CASE Network Studies & Analyses

External vs Internal Determinants of Firm Technology Strategy: Evidence from the Polish Services Sector

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No. 454/2013

CASE
Warsaw Bishkek Kyiv Tbilisi Chisinau Minsk

This report was prepared within a project entitled "The Impact of Service Sector Innovation and Internationalisation on Growth and Productivity" (SERVICEGAP). SERVICEGAP project is funded by the European Commission, Research Directorate General as part of the 7th Framework Programme, Theme 8: Socio-Economic Sciences and Humanities (Grant Agreement no: 244 552). The opinions expressed are those of the authors only and do not represent the European Commission's official position.

Keywords: **Technology Strategy, Poland, Services, Innovation**

JEL Codes: **L21, L8, O32**

Graphic Design: Agnieszka Natalia Bury

EAN 9788371785832

Publisher:

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Abstract

We use the insights from strategy research and innovation studies to address two principal questions regarding the technology strategy of a firm: what are the distinct elements of technology strategy and what are the strategy determinants? Equipped with Zahra's (1996) concept of measuring technology strategy, we analyze data from two runs of the Community Innovation Survey for Polish service firms. We propose a set of indicators reflecting four principal fields of technology strategy: pioneer-posture, R&D efforts, technology portfolio, and monitoring activities. Interactions between the strategic variables are analyzed and their determinants are assessed. Our results suggest that technology strategies are determined by both factors external to the firm, and by the hitherto less stressed in the CIS-based empirical literature, internal factors. The role of internal factors increases with the macroeconomic environment becoming less favourable.

1. Introduction

The way that firms make choices about their approaches to technological innovation and the acquisition of knowledge needed in the innovation process has been studied intensively now for well over two decades, and one important stream of this literature utilizes the concept of technology strategy (see, e.g., Ford, 1988; Adler, 1989; Pavitt, 1990; Dodgson, 1991; Drejer, 1991). Zahra (1996), based on some prior work including Zahra & Covin (1993), developed a construct for measuring technology strategy and explored the relationship between this measure, firm environment and firm performance. In doing so, he was particularly concerned to investigate how factors external to the firm affected its technology strategy and moderated this strategy's relationship with performance. The research on technology strategy has also informed work linking the categorization of firms with respect to their technology strategy profiles with the industries in which they operate, including the very well-known Pavitt taxonomy (Pavitt, 1984). In a similar vein, Castellacci (2008) is interested in the way various dimensions (e.g. national, regional, sectoral, industrial) of a firm's industrial environment determine its technology strategy profile. In these streams of work, however, the internal factors affecting the firm's technology strategy remain unexplored. This omission can be seen as particularly important in view of the finding of Srholec and Verspagen (2012) that external factors such as industry and country account for a very small proportion of the variance among firms with respect to the patterns of their innovation-related activities (on the other hand, they do not evaluate directly the importance of observable internal factors).

Here, we will attempt to evaluate the relative weight of observable internal and external factors in determining technology strategies in the service sector. We have chosen to focus on the service sector because it is by far the largest sector in today's advanced economies but has traditionally been relatively under-researched, relative to manufacturing, in the literature on innovation, and innovation in the sector is relatively poorly understood (Miles, 2007; Leiponen, 2012). Thus, while our primary concern is with the determinants of technology strategy, we also hope to make a contribution to the literature on innovation in the service sector.

We base our research on two editions of the Community Innovation Survey (CIS), those from 2004-2006 and 2008-2010. While several previous studies that used CIS applied a methodology involving cluster analysis (Srholec and Verspagen 2013, Clausen et al 2012, Szczygielski and Grabowski 2012), we resort to various kinds of regression analysis. Although cluster analysis is a useful tool in exploratory studies, there can be problems with the interpretation of results. Moreover, our aim is to examine the determinants of technology strategies, and this might be difficult if the analysis is based on clusters. Although one can investigate the determinants of cluster membership (Srholec and Verspagen 2012, Szczygielski and Grabowski 2012), this is not the same as the determinants of strategy, unless one identifies strategies with clusters. However the latter depend on the dataset in question (e.g. CIS), so in a way the theoretical analysis becomes dependant on data availability. On the other hand, our choice of methodology is motivated by the desire to maintain a clear boundary between theory and empirics. The paper is organized as follows: In section 2 we consider the relevant theoretical issues and develop hypotheses. In section 3 we present our data and methodology. In section 4 we present our results, which we go on to discuss in section 5. Section 6 concludes.

2. Background and hypotheses

2.1 The components of technology strategy and their external determinants

The components of technology strategy according to Zahra (1996) include:

1. The pioneer vs follower posture in the marketplace (implying the focus on radical or incremental innovations)
2. The content of the technology portfolio
3. The breadth of technology portfolio
4. The intensity of own R&D
5. The reliance on external technologies
6. The emphasis on technological forecasting

We shall have more to say in section 3.1 about what is observable in CIS data in terms of these components of technology strategy.

The firm's external environment, including customers, competitors, suppliers, government, technological conditions, etc., has often been invoked in the literature as an explanation for the decisions of firms and their success. In strategic management the positioning school, which is rooted in the neoclassical analysis of firms and markets, has been particularly influential (Henry 2008). It has been made popular by the famous works of Porter (1980). Porter's argument is, in short, that successful firms are those that operate in 'good' industries and/or those that have made the right decisions with respect to the positioning of their products relatively to those of the competitors. Admittedly, the internal operations of the firm are also considered, but only to the extent that they serve the general competitive strategy: there must be a 'strategic fit' between the two.

In his 1996 article, evidently in the spirit of the positioning school, Zahra argues that the technology strategy will be co-determined by the competitive environment, in particular such aspects as its dynamism (with respect to technological development), hostility (i.e. intensity of rivalry) and heterogeneity (i.e. the amount of submarkets and niches).

The relationship between firm environment and its technology strategy, as hypothesized by Zahra, is demonstrated in Table 1. They are largely confirmed by Zahra's empirical analysis based on a survey of a group of American firms.

Table 1. The relationship between firm environment and firm technology strategy, as postulated by Zahra (1996)

The below strategies will be the strongest among firms whose environments are characterized by ->	**Characteristics of the environment:**		
	1. dynamism	**2. hostility**	**3. heterogeneity**
The pioneer posture	high	moderate	moderate
The follower posture	moderate	high	low
Radical product technologies	high	moderate	moderate
Radical process technologies	moderate	moderate	moderate
Incremental product and process technologies	low	low	high
A broad technology portfolio	moderate	low-moderate	high
The intensity of internal R&D	high	low	high
The reliance on external R&D	high	high	high
The emphasis on technological forecasting	high	high	high

Source: Own table based on Zahra (1996)

On the other hand, authors in evolutionary economics have sought to classify industries according to their technological characteristics. Note that taxonomic exercises can also be viewed as a way of looking for external determinants of firms' technological policies. According to this logic, firms are likely to follow the strategies implied by their respective industries (see also the literature on sectoral systems of innovation, reviewed in Malerba, 2005).

The classic taxonomy by Pavitt (1984) developed further by Castellacci (2008) rests on the criterion of the technology regime of the industry. We focus on Castellacci's taxonomy, since it encompasses both manufacturing and services industries. In his version two criteria are considered: the technological content of the industry and the place of the industry's firms in the vertical chain. The taxonomic groups are the following:

1. *Advanced knowledge providers* (further divided into *Specialized suppliers* and *Knowledge-intensive business services*)

2. *Mass production goods* (*Science-based manufacturing* and *Scale-based manufacturing*)
3. *Infrastructural services* (*network infrastructure* and *physical infrastructure*)
4. *Personal goods and services*

The four categories are quite different. The first group consists of industries providing new knowledge and new technologies for the economy. The relevant services are consulting, software engineering (programming) and design, and technical services; in other words, the knowledge-intensive business services (KIBS). Given our focus on services, we do not discuss the second group. Infrastructural services support other parts of economy and create little new knowledge. This category is further divided into two groups. One uses network infrastructure and consists, roughly speaking of telecommunication, and financial and insurance industries. An interesting feature of Castellacci's taxonomy is that distinct ICT sub-sectors are in different categories: while programming belongs in KIBS, less knowledge-intensive communication services are in network infrastructural services. Physical infrastructural services use a different kind infrastructure, mainly buildings, roads, waterways etc. The industries in question are wholesale trade, transport and storage. Finally, personal services, such as hotels, restaurants, hairdressers, etc., are low-tech industries that are almost entirely technology adopters.

Castellacci (2008) offers hypotheses regarding innovation activities of each taxonomic group[1] (Table 2). He also verifies them using industry-level CIS data. However we know of no analogous firm-level work, and this study offers a firm-level verification.

[1] As well as their structure in terms of the average firm size.

Table 2. The relationship between industry group according to Castellacci's taxonomy and the sources and types of innovations in firms

	KIBS	Network infrastructure	Physical infrastructure
Cooperation with clients	+	+	
Cooperation with the science sector	+		
Cooperation with suppliers		+	+
Internal development of new knowledge	+	+	
Product innovations	+	+	
Process innovations		+	+
Organization innovations		+	
Training	+	+	
Acquisition of software		+	
Acquisition of machinery			+

Source: Own table based on Castellacci (2008)

Research on innovation in services has evolved from virtual neglect of the phenomenon, through a focus on technology adoption in service sectors and claims about the strong but distinctive innovation performance of service firms, to recent calls for a synthesis of theories of innovation in manufacturing and services (Szczygielski 2011). Many studies indicate that in service firms, innovations in firm organization and marketing play a particularly important role[2]. In particular, marketing innovations are important because of the character of service as a product that is, in most cases, produced in a direct co-operation with the customer, and because in many services sectors there is a limited room for technology-based competitive strategies. Organizational innovations are important for a related reason: given the 'low-tech' character of many service industries, firms tend to diversify their products or expand into upstream or downstream activities: both require changes in firm organization (Szczygielski, Grabowski 2012). Similarly, in a recent CIS-based study, Clausen et al. (2012) find that organizational innovation is particularly important for the performance of service firms in Norway when combined with technological innovation.

Based on the theoretical approaches invoked in this section, we can formulate the hypotheses for our study. We expect the industry in which firm operates to co-determine technology strategies in line with the theories reviewed above:

H1: We expect industry effects to matter significantly for firms' innovation strategy. Especially the KIBS industries are likely to adopt the pioneer posture more frequently

[2] See, for example, Djellal and Gallouy (2001), Drejer (2004), Tether (2004), Miles (2005), Tether and Howells (2007).

and to include radical product innovations in their technological portfolio[3]*. However, the 'network infrastructural industries' (especially telecommunication) are also likely to exhibit some of these features, given the dynamism of the sector.*

H2: On the other hand, physical infrastructural services are likely to focus on incremental innovations and process and organizational innovations.

H3: We expect innovations in marketing to be stressed particularly by industries that address individual customers. Innovations in firm organization are likely to occur in firms that are group members (because of their complexity) and in bigger firms. Finally, organizational and marketing innovations are more likely to be stressed by low- than high-tech industries.

2.2 Internal determinants of technology strategies

While the external environment obviously has an impact on firms' decisions and performance, one can also observe firms differing in these outcomes despite operating in seemingly similar conditions. Indeed, the need to explain the heterogeneity remarked upon by Marshall (1890/1949, cited in Laursen, 2012), and which tends to fly in the face of neo-classical assumptions that there is only one efficient way to do things and all inefficient ways are competed out of existence, was one of the most important motivations for the contribution of Nelson and Winter (1982) and the development of evolutionary economics. This heterogeneity is in prominent display in the aforementioned finding of Srholec and Verspagen (2012) that industry and country are much less important than firm-specific factors in explaining the variance among firms with respect to the patterns of their innovation-related activities. On the other hand, they treat the unexplained heterogeneity as a black box and do not attempt to identify the factors behind it. This is to some extent done by Szczygielski and Grabowski (2012), who analyze the determinants of firm membership in clusters defined by the innovation activities of the firms. These clusters correspond, in fact, to innovation strategies. In their analysis characteristics such as firm size and being a member of a group of firms are significant co-determinants of membership in the clusters; that is, they determine the firms' innovation strategies.

[3] Later in the article we consider the practice of introducing radical product innovations as an indicator of the pioneer posture. However, in Zahra's construct, the two are distinguished.

The resource-based school in strategic management argues that the firm is successful if it is able to create and sustain some unique capabilities, i.e. resources and competences that the competitors find hard to imitate. These can lead to lower unit costs, e.g. due to superb internal logistics systems, or to the firms' ability to develop unique and innovative products. More generally, the capabilities in question, rooted in the internal environment of a firm, and the way they are orchestrated by management and other internal actors, co-determine its position in the market together with the external factors considered in section 2.2 (Henry, 2008: 126).

There is a large theoretical literature, most of it deriving from Schumpeter, on the relationship between technological innovation and firm size. According to the two main theories, either growth of the firm results from successful technological innovations, which allow it to acquire market share, or innovation is a very costly and capital-intensive process which larger firms are better able to afford. In either case, there should be a positive relationship between size and (successful) technological innovation. However, the empirical evidence for such a relationship between size and innovativeness or R&D intensity is not convincing (see the review of the relevant literature in Subodh 2002). More specifically, with regard to the subject of technology strategy and its relationship to internal factors such as size and resources of the firm, Pavitt (1990:24) concluded that:

> it is not useful for a firm's management to begin by asking whether its technology strategy should be leader or follower, broad or narrow front, product or process. These characteristics will be determined largely by the firm's size and the nature of its accumulated technological competences, which will jointly determine the range of potential technological and market opportunities that it might exploit. There is no easy and generalizable recipe for success.

Sapprasert and Clausen (2012) find that firm age is an important explanatory factor for frequency and success of organizational innovation (with older firms more likely to attempt such innovation, but younger ones more likely to benefit from it). We are unable to observe firm age in our data, but size may, to some extent, proxy for age, since it is a common observation that young firms tend to either grow or exit the market (see, for example, Haltiwanger et al. 2010).

The governance or ownership structure of a firm (and particularly, in an emerging market or developing country context, the foreign or domestic ownership of the firm) is also of obvious relevance for all aspects of strategy, including technology strategy. However, the influence of foreign ownership may be ambiguous. On the one hand, in low- and middle-income countries, foreign investors can be expected to be more liberally endowed with financial resources than the average domestically owned company and have a stronger technological base in general. However, we also know from the relevant literature that multinational companies tend to concentrate their R&D activity in their headquarters (see, e.g., Patel & Vega, 1999), meaning that the relative richness of available resources does not necessarily translate into their expenditure on R&D and other innovation-related activity within the subsidiary itself.

Accordingly, we propose the following hypotheses:

H4: We expect that resource-rich firms (in particular bigger firms and those being parts of group of firms) are more likely to adopt more demanding technology strategies, based on R&D, technology pioneering and radical innovations, than resource-poor firms.

H5: Moreover we expect foreign-owned firms to be more active innovators in general than domestically owned firms, and to adopt the pioneer posture more frequently.

H6: On the other hand, we expect these firms to do less R&D, and to monitor the science sector less intensively (because they are likely to acquire their technologies from their mother companies abroad).

2.3 Interactions between strategy variables

In addition to the effects of the characteristics of the firm and its environment on the components of its technology strategy, we are also likely to observe correlations between the various components of technology strategy themselves.[4]

The concepts of exploration and exploitation were introduced by March in his classic 1991 paper to characterize the learning strategies of firms, linking them to the firms' sources of competitive advantage. For March (1991: 71), exploration "includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation", while exploitation "includes such things as refinement, choice, production, efficiency, selection, implementation, execution." Later elaborations of these ideas have identified exploration with radical innovations and exploitation with incremental innovations. For instance, Auh and Menguc (2005: 1653) state that "whereas exploration is concerned with challenging existing ideas with innovative and entrepreneurial concepts, exploitation is chiefly interested in refining and extending existing skills and capabilities."

This implicitly suggests that exploration and exploitation may be associated with preferences of firms for certain types of knowledge sources and certain types of innovation activities or strategies. It suggests, in particular, that exploitation may be linked to a substantial role of supply chain partners in providing knowledge, whereas exploration may be more strongly associated with external and in-house R&D activity.

[4] This is already implied by Zahra's and Castellacci's hypotheses discussed in 2.2. Note that the number of external factors they discuss is *smaller* than the number of strategic variables they supposedly influence. Consequently, we are likely to observe correlations between different aspects of innovation behaviour.

Some researchers have tended to view exploration and exploitation as stages that firms go through in their life cycle, generally moving from radical innovation and exploratory strategies to incremental innovation and exploitative strategies (and sometimes back again), rather than as approaches that might be adopted simultaneously (see, for example, Rothaermel and Deeds 2004, and Lavie and Rosenkopf's 2006 discussion of intertemporal balancing of exploration and exploitation). This harks back to what was said above about the role of firm age.

A recent study by Leiponen (2012) also utilizing CIS data (for Finland) focuses on measures of the breadth of firms' innovation strategies, including the number of different innovation objectives pursued and the number of types of sources of knowledge used in innovation-related activity. Breadth – one of the components of Zahra's technology strategy construct – is found to have important effects on the success of service firms' innovation efforts, with breadth of knowledge sources positively affecting innovation efforts but breadth of objectives having a negative effect (contrasted to the positive effect it has in manufacturing).

On the basis of the foregoing, we hypothesize the interrelationships between technology strategy variables to be as follows:

H7: Firms that take the pioneer posture are also likely to pursue R&D activities, to introduce radical product technologies, and to monitor the developments in relevant fields of science.

3. Methodology and hypotheses

3.1 Data

We use the data on service firms from the 2006 and 2008 runs of the Community Innovation Survey. In the part of the CIS dedicated to the services sector the coverage is approximately 25% of the population. There are 3879 observations for CIS 2006 and 4262 for CIS 2008. The scope of CIS implies that 40 NACE-Rev-2 service industries are represented (out of 103 3-digit industries in the NACE classification) representing the following broad sectors: wholesale trade, transport and storage, ICT, financial and insurance services, and some other industries (incl. consulting).

The Community Innovation Survey was first implemented in 1993. It is a joint effort of national statistical offices in the European Economic Area[5], co-ordinated by the Eurostat. The methodology follows the Oslo Manual (OECD and EC, 2005). The rule is that the Eurostat sets

[5] Several other countries now run CIS-like innovation surveys. For a review of such surveys in developing countries see Fagerberg et al. (2010).

the ‘core questionnaire’ to be incorporated by all the countries and recommends some further questions that can be included on a non-obligatory basis. Our analysis rests on the core questionnaire, listed in Box 1. Most questions refer to the three-year period preceding the circulation of the questionnaire (i.e. 2004-2006 and 2006-2008, respectively), while questions on turnover and outlays refer mainly to the year of issue. Note, however that the confidentiality conditions imposed by the Polish Statistical Office made the absolute financial data inaccessible to us. For the same reason we have no information about the exact number of employees, but only about the size classes: small (up to 49 employees) and medium-or-large (50 and more employees).

Box 1. The content of the 2004-2006 CIS core questionnaire

General information about the enterprises
Product and process innovations, hampered innovation activities
Turnover (from old and new products)
Innovation activity and outlays
Public funding of innovation
Highly important source of information for innovation during 2004-2006
Innovation co-operation during 2004-2006
Goals of innovation activities
Organizational innovations
Marketing innovations
Ecological innovations

Not all dimensions of Zahra’s technology strategy are observed by the survey, but some of them are. In particular *the intensity of internal R&D* and *the reliance on external technologies* can be assessed by examining the ‘Innovation activity and outlays’ chapter. The *pioneer vs follower posture* can be identified by verifying if firm introduced innovations new to the market in the CIS chapter ‘Product and process innovations’[6]. The same part of the CIS makes it possible to examine, to some extent, the content of technology portfolio (product or process innovations); innovations in organization and marketing are also relevant here. The question of technology forecasting is more problematic. If, following Zahra (1996), we understand forecasting as the monitoring of current technological developments with an intention to use this information for anticipating or predicting where the market is going, the CIS data can tell us about monitoring, to some extent, by telling us if and to what extent the firm uses information from different sources in its innovation activity (‘Highly important sources…’). However, this is an incomplete picture, as we do not know anything about the intention of this monitoring activity. Finally, *the breadth of technology portfolio* cannot be identified using CIS data.

[6] Following the Oslo Manual, the CIS adopts a broad definition of innovation including the introduction of products and processes new to the firm only, but not to the market in which it operates.

3.2 Methodology

Our work consists of the following stages. First, we define the strategy variables. Second we look at the determinants of technology strategies using both static and dynamic techniques. Thirdly, we estimate jointly a system of equations for the strategic variables, to assess the correlations between them. Fourth, we see to what extent the differences in technology strategies can be explained by observable firm characteristics.

The process of defining strategy variables starts from a factor analysis applied to the CIS 'chapters' listed in Box 1 We consider both runs of the survey. Once it is confirmed that the factors extracted are stable over time, we propose simple indicators of the different aspects of technology strategy: ($S^1, \ldots, S^K$). Contrary to some previous works (e.g. Srholec and Verspagen 2012, Clausen et. al 2011) our indicators are not factor scores but simple functions of the 'raw' CIS questions. This is to ensure a better comparability of the variables across time.

In the second step we look at the determinants of technology strategy. Different versions of the following equation are estimated:

$$S_i^k = f(x_i, \varepsilon_i), \qquad (1)$$

where:

$$x_i = (1, groupPL_i, groupFDI_i, small_i, indB_i, \ldots, indF_i) \qquad (2)$$

and all variables are binary variables: *groupPL* is equal 1 for firms which are members of a group of firms and the mother company is located in Poland, *groupFDI* equals 1 for group members with the mother company abroad; *small* indicates small firms (as opposed to medium and large ones cf. section 3.1), *exporter* – firms involved in exporting; and $indA, \ldots, indF$ are industry dummies given by the two-digit NACE Rev-2 division:

- $indA$ Wholesale trade (46)
- $indB$ Transport and post (49, 50, 51, 53)
- $indC$ Storage (52)
- $indD$ Telecommunication and simple ICT, e.g. web-hosting (61, 63, 581)
- $indE$ Finance and insurance (64, 65, 66)
- $indF$ KIBS (62, 71, 581)

Note that this division is consistent with Castellacci: groups A, B and C are physical infrastructure services; group D and E are network infrastructure services; finally group F consists of knowledge-intensive business services.

Equation (1) is estimated by OLS, GLS, tobit, probit or logit, depending on the character of the strategy variable S^k. We estimate it separately for 2006 and 2008. However the vector of variables indicated in (2) is just a starting point. The selection of variables in individual models is based on their statistical significance. We apply a strategy ‘from general to specific’, which means that we start with model including all variables from vector x_i. We verify significance and exclude variables, which are not significant at the 0.05 level of significance.

The third part of our methodology is dedicated to the analysis of interactions between strategic variables. To that end we estimate the parameters of the simultaneous model:

$$\mathbf{AY} + \mathbf{BX} = \boldsymbol{\Xi} \qquad (3)$$

by 3-stage Least Squares[7]. Matrix $\mathbf{Y}$ consists of strategic variables $(S^1, \ldots, S^K)$ matrix $\mathbf{X}$ consists of exogeneous variables listed in (2), and vector $\boldsymbol{\Xi}$ contains error terms. Note that using 3SLS makes it possible to learn more about the joint distribution of strategic variables than would have been possible had we used e.g. simple correlation analysis.

Lastly, we examine to what extent the variation in technology strategy can be explained by firm characteristics. In doing so, we look to the work of Srholec and Verspagen (2012), who performed a decomposition of variance of their ‘innovation strategy’ variables and concluded that a small portion of variance (up to 12%) can be explained by the variety in 2-digit NACE industries and countries (their dataset covers 13 countries). In terms of our model, Srholec and Verspagen attempted to explain the differences in technology strategies by looking at the external factors. We extend that methodology by adding internal factors: firm size and group membership. In addition, we add a dummy for public support for innovation, as some studies find this to be an important factor in innovation in Poland (Institute for Structural Research 2011).

We use a variance components model (see Goldstein, 2003), where a chosen strategy of a firm is nested in industry, size, membership in a group and receipt of public support. A basic variance components model is given as follows:

$$S_{ijklm} = a + b_j + c_k + d_l + e_m + f_{ijklm}, \qquad (6)$$

where S is the dependent variable, i is the firm, j is the industry, k differentiates firms according to group membership, l differentiates firms according to size and m differentiates firms according to the receipt of public support (b_j is variability between industries, c_k is variability between groups, d_l is variability between small and medium-or-large firms and e_m

[7] This method takes into account covariances among the error terms, which assures obtaining efficient estimates; see Greene (2012).

is variability between firms not receiving public suport, receiving public support from national programs and receiving public support from the EU programs; f_{ijklm} is variability between firms among these categories).

4. Results

4.1 Results of factor analysis and the definition of strategy variables

First, we apply factor analysis to the set of questions 'Varieties of Innovation Activities'. The results are presented in

Table 7 and **Table 8** in Annex 1. The pattern of correlation seems fairly similar for the two years. According to the results of the factor analysis, *Internal R&D* and *Acquisition of external R&D* have the highest correlations with the first factor for both years. On this basis we have constructed the variable 'R&D', which takes on a value of 1 for companies that have carried out internal R&D or acquired external R&D. In doing so we depart slightly from Zahra, for whom own R&D and that acquired from external sources are two different strategy variables. However, as shown by our analysis, they are statistically indistinguishable in the CIS.

Turning to the correlations with the second factor, we define the variable 'Capacity Building', which takes on a value of 1 for firms that indicated having engaged in at least two of the following three activities: *Acquisition of machinery, equipment and vehicles needed for innovation purposes, Acquisition of software for innovation, Training (internal or external) for innovative activities.* This variable is not mentioned in Zahra's theory; however, its importance is suggested by the resource-based approach in strategy studies. Therefore we regard it as a measure describing an augmented version of the 'Technology portfolio' dimension of technology strategy.

In the same vein, we define the variables ORGMARKT_06 and ORGMARKT_08, which is a dummy equal to 1 for firms that introduced innovations in organization or marketing. Since the respective parts of the 2006 and 2008 CIS questionnaires are not fully comparable, the variable names contain the year of survey.

In the next step we consider the CIS chapter 'Aims of Innovation'. Again, the correlations for 2006 and 2008 look largely similar (**Table 9** and **Table 10** in Annex 1). One factor loads strongly on the innovation activities aimed at improving the (widely defined) quality of production processes, while the other is correlated with aims related to a stronger position of the enterprise in the product market. Since the firms assess the importance of different aims using a 4-point Likert scale, we choose the following method of defining relevant strategic variables. First, 'Process-orientation of innovations' (PROCO) is the arithmetic mean of the three 'internal' questions: *Improving flexibility for producing goods or services*, *Increasing capacity for producing goods or services*, and *Reducing costs per unit produced or provided*. Second, *'Product-orientation of innovations' (PRODO)* is the arithmetic mean of the three external questions: *Increasing range of goods or services, Improving quality of goods or services*, and *Entering new markets*. Thus both PROCO and PRODO can take values from 0 to 3. We interpret these variables as continuous measures of the intensity of product and process innovations, respectively, which can be used to map the content of a firm's technology portfolio (to use Zahra's term).

To learn about the monitoring activities of firms, we analyze the question about highly important sources of information for innovation activities. These questions were also answered using a Likert scale. We use the results in **Table 11** and **Table 12** in Annex 1 (again, stable over time) to define two further strategic variables. The first, which we call SCIENCE, is the mean of the four sources of information that correlate strongly with Factor 1: *Polish Academy of Science institutes, Public research institutes, Foreign public research institutes*, and *Universities or other higher education institutions*. The other strategic variable describing the monitoring activities, MARKETS, is the mean of the two sources of information correlated to Factor 2: *Clients or customers* and *Competitors or other businesses in your industry*. As argued above, both SCIENCE and MARKETS are related to technology forecasting, though they cannot be regarded as measures thereof.

It is worth stressing that the results of our factor analyses are not only stable over time. They are also largely consistent with the results of authors who performed similar exercises on other CIS-based datasets, such as Srholec and Verspagen (2013), Clausen et al. (2012) and Szczygielski and Grabowski (2012).

To complete the definition of strategy variables, we take one question directly from the questionnaire. The dummy variable RADICAL equals 1 if and only if the firm has introduced innovations that were new not only to the firm, but also to the market. We regard this variable as an indicator of Zahra's pioneer posture in the marketplace.

We are now ready to discuss the descriptive statistics. Starting with independent variables, their distribution is fairly stable over time, as **Table 3** and **Table 4** indicate. Smaller firms make up roughly one third of the sample. 16% of companies are Polish group members, 20% foreign group members and the rest are standalone firms. The breakdown by industry categories is fairly similar for both years.

Table 3. Percentage of small firms and of those being members of groups

	2006	2008
SMALL	0.34	0.36

GROUP_PL	0.16	0.16
GROUP_FDI	0.19	0.20

Table 4. Composition of the sample by industry categories (cf. 3.1)

INDUSTRIES 2006	**A**	**B**	**C**	**D**	**E**	**F**
	0.30	0.12	0.05	0.07	0.28	0.18
INDUSTRIES 2008	**A**	**B**	**C**	**D**	**E**	**F**
	0.34	0.11	0.04	0.08	0.25	0.18

Table 5 shows the distribution of strategic dummy variables. The percentage of innovating firms performing or acquiring R&D activities dropped from 38 in 2008 to 31 in 2006. Interestingly, the proportion of firms that reported radical product innovations increased in that period from 34% to 42%. The shares of innovating firms that reported innovations in organization or marketing or activities towards capacity building are generally higher, but they also declined between 2006 and 2008.

Table 5. Percentage of firms for which the strategic variables listed take on value 1

	2006	**2008**
RD	0.38	0.31
CapB	0.75	0.71
ORGMARKT	0.65	0.57
RADICAL	0.34	0.42

We observe a modest growth of the average intensity of product and process innovations **(Table 6).** The reliance on science as a source of information for innovations remained on a similar level between 2006 and 2008, and the same is true for the information from markets.

Table 6. Parameters of the distributions of strategic variables

	Mean	**Std dev.**
PRODO 2006	1.75	0.94
PRODO 2008	2.20	0.86
PROCO 2006	1.20	0.95
PROCO 2008	1.38	0.98
SCIENCE 2006	0.31	0.59
SCIENCE 2008	0.30	0.62
MARKETS 2006	1.67	0.94
MARKETS 2008	1.54	0.93

4.2 The determinants of technology strategy

As we expected, industry is a significant determinant of technology strategy. The knowledge-intensive business services (group F) is indeed more likely to pioneer technologies than the base group A (**Table 15**), but also to invest in R&D (**Table 13**) and monitor the science sector (**Table 17**: a significant relationship in 2006). The pioneer posture is also characteristic of telecommunications and simple ICT services (group D; somewhat surprisingly, for 2006 the odds are even higher than for the group F). The financial industry is similar in its propensity for radical innovations, but it is less likely to invest in R&D and highly unlikely to use information from the science sector in innovating.

Regarding low-tech service industries, they are clearly less likely to invest in R&D or become technology pioneers. Wholesale trade firms introduce innovations in organization and marketing more frequently than transportation and storage companies do, but – interestingly – still less often than KIBS firms. A largely similar pattern is reproduced when we look at process innovations (**Table 20**). On the other hand, the low-tech firms are less likely to build up their capabilities than high-tech firms (**Table 14**) which is quite unexpected, given the uncomplicated nature of this task.

Turning our attention to internal factors, they seem to influence the technology strategies in the way we predicted: smaller and standalone (i.e. resource-poorer) firms are less likely to pioneer technologies and to invest in R&D. As expected, foreign-owned firms are more likely to introduce radical innovations (in 2006, **Table 15**). However, contrary to expectations, they do not appear to have a significantly lower propensity to conduct R&D or contact the science sector for help in their innovation processes. Foreign-owned group members are less likely to invest in capacity building than Polish group members and even standalone firms (**Table 14**). They are more likely to introduce innovations in marketing and organization than firms which are not group members, but the coefficient is lower than for the Polish firms-group members.

To sum up, hypothesis H1 is confirmed. Hypotheses; H2 and H3 are only partly confirmed, because, firms from high-tech industries (especially KIBS) are apparently more likely to introduce *all* kinds of innovations than ones from low-tech industries . Regarding our predictions about foreign-owned companies, hypothesis H5 is confirmed, while H6 is not.

4.3 The relationship between strategy variables

At this point we have to specify our methodology in more detail. The SLS method allows only continuous variables in the system. For MARKETS, PRODO and PROCO, we can take observable values of these variables. Though these variables are in fact discrete, the number of discrete values is large enough to treat these variables as continuous. In the case of variable SCIENCE we take observable values of this strategy for uncensored observations and truncated theoretical values for censored observations:

$$\widetilde{SCIENCE}_t = \begin{cases} SCIENCE_t & if \quad SCIENCE_t > 0, \\ x_t\hat{\beta} - \hat{\sigma}\dfrac{f\left(\dfrac{x_t\hat{\beta}}{\hat{\sigma}}\right)}{1-F\left(\dfrac{x_t\hat{\beta}}{\hat{\sigma}}\right)} & if \quad SCIENCE_t = 0. \end{cases}$$

With respect to RD, CapB, RADICAL, and ORGMARKT, we calculate theoretical values (expectations in truncated distribution). For example in the case of variable RD, we replace values of this variable by the following theoretical variable:

$$\widetilde{RD}_t = \begin{cases} \dfrac{f\left(x_t\hat{\beta}\right)}{F\left(x_t\hat{\beta}\right)} & if \quad RD_t = 1, \\ -\dfrac{f\left(x_t\hat{\beta}\right)}{1-F\left(x_t\hat{\beta}\right)} & if \quad RD_t = 0. \end{cases}$$

The dimensions of technology strategies prove to be correlated, and three patterns stand out. Firstly, in line with hypothesis H7, R&D efforts are closely related to pioneer posture and to monitoring the science sector (**Table 21** and **Table 22**). This is consistent with prior results: for instance Srholec and Verspagen (2012) identify a factor they call ‘Research’, which correlates with the three strategic variables we consider here.

Secondly, a technology portfolio based on product innovations is likely to include also process innovations and a specific kind of monitoring (and possibly forecasting), consisting in the observation of product markets. This seems natural, because new products often require new production processes. Thirdly, a technology portfolio depending on capability building activities is also likely to include innovations in marketing and organization, suggesting bundling of low-tech innovations.

4.4 Factors behind the technology strategy

Table 23 shows the results of the variance decomposition (6). In most cases internal factors contribute more to the variance than the external factor (industry). Although our result is not directly comparable to that of Srholec and Verspagen (2012), it suggests that they might have been too pessimistic about the portion of the variance in technology strategies that can be explained by firm characteristics. The trick is to consider the internal factors of firm strategies (group membership and size) Note that for all the strategic variables (with the notable exception of SCIENCE and RADICAL), the internal factors are relatively more important in 2008 than in 2006.

5. Conclusions

With this paper we hope to have contributed to research on the technology strategy of the firm. Based on previous theoretical work, we asked two principal questions: what are the elements of technology strategy and how is the choice of technology strategy determined by factors external and internal to the firm. To address these problems we analyzed data from two runs of the Community Innovation Survey for Polish service firms. As in many previous CIS-based empirical studies, we started from a factor analysis. However, instead of accepting the resulting factors as strategy dimensions, we proposed our own strategy variables, guided by the components of technology strategy proposed by Zahra (1996) as well as insights from the literature on service innovations. The resulting set of variables included pioneer posture, R&D efforts, technology portfolio variables (capacity building, innovations in organization and marketing, process- and product- orientation of innovations), monitoring the science sector and monitoring the markets. We identified the correlations between variables and assessed their determinants. To that end we looked both at the factors external to the firm (industry) and at the hitherto less stressed in the literature, internal factors (indicators of a firm's resource endowment: size and group membership). Including internal factors in the analysis increases substantially the explanatory power of our analysis. Our results suggest that technology strategies are determined by both kinds of variables, and the role of internal factors increases with the macroeconomic environment becoming less favourable.

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Annex

Annex 1. Result tables: factor analysis

Table 7. The Results of the Factor Analysis of the Varieties of Innovation Activities for year 2006

	Factor 1	Factor 2
Internal R&D	.676	-.109
Acquisition of external R&D	.642	.020
Acquisition of machinery, equipment and vehicles needed for innovation purposes	-.001	.655
Acquisition of software for innovation	.046	.765
Acquisition of external knowledge for innovation (purchase or licensing of patents and non-patented inventions, know-how and other types of knowledge from other businesses or organizations)	.493	.270
Training (internal or external) for innovative activities	.500	.441
Marketing for product innovations (including market research and launch advertising	.655	.081
Other preparatory activities for product or process innovations, such as feasibility studies, testing, software development)	.651	.082

Note: Factors are listed in the heading of each column and factor loadings are reported in the table. Extraction method: principal-components analysis. Rotation method: varimax. Number of observations: 1240 (firms that introduced product- or process innovations). Source: Community Innovation Survey 2006.

Table 8. The Results of the Factor Analysis of the Varieties of Innovation Activities for year 2008

	Factor 1	Factor 2
Internal R&D	0.805	0.080
Acquisition of external R&D	0.815	0.022
Acquisition of machinery, equipment and vehicles needed for innovation purposes	0.023	0.708
Acquisition of software for innovation	0.075	0.715
Acquisition of external knowledge for innovation (purchase or licensing of patents and non-patented inventions, know-how and other types of knowledge from other businesses or organisations)	0.528	0.307
Training (internal or external) for innovative activities	0.286	0.675
Marketing for product innovations (including market research and launch advertising)	0.345	0.460
Other preparatory activities for product and process innovations, such as feasibility studies, testing, software development	0.534	0.410

Note: Factors are listed in the heading of each column and factor loadings are reported in the table. Extraction method: principal-components analysis. Rotation method: varimax. Number of observations: 1047 (firms that introduced product- or process innovations). Source: Community Innovation Survey 2008.

Table 9. The results of the Factor Analysis of the Aims of Innovation for year 2006

	Factor 1	Factor 2
Increasing range of goods or services	.036	.867
Improving quality of goods or services	.294	.737
Improving flexibility for producing goods or services	.787	.237
Increasing capacity for producing goods or services	.825	.203
Improving health and safety	.558	.055
Reducing costs per unit produced or provided	.750	.042
Entering new markets	.114	.847

Note: Factors are listed in the heading of each column and factor loadings are reported in the table. Extraction method: principal-components analysis. Rotation method: varimax. Number of observations: 1240 (firms that introduced product- or process innovations). Source: Community Innovation Survey 2006.

Table 10. The results of the Factor Analysis of the Aims of Innovation for year 2008

	Factor 1	Factor 2
Increasing range of goods or services	.028	.868
Improving quality of goods or services	.333	.648
Improving flexibility for producing goods or services	.729	.257
Increasing capacity for producing goods or services	.802	.239
Improving health and safety	.753	.111
Reducing costs per unit produced or provided	.772	.130
Entering new markets	.238	.743

Note: Factors are listed in the heading of each column and factor loadings are reported in the table. Extraction method: principal-components analysis. Rotation method: varimax. Number of observations: 1047 (firms that introduced product- or process innovations). Source: Community Innovation Survey 2008.

Table 11. The results of the Factor Analysis of the Sources of information for Innovation Activities for year 2006

	Factor 1	Factor 2	Factor 3
Within the firm	-0.076	0.611	-0.225
Other firms in the enterprise group	-0.098	-0.135	0.789
Suppliers of equipment, materials, services, or software	0.038	0.387	0.021
Clients or customers	0.065	0.756	-0.019
Competitors or other businesses in your industry	0.198	0.625	0.057
Consultants, commercial labs, or private R&D institutes	0.556	0.236	-0.049
Polish Academy of Science institutes	0.854	-0.096	0.101
Public research institutes (Polish: JBR)	0.813	-0.002	0.072
Foreign public research institutes	0.867	0.076	0.015
Universities or other higher education institutions	0.887	0.105	0.123
Conferences, trade fairs, exhibitions	0.231	0.605	0.576
Scientific journals and trade/technical publications	0.223	0.547	0.599
Professional and industry associations	0.603	0.301	0.311

Note: Factors are listed in the heading of each column and factor loadings are reported in the table. Extraction method: principal-components analysis. Rotation method: varimax. Number of observations: 1240 (firms that introduced product- or process innovations). Source: Community Innovation Survey 2006.

Table 12. The results of the Factor Analysis of the Sources of information for Innovation Activities for year 2008

	Factor 1	Factor 2	Factor 3
Within the firm	-.116	.633	-.267
Other firms in the enterprise group	-.053	-.191	.732
Suppliers of equipment, materials, services, or software	.029	.392	.036
Clients or customers	.060	.705	-.022
Competitors or other businesses in your industry	.158	.662	.061
Consultants, commercial labs, or private R&D institutes	.524	.245	-.063
Polish Academy of Science institutes	.901	-.032	.062
Public research institutes (Polish: JBR)	.873	-.012	.053
Foreign public research institutes	.880	.027	.043
Universities or other higher education institutions	.809	.077	.086
Conferences, trade fairs, exhibitions	.286	.558	.503
Scientific journals and trade/technical publications	.243	.534	.556
Professional and industry associations	.578	.340	.304

Note: Factors are listed in the heading of each column and factor loadings are reported in the table. Extraction method: principal-components analysis. Rotation method: varimax. Number of observations: 1047 (firms that introduced product- or process innovations). Source: Community Innovation Survey 2008.

Annex 2. Result tables: determinants of technology strategy

Table 13. Internal and external determinants of strategy variable RD (Estimates of PROBIT)

	Variable	const	SMALL	GROUP	Ind_F
2006	Coefficient	-0.404	-0.157	0.219	0.348
	Std. error	0.058	0.080	0.078	0.095
	Z-statistic	-6.960	-1.966	2.810	3.678
	P-value	0.000	0.049	0.005	0.000
	Marginal effect		-0.059	0.084	0.135
	Meaning of variable		10%	30%	60%
2008	Variable	const	SMALL	GROUP	Ind_DF
	Coefficient	-0.583	-0.331	0.331	0.275
	Std. error	0.068	0.090	0.086	0.092
	Z-statistic	-8.602	-3.683	3.835	2.984
	P-value	0.000	0.000	0.000	0.003
	Marginal effect		-0.113	0.118	0.099
	Meaning of variable		38%	40%	22%

Note: Probit analysis Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.

Table 14. Internal and external determinants of strategy variable CapB

	Variable	Const	SMALL	Ind_E	Ind_F	
2006	Coefficient	0.519	-0.173	0.561	0.350	
	Std. error	0.057	0.082	0.096	0.108	
	Z-statistic	9.134	-2.099	5.863	3.237	
	P-value	0.000	0.036	0.000	0.001	
	Marginal effect		-0.056	0.161	0.102	
	Meaning of variable		5%	75%	20%	
2008	Variable	Const	SMALL	GROUP_PL	GROUP_FDI	Ind_DEF
	Coefficient	0.509	-0.260	0.279	-0.327	0.350
	Std. error	0.075	0.088	0.127	0.104	0.083
	Z-statistic	6.763	-2.946	2.188	-3.130	4.188
	P-value	0.000	0.003	0.029	0.002	0.000
	Marginal effect		-0.090	0.989	-0.116	0.118
	Meaning of variable		20%	9%	24%	47%

Note: Probit analysis. Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008..

Table 15. Internal and external determinants of strategy variable RADICAL

	Variable	const	GROUP	Ind_C	Ind_D	Ind_E	Ind_F
2006	Coefficient	-1.234	0.607	-1.255	1.516	0.330	1.032
	Std. error	0.113	0.130	0.445	0.252	0.151	0.169
	Z-statistic	-10.90	4.665	-2.821	6.015	2.177	6.109
	P-value	0.000	0.000	0.005	0.000	0.029	0.000
	Marginal effect		0.138	-0.214	0.362	0.075	0.244
	Meaning of variable		19%	8%	36%	2%	35%
2008	Variable	const	GROUP_FDI	Ind_BC	Ind_DF		
	Coefficient	-0.340	0.163	-0.360	0.562		
	Std. error	0.056	0.098	0.122	0.092		
	Z-statistic	-6.051	1.654	-2.945	6.097		
	P-value	0.000	0.098	0.003	0.000		
	Marginal effect		0.064	-0.135	0.221		
	Meaning of variable		2%	16%	82%		

Note: Logit analysis for 2006 and probit analysis for 2008. Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.

Table 16. Internal and external determinants of strategy variables ORGMARKT_06 and ORGMARKT_08

	Variable	const	SMALL	GROUP_PL	GROUP_FDI	Ind_B	Ind_C	Ind_E
2006	Coefficient	0.384	-0.285	0.492	0.261	-0.354	-0.897	0.242
	Std. error	0.070	0.081	0.113	0.101	0.118	0.179	0.089
	Z-statistic	5.519	-3.504	4.349	2.584	-2.997	-4.996	2.721
	P-value	0.000	0.000	0.000	0.010	0.003	0.000	0.007
	Marginal effect		-0.107	0.166	0.093	-0.136	-0.346	0.087
	Meaning of variable		15%	26%	7%	10%	34%	8%
2008	Variable	const	SMALL	GROUP				
	Coefficient	0.136	-0.281	0.445				
	Std. error	0.061	0.083	0.085				
	Z-statistic	2.245	-3.374	5.228				
	P-value	0.025	0.001	0.000				
	Marginal effect		-0.111	0.171				
	Meaning of variable		27%	73%				

Note: Probit analysis Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.

Table 17. Internal and external determinants of strategy SCIENCE

Year	Variable	const	Ind_E	Ind_F	Sigma
2006	Coefficient	-0.458	-0.656	0.399	1.331
	Std. error	0.076	0.116	0.117	0.062
	Z-statistic	-6.044	-5.646	3.413	
	P-value	0.000	0.000	0.001	
	Meaning of variable		76%	24%	
2008	Variable	const	Ind_E		Sigma
	Coefficient	-0.331	-0.559		1.027
	Std. error	0.056	0.120		0.054
	Z-statistic	-5.911	-4.663		
	P-value	0.000	0.000		
	Meaning of variable		100%		

Note: Normal TOBIT for 2006 and t-student TOBIT for 2008. Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.

Table 18. Internal and external determinants of strategy MARKETS

Year	Variable	Const	SMALL	Ind_B	Ind_DEF
2006	Coefficient	1.599	-0.104	-0.178	0.256
	Std. error	0.048	0.056	0.088	0.057
	Z-statistic	33.39	-1.861	-2.039	4.488
	P-value	0.000	0.063	0.042	0.000
	Meaning of variable		7%	9%	84%
2008	Variable	Const	SMALL	Ind_BC	Ind_DF
	Coefficient	2.042	-0.203	-0.270	0.177
	Std. error	0.038	0.056	0.092	0.057
	Z-statistic	53.36	-3.614	-2.933	3.108
	P-value	0.000	0.000	0.003	0.002
	Meaning of variable		59%	22%	19%

Note: OLS estimates for 2006 and GLS estimates for 2008. Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.

Table 19. Internal and external determinants of strategy PRODO

	Variable	const	GROUP	Ind_BC	Ind_DEF	
2006	Coefficient	1.534	0.177	-0.344	0.373	
	Std. error	0.059	0.052	0.099	0.063	
	Z-statistic	25.88	3.368	-3.481	5.918	
	P-value	0.000	0.001	0.000	0.000	
	Meaning of variable		26%	7%	67%	
2008	Variable	const	SMALL	GROUP_FDI	Ind_C	Ind_D	Ind_EF
	Coefficient	2.122	-0.139	0.129	-0.331	0.319	0.184
	Std. error	0.050	0.057	0.062	0.130	0.084	0.057
	Z-statistic	42.70	-2.428	2.084	-2.546	3.810	3.232
	P-value	0.000	0.015	0.037	0.011	0.000	0.001
	Meaning of variable		9%	12%	29%	34%	16%

Note: GLS estimates. Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.

Table 20. Internal and external determinants of strategy PROCO

	Variable	Const	SMALL	Ind_B	Ind_CF
2006	Coefficient	1.233	-0.188	-0.299	0.217
	Std. error	0.038	0.056	0.083	0.064
	Z-statistic	32.41	-3.361	-3.617	3.390
	P-value	0.000	0.001	0.000	0.001
	Meaning of variable		34%	43%	23%
2008	Variable	Const	SMALL	Ind_E	Ind_F
	Coefficient	1.500	-0.279	-0.144	0.152
	Std. error	0.044	0.062	0.071	0.080
	Z-statistic	33.851	-4.517	-2.036	1.899
	P-value	0.000	0.000	0.042	0.058
	Meaning of variable		88%	6%	6%

Note: OLS estimates. Number of observations: 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.

Annex 3. Result tables: the relationship between strategy variables

Table 21. Analysis of the relationships between strategic variables for year 2006

Dependent variable: RDTeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	0.122	0.042	2.925	0.003
SCIENCETeor	0.374	0.051	7.280	0.000
RADICAL	0.264	0.045	5.872	0.000
Dependent variable: CapBTeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-0.000	0.020	-0.000	1.000
ORGMARKT_06Teor	0.242	0.101	2.402	0.016
Dependent variable: SCIENCETeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-0.579	0.036	-15.880	0.000
RDTeor	0.917	0.183	5.003	0.000
Ind_C	0.207	0.143	1.444	0.149
Dependent variable: ORGMARKTTeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-0.631	0.100	-6.302	0.000
PRODO	0.364	0.056	6.454	0.000
Dependent variable: MARKETS				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	0.733	0.034	21.800	0.000
PRODO	0.525	0.010	50.240	0.000
CapBTeor	-0.058	0.021	-2.780	0.005
Ind_E	0.122	0.054	2.275	0.023
Dependent variable: PROCO				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	0.185	0.209	0.886	0.375
PRODO	0.574	0.119	4.819	0.000
ORGMARKT_06Teor	-1.010	0.254	-3.971	0.000
Dependent variable: PRODO				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-1.421	0.082	-17.410	0.000
MARKETS	1.921	0.037	52.100	0.000
Ind_E	-0.233	0.105	-2.228	0.026

Note: 3SLS estimates. Number of observations: 1240 i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006.

Table 22. Analysis of the relationships between strategic variables for year 2008

Dependent variable: RDTeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-0.009	0.049	-0.174	0.862
SCIENCETeor	0.178	0.088	2.033	0.042
RADICAL	0.171	0.050	3.453	0.001
Dependent variable: CapBTeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	0.000	0.022	0.000	1.000
ORGMARKT_08Teor	0.142	0.059	2.396	0.017
Dependent variable: SCIENCETeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-0.373	0.037	-10.020	0.000
RDTeor	0.878	0.332	2.649	0.008
Ind_C	0.167	0.101	1.663	0.096
Dependent variable: ORGMARKTTeor				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-0.725	0.212	-3.420	0.001
PRODO	0.331	0.096	3.442	0.001
Dependent variable: MARKETS				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	-0.295	0.052	-5.669	0.000
PRODO	1.046	0.023	44.870	0.000
CapBTeor	-0.383	0.025	-15.070	0.000
Ind_E	-0.082	0.021	-3.885	0.000
Dependent variable: PROCO				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	2.207	0.480	4.599	0.000
PRODO	-0.373	0.219	-1.706	0.088
ORGMARKT_08Teor	1.636	0.496	3.297	0.001
Dependent variable: PRODO				
Variable	**Coefficient**	**Std. error**	**z statistic**	**p-value**
Const	0.251	0.047	5.284	0.000
MARKETS	0.971	0.024	41.140	0.000
Ind_E	0.081	0.021	3.961	0.000

Note: 3SLS estimates. Number of observations: 1047 i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2008.

Annex 4. Variance decomposition

Table 23. Results of the variance components ANOVA (Type III) analysis for strategies. First row- 2006, second row- 2008

	INDUSTRY	GROUP	SIZE	SUPPORT
RD	20% 13%	7% 13%	9% 8%	6% 17%
RADICAL	15% 24%	13% 5%	4% 4%	12% 14%
CapB	30% 12%	3% 11%	10% 11%	4% 12%
ORGMARKT_06 **ORGMARKT_08**	18% 5%	9% 21%	10% 11%	8% 8%
SCIENCE	27% 26%	12% 12%	2% 1%	4% 8%
MARKETS	22% 4%	4% 2%	7% 23%	15% 17%
PRODO	25% 16%	10% 5%	5% 12%	7% 13%
PROCO	23% 4%	5% 2%	4% 19%	17% 22%

Note: Number of observations is 1240 (2006) and 1047 (2008) i.e. firms that introduced product- or process innovations. Source: Community Innovation Surveys 2006 and 2008.