

Mapping and factoring the 2007 ATECO categories in regard to specialised human capital

Luigi Fabbris, Paolo Feltrin

1. Introduction

The paper describes an exercise of classification of the five-digit categories of the 2007 Ateco classification system of economic activities (<https://www.istat.it/en/methods-and-tools/classifications>). The purpose of the work is to highlight the categories showing top levels of human capital (HC) in order to pinpoint the categories that are likely to lead the Italian economic growth in the near future.

An attempt to measure the effects of HC concentration in a territory was realised by Moretti (2012) in the United States. He showed that innovation can attract in a territory many other jobs and form the basis of a global knowledge economy (see also Etzkowitz and Leydesdorff, 1997). In Italy, attempts to link HC to territorial clusters was studied, among others, by Colombo and Delmastro (2002) with reference to technology incubators, Liberati et al. (2013) to science and technology parks, and Bertamino et al. (2014) to technological districts. All Italian studies conclude that locating firms within a specialised territory does not influence significantly business R&D. This may be due to the different demographic density of the United States and Italy. In this work, we ignored the location of economic activities and scouted the complementary hypothesis that HC impacts certain activities more than others and this can lead to an enduring development of the activities.

Our exercise was realised through a multivariate mapping of the two-digit Ateco categories on the basis of HC indicators and a factorisation of the indicators so to understand if and how higher competence can be considered a connection trait of certain economic categories.

The results of our analysis could be useful, among else, to evaluate possible relations between academic education and economic growth in Italy. This possible relationship correlates also with some strategies of the Italian PNRR (National Plan for Recovery and Resilience; <https://www.governo.it/sites/governo.it/files/PNRR.pdf>) and may help forecasting its possible outcomes.

The rest of the paper is organised as follows. Section 2 shortly describes the indicators created for defining the HC of Ateco categories and the methodology adopted for the exercise; Section 3 presents the main results of the data analysis; and Section 4 discusses the results of the statistical analysis with reference to the mainstream literature and then concludes.

2. Data and methodology

The indicators of HC associated to the Ateco categories are the following.

1. Per cent frequency of workers with a university degree (from now on also “higher HC”) out of total Italian workers at year T .
2. Per cent ratio between the relative frequency of “higher HC” at years T and $T-1$.
3. Per cent frequency of workers in intellectual or scientific jobs (ISCO-02, from now on also “higher jobs”) out of total workers at year T .
4. Per cent ratio between the relative frequency of ISCO02 workers at years T and $T-1$.
5. Per cent frequency of self-employed workers with a university degree (“higher HC-SE”) out of total self-employed at year T .

6. Per cent ratio between the relative frequency of higher HC-SE at years T and $T-1$.
7. Per cent frequency of self-employed workers in intellectual or scientific jobs (ISCO-2) out of total self-employed at year T .
8. Per cent ratio between the relative frequency of ISCO02-SE at years T and $T-1$.
9. Per cent frequency of self-employed workers out of total workers at year T .
10. Per cent ratio between the relative frequency of self-employed at years T and $T-1$.

To obtain more stable estimates, year T data were averaged over years 2018 and 2019 and $T-1$ data were averaged over years 2011 and 2012. The Ateco categories that changed from 2011 to 2019 or were null at either year were merged or excluded from the analyses. We ended up with 84 Ateco categories. The Covid-19 pandemic particularly threatened employment; that is why, in this work, we considered anomalous, and then ignored the 2020 data.

The idea in the background of our choice of indicators was that a leading economic category is one that is qualified by a high frequency of college-educated workers and parallels that of people working in higher jobs. This frequency is evaluated for both all Italian workers and the self-employed. While the relevance of higher education as a distinctive trait of leading economic activities recurs in the mainstream literature (Autor et al., 2003 and Moretti, 2012, though the latter argues that excellent exceptions are numerous), that of self-employment as a qualitative symptom derives from studies on the future of work (European Commission, 2013; OECD, 2019), which forecast a growing relevance of self-employment for job creation or job restructuring in the next decades.

The relational analysis of the indicators was based on a Varimax-rotated principal-component factor analysis (Browne, 2001). The analysis aimed to elicit the multiple relationships between indicators and define a mapping system of categories inclusive of all intercorrelated indicators.

The R Studio package was used to compute the estimates.

3. Results

The statistical analysis of the basic indicators showed that, in Italy, both the percentage of workers with a college (from now on also “higher education”) degree and that of workers in an intellectual or scientific job (from now on also “higher job”) are important and show an increasing trend (Table 1). In particular, the proportion of the employed with a higher education degree was 23.3% in 2018/19 and had an amazing increase since 2011/12: +29.5% (basis 2011/12=100).

Even the employed in a higher job represented a relevant and increasing quota of Italian workers: in 2018 and 2019, the quota of workers in an intellectual or scientific job was 14.8%, with a notable increase (+14.8%) from to the basic year. This may be due to the diffusion of technological innovation also in many traditional sectors, which, in turn, activated an additional demand for highly qualified jobs.

The proportion of self-employed was relevant (22.8%, average value of the years 2018 and 2019), at least in comparison with other European countries, but in diminution (-8.3%) from 2011/12. The stream-lining concerned the categories of para-subordinates and of self-employed in craft, commerce and agriculture: in fact, most movers from these categories either retired or became employees. Instead, the number of employers and freelances increased during the examined time span (Fabbris and Feltrin, 2021). Our data show that the increase concerned both the self-employed with a college degree and those in a higher job and this increase was larger than that that involved employees. It is interesting that all indicators of level are positively skewed, and this allows pinpointing the Ateco categories with the higher levels of the examined indicators.

So, we applied factor analysis twice, once to examine the relationships among the level at 2018/19 and its variation from 2011/12 of three basic indicators (per cent of workers with a higher education degree, in a higher job, and self-employed) and another including also the level and variation of two qualified categories (workers with a college education and workers

in an intellectual or scientific job) among the self-employed. The latter, which was named 10-variable analysis, was an attempt to involve in the analysis the interactions between self-employment and the other two basic indicators.

Table 1. Mean values of HC indicators at years 2011/12 and 2018/19, Italy

Indicator	Mean 2011/12	Mean 2018/19	Variation 2018/19 vs. 2011/12
Per cent workers with a college degree	18.0	23.3	29.5
Per cent workers in an intellectual or scientific job	12.9	14.8	14.8
Per cent self-employed workers	24.9	22.8	-8.3
Per cent self-employed with college degree	20.0	26.6	33.2
Per cent self-employed in an intellectual or scientific job	16.2	19.3	18.9

Table 2. Correlation coefficients between human capital indicators (Italy, 2018/19) (significance levels in the upper triangle: ***<1%; **<1%; *<5%; °<10%)

	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀
X ₁	=		***		***	*	***		*	
X ₂	-0.039	=		***	**		*			°
X ₃	0.893	-0.157	=		***		***		**	
X ₄	0.008	0.501	-0.087	=						
X ₅	0.842	-0.297	0.802	-0.174	=		***		**	
X ₆	-0.231	0.053	-0.169	-0.155	-0.054	=				
X ₇	0.828	-0.243	0.912	-0.178	0.883	-0.130	=		**	
X ₈	-0.099	0.084	-0.073	-0.002	-0.027	0.133	-0.038	=		
X ₉	0.275	-0.096	0.346	-0.104	0.309	0.076	0.349	-0.104	=	*
X ₁₀	-0.034	-0.196	0.021	-0.175	0.083	0.178	0.019	-0.110	0.283	=

Table 3. Two-factor Varimax-rotated configuration with 6 and 10 HC indicators, 2018 and 2019, Italy.

	6 indicators		10 indicators	
	f ₁	f ₂	f ₁	f ₂
X ₁	0.84	-0.45	0.94	0.15
X ₂	-0.38	-0.69	-0.20	0.68
X ₃	0.90	-0.32	0.95	0.01
X ₄	-0.31	-0.73	-0.09	0.75
X ₅	=	=	0.91	-0.15
X ₆	=	=	-0.24	-0.40
X ₇	=	=	0.95	-0.09
X ₈	=	=	-0.10	0.09
X ₉	0.59	0.09	0.40	-0.35
X ₁₀	0.25	0.51	0.00	-0.62
<i>Eigenvalue</i>	2.17	1.56	3.80	1.75

The correlation coefficients between the indicators, presented in Table 2, showed that:

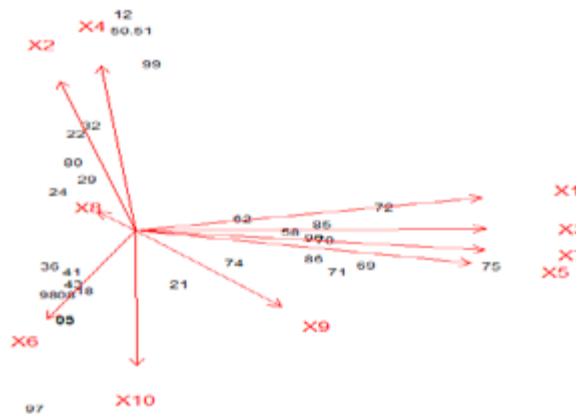
- The indicators of the 2018/19 levels highly correlated to each other: the correlation among X1, X3, X5 and X7 is exceptionally high, since all correlation coefficients were above 0.80. Just X9 – the self-employment rate – though positively intercorrelated, is below this high level. This means that education and innovation cross-fertilise both among employees and the self-employed within certain economic activities and stay close to the bottom in others.
- Correlations between change indicators are weaker and follow different patterns: the

correlation between the rate of variation of high education and high jobs is positive both among the complex of Italian workers (0.50) and the self-employed (0.13), while it is not significant or negative for all the other analysed variations.

Both the 6-indicator and the 10-indicator factor analyses (Table 3) showed that two factors are enough to represent the between-indicator correlations. In fact, the first two factors explained, respectively, 62% and 55.5% of the global variance. Though, the higher complexity of the 10-indicator analysis led us to privilege it for our analysis. The two-factor solution (Figure 1) showed that:

- There is a strong positive inter-correlation between the indicators X1, X3, X5 and X7 and a mild one with X9. The five indicators describe the level of qualified workers in 2018/19, that is why we can call the first factor “high skill levels” and higher scores pinpoint the activities with a higher density of very skilled jobs.
- There is a positive relation between the second factor and indicators X2 and X4 of time change and a negative one with X6, again of time change. The other two variation indicators (X8 and X6) do not fit neither this factor, nor the previous one. The second factor, which includes variables X2, X4 and X10 (the latter with a negative sign) can be called “positive trend of high skill activities”.

Figure 1. Map of the Ateco categories on the surface defined by the first (abscissa) and second factor (ordinate) obtained with a Varimax rotated 10-indicator factor analysis, Italy (numeric codes refer to two-digit Ateco classification; X-arrows represent the indicators)



The Ateco categories represented in Figure 1 show that the categories leading the intensity scale of human capital as measured by higher education, higher jobs and entrepreneurial spirit were: 75 (veterinary services), 72 (scientific research and development), 70 (business management and consultation), 71 (studies of architecture, engineering and other technical services), 86 (health services), 69 (legal and accounting offices), 85 (education) and 90 (creative, artistic and entertainment activities). In all these categories graduates exceeded 50% of total workers and, with the exception of category 90, exceeded 60% rate of workers possessing a higher education degree. Also, the categories number 58 (editorial activities), 62 (software production) and 74 (other professional, scientific or technical activities) scored positively on this main factor. All the quoted categories but number 62 (software production) showed also a positive trend at the end of the examined period. As expected, high skill jobs are associated to innovative sectors and refer to both employees and the self-employed.

The category scoring negatively on the first factor but showing a steep qualitative increase during the considered period is number 97 (family and community assistance), meaning that the personnel to assist families for housework and/or people with impairments were less educated than average in 2011 but are notably increasing their education and skills in the last years.

4. Discussion and conclusion

In this work, we aimed to highlight the Ateco categories showing higher and/or increasing levels of human capital at 2018 and 2019. The indicators of HC intensity referred to both college-educated skills, workers' employment in higher jobs, and entrepreneurship. Taken together, the indicators aimed at representing both the rate of superior knowledge required by jobs at certain economic activities and the innovation necessary to improve products and processes, as well as the entrepreneurial spirit that should accompany knowledge and innovation as drivers of business opportunities. We examined both the level of indicators and their dynamic perspective. Variation was taken with reference to 2011 and 2012 as baseline years.

Our exercise is similar to that of defining what economists, referring to industrial clusters, call "the Marshallian trinity of information exchange, specialized suppliers, and a pool of labor with specialized skills" (Krugman, 2017). Of course, in our case, proximity does not refer to territory but to similar economic activities: paraphrasing Becattini (1990), we asked ourselves if there were economic categories sharing a system of values, views, language, expectations and behaviours, combined to an entrepreneurial culture and knowledge, that shape the productive atmosphere and drive the development of the firms and the workers in them. In particular, people working for themselves should know what hitherto and in perspective would be managed for them.

We have found that there are categories leading the trinomial: knowledge-innovation-entrepreneurial spirit. Some of them could be given for granted, such as medical, veterinary, education and R&D activities that are mainly related with top jobs. Legal, accounting, architecture, engineering and other highly technical activities require superior education and training and are often realised in a self-employed environment, either solo or in small offices.

What may be a novelty in this knowledge-oriented group of activities is that of business and management consultation and that of creative artistic and entertainment industry. Business consultant and managers are relevant to the development of both local and global businesses and work in competition to each other at national and international levels. To consult and manage firms you need not only a specific knowledge but also culture and a personality adequate to make strategic decisions. Specific education and training and the capacity to identify themselves with entrepreneurs are essential components of the professional personality of these workers.

The relevance of creative industries as a driver of local development is underlined in Moretti (2012). In Italy, these sectors refer to the so-called "four Fs" of made in Italy (fashion, food, factory automation, furniture and design), as well as tourism, leisure and information diffusion. The peculiarity of this industry is that technical activities are of the creative and cultural type.

All this raises an education issue. With reference to universities, the issue implies decisions ranging from educational strategies to practicalities, such as thinking in terms of building transferable skills, and in particular developing attitudes and skills for running a business. Educating students to start an own business and developing their business competencies could support the graduates in their job finding and raise the productive capacity of the whole economic system. Also, the matching between economic activities involving graduates and higher education paths could help universities to pinpoint their productive stakeholders and imagine future courses.

Our hypotheses of a cogent relationship between the intensity of higher education required by certain jobs and that of higher jobs of a given economic activity was confirmed. We did not find overt relations between these two variables and self-employment. The correlation between knowledge intensity and self-employment frequency was positive but the variation between the two variables was negative, namely, while the intensity of knowledge employed by firms grows in time, the number of self-employed diminishes. This does not imply that self-employment requires lower education, but the opposite. In fact, the groups of self-employed diminishing in recent years are craft, commerce and agriculture self-employed workers, who are, on average, less educated than the other self-employed.

So, while the number of self-employed diminishes, the knowledge required to them and to the

category of business owners, with or without other employees, increases. Education and training help the self-employed to become self-reliant. He may become better at finding customers, or at least at handling his personal finances. He may even understand the world of business better if he has all had to run one, however small, at one time or another, and this introduces a variable we did not consider in our exercise, the age of worker. This could be matter for future work.

Even though the self-employed work showed time trends diverging from those of knowledge and innovation, entrepreneurship remains a relevant pillar of our argument. We support the idea that creating the conditions to foster self-employment is socially and economically relevant. A better understanding of how the self-employed organise their work and harness the benefits of knowledge and innovation while managing their job activities can offer insights to policymakers, employers and employees on the changing work domain. Though, the Covid-19 calamity may prevent some workers to run an own business, even for long time.

Our exercise has a main limit: the two-digit Ateco classification. This classification is raw; the analysis of one more digit classification might inform more than we did. Even this exercise showed problematic while computing variations because of low frequencies in some classes. This means that a more implied analysis should be realised *cum grano salis*. Finally, we did not assume a criterion variable and the presented analyses concerned just the non-hierarchical relationships among the selected indicators. Even this could be a further issue for future work.

References

- Autor, D.H., Levy, F., Murnane, R.J. (2003). The skill content of recent technological change: An empirical exploration. *Quarterly Journal of Economics*, **118(4)**, pp. 1279-1334.
- Becattini, G. (1990). The Marshallian industrial district as a socio-economic concept, in F. Pyke, G. Becattini and W. Sengenberger (eds). *Industrial Districts and Inter-Firm Cooperation in Italy* (pp. 37-51). Geneva: ILS.
- Bertamino, F., Bronzini, R., De Maggio, M., Revelli, D. (2014). Local policies for innovation: The case of technological districts in Italy (<https://www.bancaditalia.it/pubblicazioni/altri-atti-convegna/2014-innovazione-italia/Bertamino-Bronzini-DeMaggio-Revelli.pdf>).
- Browne, M.W. (2001). An overview of analytic rotation in exploratory factor analysis. *Multivariate Behavioral Research*, **36(1)**, pp. 111–150.
- Colombo M., Delmastro M. (2002). How effective are technology incubators? Evidence from Italy, *Research Policy*, **31**, pp. 1103-1122.
- Etzkowitz H., Leydesdorff L. (1997). *Universities and the Global Knowledge Economy*. London: Pinter.
- European Commission (2013). *Entrepreneurship 2020 Action Plan. Reigniting the Entrepreneurial Spirit in Europe*. Brussels: DG Internal Market, Industry, Entrepreneurship and SMEs.
- Fabbris, L., Feltrin, P. (2021). Measuring the movement between employment and self-employment: a survey proposal. In: B. Bertaccini, L. Fabbris and A. Petrucci (eds.) *ASA 2021 Statistics and Information Systems for Policy Evaluation* (pp. 65-70), Firenze University Press, Florence (<https://fupress.com/capitoli/measuring-the-movement-between-employment-and-self-employment-a-survey-proposal/6065>).
- Krugman, P. (2017). The gambler's ruin of small cities (Wonkish) (<https://www.nytimes.com/2017/12/30/opinion/the-gamblers-ruin-of-small-cities-wonkish.html>).
- Liberati, D., Marinucci, M., Tanzi, G.M. (2013). Science and technology parks in Italy: Main features and analysis of their effects on hosted firms (<https://www.bancaditalia.it/pubblicazioni/altri-atti-convegna/2014-innovazione-italia/Liberati-Marinucci-Tanzi.pdf>).
- Moretti, E. (2012). *The New Geography of Jobs*. Boston, New York: Houghton Mifflin Harcourt.
- OECD (2019). *The Future of Work. OECD Employment Outlook 2019. Highlights* (<https://oe.cd/employment-outlook>).