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Innovation Strategies and Productivity in the Polish Services Sector in the light of CIS 2008

Krzysztof Szczygielski
Wojciech Grabowski

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CASE-Center for Social and Economic Research on behalf of CASE Network
al. Jana Pawla II 61, office 212, 01-031 Warsaw, Poland
tel.: (48 22) 206 29 00, 828 61 33, fax: (48 22) 206 29 01
e-mail: case@case-research.eu
http://www.case-research.eu

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Krzysztof Szczygielski *obtained his PhD in economics from the Warsaw School of Economics. He has been with CASE since 2001 working on projects on international economics, European integration and innovations. His current research interests include problems of public policy, in particular science, technology and innovation policy. Since 2007 he has been a lecturer at the Lazarski University in Warsaw. In 2009-2010 he was a guest researcher at the TIK Institute at the University of Oslo. In 2010 he was awarded the Ministry of Science and Higher Education scholarship for outstanding young researchers.*

Wojciech Grabowski *graduated from the Warsaw School of Economics and obtained his PhD in economics from the University of Lodz. He is a lecturer at the University of Lodz and at the Lazarski University in Warsaw. He published more than 20 papers in polish and international journals and conference proceedings. His research interests include cointegration analysis, stationarity testing, financial crises modeling and limited-dependent variables models.*

Abstract

Industry- and firm-level research into both innovations and productivity has long been limited to manufacturing. With this paper, we aim to contribute to the stream of literature that aims at extending the scope of such investigations to the services industry. To this end we analyze the innovation strategies in several service sectors in Poland in 2008 and examine their relationship to productivity. Our results show that service firms differ considerably in their innovation strategies, but that most of those strategies lead to productivity gains.[1]

[1] This text is a deliverable in the SERVICEGAP project, WP3, Task2

1. Introduction

The 'services' industry is an extremely heterogenous sector that constititutes the bulk of modern economies. Despite their dominant role in output and employment structures, some aspects of service companies' performance have only recently attracted scholars' interest. This is undoubtedly the case with the innovation activities of service firms, which for a long time were assumed to be nonexistent [23]. In this paper we have two aims. Our first aim is to learn more about the innovation strategies in the service sector in order to offer a test to the growing body of theoretical literature. Second, we would like to assess the influence of different innovation strategies on firm productivity.

The rest of the paper is structured as follows. In Section 2, we discuss the background of the study, in particular the theory of service innovations and the literature on productivity in the services sector. In Section 3 we briefly describe the Polish services sector and its transition-economy context. We then continue (Section 4) with our empirical contribution: the novel elements of our methodology are introduced and the data sources are presented. In Section 5 we discuss the results of our research and in the final section we offer conclusions.

2. Background: Innovation in Services and Productivity

2.1. Service Innovations: A Conceptual Framework

Conceptualizing the innovation process in services magnifies all the challenges of building theories of innovation in the manufacturing industries. As stressed by Pavitt [20] in his discussion of the innovation process in large companies in advanced countries, the process is strongly 'contingent' on the sector, country, field of knowledge and type of innovation. We would argue that this is even more relevant for services, which are comprised of industries as different as ICT on one hand, and housecleaning on the other. This heterogeneity makes it difficult even to formulate one, all-encompassing definition of the 'services sector', so many authors resort to simply enumerating service industries instead[2] [23].

[2] For instance Miles [15] resorts to the NACE classification: 'In the NACE framework, services sections are: G (wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods " trade services for short), H (hotels and restaurants " often shortened to HORECA, meaning hotels, restaurants, catering), I (transport, storage and communication " note that this includes electronic communications

In this context, the conceptual framework introduced by Pavitt for the analysis of the innovation process is a useful starting point. He suggested dividing innovation into three, partly overlapping processes: (i) production of scientific and technological knowledge, (ii) translation of knowledge into working artifacts and (iii) responding to and influencing market demand (p. 88). Rooted in the studies on manufacturing, this framework can be applied to some extent to services as well. It is directly applicable to some industries within the services sector, which rely on progress in scientific knowledge in a similar way as high-tech manufacturing industries do. These are ICT services, banking and financial services and some of the transport industries (air- and railway transport). In a different sense Pavitt's framework also fits the many service industries that adopt new technologies developed in manufacturing. This is the kind of innovation that had once been considered the only one relevant for the services sector (the so-called 'subordination' approach to service innovations, [23]).

We would argue, however, that another type of innovation activities in the services sector is concealed in just one of the analytical fields specified above, i.e. in point (iii): the interactions between firms and customers. This is because one kind of innovation that plays a critical role for service firms is marketing innovation, and this for at least two reasons.

The first reason is technology. Most service industries can be thought of as 'low-tech', i.e. as industries where the relevant scientific and technological knowledge is progressing only at a slow pace if at all. As argued convincingly by von Tunzelmann and Acha [24] firms in such sectors 'may place less emphasis on technology functions and more on product/marketing functions than, say, a science-based industry' (p. 418). A company operating in a mature industry carries the risk of being forced to compete in terms of prices only, and developing an active marketing policy is a way of mitigating this danger. Indeed, firms in such industries often seek to upgrade the perceived quality of their products or to cater to new tastes ([24], p. 416). As technological barriers to entry are relatively low, incumbent firms have to be particularly sensitive to changes in demand resulting from changes in the economic, cultural and regulatory environment. This stress on marketing in low-tech industries bears a striking resemblance to the findings of the literature on services, which clearly indicates the central role of marketing innovations in the sector (cf. the review by Kanerva et al., [14]).

The second reason for the central role of marketing innovations is the nature of services. A characteristic feature of a service is that the consumer participates in its production.

alongside more traditional activities), J (financial intermediation), K (real estate, renting and business activities), and a number of subsectors that are mostly not treated as market services, namely L (public administration and defence; compulsory social security), M (education); N (health and social work), and O (other community, social and personal service activities).' (p. 251)

Frequently, production and consumption occur at the same time (*coterminality*)[3]. In that case 'through inputs such as information, self-service activities, inquiries and complaints, customers participate in the service process and influence the progress of the process and its outcome' ([12]). Since customer must often be involved in the production of a service, the particular terms of this involvement become critical for the perceived quality of the product. It is also these terms that become targets of the innovation strategy. Den Hertog proposes thinking of service innovations in four dimensions: the service concept (critical characteristics of the service), the client interface (the way the consumer participates in the design of the service, production and consumption), the service delivery system (e.g. traditional vs. electronic) and technology ([6], [16]).

The final aspect of innovation in services – and one that hardly fits into Pavitt's framework – is organizational innovation. Again, there are analogies to low-tech manufacturing industries. Changes in product policy might induce changes in a company's organization. A case in point is the policy of many firms to pursue 'unrelated diversification', i.e. to embrace products that are technologically distinct from the company's traditional focus, but – and this is the main point – that can be re-branded and thus provide the firm with a competitive edge (cf. [24]).

Also, as sectors mature, firms sometimes seek to expand and embrace activities of upstream or downstream companies (e.g. through mergers), which might enable them to offer more sophisticated product- and marketing strategy ([24]). Such changes in the organization of economic activities almost by definition imply organizational changes in the firm. Yet another reason, why organizational innovations are important in services, is the impossibility of storing service products and hence the inability of firms to use inventories to manage their capacities efficiently [12]. Service firms are therefore forced to perfect their organization so as to adjust the supply to the demand.

2.2. Innovation Strategies

The innovation process is an outcome of firm-level activities. A notion that has been developed in this context is that of *innovation strategies*. One way of making the notion operational is to go back to such concepts as business strategy (or corporate strategy or competitive strategy), which have been discussed at length in the management science literature (cf. [9]). Another approach to innovation strategy is that of evolutionary economics along the lines of Nelson and Winter [17]. They focus on firms' 'routines', which play a role

[3] On the other hand, in some service industries, e.g. telecommunication, the consumer uses the infrastructure that had been prepared by the producer before.

analogous to genes in biology and influence the survival of firms in a competitive environment.[4]

Empirical studies of innovation strategies have been mostly narrow in scope, because of the 'contingency' problem discussed above. As a result, most of them focus on one particular industry and often one specific country or region. The paper by Srholec and Verspagen [22] is an exception. The authors analyze Community Innovation Survey (CIS-3) firm-level data from 13 countries and they investigate innovation strategies in all the manufacturing and most business-services industries. Factor analysis is employed so as to find the regularities in the innovation behaviour of companies. By doing so the authors can take advantage of the rich pool of information that is available in the CIS. Calculations are done in two steps: first factor analysis is applied to the 'chapters' of the CIS (*variety of innovation activity*, *effects of innovations*, *source of information for innovation* etc.) and then it is applied to the factors extracted in the first stage. The results are four principal factors that the authors interpret as the 'ingredients' of innovation strategy: 'Research', 'User', 'External', 'Production'.

The 'Research' factor is associated with performance and acqusition of R&D, innovation co-operation (especially with the science sector) and the formal and informal protection of findings. The second factor ('User') is correlated strongly with the 'product effect' of innovation actvities (a wider range of goods/services offered, increased market share, higher quality of output), the marketing of innovations, the high importance of the information from clients and industry, and non-technological innovation. The 'External' factor reflects activities aimed at technology adoption. Finally, the 'Production' factor is correlated with the 'process effect' of innovations (an increased flexibility of production, higher capacity, reduced unit costs) and with the concern for meeting health, safety and regulatory standards[5].

We actually find this approach to an empirical identification of innovation strategies quite compelling. Its strengh is that it allows for the diversity of strategies encountered in real world. This is the reason why we propose mapping innovation activities by including a module similar to the one described above. This allows for a more precise analysis of the link between innovation and firm performance.

[4] 'We propose to assimilate to our concept of routine all of the patterning of organizational activity that the observance of heuristics produces, including the patterning of particular ways of attempting to innovate' ([17], s. 133).

[5] Srholec and Verspagen also attempt to investigate the industry- and country patterns of the innovation strategy and find that these two variables cannot explain a substantial part of the variation. They propose their own groups based on cluster analysis, instead.

2.3. Innovation and Productivity

The relationship between a firm's innovation performance and its productivity growth is somewhat tricky. For Schumpeter, innovation is the entrepreneur's principal tool of competition, and the aim of competition is to maximize profit – to fulfill the 'promises of wealth' ([21], pp. 76 and 84). Hence, innovation does not necessarily imply enhanced productivity, at least at the firm level. On the other hand, the Schumpeterian 'creative destruction' mechanism supports productivity growth. We would like to study the details of this process.

A firm-level analysis poses a methodological problem, though[6]. The selection of firms into innovators and non-innovators is not random and it is likely to be influenced by factors that also impact productivity. Consequently simple estimates of the relationship between innovation performance and productivity might be biased and inconsistent. Crepon et al. in a now classical paper [5] presented a way of solving this problem by applying the Heckman selection model (cf. [13]) to data on patents and productivity[7]. Their model, called the CDM-model after the initials of the authors, consists in simultaneously estimating three relationships: (i) between firm and market characteristics – and R&D expenditure, (ii) between R&D expenditure, firm and market characteristics – and patenting innovation performance, and (iii) between innovation performance and capital intensity of production – and productivity. The idea behind applying a Heckmann selection model is that while only a minority of firms report any R&D spendings and fewer yet patent their findings, many others may have been involved in various kinds of innovation activities that do impact firm productivity.

The CDM model in its different varieties has been replicated in several national contexts and the general conclusion is that better innovation performance is associated with higher productivity, however there are countries for which this result applies only with respect to process innovations and for others only with respect to product innovations (cf. [3])

In the original CDM model the 'innovation performance' variable in the relationship (ii) was patenting. Later studies based on the CIS have frequently used wider categories such as reporting product or process innovations (cf. the work by Griffith et al. on four European countries [11]). Nevertheless innovation performance is always characterized by just one variable.

We find this approach somewhat narrow, given the variety of innovation strategies documented in the literature. Consequently, we propose a modification of the prior

[6] For interesting cross-country studies, see [4], [7], [8]
[7] They also addressed several other problems with estimating firm-level models based on R&D data

methodologies, wherein 'innovation performance' is identified with innovation strategy, itself described in several dimensions. These dimensions will be determined through factor analysis and then used in a cluster analysis in a way similar to Srholec and Verspagens proposed method [22]. On the other hand, due to the aggregate character of our productivity dataset we are unable to address the selection problem. A detailed presentation of our methodology follows in section 4.

3. Study Context and Hypotheses

3.1. Services sector in Poland

When analyzing the services sector in a country with a communist heritage, like Poland, one has to mention history. Communist ideology placed heavy industry at the centre of the economy and the services sector, especially the service industries that of it cater to individual consumer needs, used to be was neglected in all the centrally-planned systems. According to one study, in the mid-1980s, the relative share of employment[8] in trade (both retail and wholesale) in socialist economies was one-third of the respective share in a group of OECD economies ([19] cited by [18]).

As a consequence, when those countries embarked on market reforms in the early 1990s, they had to undergo deep structural changes. This is well illustrated by Table 1: while in Germany, Italy, and France, the increase in the share of GDP created by the services sector between 1990 and 2010 was about 10 percentage points, the corresponding increase in the Czech Republic was 15 pp and in Poland 23pp! In fact the figure for Poland might even be understated, because of the starting year of the analysis: by the end of 1990, considerable changes had already taken place following the liberalization of economy in late 1989[9].

How exactly that structural change occurred is beyond the scope of this paper. However it might be useful to make a few points about the major developments in the Polish services sector since 1989:

- The beginning of the transition saw an explosion of microenterprises filling the numerous niches, especially in retail and wholesale trade but also in hotels,

[8] As compared to the industry employment
[9] Pre-transition data are not easily available and problematic for methodological reasons.

restaurants and catering. These industries have become more consolidated over time, with many micro-firms leaving the market[10](cf. [10]).

- The development of business services was, in turn, more gradual as it followed the proliferation of private firms in general. FDI have dominated the growth of knowledge-intensive business services (KIBS)[11]

- Similarly, the whole financial sector saw big inflows of foreign capital. This was especially the case in late 1990s and early 2000s when all the large, previously state-owned banks (but one) were sold to global players. This was a deliberate policy that was supposed 'to achieve a good governance structure in banks and receive capital and technology injections' ([2], p. 26).

- The mid- to late 1990s also saw the entry of (mostly foreign-owned) super- and hypermarkets[12], which substantially changed the landscape of wholesale- and retail trade. As of 2010, foreign-owned stores accounted for 24.1% of the sales area in Poland (85.5% in the case of hypermarkets and the 64.4% in case of supermarkets)[13]. Super- and hypermarkets accounted for 22.1% of the total retail trade turnout ([1]).

Having this in mind one can expect the Polish services sector to consist of (i) foreign-owned firms in some subsectors, (ii) middle-sized relatively young domestic actors, (iii) a large number of SMEs and microenterprises in service industries not involving high fixed costs. A simple analysis of the average number of persons employed in service firms suggests that Polish service companies are indeed relatively small, the exception being 'real estate activities' (Table 2). Also if we go ahead of our story and consider the descriptive statistics of our dataset, it will become apparent that foreign-owned firms are on average larger than their domestic competitors (Table 5). We can also show that they play an important role in some knowledge-intensive sectors (Table 6) but we cannot prove it for all the relevant industries, probably due to the restrictive definition of foreign ownership in our dataset[14].

Finally, note that the structure of the Polish services sector differs from that of more developed countries. Although the low-skilled-intensive industries – trade, HORECA, transport, accommodation and storage – are dominant in every country, in Poland they

[10] Growing consumer expectations with respect to quality has certainly been a major reason for this. Another could be tightened regulation

[11] Andersen Consulting, Arthur Andersen, PriceWaterhouseCoopers, KPMG and McKinsey all opened their offices in Poland in the early 1990s

[12] According to the classification of the Polish Statistical Office, a supermarket is a grocery store with a sales area of 400-2499 sq. meters while a hypermarket is a store with an area of more than 2500 sq. meters

[13] Retailers employing at least 9 persons are considered

[14] The CIS does not provide information on the ownership of firms. We assumed that foreign-owned companies are those that are part of the group and whose mother company is located outside of Poland. However there are certainly many foreign-owned companies that do not comply with this definition.

account for a particularly high share of services employment and value-added (cf. Figures 1, 2).

3.2. Hypotheses

What can we expect to find out about the innovation patterns of Polish service firms and their impact on productivity? First of all, both the theory and the empirical studies reviewed above suggest that services firms will attach a particular weight to technology adoption and to organizational and marketing innovations. On the other hand, our study follows Srholec and Verspagen's study [22] and given their wide country- and industry-coverage, one could expect that we would arrive at similar results in terms of 'ingredients' or 'dimensions' of innovation strategies.

Consequently, we hypothesise that the innovation strategies of service firms can be described in dimensions that include, in particular, 'research', 'customer orientation' and 'technology adoption', but that service firms stress process and, organizational and marketing innovations to a larger extent than do manufacturing companies. Also, we expect research activities to be confined to individual sectors. The 'soft' character of service innovations should be reinforced by the relatively short history of the services sector in Poland, its dispersion and labour-intensity (see previous section). By the same token, we presume that firms being part of a group (many of which are foreign-owned) are on average more innovative than independent companies and that larger firms are more innovative than smaller ones.

As for the relationship between innovation performance and productivity, we expect earlier results to be confirmed in the services sector, i.e. we expect firms introducing innovations to be more productive than those adopting more passive policies. What is more, it is our assertion that this rule also applies to organizational and marketing innovations, i.e. to the dimensions of innovation strategies that do not improve a firm's technology in the narrow sense of the word.

4. Data and Methodology

4.1. Data

We analyzed data from the 2006-2008 run of the Community Innovation Survey (CIS 2008). Only medium and large firms were surveyed and the coverage was about 25% of the population. There are 4262 observations from 40 NACE-Rev-2 industries (at the 3-digit level). Note that the 40 industries are less than half of all the 3-digit industries as defined by

the NACE classification (there are 103 of them). This is determined by the scope of the Community Innovation Survey. A list of industries is provided in Table 3. For the purpose of our analysis we divided the 40 industries in five groups:

A. Wholesale trade (2-digit NACE category: 46)

B. Transport and storage (49, 50, 51, 52, 53)

C. Information and communication technology industries (61, 62, 63 and 582)

D. Financial and insurance services (64, 65, 66)

E. Miscellaneous (581, 71)

The confidentiality conditions imposed by the Polish Central Statistical Office (CSO) imply that data on outlays are only on a per-employee basis. In the same vein, the CSO does not disclose firm-level productivity data implying that we only have the productivity data (sales per employee) for statistical units defined by the 3-digit NACE level and firm size (medium or large). That leaves us with 44 observations (not 2*4=80 because, in our dataset, some NACE categories were pairwisely merged, for some we do not have the medium-large division because of confidentiality requirements and for some the data on investments per employee necessary for the estimation of the productivity equation).

4.2. Methodology

We shall start by identifying the dimensions of the innovation strategies of Polish firms. To this end, we follow a two-stage procedure similar to that proposed by Srholec and Verspagen in [22]. First we apply factor analysis to groups of questions anwered by firms in the CIS. We distinguish four groups, of which two are isolated by the CIS questionnaire as ’chapters’: these are ’Sources of information for innovation’ and ’Varieties of innovation activities’. Two further groups were created by merging ’chapters’ referring to technological and non-technological innovations. These are: ’Scale and Scope of Innovation’ and ’Aims of Innovation’. While in the case of technological innovations these questions are treated in separate chapter, this is different for non-technological innovations: there is one chapter about organizational innovation and one about marketing innovation and each of them includes questions both on the scale of innovation and its aim.

Having isolated factors for each of the four groups of questions, we applied factor analysis to these factors. We shall interpret the outcome (the factors extracted in the second stage) as dimensions of innovation strategies. For each firm the vector consisting of the values of

second-stage factors describes the 'innovation performance' of the company. Assume we extract *K* factors, we shall denote them by $F^1,...,F^K$.

Since the absolute values of the variables obtained by factor analysis have no obvious interpretation, we perform a cluster analysis to complete our investigation of innovation strategies. Assume we extract *L* clusters: $C_1,...,C_L$. In addition we classify all the non-innovative firms into one cluster (C_0).

We then analyze the determinants of cluster membership by estimating a multinomial logit model which can be summarized as follows. Let $y_i=l$ if company *i* is in cluster *l*. Then

$$\Pr\{y_i = l\} = \frac{\exp(\mathbf{x}_i'\alpha_l)}{1+\sum_l \mathbf{x}_i'\alpha_l} \quad \text{if } l \in \{0,1,...,L\} \setminus \{l_{ref}\} \qquad (1)$$

$$\Pr\{y_i = l_{ref}\} = \frac{1}{1+\sum_l \mathbf{x}_i'\alpha_l} \qquad (2)$$

where l_{ref} is the reference category and vector $\mathbf{x}_i$ itself consists of dummies:

$$\mathbf{x}_i' = (1, medium_i, group_i, export_i, A_i, B_i, C_i, E_i)$$

In particular $medium_i$ takes on value 1 if the firm is medium (as opposed to large), $group_i$ – if the firm is a member of a group of firms, $export_i$ – for exporters, and A_i, B_i, C_i, E_i for respective industries. The parameters of the model are estimated by maximum likelihood.

We estimate two versions of model (1)-(2): one for all firms with C_0 as reference category and one only for innovative firms with one of the nontrivial clusters as reference. The results are reported in the form of relative risk ratios:

$$\frac{\Pr\{y_i = l\}}{\Pr\{y_i = l_{ref}\}} = \exp(\mathbf{x}_i'\alpha_l) \qquad (3)$$

Finally we investigate the impact of innovation strategies on productivity. As explained earlier we can only do that on an aggregate firm-class-level. We estimate the parameters of the following model:

$$z_j = \mathbf{w_j}'\beta + \xi_j \qquad (4)$$

where j=1...J indexes firm classes defined the NACE industry and by size, z_j is the logarithm of mean sales per employee for all firms in the class, while vector w_j is defined as follows:

$$\mathbf{w}_j' = (1, capital_j, \hat{C}_j^1, ..., \hat{C}_j^L)$$

Variable $capital_j$ denotes the log of mean per employee investments in the firm class, while $\hat{C}_j^l$ stands for the *percentage of firms* in the firm class *j* that belong to cluster *l*. The parameters of model (4) are estimated by OLS and we verify hypothesis about homoskedasticity. If this hypothesis is rejected, we estimate parameters by GLS.

5. Results

5.1. Identification of innovation strategies

Let us start by discussing some descriptive statistics. Table 4 provides the frequencies of the dummies used in the estimations of equations. Apparently there are roughly as many medium firms in the sample as there are large ones. About 40% of companies export and about 20% are members of groups of firms. Approximately one-quarter of the firms have engaged either in product- or process innovations (or both). Tables 5-6 illustrate the role of (some of the) foreign-owned firms in our dataset (see the discussion in section 3.1), as well as give a more exact picture of the structure of the sample by industry: the single most numerous category is wholesale trade, followed by land transport and financial industry.

The results of the factor analyses are reported in Tables 7-11. We start with the group of questions entitled 'Scale and Scope Innovations' which provide some basic insights into the kind and the intensity of innovation activities. Three factors were isolated for this group (Table 7): 'Marketing innovation', 'Process and organisational innovation' and 'Product innovation'.

The second group of variables ('Varieties of Innovation Activities') describes firms' innovation efforts in more detail. In this group two factors were isolated (Table 8): 'R&D- based innovation', loading strongly on internal and external R&D and 'Innovation based on technology adoption', correlated strongly with the acquisition of equipment, software, intellectual property rights, and training.

It might be useful, at this point, to compare our results with those of Srholec and Verspagen [22]. They do not perform factor analysis on the first group of questions ('Scale and Scope..') but they do it with respect to the second group ('Innovation Activities'...). They extract three factors, of which two clearly respond to ours i.e. they load strongly on the same set of CIS

questions. Their third factor loads strongly on the activities related to the market introduction of innovations.

With respect to the 'Sources of Information for Innovation' group of questions, we distinguished three factors (Table 9). The first factor, 'Science and technology based innovation', is high for companies cooperating with academic establishments and professional and industry associations etc. The second factor, 'Innovation based on networking, own sources, customers', loads strongly on extracting information for innovation from suppliers, clients, customers, competitors, conferences, trade fairs etc. Finally, firms that score highly on the third factor, 'Innovation within the enterprise group', gain information mainly from the group, but also from trade fairs etc., scientific and technical publications and professional and industry associations.

Srholec and Verspagen's approach to the sources of information for innovation is slightly different, as they do not consider the possible effects of a firm being part of a group of companies. As a result they obviously do not isolate a factor corresponding to our 'Innovation within the enterprise group'. On the other hand, they also come up with the 'Science' factor that is very similar to ours. However where we extract one factor ('Innovation based on networking...') they have two: one responsible mainly for the relationship with clients, the other one describing contact with suppliers.

Finally, we investigate the 'Aims of Innovation' group of questions. Three factors are extracted (Table 10): 'Internally-aimed innovations', 'Market-aimed innovations', and, 'Organizational improvements'. The first two factors have clear counterparts in Srholec and Verspagen's work while the organization of production does not, for the goals related to organization are not considered in their work at all. Instead they look at the aims related to meeting regulatory and safety regulations; those are then aggregated to one factor that is absent in our paper.

To complete the identification of innovation strategies we use the values of all 11 factors and add another question from CIS (if the firm co-operated for innovation[15]), and apply factor analysis to these data. In this second stage five factors (K=5) were isolated (cf. Table 11):

1. 'Market-oriented innovation' (in short: MARKET-ORIENTATION)

2. 'Process and organization innovation based on research and co-operation within the group' (R&D and GROUP)

3. 'Process innovation by technology adoption' (ADOPTION)

[15] This is also the way Srholec and Verspagen use this information.

4. ’Technology-based process innovation’ (PROCESS)

5. ’Marketing innovation’ (MARKETING)

Comparing these results to those by Srholec and Verspagen is difficult inasmuch as the selection and the grouping of the CIS variables for the first-stage analysis is different. However a careful analysis of the correlations at both stages suggests the following. Three out of five factors we extraced have direct counterparts in [22]. These are: MARKET-ORIENTATION which is similar to their ’User’ factor; ADOPTION which is very similar to the ’External’ factor and PROCESS which is the counterpart of the ’Production’ factor in the other study.

However, we isolated marketing innovations as a separate factor, while in Srholec’s and Verspagen’s work this kind of innovation activity is absorped by the ’User’ factor. And, although both analyses extracted second-stage factors strongly correlated with R&D (GROUP and ’Research’ respectively) in our case this factor is quite specific as it loads strongly on process innovations and the membership in a group of firms. The group-imposed innovation behaviour is absent in Srholec and Verspagen’s work as they did not analyze the CIS ’group variables’ at all.

In sum, the five factors isolated largely meet our assumptions: there is a a factor reflecting technology adoption (ADOPTION) and even two factors reflecting customer-orientation: MARKET-ORIENTATION and MARKETING. There is also a research-related factor (GROUP) but the research behind it seems to be of a particular kind: influenced by other firms in the group and resulting in process innovations. On the other hand, organizational innovations have not been singled out as an independent innovation strategy dimension: they are measures supporting other innovation activities (mostly process innovations). Generally speaking, Polish service firms stress process and marketing innovations more than they do product innovations.

5.2. Clusters of innovation firms

Next we perform cluster analysis to define group of firms relatively homogenous with respect to their innovation strategies. As reported in Tables 12-14 that brings us to five groups of companies. Four of them have one dominant strategic dimension(*1: Marketing*, *2: Market-oriented*, *4: Adoption*, *5: Process innovations*) while one seems to follow a more complex innovation policy (*3: Marketing and adoption*). We are unable to attribute the R&D activities to any of the clusters; we note that it is negatively correlated with the membership in clusters 4 and 5 and positively with the other three. The number of companies in each of the clusters 2-

5 is similar; on the other hand there are three times fewer companies in cluster 1 than in any of the remaining groups.

What determines firm strategies and the decision to innovate in the first place? Table 15 shows the results of the logistic regression (1)-(2) applied to all the firms in the sample with Cluster 0 (*non-innovative firms*) as base category. The relative risk ratios (3) are reported, so the numbers in Table 15 tell us, if a given characteristics makes the firm more likely to belong in one of the innovative clusters 1-5 than in the non-innovative cluster 0: this is the case if the respective coefficient in Table 15 is bigger than 1; otherwise the firm characteristcs makes the firm less likely to innovate.

Apparently firms that are members of the group are much more likely to be innovators than single companies. Exporters are also more likely to innovate, but to do it in specific ways, i.e. to follow either the *Adoption* or the *Process innovation* strategies. Medium firms are, generally speaking, less inclined to innovation activities than are bigger firms. All four variables describing the groups of branches turned out to diminish the probability to innovate, but this only means that they are less likely to innovate than the reference group[16] D (*Financial and insurance services*).

To learn more about the heterogeneity of strategies *within* the group of innovating companies we turn to Table 16. This model is worse at predicting the cluster membership, but still there is a number of statistically significant outcomes. The reference category is now Cluster 4 (Adoption) and it can be observed that firms-group-members are less likely to adopt this strategy than any other strategy distinguished in the course of factor analysis (this is evident because all the numbers in the first row of Table 16 are bigger than 1 and significant. Exporting is not a defining characteristics as far as innovation strategies is concerned. Medium firms are more likely to adopt the *Market-oriented* and the *Process-innovations* strategies than big companies.

Innovation strategies seem to depend strongly on the industry. Firms from groups A (wholesale trade) and B (Transport and storage) prefer the strategy based only on marketing (Cluster 1) more than it is the case with firms from group D. The marketing-based strategy seems to be popular also among ICT firms from group C but apparently the difference with financial industry is not statistically significant. On the other hand, the market-oriented strategy is *less* popular in group C than it is in group D. It seems that the financial industry prefers the strategies C_3 (*Marketing and adoption* and C_5 (Process innovation) to the reference strategy C_4.

[16] Note that this is a different reference category than the reference cluster

5.3. Innovation strategies and productivity

Three versions of the productivity equation 4 are estimated. Recall that we observe aggregate categories (firm classes) and that variables $\hat{C}^1 \ldots \hat{C}^5$ refer to the percentage of firms in a given firm class following respective strategies.

Version (1) takes equation 4 literally and considers all the variables listed there. The result is, however, that the *capital* variable is not statistically significant. This is rather weird and contradicts the outcome of virtually all previous studies. The reason for the strange result is almost certainly – collinearity. Indeed, the coefficient of correlation between variables *capital* and $\hat{C}_3$ is more than 0.5. This should not be surprising given that our capital variable is based on investment data and investment is closely related to technology adoption. This is also visible in estimation (2), where the capital variable is ommitted: the coefficient for $\hat{C}_3$ grows and it becomes even more significant.

Consequently, the most reliable estimation is version (3). Here we merge clusters 3 through 5 into one group and include in the regression the percentage of companies in that new group. All variables come out significant. The results are quite interesting. First of all it turns out that the firm classes with many companies from the *Marketing* cluster were actually less innovative than average! Apparently a narrow innovation strategy, based entirely on marketing was actually counterproductive. This can be contrasted with the results for the the group *Market-oriented* i.e. cluster 2 and for the composite variable grouping clusters 3-5 i.e. *Marketing and adoption*, *Adoption*, and *Process innovations*. Obviously, we have to keep in mind the limitations of our aggregate-level analysis.

6. Conclusions

In this article we analyzed the innovation strategies of Polish service firms and how they contribute to the differences in firm productivity. The results of an elaborated firm-level analysis broadly confirm the theoretical work on service innovations. They are not limited to technology adoption (even though it is important) but consist of a wide range of other measures, mostly related to improving processes. There is also a strong marketing aspect of service innovations. Organizational innovations play an auxiliary role as they accompany changes in technology or marketing.

The heterogeneity of the innovation strategies notwithstanding, most kinds of innovation activities turned out to be associated with a higher firm productivity in our aggregate-level analysis. One exception is the innovation strategy based entirely on marketing: firms in that cluster showed less-than-average productivity. By contrast, market-oriented strategy stressing networking with clients and other firms was associated with a higher productivity. This outcome is consistent with other studies of the relationship between innovation and firm productivity ([5], [11]), but it gives a more nuanced view than previous works.

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Tables

Table 1. Sector shares of value added (in percentage)

	Germany		France		Italy		Czech Rep.		Poland	
	1990	2010	1990	2009	1990	2010	1990	2009	1990	2010
Agriculture	1.5	0.9	4.2	1.8	3.5	1.9	6.2	2.4	8.3	3.5
Industry	37.3	28.1	27.1	19.0	32.1	25.3	48.8	37.6	50.1	31.6
Services	61.2	71.0	68.7	79.2	64.4	72.8	45.0	60.0	41.6	64.8

Source: World Bank (World Development Indicators)

Table 2. Average number of persons employed per firm in 2008

NACE industry	Poland	NMS	EEA-13*
G: Wholesale and retail trade and repair of motor vehicles and motorcycles	3.2	4.2	5.5
H: Transportation and storage	5.4	8.7	11,3
I: Accommodation and food service activities	4.4	5.8	6.6
J: Information and communication	5.0	6.3	7.2
L: Real estate activities	4.7	2,6	2.4
M: Professional, scientific and technical activities	2.7	2.7	3.2
N: Administrative and support service activities	8.3	8.4	11.2

Source: Structural Business Statistics by Eurostat. NACE-Rev 2 industries at the first level of classification

* EEA-13 stands for EU-15 minus France, Germany and Denmark, plus Norway.

Table 3. Industries according to the NACE-Rev-2 classification

NACE code	Description
461	Wholesale on a fee or contract basis
462	Wholesale of agricultural raw materials and live animals
463	Wholesale of food, beverages and tobacco
464	Wholesale of household goods
465	Wholesale of information and communication equipment
466	Wholesale of other machinery, equipment and supplies
467	Other specialised wholesale
469	Non-specialised wholesale trade
491	Passenger rail transport, interurban
492	Freight rail transport
493	Other passenger land transport
494	Freight transport by road and removal services
495	Transport via pipeline
501	Sea and coastal passenger water transport
502	Sea and coastal freight water transport
503	Inland passenger water transport
504	Inland freight water transport
511	Passenger air transport
512	Freight air transport and space transport
521	Warehousing and storage
522	Support activities for transportation
531	Postal activities under universal service obligation
532	Other postal and courier activities
582	Software publishing
611	Wired telecommunications activities
612	Wireless telecommunications activities
613	Satellite telecommunications activities
619	Other telecommunications activities
620	Computer programming, consultancy and related activities
631	Data processing, hosting and related activities; web portals
639	Other information service activities
641	Monetary intermediation
649	Other financial service activities, except insurance and pension funding
651	Insurance
661	Activities auxiliary to financial services, except insurance and pension funding
662	Activities auxiliary to insurance and pension funding
663	Fund management activities
581	Publishing of books, periodicals and other publishing activities
711	Architectural and engineering activities and related technical consultancy
712	Technical testing and analysis

Table 4. Descriptive statistics

Variable	Frequency
A	0.424
B	0.204
C	0.138
D	0.147
E	0.087
Export	0.397
Group	0.204
Medium	0.519
Product innovation	0.171
Process innovation	0.202
Product- or process innovation	0.246

Number of observations: 4262 (full sample)
Source: Community Innovation Survey 2008

Table 5. The structure of the sample by firm size and ownership (domestic/foreign)

	medium	**large**	**total****
domestic	2,064 *56.88*	1,565 *43.12*	3,629
foreign*	148 *34.18*	285 *65.82*	433
total	2,212 *54.46*	1,850 *45.54*	4,062

Note: Numbers in italics are percentages.

* 'Foreign firms' are defined as those being part of the group and the mother company is located outside of Poland.

** The total is less than the full sample (4262) because for 200 firms the information on their size is confidential.
Source: Community Innovation Survey 2008.

Table 6. The structure of the sample by firm industry and ownership (domestic/foreign)

NACE industry	domestic	foreign*	total
46	1,600 *88.50*	208 *11.50*	1,808
49	575 *95.51*	27 *4.49*	602
50	21 *80.77*	5 *19.23*	26
51	12 *75.00*	4 *25.00*	16
52	191 *88.84*	24 *11.16*	215
53	9 *75.00*	3 *25.00*	12
58	182 *87.08*	27 *12.92*	209
61	105 *96.33*	4 *3,67*	109
62	192 *86.88*	29 *13.12*	221
63	33 *66.00*	17 *34.00*	50
64	350 *92.84*	27 *7.16*	377
65	28 *27.33*	47 *62.67*	75
66	153 *87.43*	22 *12.57*	175
71	342 *93.19*	25 *6.81*	367
Total	3,793 *86.00*	469 *11.00*	4,262

Note: Numbers in italics are percentages.

* 'Foreign firms' are defined as in Table 5

Source: Community Innovation Survey 2008.

Table 7. The Results of the Factor Analysis of the Scope and Scale of Innovation

	Marketing innovations	Process and organisational innovations	Product innovations
Product innovations: new or significantly improved goods or services?	.217	.161	.752
Process innovations: new or significantly improved methods of producing goods or services	-.126	.729	.339
Process innovations: new or significantly improved solutions in logistics of inputs or outputs or in the supplying of outputs	.236	.575	-.131
Process innovations: new or significantly improved process supporting systems e.g. conservation, accounting or calculation systems	.104	.324	-.731
Marketing innovations: significant changes to design or packing of goods or services	.662	.212	.164
Marketing innovations: new media or techniques of product promotion?	.716	.156	-.028
Marketing innovations: new methods or distribution channels (e.g. first implementation of franchising, licensing, new concepts of product exposition)?	.747	.178	.014
Marketing innovations: new methods of pricing (e.g. new systems of discounts)?	.701	.146	.013
Organisational innovations: new managment systems in supply organizations; business reengineering, leand production, quality managment systems etc.	.270	.647	-.052
Organisational innovations: internal structure	.373	.530	-.146
Organisational innovations: external relations, outsourcing, alliances etc.	.405	.531	-.089

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 8. The Results of the Factor Analysis of the Varieties of Innovation Activities

	R&D-based innovation	Technology adoption
Internal R&D	.805	.080
Acquisition of external R&D	.815	.022
Acquisition of machinery, equipment and transportation means for innovation	.023	.708
Acquisition of software for innovation	.075	.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 organizations)	.528	.307
Training (internal or external) for innovative activities	.286	.675
Marketing for product innovations (including market research and launch advertising	.345	.460
Other preparatory activities for product or process innovations, such as feasibility studies, testing, software development)	.534	.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 Sources of Information for Innovation

	Innovation inspired by changes in S&T (technology-push)	Innovation inspired by networking, own sources, customers (market-pull)	Innovation inspired by the enterprise group (and some other contacts)
Within the firm	-0.116	0.633	-0.267
Other firms in the enterprise group	-0.053	-0.191	0.732
Suppliers of equipment, materials, services, or software	0.029	0.392	0.036
Clients or customers	0.060	0.705	-0.022
Competitors or other businesses in your industry	0.158	0.662	0.061
Consultants, commercial labs, or private R&D institutes	0.524	0.245	-0.063
Polish Academy of Science institutes	0.901	-0.032	0.062
Public research institutes (Polish: JBR)	0.873	-0.012	0.053
Foreign public research institutes	0.880	0.027	0.043
Universities or other higher education institutions	0.809	0.077	0.086
Conferences, trade fairs, exhibitions	0.286	0.558	0.503
Scientific journals and trade/technical publications	0.243	0.534	0.556
Professional and industry associations	0.578	0.340	0.304

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.

Table 10. The Results of the Factor Analysis of the Aims of Innovation

	Internally-oriented innovation	Market-oriented innovation	Organization-oriented innovation
Increasing range of goods or services	.040	.866	.025
Improving quality of goods or services	.340	.646	.007
Improving flexibility for producing goods or services	.731	.249	-.010
Increasing capacity for producing goods or services	.804	.230	-.024
Improving health and safety	.758	.097	.068
Reducing costs per unit produced or provided	.771	.122	-.080
Entering new markets	.248	.739	-.011
Shortening the time of reaction to clients and suppliers needs	-.007	-.027	.944
Organisation: improving quality of goods or services	-.021	.045	.943

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 Dimensions of Innovation Strategies (The Results of the Factor Analysis on Factors)

	MARKET ORIENTA-TION (F^1)	R&D AND GROUP (F^2)	ADOPTION (F^3)	PROCESS (F^4)	MARKETING (F^5)
Marketing innovations	-.119	.111	.198	-.003	.872
Process and organisational innovations	-.180	.512	.347	-.513	-.301
Product innovations	-.725	-.138	-.290	.023	-.051
R&D-based innovation	-.410	.566	-.086	-.215	.222
Technology adoption	-.014	-.031	.798	-.101	.096
Inspired by developments in S&T	-.087	-.092	.315	.601	-.382
Inspired by the firm, markets and competitors	.561	-.107	-.456	.203	-.089
Inspired by the group	.007	.641	-.161	.296	-.084
Internally-oriented innovation	.048	.101	-.173	.788	.065
Market-oriented innovation	.752	-.067	-.340	-.055	-.113
Organization-oriented innovation	.234	.603	.174	-.178	.175
Cooperation for innovation	-.055	.449	.421	.111	.133

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 12. The results of cluster analysis: cluster centres

	Cluster				
	C_1: **Marketing**	C_2: **Market-oriented**	C_3: **Marketing and adoption**	C_4: **Adoption**	C_5: **Process innovations**
Market orientation (F^1)	.32665	1.28785	-.46099	-.27208	-.64428
R&D and group (F^2)	.33290	.11017	.26099	-.23427	-.25583
Adoption (F^3)	-1.12652	.02376	.70784	.41772	-.97422
Process (F^4)	-1.7737	.4195	.1993	-.6475	.7464
Marketing (F^5)	1.18694	-.12598	.91234	-.90695	-.23467

Note: Clsuters are listed in the heading of each column. The coordinates of cluster centres, expressed in standardized factor values, are reported in the table. Source: Community Innovation Survey 2008.

Table 13. Distances between cluster centres

Cluster	1	2	3	4	5
1		2.972	2.821	2.953	3.112
2	2.972		2.162	2.111	2.232
3	2.821	2.162		2.096	2.178
4	2.953	2.111	2.096		2.115
5	3.112	2.232	2.178	2.115	

Table 14. Number of cases in clusters

Cluster	Number of cases
1	77
2	235
3	253
4	267
5	215
Total	1047

Table 15. Determinants of cluster membership – all firms

	Cl_1:*Marketing*	Cl_2:*Market-oriented*	Cl_3:*Marketing and adoption*	Cl_4:*Adoption*	Cl_5:*Process innovations*
group	2.48***	2.47***	3.26***	1.41**	2.40***
export	1.10	1.20	1.19	1.57***	1.82***
medium	0.41***	0.58***	0.38***	0.40***	0.88
A	0.86	0.42***	0.23***	0.34***	0.33***
B	0.91	0.36***	0.17***	0.31***	0.15***
C	1.40	0.33***	0.76	0.87	0.65*
E	0.82	0.30***	0.18***	0.82	0.43***
Pseudo R^2	0.07				
Percentage of correctly predicted cases	75.4				
χ^2 test(35) +	544.35 [0.000]				

Note: Relative risk ratios (3) from the logit model (1)-(2) are reported. Cluster 0 (*non-innovative firms*) is the reference category. ***, ** and * denote significance at 1%, 5% and 10% respectively.

+ Significance in parentheses
Source: Community Innovation Survey 2008.

Table 16. Determinants of cluster membership – only innovative firms

	Cl_1:*Marketing*	Cl_2:*Market-oriented*	Cl_3:*Marketing and adoption*	Cl_5:*Process innovations*
group	1.70***	1.71***	2.27***	1.71***
export	0.70	0.75	0.80	1.12
medium	1.08	1.50**	0.92	2.18***
A	2.54**	1.28	0.63*	1.04
B	2.91**	1.22	0.51	0.53***
C	1.60	0.38***	0.83	0.76
E	1.01	0.37**	0.22***	0.54***
Pseudo R^2	0.04			
Percentage of correctly predicted cases	34.1			
χ^2 test(28) +	123.86 [0.000]			

Note: Relative risk ratios (3) from the logit model (1)-(2) are reported. Cluster 4 (*Adoption*) is the reference category. ***, ** and * denote significance at 1%, 5% and 10% respectively.

+ Significance in parentheses
Source: Community Innovation Survey 2008.

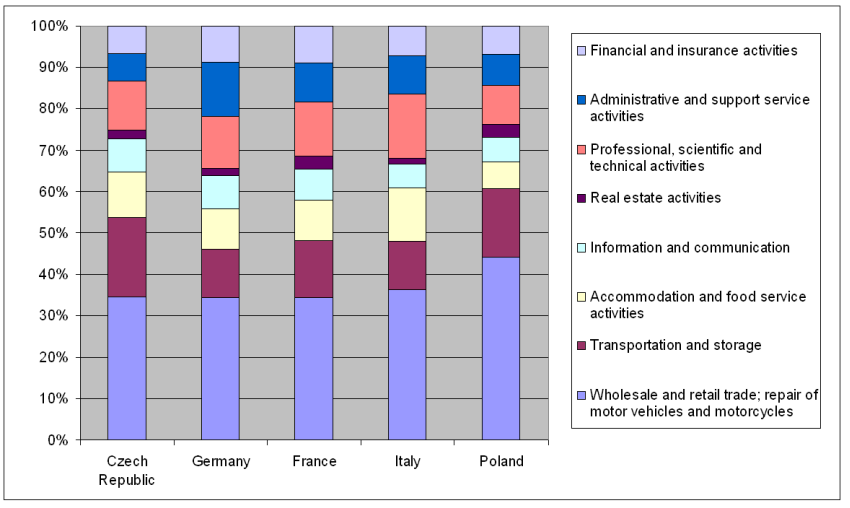
Table 17. The relationship between innovation performance and productivity

	(1)	(2)	(3)
const	0.94 (0.89)	2.22*** (0.20)	0.84 (0.89)
capital	0.26 (0.17)		0.40** (0.18)
$\hat{C}^1$	-16.29** (6.22)	-18,74** (6.09)	-11.41** (5.39)
$\hat{C}^2$	7.24** (3.01)	6.28** (2.98)	5.81* (3.18)
$\hat{C}^3$	6.87*** (1.82)	8.22*** (1.60)	
$\hat{C}^4$	2.08 (2.31)	3.05 (2.25)	
$\hat{C}^5$	-3,64 (2.63)	-4.16 (2.64)	
$\hat{C}^3+\hat{C}^4+\hat{C}^5$			2.61** (1.05)
Estimation method	OLS	OLS	OLS
No. of observations	44	44	44
R sg.	0.48	0.44	0.36
Adjusted R sq.	0.39	0.37	0.30
Breusch-Pagan test for heteroskedasticity in model (3) Ho: Constant variance	$\chi^2(4)=3.79421$	$\Pr\{\chi^2 > 3.79421\} = 0.434572$	

Note: equation (4) is estimated (see section 4.2 and modifications to the equation explained in section 5.3) and the coefficients of regressions are reported. ***, ** and * denote significance at 1%, 5% and 10% respectively.
Source: Community Innovation Survey 2008.

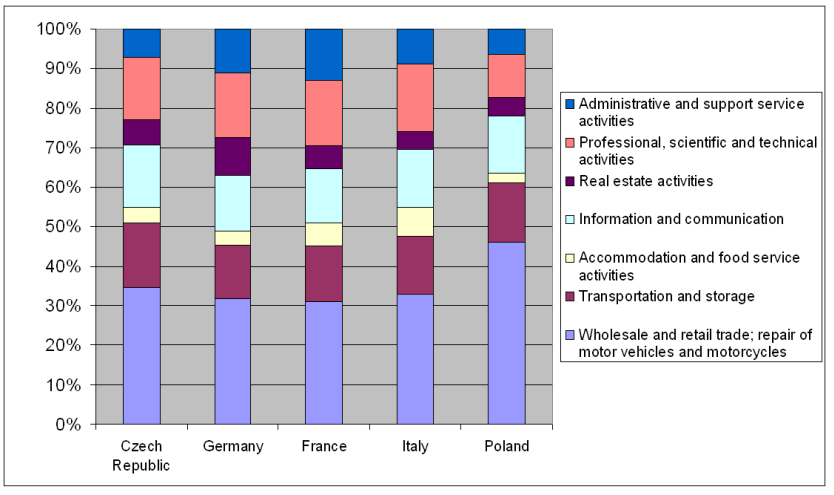
Figures

Figure 1. Share of services sectors in total service employment 2008



Source: Labour Force Survey

Figure 2. Share of services sectors in total service value-added 2008



Note: no data on the financial industry is available

Source: Structural Business Statistics by the Eurostat