

## Firms complexity: Technological scope, coherence and performance

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The aim of this work is to shed light on the relationship between firms performance and their technological portfolios using tools borrowed from the complexity science. In particular, we ask whether the accumulation of knowledge and capabilities related to a coherent set of technologies leads firms to experience advantages in terms of productive efficiency. To this end, we analyzed both the balance sheets and the patenting activity of about 70 thousand firms that have filed at least one patent over the period 2004-2013. From this database it is possible to define a monopartite network of technological codes, in the spirit of [1], that can be used to assess the firms configuration, defined as the set of technologies in which the given firm is active. We then introduce firms coherent diversification [2], a quantitative assessment that evaluates a technological portfolio taking into account the number of fields it encompasses and weighs each of them on the basis of their coherence with respect to the firms global knowledge base. Differently from what is usually done for countries [3], such a measure implicitly favors companies with a diversification structure comprising blocks of closely related fields with respect to firms with the same breadth of scope, but a more scattered diversification structure. In this respect, our work points out a qualitative difference between the industrial production of goods and services and the technologies, in terms of patenting activities, that are needed to produce them and to be competitive at the market level. We find that our measure of the coherent diversification of firms is quantitatively related to their economic performance and, in particular, we prove on a statistical basis that it explains labor productivity better than standard diversification. This is an empirical evidence that this measure of the coherent diversification of technological portfolios captures relevant information about the productive structure of the firms. As a consequence, it can be used not only to investigate possible synergies within firms but also to recommend viable partners for merging and acquisitions.

[1] A. Zaccaria, et al., Plos ONE **9**(12), e113770 (2014).

[2] E. Pugliese, et al. (2017), in preparation.

[3] A. Tacchella, et al., Sci. Rep. **2**, 273 (2012).