

Innovation is a Multidimensional Phenomenon

Introduction

The question of economic development is one of the oldest and perhaps also the most intriguing topics that researchers tend to share across many fields of social science. Schumpeter (1934) put forward the idea that the main driving force behind economic development is innovation, i.e. qualitative change endogenously generated in the economic system, which has inspired thinking along these lines for generations. Schumpeter's original understanding of innovation was very broad, generally involving the "carrying out of new combinations" which need "by no means be

founded upon a discovery scientifically new" (Schumpeter 1934, pg. 66).

All too often the concept of innovation is dominated by a very narrow view of it as resources devoted to formal research and development activity (R&D), at least insofar as mainstream economic tradition is concerned.

However, a debate about innovation and economic development needs to be based on a broad approach to innovation. The argument elaborated in this paper is that an analysis of innovation needs to embrace the multidimensional nature of the innovation process. I would also argue that we need to use analytical methods that take this on board.

A need for quantitative evidence

One major challenge for empirical literature is to strike a balance between the analysis of qualitative and quantitative aspects of innovation. For a long time, innovation has been studied using qualitative methods such as detailed case studies of particular firms and/or projects. Among the prime reasons for this was the fact that innovation in the broad sense, i.e. not limited to R&D statistics, proved to be difficult if not impossible to measure quantitatively over a long period of time. Nowadays, it is clearly understood in the innovation literature that, on one hand, innovation does not depend on how much is spent on R&D and, on the other, that quantitative evidence constitutes the key input for the design, implementation and evaluation of modern innovation policies.

As a consequence of frustration in the field of innovation studies regarding the use of R&D as the main proxy for innovation activity, enormous efforts have been devoted to developing new approaches to measure innovation since the early 1990s. The concrete outcome of this work is a series of surveys of innovation activity, the so-called Community Innovation Survey, organised by Eurostat and the OECD. It provides a



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battery of new quantitative indicators which move beyond the traditional focus of R&D statistics (for details, see OECD 2005). As a result, a vast sea of new micro data on various aspects of the innovation process has become increasingly available for research purposes. One question that presents itself involves how we can make the most of this new evidence.

Factor analysis

Most of the empirical analysis on innovation continues to emulate methods employed in the old “R&D-based paradigm”, such as the standard toolkit of conventional regression estimates. However, we need to use analytical methods that are appropriate for the complex nature of innovation which the new sources of data aim to capture. It should come as no surprise by now that the main inspiration should come not from tools used by the mainstream economic profession, but rather from other fields of social science and the humanities, such as psychology and sociology, in which researchers are accustomed to dealing with somewhat similar methodological challenges. How, then, can we analyse qualitative phenomena using quantitative methods? Let me briefly put forward one of the most promising candidates.

Factor analysis is a method of multivariate analysis that is used to indicate the structure and reduce the complexity of multidimensional data (Basilevsky 1994). The idea is that highly correlated indicators are likely to reflect the same underlying dimension and can therefore be combined to represent latent aspects of the data without loss of much information. In other words, the aim of factor analysis is to reduce a complex set of variables into a small number of (principal) factors that account for a high proportion of the variance. One of the most attractive aspects of factor analysis is that the method allows us to analyse multidimensional phenomena that cannot be observed directly and would therefore otherwise defy quantitative measurement. For the first time, factor analysis has been used in psychology to identify various facets of intelligence (Spearman 1904) and then diffused to other social sciences (Hotelling 1933).

Like the problem of measuring intelligence, measuring innovation is a multidimensional phenomenon. As has been already emphasised, innovation refers to new combinations of productive means, which often involve a diverse set of resources and capabilities far beyond R&D spending (Dosi 1988, Nelson 1991, Teece and Pisano 1991), but this has not been reflected in the quantitative analysis of innovation for a long time. Until relatively recently, factor analysis has not been used in the field of innovation studies, although this new stream of work clearly demonstrates how this method can help to derive new insight into the innovation process.

For example, Hollenstein (2003), Leiponen and Drejer (2007) and Srholec and Verspagen (2007) show that factor analysis can be applied to micro data from the innovation surveys to identify latent aspects of the innovation process in firms. Fagerberg *et al.* (2007) use the method to construct new indicators of technological and capacity competitiveness that proved to be significant explanatory factors for differences in economic growth between countries. Likewise, Fagerberg and Srholec (2007) confirm in a large sample of countries that many indicators of economic, technological and social development can be reduced with the help of factor analysis into a few principal factors that jointly explain

almost three-quarters of the total variance. More research along these lines has a strong potential to improve our understanding of the multifaceted nature of innovation.

Reflections

The application of quantitative methods that are widespread in economic literature has led to great improvement in the analysis of innovation, but opportunities for new insights based on these methods are increasingly being depleted. Although useful for the purpose of the innovation research, it should be noted that factor analysis has rarely (if ever) been used in mainstream economics. Perhaps we tend to use methods developed in economics to study innovation too often. Needless to say, the application of methods used in other sciences to a new field often opens entirely new avenues for original (and interdisciplinary) research. This is the road being paved by the application of factor analysis in the field of innovation studies.

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