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BEHIND THE INNOVATION-FIRM PERFORMANCE LINK: A THEORETICAL ANALYSIS WITH APPLICATIONS TO EMPIRICAL STUDIES*

INTRODUCTION

A large and growing empirical literature investigates the relationship between firms' innovation activities and their performance. This trend has been particularly strong ever since Crepon et al. (1998) proposed a methodology (based on the Heckman model) that solves the inherent selection problem, and since the successive runs of the Community Innovation Survey (CIS) offered a rich empirical material for the analysis. Indeed the CDM model, as it is called after the initials of the authors, has become a classical work.

It is important to stress that the empirical literature is indeed huge. The review by Hall et al. (2010) includes more than 150 contributions, including earlier studies e.g. by Zvi Grilliches that did not use selection models. At least ten more papers have been published after the review was completed, including Marin's (2014) article on Italy, the analysis of a group of European countries by Hashi and Stojčić (2013) and an article on Poland by Szczygielski and Grabowski (2014)[1].

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1 Strictly speaking, the latter article analyzes the innovation-performance link without resorting to the Heckman type selection model. The reason is that productivity data are available only on an aggregate basis due to the restrictive policy of the Polish Statistical Office.

The outcome of these studies has been, generally, that firms that do invest in R&D or, more generally, do innovate tend to have higher labour productivity (controlling for capital-intensity). Interestingly, analyses carried out in different country contexts come up with different results with respect to the role of innovation types that seem to be associated with better innovation performance (product innovation, process innovation).

However do we fully understand these outcome? How can it be explained from the theoretical viewpoint? And what is the scope of theoretical problems that can be verified by the CDM methodology applied to the Community Innovation Surveys data?

These are the questions I seek to answer in this text. The goal is to contribute to the methodology of the empirical studies of the innovation-performance relationship, especially those based on the CIS data. I start by presenting the methodology of the study, defining key notions and discussing the Community Innovation Survey. Then several theoretical approaches – neoclassical economics, transaction-costs economics, Porter's framework, evolutionary economics – are reviewed one by one. Innovation-related hypotheses are discussed and their compatibility with CIS data is analyzed. Conclusions are offered in the final section.

1. Methodology

Since the focus of the article is the innovation-performance link, I start by discussing the notions of 'innovation' and 'performance', so as to define the common ground for the theoretical approaches invoked later.

'Innovation' is defined in numerous references, in particularly by the Oslo Manual. I shall use the latter convention, not because it is perfect, but because it gave rise to the Community Innovation Survey. Consequently, we should consider four types of innovation:

'156. A *product innovation* is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. (...)

163. A *process innovation* is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. (...)

169. A *marketing innovation* is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. (...)

177. An *organisational innovation* is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.' (Eurostat and OECD (2005), emphasis in original)

Note that the innovation might be new to the world (as is the case with true inventions), new to the market in which the firm operates or new to the firm only. If it is a truly new solution it might be subject to intellectual property protection, e.g. in the form of a patent. Innovation might be the result of firm's R&D activities or it might come to existence without such efforts.

Turning to 'performance', virtually all CDM models refer to the 'productivity' of firms as the dependent variable and their econometric specification relies on the production function analysis. Hence the variable that would be most logical to represent productivity would be value added per worker or sales per worker in constant prices. Such data, however, is not the available in the CIS dataset. Let us therefore discuss the limitations of the Community Innovation Survey.

The CIS was first implemented in 1993. It is a joint effort of national statistical offices in the European Economic Area, co-ordinated by the Eurostat, which sets the 'core questionnaire' to be incorporated by all the countries and recommends some further questions that can be included on a non-obligatory basis. Most questions refer to the three-year period preceding the circulation of the questionnaire (e.g. 2008–2010 for CIS 2010), while questions on turnover and outlays refer mainly to the year of issue. Currently the survey is conducted on a bi-annual basis. The 2010 edition of the Community Innovation Survey included the following sections in its core questionnaire (each containing several specific questions):

1. General information about the enterprise
2. Product (good or service) innovation
3. Process innovation
4. Ongoing or abandoned innovation activities for process and product innovations
5. Innovation activities and expenditures for process and product innovations.
6. Sources of information and cooperation for product and process innovation
7. Objectives for your product and process innovations during 2008 to 2010

8. Factors hampering product and process innovation activities
9. Organisational innovation
10. Marketing innovation
11. Creativity and skills
12. Basic economic information on your enterprise.

An important characteristics of CIS is that firms that declare no product or process innovations, be it successful or hampered, are exempted from completing most of the questionnaire (points 4 through 8). Therefore most analyses based on the qualitative information from the CIS are restricted to the subset of innovative firms (cf. Clausen et al. (2012), Srholec and Verspagen (2012)). Another distinguishing feature of the survey is that the general information on enterprises is quite limited and in case of many countries restricted to the number of employees, whether the firm engages in exporting activities and what is it's principal markets (local/domestic/foreign), and whether the firm is a member of group of enterprises. In particular there is no information on total costs firms incur – only on the innovation-related costs.

It is these constraints that force all empirical studies I am aware of to use the sales per worker in current prices as a measure of firm performance. While it is understandable from the practical point of view, there are some important consequences one should be aware of. Bearing in mind that most firms are indeed multi-product, the sales per worker (or sales-employment ration, *SE*) for firm i manufacturing n products is:

$$SE_i = \frac{Q_i^1 P_i^1 + Q_i^2 P_i^2 + ... + Q_i^n P_i^n}{L} = \frac{Q_i^1}{L_i^1}\frac{L_i^1}{L}P_i^1 + ... + \frac{Q_i^n}{L_i^n}\frac{L_i^n}{L}P_i^n = T_i^1 l_i^1 + ... + T_i^n l_i^n$$

where: T_i^k is the (technical) productivity of firm i in manufacturing product k and l_i^k is the share or labour employed in manufacturing of k.

For a given firm this indicator can grow due to several factors. First, it may indeed increase as a result of improving technical productivity i.e. any of the T_i^k rations[2] (in fact it is likely that they are all equal). Secondly, however, an increase might be a result of the firm commanding a higher price P_i^k thanks to product differentiation, in particular improving upon some characteristics of the product. Thirdly, a firm may add to its portfolio a new product (change in n), with a sales-employment ration higher than that firm's average. Note that all three kinds of changes count as innovation in empirical

[2] One should actually add index t for time but I am not doing it for the sake of transparency.

studies and in the Community Innovation Survey, but while the first would be process- or organizational innovation, the latter two would be regarded as product or marketing innovations. However there are two more events that increase SE_i but are hardly related to innovation activities. A firm may actually drop a product that performs poorly in terms of the indicator, or, more generally, it can change the structure of the output (i.e. the weights: $l_i^1, \ldots, l_i^n$) in favour of the products that yield a higher sales-employment quotient.

Taking a cross-section perspective, the same set of cross-firm differences has to be taken into consideration. A firm with higher sales-employment ratio must be either more productive or positioned in the higher segment of the market (to use the marketing jargon) or both. These are the necessary outcomes of the firm's innovation policy, if the differences in sales-employment ratio are to be the result of the firm's innovation activities. In the rest of the article, whenever there is reference to 'productivity', I mean technical productivity (T_i^k) while I use the abbreviation SE_i for the sales-employment ratio. Note that higher productivity implies, ceteris paribus, a higher SE_i, but not vice versa.

With the notions of innovation and performance defined and the strengths and weaknesses of CIS presented I can turn to the discussion of theoretical approaches to the innovation-performance link and how can they be verified empirically. More specifically, for each theory I invoke the following questions will be posed. First, what is the place of the notion of 'innovation' within the theory? Secondly, how does this understanding of innovation fit the definitions of different kinds of innovation introduced by the Oslo Manual? Thirdly, based on the theoretical approach, what kind of relationship between innovation and performance should we expect, specifically? In particular, which modes of innovation should be most favorable to a firm's performance and what are, if any, the additional conditions a company has to meet?

2. Neoclassical economics

By neoclassical economics I mean traditional microeconomics, Industrial Organization and other streams of research based on neoclassical principles. The principles I have in mind are the following: (i) the assumption that agents act so as to maximize a certain objective function given some constraints and while doing so they make no mistakes (ii) the postulate that these constraints as well as all other parameters of the model are known to the agent, or at least they are random variables with known distributions, (iii) the lack of interest in the phenomena internal to the firm that is treated

as a blackbox, (iv) the reliance on the concept of equilibrium as the way to draw conclusions from the model.

Since neoclassical theories rely on equilibrium analysis, one can think of two possible perceptions of innovation. The first one assumes product or process innovations as an equilibrating process that takes place outside the actual model: in some unspecified way firms change their products and/or technology so as to arrive at the new equilibrium. The related innovation is most likely novel only to the firm. The second approach takes the innovation directly into the model and defines it as a product or technology that can also be novel to the whole market.

Let us start with the first approach. Traditional microeconomics' models resting on the assumptions of uniform technology and product homogeneity has no room for the notion of innovation, as any adjustments one can think of, are made with respect to the quantity of the productions factors used or units of the output produced. It might seem, at a first glance, that the more elaborated Industrial Organization models with product differentiation can accommodate innovation better. However product differentiation per se does not solve the problem. Take the simple Hotelling-type model with n firms identified with locations in a one-dimensional space of tastes and competing in locations. Assume there exists a Nash location equilibrium (such an equilibrium is determined up to a possible permutation of firms). One could think of introducing a product innovation – i.e. changing the location – as a mechanism by which a firm looks for 'its' place in the space of tastes. However why would a firm that engages in such an innovation perform better (e.g. in terms of *SE*) than other that does not? In fact the opposite could be the case: a firm that does not innovate might already be in the 'right' place and be reaping higher profits than the one that is located wrongly and has to move.

What is demonstrated by this example is that any static IO model that is complicated enough for the notions of innovations (i.e. changes in product or technology) to make sense, requires also a complex story of how equilibrium is achieved. Such a story is not as readily found as it is, say, in the case of price equilibrium in a perfectly competitive goods market.

Consequently, the second approach to innovation within neoclassical economics, is to model it directly. Firms are assumed to perform costly R&D activities to improve their profits. One way by which it can happen is to arrive at a discovery that can be patented and thus can ensure a rent, either through product differentiation or lower cost. Strategic interactions that occur in this context have been the focus of a set R&D race models (sometimes called patent race models), wherein firms optimize their expenses based on the known distribution of the probability of invention. These models have been

concerned mainly with two broad set of issues. The first: is the funding (or the timing) of R&D socially optimal? Secondly, who is going to invest more in research (or be the first to invest): the leading company or the follower? (cf. Reinganum (2008)). The latter question seem to be of some relevance to our study. The problem is that R&D models came up with opposite answers, depending on the set of assumptions adopted by particular authors.

From the point of view, of this article, the principal question is whether the R&D literature supports the innovation-performance link. Observe that the general idea that firms assume market power due to proprietary, non-imitable knowledge obtained through R&D activities is indeed consistent with the CDM models[3]. Since the notion of innovation is associated with the R&D efforts, this is the kind of firm activities that should be associated with better firm performance. Note that the causality chain from high R&D spendings to patent-protected innovation to higher *SE* is exactly the pattern that has been sought (and partly found) in the original paper by Crepon et al. (1998).

Further conclusions for the CIS-based research are the following. This mode of innovation is more likely to be observed in high-tech industries i.e. those where the scientific and technical progress is still rapid, as well as in the industries where inventions are patentable (hence less often in services industries, except for ICT and to some extent financial services). Also, since the innovation is based on R&D, then firms should perform R&D activities (cf. section 4 of the 2010 CIS questionnaire), and declare a high level of co-operation with the R&D sector (section 6). As for the protection of intellectual property, such questions were included in older editions of the CIS up to the 2006 edition, but not in the recent ones.

3. Transaction costs economics

The approach of transaction cost economics (TCE) to firm strategy is totally different. TCE has little to say about the strategic aspects of competition in the product market, as it focuses on the internal organization of

[3] Some specific R&D race models might actually spoil the picture by demonstrating that that even though follower firms are likely to invest more in R&D, the leader still has a better chance of winning the race (Doraszelski (2003)). The problem is how to translate such relationships into empirical studies: in real life market leaders are likely to be big multi-product companies, whose total R&D spendings over all the products are bigger than those of the followers. Thus, in the end, the positive relationship between R&D expenditure would still be sustained.

production in the firm i.e. the optimal choice of governance structure. The principal question is how to organize activities that lead to the manufacturing of the final product or service, in particular which contractual form should be chosen for each activity. As we will see it is the organizational innovation that will be the most relevant in this respect.

For the organization of activities, the choice is between contracts based on the market relationship, those based on the power relationship (hierarchies), and the hybrid forms (franchising, long-term contracts). In short, the optimal decision is reached by keeping the transaction costs (i.e. the costs of finding the partner and preparing and executing the contract) low while at the same time maintaining the high level of incentives or the contractors, who should be interested in performing the activity as efficiently and as diligently as possible.

The notion of transaction costs would have made little sense had the key assumptions of neoclassical economics been kept: that agents are fully rational and perfectly informed. TCE however assumes a bounded rationality of agents, who do not have a perfect overview of the markets at all times, and, more importantly, cannot predict future perfectly. As a result, contracts are usually imperfect i.e. events not specified by contract provisions can take place. In terms of the entrepreneurship literature, there is an ignorance with respect to future events (cf. Kirzner (1978), pp. 69–70). This is when the second key assumption of transaction cost economics comes into picture: that at such (contractually unspecified) moments agents will exploit the opportunities to increase their utility even to the disadvantage of the other contract's party (moral hazard).

Contracts that are to a larger extent based on hierarchies can secure the firm better from moral hazard, but that comes at the costs of diminished incentives. The textbook example is a firm's decision if it should employ the workers to produce a component internally or if it should procure the manufacturing of the component from the external company. By choosing the former option the firm economizes on the costly procedure leading to signing the contract and the possible costs of occurrence of unexpected events and the related opportunistic behavior of the supplier. But by producing the component internally, the firm also makes the agent directly involved in the activity less motivated to work more efficiently and/or introduce innovations, as any residual benefit from such actions goes to the company and not to the employee. Note that this idea of 'disincentives' costs' must rely either on bounded rationality (the principal cannot observe agents' effort perfectly) or on a kind of strong technological uncertainty (new technological opportunities might occur) or on the existence of learning capabilities of the agents.

Which contractual form delivers the optimal cost-benefit ratio, depends on the nature of activity, in particular on: the specificity of the assets involved, the frequency of activity, the (degree of) uncertainty, the possibilities to measure the activity. Of those asset specificity i.e. 'the ease with which an asset can be redeployed to alternative uses and by alternative users without loss of productive value' is argued to be most relevant (Williamson (1991), p. 82). With asset specificity growing, the optimal contractual relations are, consecutively, market, hybrid and hierarchy governance.

In terms of a company's innovation performance, transaction cost economics can offer insights into changes occurring inside the firm[4]. Although the concept does not address the problem of innovation one could argue that it is relevant for organizational innovation – one of the four kinds of innovations specified in the Oslo Manual. However when looking for the justification of the link between organizational innovation and performance, one encounters the same problem as with the Industrial Organization models (see previous section). This is because, for all its stress on bounded rationality and moral hazard, transaction cost economics remains to a large extent rooted in the logic of neoclassical modelling i.e. it offers hypotheses about the optimal firms' choices but no theory of how these choices are attained. In fact, Williamson's 'discriminating alignment hypothesis' maintaining inter alia that that 'transactions, which differ in their attributes, are aligned with governance structures, which differ in their costs and competencies, so as to effect a (mainly) transaction cost economizing result' (Williamson (2005), p. 14) is an organization-economics version of neoclassical equilibrium concept. But there has been little research on how this intra-firm equilibrium is attained.

Therefore it seems fair to say that the transaction cost economics on its own can explain the positive correlation between firm's innovation activities and its the performance only to a limited extent. What it shows is that the changes in company organization *may* under some circumstances enhance performance (e.g. when autonomous technological progress changes the

[4] Indeed, Williamson argues that 'economy is the best strategy': while strategic product--market considerations are relevant only for the minority of companies that have market power, efficiency considerations are relevant for all firms. This is an interesting point if quite controversial. Note that even if most companies do not have market power, the ones that do have it might be the most important in terms of industry output and productivity development. And although setting the optimal governance structure is important for all firms, it matters the most for large companies, which, as it happens, are more likely to possess market power.

degree of specificity of some assets). But other theoretical concepts are necessary to find a more general explanation of the innovation-performance link.

4. Porter's competitive strategies

Porter's approach to firm strategy is exactly the opposite of Williamson's in the sense that it rests largely on the analysis of a firm's competitive environment. A firm's strategy is determined by how it decides to compete in the marketplace. Although it certainly has consequences for the measures the company takes to enhance its efficiency, the product-market policies are at least as affected and probably more (Porter (1980), ch. 2).

Porter argues that essentially all successful businesses are located in 'attractive relative position', which come in two kinds: either a firm can produce at lower costs than the rivals, or it is able to differentiate the product and so 'command a premium price that exceeds the extra cost of doing so' (Porter (1991), p. 101). A firm can sometimes possess both kinds of competitive advantage at the same time.

However as stressed by Porter, 'an attractive position is, of course, an outcome and not a cause' (loc cit). To attain it, the company has to implement a consistent set of policies with respect to 'activities' that can be roughly divided into groups related to a product (inbound logistics, operations, outbound logistics, marketing and sales, service), as well as groups of horizontal activities (infrastructure management, HR management, technology development, procurement). Consistency is key: a firm that can achieve neither particularly low costs nor a considerable degree of differentiation risks being 'stuck in the middle' and generating only a mediocre level of profitability[5].

Going deeper, Porter seeks to explain why are some firms able to achieve a competitive advantage in their activities. His answer, or a step towards an answer, is a set of historical and structural factors that he labels 'drivers': 'The most important drivers of competitive advantage in an activity include its scale, cumulative learning in the activity, linkages between the activity and others, the ability to share the activity with other business units, the pattern of capacity utilization in the activity over the relevant cycle, the activity's

[5] Porter acknowledges that in some sectors only cost leadership is possible as there is little room for differentiation (mass products) while in others the only reasonable competitive position is that of a differentiating producer (consumers do not bother about price that much or the cost competition is too intense to give any prospect for leadership, Porter (1980), ch. 2). However this does not weaken the case for consistency.

location, the timing of investment choices in the activity, the extent of vertical integration in performing the activity, institutional factors affecting how the activity is performed, such as government regulation, and the firm's policy choices about how to configure the activity independent of other drivers. The same set of drivers determines both relative cost and differentiation. The mix and significance of individual drivers varies by activity, by firm, and by industry' (Porter (1991), p. 104).

There is an interesting question about the determinates of drivers (Porter's answer is related to his work on the regional competitiveness), however from the point of view of this paper the study of drivers is already a level of analysis that is advanced enough as the data that would be needed to tackle empirically the question of drivers' is only to a small extent available in the CIS questionnaire.

What are the ramifications of Porter's work for the empirical link between innovation and performance? Starting with the understanding of innovation, Porter himself uses the word in the sense of *invention*, i.e. a radical technological change in products or production process. However any new step taken by the company with respect to its activities can be regarded as a kind of innovation in the Oslo Manual sense of the term. Several of such implicitly defined innovations can be identified via CIS. First of all they are likely to be reflected in the occurrence product, process, organizational or marketing innovations. Secondly, the specific kind of activity that is subject to innovation can be unveiled by analyzing firm responses to the questions about the objectives of innovation activities (section 7 in the 2010 CIS questionnaire), where possible options include 'entering new markets or increasing market share', 'improving quality of goods or services', 'reducing labour costs per unit output' among other things. Another important source of information is section 9 of the CIS, where firm describe their organizational innovations in more details (e.g. a change in internal organization vs. a change in external relations).

According to Porter, consistently implemented cost-leadership or product differentiation strategies are likely to improve a firm's profitability. Although this is not the same as a high *SE* ration, as the latter says nothing about the costs, the two indicators are likely to be correlated. Therefore it is fair to say, that the theory of competitive strategies by Porter offers an explanation for the link between the innovative activities of firms and their performance as measured by *SE.* However the innovative efforts in question should fall into one of two categories: a consistent policy of cost containment or a consistent policy towards product differentiation.

The former should be reflected in the CIS questionnaire as follows: the firm implements process and organizational innovations, declares that the objective of innovation activities is to reduce unit costs, and possibly limits the expenditure on R&D while engaging in technology adoption instead.

A consistent product differentiation strategy is likely to leave the following traces in a firm's answers to the CIS questions. The firm would introduce product innovations, possibly new to the market (and not only to the firm). Likely objectives include improving product quality or winning market shares. High expenditure and taking measures to protect intellectual property can also be associated with a product differentiation strategy

Note that if all the correlates of differentiation strategy are observed then we arrive at almost the same set of features that characterize 'neoclassical' innovators – but this is not the case with the cost containment strategy. If panel data is observable then an additional check of the consistency can be done: firms that implement the same set of policies for longer periods of time, are more likely to achieve a higher *SE*.

5. Evolutionary economics

Let us start by saying, that the principal problem of evolutionary economics is stated differently than that of neoclassical economics. While the latter is concerned with the allocation of resources in economy and the mechanisms that govern it, the former is particularly interested in the economic and technological *change*. Following Schumpeter, evolutionary theorists regard innovation (in the broad sense) as the essence of competition, which, to use Schumpeter's famous lines 'commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives.' (Schumpeter 1943/2003, p. 84). Thus going somehow ahead of the story we can thus say that the link between more active innovation behaviour and better firm performance is almost obvious in this theory.

The evolutionary formulation of the economic problem calls for a multilevel analysis, including a careful research into the operations of the firm. Blackboxing companies, as it had been done in the neoclassical theory, cannot be sustained. The fundamental principle of the evolutionary theory of the firm is, that is routines and rules and not objective function maximization that drives a firm's behaviour (cf. Dosi 1988). This is because, firstly, firms can only to a limited extent understand the options available to them (note

that this is an important departure from the hyperrational assumptions of neoclassical economics). Hence they develop standardized ways of addressing what they perceive as certain types of problems. These ways are referred to as 'routines' and the set of 'routines' known to the organization (or an organization member) is called its 'repertoire'. Secondly, companies usually have to make a set of interrelated decisions to address complex problems they face. The result are rules and routines that might be subject to considerable inertia.

The notion of 'routine' can be defined at different levels of intra-firm analysis (cf. Nelson and Winter (1982, ch. 4–5)). At the level of individual workers it refers to performing their tasks and is strongly related to their skills; at the level of company subunits it refers to performing their functions, including the co-ordination of work of individual employees; at the level of top management it involves making key decisions about firm policy, including 'meta-routines' that govern the search for new lower-level routines once the company's performance goes below the level that is by some measure acceptable.

As noted by Foss (2005, pp. 91–95), the analogy that Nelson and Winter assumed between individual and collective routines is projected on the analogy between skills and organizational capabilities. In other words, since organizational capabilities are, roughly speaking, well-working routines, and routines are analogous to skills, organizational capabilities improve as firm learn and interact with the environment – just as individuals learn by doing.

Organizational capabilities has become the central notion of the evolutionary theory. For Nelson (1991) it is one of the firm characteristics that he argues determine company performance (the other two are the strategy, which is defined as a set of company objectives and broadly stated plans to achieve those, and the organizational structure which determines how the information flows and the are made and implemented within the firm). Teece et al. (1997) argue that in the industries operating in the conditions of rapid technological change the 'dynamic capabilities' are key for firm success[6].

While the positive relationship between innovation and performance is simply *assumed* in the evolutionary approach, the theory offers a hypothesis about how this effect works: it is largely due to successful learning of the firms. This assertion can be verified using the Community Innovation Survey dataset. Indeed, firms that learn more intensively, should be more success-

[6] 'In short, identifying new opportunities and organizing effectively and efficiently to embrace them are generally more fundamental to private wealth creation than is strategizing, if by strategizing one means engaging in business conduct that keeps competitors off balance, raises rival costs, and excludes new entrants' (p. 509).

ful in, first, accomplishing innovations (measured by innovation that were completed and not abandoned in terms of CIS, cf. section 4) and second in exploiting the business effects of innovations (that can be measured by *SE*). Learning can be identified by looking at the R&D activities of the firms (section 5 of the 2010 CIS questionnaire)[7], and by analysing the number and the kind of sources from which the firm draws the innovation-related information and the variety of partners which with it co-operates (section 6).

Summary and Conclusions for Empirical Research

Several of the theoretical approaches to the innovation-performance link that were reviewed in this article support the positive effect observed in the CDM models. However the ways in which innovation activities are argued to influence firm performance are quite various. Firstly, there is a kind of neoclassical effect, based on market-power obtained through R&D activities and intellectual property protections. Secondly, according to Porter, firms that consistently introduce process- and organizational innovation aiming at cost-containment, are likely to outperform competitors. The third hypothetic consequence of innovation, also due to Porter, would consist in product- and marketing innovations aimed at product differentiation. Finally, the evolutionary approach to innovation stresses the role of improving firm capabilities, especially through learning in gaining a competitive advantage via innovation. Observe that these effects are not always mutually exclusive and some of them can in fact co-exist.

The focus of this article is an economic one and some relevant theoretical concepts in strategy research were not discussed (e.g. the resource-based-approach to firm strategy). Nevertheless, based on the theoretical consideration and on the analysis of the CIS dataset and the indicators used in the literature, some important conclusions for the empirical research can be drawn. First of all, the positive relationship between innovation and performance is strongly backed by economic theory, but the theory suggests also that the mechanisms behind the link can vary. Logically, the second conclusion is that it is the precise nature of this connection that seems particularly worth investigating in the next future. Finally, the way for this research has

[7] It has long been recognized in innovation studies firm R&D efforts are in fact a form of learning and they improves e.g. the odds of successful imitation, cf. Cohen and Levinthal (1989).

been suggested: it is through exploring the parts of the CIS database that were largely neglected in the empirical studies of innovation-performance link to date.

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BEHIND THE INNOVATION-FIRM PERFORMANCE LINK: A THEORETICAL ANALYSIS WITH APPLICATIONS TO EMPIRICAL STUDIES

Summary

There is a growing empirical literature investigating the relationship between innovation activities of the firms and their 'performance'. These firm-level studies usually employ Heckmann's methodology and go under the name of CDM models (after the initials of the authors of the classical 1998 paper: Crepon, Duguet and Mairesse). The outcome of these studies is that firms that innovate more usually perform better, but there is a considerable variation when it comes to the details of the results. The aim of this paper is to contribute to the methodology of such literature, firstly, by discussing the theoretical foundations of the CDM models and thus shedding more light on the hypotheses underlying them, and secondly by assessing the usefulness of

the Community Innovation Survey (CIS) in this respect. Several theoretical approaches are invoked, including neoclassical economics, Porter's framework and evolutionary economics. It is argued that the positive relationship between innovation and performance is strongly backed by economic theory but the hypothetical mechanisms behind the link can vary. Investigating the nature of the connection is a promising line of future research and examining the parts of the CIS database that were largely neglected in CDM-type studies to date can help resolve the puzzle.

ZWIĄZEK MIĘDZY DZIAŁALNOŚCIĄ INNOWACYJNĄ FIRMY A JEJ WYNIKAMI: ANALIZA TEORETYCZNA ORAZ WNIOSKI DLA BADAŃ EMPIRYCZNYCH

Streszczenie

Liczne opracowania empiryczne podejmują problem związku między działalnością innowacyjną firmy a jej wynikami. Prace te, nazywane „modelami typu CDM" (od nazwisk autorów klasycznego artykułu z 1998 roku, Crepon, Duguet i Mairesse), korzystają przeważnie z metody selekcji Heckmana. Ogólny wniosek z tej literatury jest taki, że firmy, które aktywniej wprowadzają innowacje, zwykle osiągają lepsze wyniki, ale poszczególne opracowania bardzo różnią się co do szczegółów tego związku. Niniejszy artykuł wnosi wkład metodologiczny do wspomnianej literatury poprzez, po pierwsze analizę teoretycznego umocowania modeli typu CDM i uściślenie związanych z nimi hipotez, a po drugie analizę przydatności danych z bazy *Community Innovation Survey* (CIS, w wersji polskiej – badanie PNT) dla tego rodzaju badań. Omawiane są różne ujęcia teoretyczne, w tym ekonomia neoklasyczna, teoria strategii konkurencyjnych Portera i ekonomia ewolucyjna. Zgodnie z tezą artykułu, pozytywny związek między działalnością firmy a jej wynikami znajduje silne poparcie w teorii ekonomii, jednak natura tego związku może być rozmaita. Jej szczegółowe zbadanie powinno być celem dalszych prac empirycznych, które powinny opierać się na tych częściach bazy CIS, które nie były uwzględniane w dotychczasowych studiach.

Проблемы связи между инновационной деятельностью фирмы и её экономическими показателями: теоретические предпосылки и эмпирические исследования

Резюме

Многочисленные эмпирические исследования связаны с решением проблемы связи между инновационной деятельностью фирмы и её показателями. Эти разработки, называемые «моделями типа КДМ» (на основе первых букв фамилий авторов классической статьи 1998 года Крепона, Дуку и Мэресса), в основном опираются на метод селекции Хэкмана. Общий вывод на основе этой литературы можно сформулировать следующим образом: фирмы, наиболее активно внедряющие инновации, обычно достигают лучших результатов, однако отдельные исследования сильно различаются между собой деталями этой взаимосвязи. Данная статья служит методологическим дополнением к упомянутому источнику, во-первых, благодаря анализу теоретического обоснования модели типа КДМ и уточнению связанных с ней гипотез, и, во-вторых, анализу полезности данных из базы Community Innovation Survey (Анализ Инноваций Сообщества – przypis tłumacza – E.S.) (CIS, в польской версии – исследование PNT) для данного типа исследований. Подвергнут анализу целый ряд теоретических понятий, в частности, неоклассическая экономика, теория конкурентных стратегий Портера и эволюционная экономика. Согласно тезису статьи, положительная взаимосвязь между деятельностью фирмы и её результатами имеет сильную поддержку в экономической теории, однако природа этой взаимосвязи может быть разнообразной. Её детальный анализ должен быть целью дальнейших эмпирических исследований, опирающихся на те части базы CIS, которые не были учтены в прежних источниках.