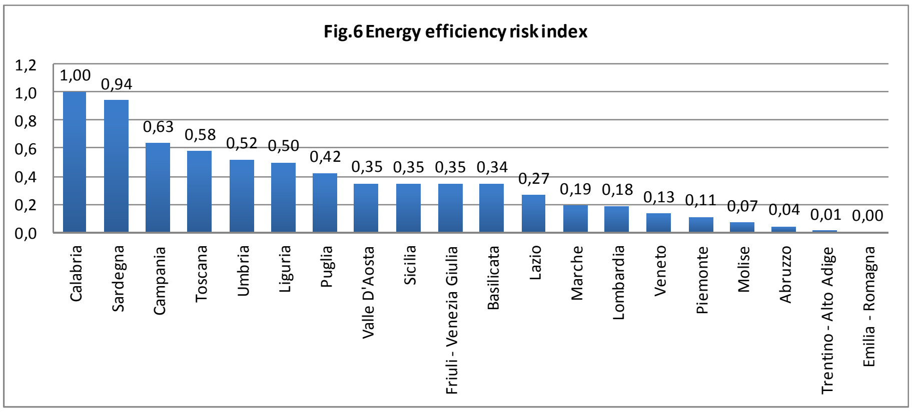


Fig.6 Energy efficiency risk index

Source: based on Infocamere, Inps, Istat data

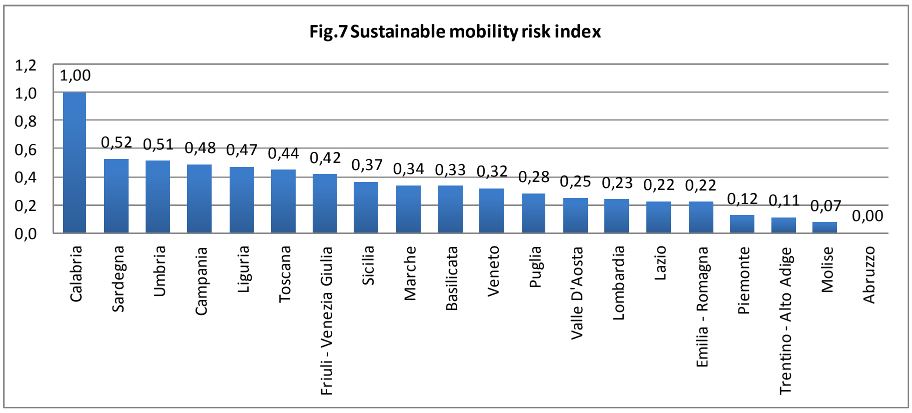


Fig.7 Sustainable mobility risk index

Source: based on Infocamere, Inps, Istat data

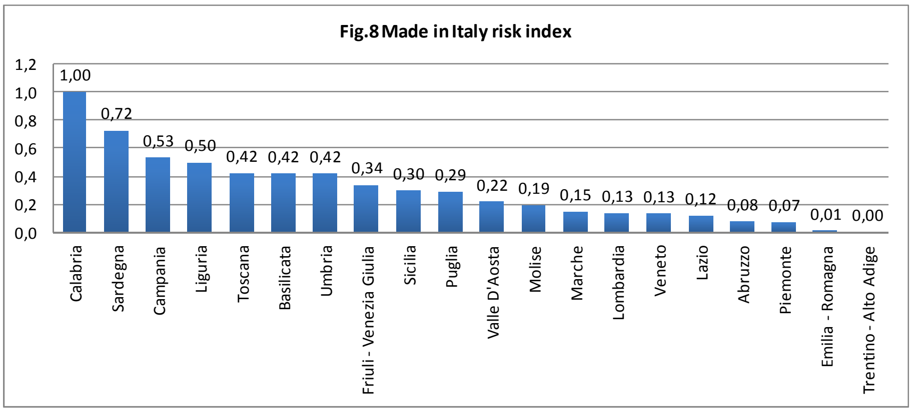
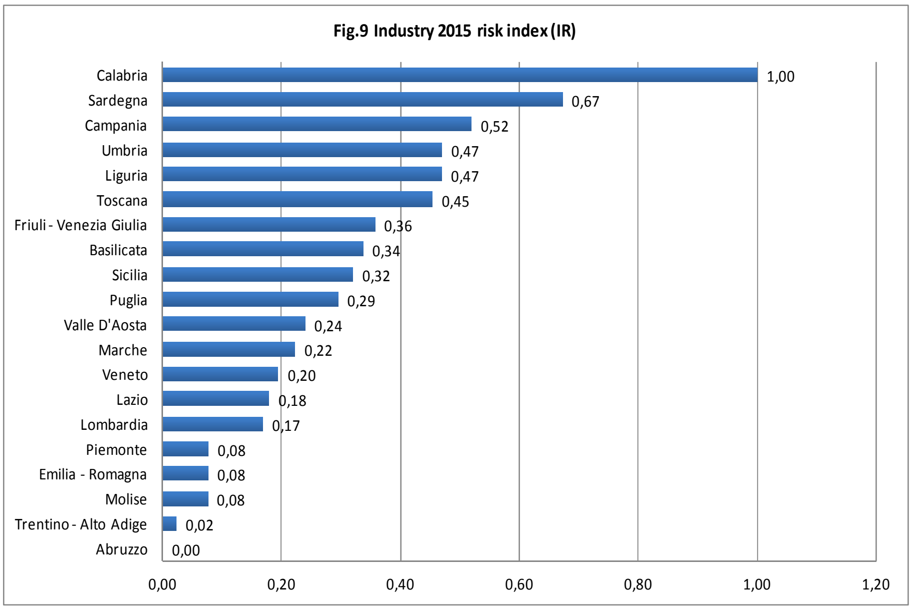


Fig.8 Made in Italy risk index

Source: based on Infocamere, Inps, Istat data



Source: based on Infocamere, Inps, Istat data

5 - The assessment of the Industry 2015 technologies

On the base of the results of the technical and scientific assessment performed during the design and programming phase of the Industry 2015 initiative, several technological themes have been identified inside each area. As for the sectoral clusters, for the technological ones a proxy has been used, corresponding to the ex post distribution of spending, among technological themes and regions, proposed by firms beneficiaries of the calls.

A regions-technologies swot matrix has been built, weighting relative spending distribution data with the values of the regional/sectoral index (see Table 2). This matrix has been used to rank the risk of the technologies. In particular, Table 3 contains the list of the 15 technologies with the lowest PD values.

Tab.2 Investment composition (%) weighted by regional index

REGIONS/TECHNOLOGIES		Piemonte	Valle D'Aosta	Lombardia	Trentino - Alto Adige	Veneto	Friuli - Venezia	Liguria	Emilia - R.	Toscana	Umbria	Marche	Lazio	Abruzzo	Molise	Campania	Puglia	Basilicata	Calabria	Sicilia	Sardegna	Identification of development technologies
	weight (regional index)	***6,2***	***5,4***	***5,7***	***6,5***	***5,6***	***4,7***	***4,1***	***6,2***	***4,2***	***4,1***	***5,4***	***5,7***	***6,6***	***6,2***	***3,9***	***5,1***	***4,8***	***1,3***	***4,9***	***3,1***	***100,0***
Energy efficiency	a1) Solar PV	1,2	0,0	1,7	3,1	1,5	3,4	0,0	13,6	4,7	12,2	0,0	0,0	0,0	0,0	0,9	0,9	0,0	8,9	4,6	10,8	2,9
	a2) Solar thermal and thermodynamic	0,0	0,0	2,8	0,0	0,1	2,4	0,3	0,6	0,9	30,4	0,0	0,6	0,0	0,0	0,4	0,3	0,0	0,0	0,5	0,0	1,7
	a3) Bioenergy	12,5	0,0	9,7	19,1	13,4	0,0	2,3	6,3	0,7	0,7	0,2	6,0	1,8	0,0	0,2	19,4	31,5	6,7	33,1	0,0	8,6
	a4) Fuel Cells and Hydrogen	0,5	0,0	1,9	0,8	2,7	0,0	0,4	1,9	4,2	0,0	0,0	1,6	0,0	0,0	0,0	0,3	0,0	1,4	0,0	0,0	0,8
	a5) Distributed Generation	1,9	0,0	0,9	12,3	6,5	4,6	0,0	3,9	0,8	8,3	11,7	0,8	0,0	0,0	0,0	0,0	6,0	0,0	3,1	11,5	3,6
	b1) Wind power	0,0	0,0	0,6	27,2	2,1	1,8	7,0	1,1	6,4	0,0	0,0	0,0	0,0	0,0	0,1	1,9	0,0	2,8	0,0	0,0	2,8
	b2) Building bioclimatic	1,0	0,0	3,7	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,3	1,3	0,0	0,0	3,4	0,0	2,1	2,6	0,0	0,0	0,7
	b3) Electric motors with high efficiency	0,6	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	11,3	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7
	b4) Advanced Lighting Technologies	0,9	0,0	0,3	2,8	0,2	10,7	1,2	0,6	0,0	0,0	0,0	1,0	0,0	0,0	0,5	0,0	0,0	0,0	0,2	0,0	0,9
	b5) Electric high-efficiency	2,5	0,0	8,1	1,7	2,0	2,8	0,0	0,8	1,7	0,0	18,4	3,2	0,0	0,0	9,4	0,8	0,0	0,0	2,0	27,7	3,6
	b6) Energy efficiency of industrial processes	0,0	0,0	0,2	0,0	0,0	13,4	2,3	2,5	2,1	0,0	0,0	2,1	0,0	0,0	0,6	5,0	1,7	0,0	0,0	6,9	1,7
Sustainable mobility	a1) Naval systems and subsystems	0,4	0,0	1,9	0,0	0,1	9,3	11,7	0,1	0,0	0,0	1,3	0,0	0,0	0,0	0,6	2,5	0,0	0,0	0,0	0,0	1,3
	a2) Boats	0,0	0,0	0,5	4,6	1,9	1,8	1,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6
	a3) Urban road vehicles	26,4	0,0	3,7	1,2	4,4	1,4	2,2	13,8	10,8	1,5	0,0	7,0	15,4	0,0	1,7	0,2	0,0	0,0	2,0	0,0	5,3
	a4) Rail vehicles	4,3	0,0	1,6	0,0	3,1	5,7	9,5	0,2	2,0	0,0	0,0	0,0	4,7	0,0	10,9	4,3	0,9	0,0	0,0	0,0	2,3
	b1) Management of intermodal transfer	0,5	0,0	0,7	0,0	0,7	6,5	31,2	0,2	4,2	0,0	0,8	1,1	0,0	0,0	0,8	2,5	7,8	5,9	0,0	0,0	2,6
	b2) Systems for the safe mobility and integrated	8,8	0,0	7,9	4,9	1,8	1,0	7,2	3,7	14,0	10,7	0,2	23,4	9,4	0,0	4,9	1,1	8,5	0,0	2,7	0,0	5,8
	b3) Modular production systems	4,7	0,0	0,7	0,0	1,9	2,3	0,6	0,6	0,0	0,0	0,0	0,3	0,0	0,0	0,1	0,0	1,1	0,0	0,0	0,0	0,7
Made in Italy	a1) New needs of consumers	0,3	0,0	2,7	1,6	5,3	7,9	1,0	4,0	5,3	2,8	15,4	3,5	17,1	0,0	1,3	1,4	0,0	1,0	0,4	0,0	3,9
	a2) Innovative and intelligent materials	3,5	0,0	10,7	2,3	9,4	17,7	1,8	13,9	7,0	0,0	2,2	4,0	15,3	0,0	4,6	4,0	6,9	0,4	5,7	8,8	6,2
	a3) Mechatronic solutions	12,0	9,2	13,7	5,9	9,6	2,9	7,9	7,0	10,6	11,2	13,6	15,9	28,2	0,0	12,3	14,4	2,8	14,6	17,3	3,8	10,8
	a4) Systems for civil and industrial environments	0,6	90,8	0,8	0,0	2,3	0,0	0,7	4,7	0,7	6,7	2,2	2,4	0,0	0,0	9,0	0,0	7,7	6,8	5,4	15,9	7,5
	a5) Production systems for the quality of life	2,3	0,0	2,6	3,8	3,3	0,6	1,3	6,9	6,8	12,3	2,3	7,4	2,0	18,0	5,0	11,0	2,1	0,4	3,9	0,0	4,9
	a6) Environmental performance and life of products	3,8	0,0	4,8	0,0	5,0	0,6	2,4	4,5	2,3	1,0	0,0	3,0	0,0	13,6	3,7	2,0	4,2	5,5	0,0	0,0	2,9
	b1) Environmentally friendly processes, renewable raw	4,7	0,0	5,5	0,0	4,6	1,0	0,0	0,8	6,4	1,0	0,0	0,2	4,4	0,0	0,2	0,0	0,0	0,0	1,7	0,0	1,7
	b2) Supply chain systems for the production cycle	1,2	0,0	1,2	0,0	5,0	0,0	0,0	0,5	0,8	0,0	0,5	1,7	0,8	0,0	6,4	2,5	8,2	0,0	4,8	0,0	1,7
	b3) Organization of supply chains	1,2	0,0	2,0	0,0	8,8	0,0	0,0	1,0	0,0	0,0	0,0	2,3	0,0	59,7	6,1	2,8	0,0	1,1	5,2	0,0	5,2
	c1) Innovative retail formats on the market	0,5	0,0	1,7	8,7	2,8	0,0	6,3	2,0	1,8	0,0	4,3	1,6	0,0	0,0	2,5	1,1	0,0	26,5	0,7	14,5	2,6
	c2) Tools for marketing business	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,8	0,2	0,8	0,0	1,1	1,1	0,0	0,0	2,1	0,0	0,7
	c3) E-commerce e market intelligence	0,4	0,0	3,1	0,0	0,5	0,0	0,0	0,0	0,4	1,1	0,0	5,9	0,0	0,0	9,4	0,8	0,0	0,0	0,0	0,0	1,0
	c4) Logistics supply chain solutions	3,3	0,0	4,6	0,0	1,0	2,4	0,9	3,3	5,4	0,0	7,3	3,3	0,0	8,6	3,7	19,7	8,5	15,7	4,7	0,0	4,2
TOTAL		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: based on Ministry of Economic Development data

Tab.3 Identification of the best 15 Industry 2015 technologies

Cluster	Technologies	Weight
Made in Italy	a3) Mechatronic solutions	10,78
Energy efficiency	a3) Bioenergy	8,59
Made in Italy	a4) Systems for civil and industrial environments	7,53
Made in Italy	a2) Innovative and intelligent materials	6,21
Sustainable mobility	b2) Systems for the safe mobility and integrated	5,78
Sustainable mobility	a3) Urban road vehicles	5,31
Made in Italy	b3) Organization of supply chains	5,25
Made in Italy	a5) Production systems for the quality of life	4,89
Made in Italy	c4) Logistics supply chain solutions	4,22
Made in Italy	a1) New needs of consumers	3,92
Energy efficiency	a5) Distributed Generation	3,64
Energy efficiency	b5) Electric high-efficiency	3,64
Energy efficiency	a1) Solar PV	2,93
Made in Italy	a6) Environmental performance and life of products	2,88
Energy efficiency	b1) Wind pow er	2,77
Energy efficiency		**21,57**
Sustainable mobility		**11,09**
Made in Italy		**45,68**
INDUSTRY 2015		**78,34**

Source: based on Ministry of Economic Development data

The method can also be used to compare the risk profiles, in terms of expected loss rate, of the fifteen technologies with lowest PD values, (Tab.3), and the whole Industry 2015 projects portfolio.

The primary inputs of the Internal Rating Based approach (IRB) of the credit risk to calculate the expected loss (EL) are:

- Probability of Default (PD), measuring the likelihood that the borrower will default over a given time horizon;
- Loss Given Default (LGD), measureing the proportion of the exposure that will be lost if a default occurs;
- Exposure At Default (EAD), measureing the amount of the facility that is likely to be drawn if a default occurs.

To calculate the expected loss, it is necessary to weight the credit exposure calculations discussed above by the probability of default.

The function of expected loss is as follows:

$$EL = PD_n * LGD_n * EAD_n$$

where: LGD is equal to 75% (proposed in the Basel 2 Capital Accord, for subordinated loans); EAD and EL in millions euro.

Tab.4 Results: a comparison between Industry 2015 and portfolio of the best 15 Industry 2015 technologies

Inputs	**Industry 2015**	Energy efficiency	Sustainable mobility	Made in Italy
PD	**2,84**	2,64	3,46	2,34
LGD	**75,0**	75,0	75,0	75,0
EAD	**2.159**	593	485	1.080
Expected loss (EL)	**46**	12	13	19
Exp. loss rate (EL/EAD*100)	**2,13**	1,98	2,59	1,75

Inputs	**Portfolio (15 techn.)**
PD	**2,58**
LGD	**75,0**
EAD	**1.640**
Expected loss (EL)	**32**
Exp. loss rate (EL/EAD*100)	**1,93**

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