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Approximating innovation potential with neurofuzzy robust model

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ABSTRACT

In a remarkably short time, economic globalisation has changed the world's economic order, bringing new challenges and opportunities to SMEs. These processes pushed the need to measure innovation capability, which has become a crucial issue for today's economic and political decision makers. Companies cannot compete in this new environment unless they become more innovative and respond more effectively to consumers' needs and preferences – as mentioned in the EU's innovation strategy. Decision makers cannot make accurate and efficient decisions without knowing the capability for innovation of companies in a sector or a region. This need is forcing economists to develop an integrated, unified and complete method of measuring, approximating and even forecasting the innovation performance not only on a macro but also a micro level.

In this recent article a critical analysis of the literature on innovation potential approximation and prediction is given, showing their weaknesses and a possible alternative that eliminates the limitations and disadvantages of classical measuring and predictive methods.

Aproximación al potencial innovador con un modelo robusto de neuro-fuzzy

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RESUMEN

En un plazo increíblemente corto, la globalización económica ha cambiado el orden de la economía, creando nuevos retos y oportunidades a las pequeñas y medianas empresas. Por ello se esta dando la necesidad de crear maneras de medir capacidad de innovación que resulta fundamental para quien debe tomar decisiones politico-economicas. Las compañías no pueden competir en este nuevo entorno a no ser que sean mas innovadoras y respondan de manera más eficiente a las necesidades y preferencias del consumidor-como de hecho se ha mencionado en la Estrategia de Innovación de la UE. Las decisiones no pueden ser tomadas de manera eficiente y adecuada sin el conocimiento de la capacidad de innovación de compañías de un determinada región y/o sector. Esta necesidad está forzando a los economistas a desarrollar un método completo integrado y unificador de medir, aproximar e incluso predecir el rendimiento innovativo tanto a micro como a macro niveles.

En este reciente articulo se ha hecho un análisis critico de la literatura que trata sobre aproximaciones y/o predicciones del potencial innovador, mostrando sus defectos y posibles alternativas que eliminarían las limitaciones y desventajas de las mediciones clásicas y métodos predictivos.

1. Introduction

In any innovation research the positivist paradigm should play the main role in specific coherent practices concerning the standards of academic pragmatics (laws, theories, adaptations, tools of research, and models). This can be justified on the one hand by the characteristics of the topic and on the other hand the predominance of positivist approach literature over the normative approaches.

The positivist approximation can be decolonized from any ethical considerations or normative verdicts (Friedman, 1953): according to Keynes (1891) it deals with what exists and not what should exist. This approach involves generalizations, which make it possible to describe correctly the effects of the economic changes with such performance that depends exclusively on the accuracy

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and scope of prediction (observation) and on its consistency with fact – creating an objective system as they occur in natural sciences (Friedman, 1953). According to the positivists a theory which is unable to describe reality with numbers, is inappropriate and not well reasoned (McCloskey, 1986). The goal of science for the positivist researchers is to reveal the scientific regularities whereby the phenomena under investigation will be explicable and at the same time predictable (Alvesson, 2000). The goal of research is to reveal the objective verity amidst the effects of the researcher's personality, the chosen research method and the influential factors (McCloskey, 1986). Hence the analytic confines of the research are predefined and universal, the analytic model is class-based (problem granulation), and the process of the research is convergent, logically traceable and objective. According to Friedman's theory (1953) the positivist science is just as objective (or transposable) as any other natural science. Nevertheless the fact that social sciences deal with connections between people and organizations makes the researcher a part of the research – in a more direct way than in natural sciences and thus, makes it significantly difficult to reach objectivity.

Accordingly there are two potential alternatives. One of them is loosening the objectivity postulations set up by positivism. This way can be reasonable to consider how much is the greatest permissible subjectivity which is still able to grant the objectivity of the natural scientific positivist approach.

The other way is to prepare the applied methodology to cope with handling "fuzzy", subjective, often inaccurate and 'noisy' dataset by objective, solid mathematical laws.

Researchers must choose from these two possible ways as Friedman's thesis (1953) says that every economic deduction necessarily – even genuinely or implied – is based on a positivist prediction telling us the consequences of doing *this* instead of *that*: providing information about the consequences of a given series of actions and not determining normative verdicts.

In the course of my research the second of these is chosen: in an attempt to apply such modelling methodology to economics which, based on the positivism's logical foundations, is able to consider also subjective and inert factors beside the expected objectivity (without yielding it). These factors are either forced to be precise (along with a high bias) by the classic methodologies or easing the positivist objectivism.

The paper intends to show a complete model building and testing procedure for innovation potential estimation to decide whether classical ways of measurements adequate or modern heuristic, artificial intelligence-based methods give better estimations. In order to answer this question the modelling issues of classical methods are summarized and a description of a possible robust model is given before a certain model is specified.

1.1. Modelling preferences

Natural sciences as positivist sciences contain conditionally approved generalizations related to social/economical phenomena. With these generalizations the effects of variations, which occur in the case, can be predicted in the form of maps. The extension of generalization, the accuracy of approximations, the confidence level of them and the enhancement of the predictions' accuracy are discouraged not only by the boundaries of the researcher's capabilities, but particular circumstances occurring in social sciences, especially in economics – although this is not their obligate idiosyncrasy (Friedman, 1953). In economics inevitably we rather rely on non-controlled experiences than on controlled experiments; hence it is exceptionally hard to provide clear and unambiguous evidence to verify hypothesizes correctly.

The justness of a hypothesis can only be tested with the accuracy of its inferences and predictions. This is what disturbs our methodological principles: causing difficulties in testing hypothesizes and verifying them. Ergo, the social scientist, has to be fully aware of his methodological principles, more than any others and must strictly insist to their restrictive case maps, not allowing the rejection of one or more of them. In this manner a social scientist has to adapt to those few deductible conclusions.

Considering the issues above, an awareness of restrictive assumptions is elementary during the phase when we are building our model. It is also indispensable to have the wide knowledge about the techniques of testing the restrictive assumptions and a familiarity with the standard system of requirements for social science models.

The essential requirements of modelling in social sciences – just like in mathematics – are accuracy, significance and strictness (Retter, 2006). The consistency originates in that tract of the science philosophy of mathematics in the 19th century, which is called the "Revolution of strictness". The naming originates itself from Imre Lakatos, Hungarian mathematician and science philosopher (positive heuristics, the critique of naive falsificationism). Since that time we know the very precise and exact standardization which was taken over into the classic (hard) modelling of social science. Herewith arithmetization and standardization of modelling have been started. By arithmetization an attempt was made to reconduct the exclusive terms of analysis and the theory of real numbers to the certain conception of natural numbers. Standardization meant the method of strict verification analysis.

The second group of requirements was conceived by Lotfi Zadeh – professor of mathematics at Berkeley University – in his "Fuzzy systems" theory. The first paradox states that increasing the complexity of a model (system) causes the decrease of the ability to make precise and significant conclusions. Moreover at a margin we realize that **exactitude** (arithmetical formalism) and **significance** became two criteria of the system, which are respectively bearing out each other. The stability/plasticity dilemma means also a similar problem: how could we build such a model which is **plastic** enough to bear with its fast changing environment but at the same time it is also **stable** enough to reserve the previously acquired knowledge (coherence) (Retter, 2006).

A similar contradiction turns up in case of interpretability – exactitude and interpretability – significance concept pairs.

1.2. Restrictive requirements

Beside the requirements above the researcher must face several restrictive requirements during the procedure of model building. The classic modelling techniques viz. often are not prepared for such problems like for instance issued by the extreme complexity of the target function: what should be done when we cannot formulate the function which is analysed for optimum (or any other known point). Perhaps if the high statistical error couples with low significance level or we can draw only approximate inference. Stochastic mindset causes a lot of problems and restrictions in social sciences, as the researched phenomenon is hard to be expressed by clearly observed variables; the determination of measurement tool and method can also lead to confusions; some certain issues on error of measurement; and the treatment of the role of the role of outliers. Rappai (2010) also argues these issues on modelling. In the perspective of the current research, the following topics can be identified.

A very common restrictive requirement is subjective system information, as applying quantitative criteria is a common assumption of classic system modelling techniques. However in social science these objective quantitative criteria are often not given to the researcher. In these cases the established custom is to transform the qualitative criteria to quantitative but does this ensure objectivity? Are these transformations effective? The