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Innovation pattern heterogeneity: A data-driven retrieval of the firms' approaches to innovation

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Abstract

Innovation is one of the usual suspects in defining differences in performance among firms, according to a strong and diverse theoretical framework. Understanding the diversity that exists within the population of innovative firms is essential to elaborate appropriate innovation policies. Our study explores the diversity of innovation patterns among Norwegian firms included in the 2018 Community innovation survey (CIS2018). By applying factor analysis on a wide array of survey variables and on a large sample of firms, we identify eleven typical approaches to innovation, which recurrently connect innovation inputs and outputs at firm level. A main outcome of our study is a renewed fine-grained view on innovation as a multifaceted concept.

Keywords: Technological change; Innovation survey; Factor analysis; Business strategies; Intra-industry heterogeneity.

JEL classification: O31; O32; O33.

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1. Introduction

Innovation is one of the usual suspects in defining differences in performance among firms, according to a strong and diverse theoretical framework (Dosi, Marsili, Orsenigo, & Salvatore, 1995; R Nelson & S Winter, 1982). Innovation facilitates the high growth of ‘‘superstars’’, as well as the establishment and continued existence of profitable companies that do not seek to become large enterprises (Tether, 1997). Understanding the diversity that exists within the population of innovative firms is essential to elaborate appropriate innovation policies. Our study explores the diversity of innovation patterns among Norwegian firms and identifies typical approaches to innovation, which recurrently connect innovation inputs and outputs at firm level.

The mechanisms linking R&D, innovation success and firm performance are largely indebted to the Schumpeterian endogenous growth representation, according to which firms strive to innovate so that they can enjoy monopoly rents (Aghion & Howitt, 1992). The forward-looking firm takes a decision over its level of research input, based on expected returns to R&D (in terms of sales or directly in terms of profits) that affects the stochastic innovation process. Innovation success in turn automatically raises the firms’ profitability or productivity level (Klette & Griliches, 2000; Pakes & Ericson, 1998). Such stochastic and optimizing representation has however been challenged by models in which boundedly rational agents search for more productive techniques in an uncertain environment, in which the impact of innovation on firm growth is itself random (Richard Nelson & Sidney Winter, 1982). In such a framework, firms are heterogeneous in their ability to innovate, not only because of their financial resources, but also because they differ in terms of their ability to reach for technological opportunities. Path dependency explains the concentration of many innovations in the hands of a limited number of firms (Dosi et al., 1995), while heterogeneity in growth patterns can exist also for the same levels of R&D, due to the uncertain nature of the R&D process (Coad, Mathew, & Pugliese, 2020). Even among successful innovators, heterogeneity persists: while innovators are likely to enjoy superior employment growth with respect to non-innovators, the bulk of this differential derives from the exceptional job creation activities of a few firms (Freel, 2000).

If the policy instruments are willing to affect different firms (incumbents or entrants), a first way to group the target firms is by the type of products and processes they deal with, which in turn defines roughly the economic sector to which the firms belong. At high levels of aggregation, product-based classifications of sectors like NACE have often been considered impractical for understanding the sectoral dynamics of innovation. Therefore, other classifications have been suggested to this purpose, which base on finer disaggregation level to build new definitions of economic sectors. (Pavitt, 1984) proposed a four-sector taxonomy based on size, innovation patterns and sources of innovation: scale-intensive, supplier-dominated, science-based and specialised supplier. (Miozzo & Soete, 2001) proposed to take out services from the supplier-dominated category in Pavitt’s original classification and suggested four additional categories: supplier-dominated services, physical network services, information network services and knowledge-intensive business services. This led to an eight-fold taxonomy, including four manufacturing and four service sectors; the taxonomy was later used by other studies (see, e.g., Castaldi, 2009) and was subject to further aggregation by Castellacci (2008).

However, the mentioned taxonomies have still grouped data at the level of industries rather than of firms. Such choice ignores the fact that firms in the same industry may have a very different technological base. This issue was raised by (Archibugi, 2001) saying that "[h]opefully, over the next few years more statistical and econometric work will be carried out to group firms, as opposed to industries, into the taxonomy's categories [...] according to their intrinsic characteristics such as the

rate and direction of technical change and their sources of innovation" (Archibugi, 2001, p. 420). The hope was partially misplaced, since data limitations have often bound researchers in innovation studies to using output-based sectoral definitions. In our study, we use firm-level data from the Innovation Survey conducted in Norway in 2018, to identify recurrent approaches to innovation. Drawing on De Jong and Marsili (2006) and Leiponen and Drejer (2007), we employ a factor analysis to reconduct correlations in survey answers to the typical patterns of innovation behaviour. Unlike previous studies, we do not aim at labelling each firm according to one specific approach to innovation, but we allow for the coexistence of several approaches to innovation within a same firm. The eleven innovation patterns we identify are therefore eleven different, but not exclusive, ways for a firm to be innovative.

Further, section 2 describe the existing literature on which our study is based. Section 3 explains how we construct and use variables for our factor analysis. Section 4 describes and discusses the results of the analysis, while section 5 concludes.

2. Literature

Variety in the sources, nature and use of innovation has often been shown by empirical studies and practical experience. Pavitt (1984) proposed to classify industries according to a four-sector taxonomy based on size, innovation patterns and sources of innovation: scale-intensive, supplier-dominated, science-based and specialised supplier. Similarities and differences amongst sectors in the sources, nature and impact of innovation were defined by the sources of knowledge inputs, by the size and principal lines of activity of innovating firms, and by the sectors of innovations' production and main use. The dataset comprised 2000 significant innovations, and the corresponding innovating firms, occurred in UK from 1945 to 1979. Notably, the data covered only eleven 2-digit industries. The data did not measure the scope of significy of innovations, nor captured precisely incremental innovations. The four sectors resulting from the analysis by Pavitt (1984) are:

- scale-intensive (SI): includes both complex and consumer durables (food, chemicals, motor vehicles), and processed raw materials (e.g. metal manufacturing, glass and cement). Firms tend to be large and to rely mainly on internal resources for their innovations. Carrier industries in the Fordist paradigm;
- supplier-dominated (SD): includes industries where firms mostly produce technologically simple goods (e.g. textiles, leather goods, pulp and paper), where the capital and intermediate components suppliers are the main sources of innovation;
- science-based (SB): includes industries where innovation is linked directly to advances in academic research (e.g. pharmaceuticals, electronics, scientific instruments). Innovation rates are particularly high. Carrier industries in the ICT paradigm;
- specialised supplier (SS): includes equipment building, design and mechanical engineering, where innovation typically emerges from informal activities. Firms in this group tend to be small, and innovation rates particularly high. Supportive of the Fordist paradigm.

Miozzo and Soete (2001) proposed to take out services from the supplier-dominated category in Pavitt's original classification and suggested four additional categories: supplier-dominated services, physical network services, information network services and knowledge-intensive business services, defined as in the following:

- supplier-dominated services (SDS): rely on the purchase of capital goods for their innovation. They are mostly small companies providing services directly to customers (e.g. hotels, restaurants, rental services and personal services). Innovation rates are particularly low;
- physical network services (PNS): include all transport, retail and wholesale trade related services. Supportive of the Fordist paradigm;
- information network services (INS): include all information-intensive activities (communication, financial intermediation, insurance, real estate). Firms tend to be large and to innovate in interaction with suppliers and users. Supportive of the ICT paradigm; and
- knowledge intensive business services (KIBS): include R&D services, consultancy and computer-related activities. Firms tend to be small and medium firms that produce their own innovation. Innovation rates are particularly high. Supportive of the ICT paradigm.

This taxonomy (we will call it "Pavitt-Miozzo-Soete", since it is a direct evolution of the original taxonomy by Pavitt) was later used by other studies (see, e.g., Castaldi, 2009) and was subject to further aggregation by Castellacci (2008), who took up the challenge of addressing explicitly the relations between manufacturing and services. In this latter study, supplier-dominated goods and supplier-dominated services appear together at the final stage of an ideal knowledge chain, at a position where they are able to implement new technologies created elsewhere in the economy. At the other end of the chain there are the "advanced knowledge providers": specialised manufacturing firms and knowledge intensive business services, both characterized by great technological capability and a significant ability to manage and create complex technological knowledge. All the other industries are divided between the "supporting infrastructure services", upon which business and innovative activities in the whole economy are based, and the sectors producing "mass production of goods", are carriers of knowledge in the form of scale-intensive and science-based firms.

The mentioned taxonomies have grouped data at the level of industries rather than of firms. Such choice ignores the fact that firms in the same industry may have a very different technological base. Micro-founded definitions of economic sectors could help to understand better the innovation processes and to elaborate more targeted innovation policies (Archibugi, 2001). This empirical path was opened by Cesaratto and Mangano (1993), who analyse data from an extensive innovation survey conducted among Italian manufacturing firms to identify six main clusters or dominant technological profiles of firms. The authors state that a degree of technological determinism predominates in the model by Pavitt (1984), while an established tradition in organization theory (see, e.g., Miller & Blais, 1992) has also emphasized the "strategic choice" available to firms in manipulating their internal and external environments. By applying a cluster analysis on data about technological inputs, technological outputs and impact of innovation on sales, six clusters of firms emerge:

- Cluster 1 represents the case of struggling companies competing in dynamic R&D-intensive technological trajectories;
- Cluster 2 shows a smaller group of aggressive companies competing in dynamic trajectories through a blend of R&D, industrial design and investment policy;
- Cluster 3 displays less resolute innovative strategies;
- Cluster 4 is representative of technological trajectories based on industrial design and incremental technical change;
- Clusters 5 and 6 both show embodied technical change as the main innovation channel, with Cluster 5 representing a more traditional component of the industrial landscape and Cluster 6 blending heavy capital accumulation and some in-house innovative activities.

In the words of the authors, "[t]he intersectoral nature of clusters seems to attest to the existence of a considerable degree of choice in company strategy as compared to the more marked sectoral determinism emerging from Pavitt's taxonomy" (Cesaratto & Mangano, 1993, p. 252).

Strategy constitutes an important element also for a subsequent micro-based taxonomy built by De Jong and Marsili (2006), who employ data from computer assisted telephone interviews to managers and entrepreneurs of small and micro enterprises. The interviews are aimed at capturing novel relevant variables like managerial attitude, innovation planning and external orientation. The focus on the bottom of the firm size distribution is here motivated by the unproportionate attention on large firms given by previous studies, including the study by Pavitt (1984). Somewhat surprisingly, after running a cluster analysis on their survey data, De Jong and Marsili (2006) obtain a taxonomy of small and micro firms which closely resembles the taxonomy by Pavitt (1984). Three of the four original categories are even defined under the same name as in Pavitt (1984), although showing additional qualities: supplier-dominated firms appear to be relatively open, consulting on average with more than three external parties; specialised suppliers reach high levels in product innovation through a more diffused use of specialized labor; science-based firms are managed with a strongly positive attitude towards innovation, frequently accompanied by a written-down plan. The firms in the fourth category, called "resource-intensive" firms, allocate financial and time resources to innovation, but they limit their use of personnel employed in innovation and of external networks; their main difference from the "scale-intensive" firms in the Pavitt taxonomy consists in their not being associated to a large firm size. No clear-cut relationship emerges between industrial sectors and clusters of firms: following an expression by Caves and Porter (1977), also De Jong and Marsili (2006) confirm that different "strategic groups" coexist within industries.

Leiponen and Drejer (2007) use a similar approach to assess whether industry boundaries truly define the boundaries of technological regimes. Again, the intuition behind their work lies in the idea that intra-industry heterogeneity may derive from strategic diversity. Importantly, their theoretical foundation strongly emphasises the myopic trajectories followed by some firms which, especially under rapidly changing conditions, must take strategic decisions under very limited knowledge conditions. Differences in knowledge could then pair up with differences in skills to produce different patterns of innovation within industries. Their empirical analysis is based on cross-sectional Community Innovation Survey (CIS) datasets containing data on manufacturing and service firms located in Denmark and Finland and covering the period 1994–1996. The study is conducted over two phases: first, a factor analysis is performed on a set of survey variables; then, the scores obtained from the factor analysis are input into a cluster analysis with the aim of grouping the firms into distinct categories, homogeneous as possible with respect to the factor dimensions. Both the factor analysis and the subsequent cluster analysis point at four types of innovative behaviour, displaying a partial overlap with the Pavitt categories. Indeed, the analysis by Leiponen and Drejer (2007) shows the existence of supplier-dominated firms; in Finland, suppliers are often direct collaborators of these firms, whereas in Denmark they act simply as sources of information. On the other hand, market-driven firms tend to open new markets and extend current ones, sourcing information intensively from clients. Collaboration with universities, often associated with patenting, marks instead the behaviour of science-based firms, while production-intensive firms mainly focus on improving existing products. Finally, one cluster in each country is called *ad hoc*; its firms do not draw much on any sources nor they are driven by clear objectives in their innovation activities. Notably, only half of the four-digit (Denmark) and five-digit (Finland) NACE industries, with six or more observations, have more than 50% of firms associated to one cluster. In other words, about half of the industries do not have a dominant cluster, hinting that firms have more room for strategic choice than commonly thought in the innovation literature.

Our work follows directly on Leiponen and Drejer (2007) by conducting a factor analysis on innovation survey data and by complementing the analysis with additional information from other data sources. We particularly stress the advantage of factor analysis over rigid clustering techniques, in that we are able not only to avoid restrictions from existing industry-based taxonomies (which represent the benchmark throughout our study) but also to point out cases where several types of innovation

behaviour coexist. We conduct our factor analysis on a wide array of survey variables and on a large sample of firms, to obtain a fine-grained view of the firms' approaches to innovation.

3. Variable construction and estimation strategy

For the analysis, we use Norwegian microdata on the firms included in the 2018 Community innovation survey (CIS2018), covering the three-year period 2016–2018. These data are collected by Statistics Norway and contain detailed information on firms' innovation activities, including expenditures on these activities (divided into intramural R&D, extramural R&D services and other related to innovation activities), whether the firm has introduced a new product (for the firm or for the market) or a process innovation, and whether it has applied for a patent and/or other IPR over the corresponding three-year period. The sample for the survey is selected using a stratified method for firms with 10–50 employees, whereas all firms with more than 50 employees are included. The strata are based on industry classification (NACE codes) and firm size. CIS2018 contains information on 6360 firms.

Based on questions from CIS2018 we have constructed a set of binary indicators that cover various firm innovation activities and other relevant to them activities[1]:

- *Market location (question 1.1)*: a set of dummy variables indicating whether a firm sells its products (goods or services) mainly in local/regional, national, European or other international markets. This question indicates the location of firm's main competitors. The corresponding dummy variables are *d_sigmarloc*, *d_sigmarnat*, *d_sigmareur* and *d_sigmaroth*.

- *Firm's strategies (question 2)*: a set of dummy variables indicating whether the following strategies were important[2] to the economic performance of a firm during 2016–2018:
    - Focus on improving your existing goods or services, *d_straimp*
    - Focus on introducing new goods or services, *d_straint*
    - Focus on low-price (price leadership), *d_stralow*
    - Focus on high-quality (quality leadership), *d_straqua*
    - Focus on a broad range of goods or services, *d_straran*
    - Focus on one or a small number of key goods or services, *d_strafoc*
    - Focus on satisfying established customer groups, *d_straest*
    - Focus on reaching out to new customer groups, *d_stranew*
    - Focus on standardised goods or services, *d_strasta*
    - Focus on customer-specific solutions, *d_stracus*

- *Customisation and co-creation[3] (questions 3 and 3.1)*: a set of dummy variables indicating whether a firm offered any of the following types of goods or services to meet user requirements during 2016–2018 and the group of users involved:
    - Goods or services co-created with users, i.e. the user had an active role in the creation of the idea, design and development of the product (co-creation), *d_specoc*
    - Goods or services designed and developed specifically to meet the needs of particular users (customisation), *d_specom*
    - Standardised goods or services offered to different users in the same way (mass customisation), *d_specus*
    - Users involved in customisation and co-creation included private business enterprises, *d_spedpr*

[1] Question number from the Norwegian version of CIS2018 that is used for the construction of the corresponding set of indicators is in parentheses (jf. Appendix A for the questionary).
[2] The corresponding indicator is set equal to 1 in case of high or medium importance, and 0 in case of low or no importance.
[3] A difference between customisation and co-creation is that for 'customisation' the enterprise designed and developed the product alone, whereas for 'co-creation' the enterprise designed and developed the product together with the user.

    - Users involved in customisation and co-creation included public sector and non-profit organisations, *d_spedpu*
    - Users involved in customisation and co-creation included individuals or households, *d_spedhi*

- *Use of intellectual property rights, IPR (question 4)*: a set of dummy variables indicating whether a firm applied for a patent, registered an industrial design right or trademark, claimed a copyright or used trade secrets during 2016–2018. The corresponding dummy variables are *d_propat*, *d_prodes*, *d_protm*, *d_prosec* and *d_procp*.

- *IPR marked (question 5)*: a set of dummy variables indicating whether a firm sold its own IPR or purchased IPR from others during 2016–2018:
    - Sold its own IPRs (or assign IP rights) to others, *d_intoth*
    - Licensed out its own IPRs to others, *d_intlic*
    - Exchanged IPRs (pooling, cross-licensing, etc.) with others, *d_intsha*
    - Purchased or licensed-in patents or other IPRs from private business enterprises or individuals, *d_intbpr*
    - Purchased or licensed-in patents or other IPRs from public research organisations, universities or other higher education institutions, *d_intbpu*

- *Acquisition of knowledge (question 6)*: a set of dummy variables indicating whether a firm used any of the following channels to acquire knowledge during 2016–2018:
    - Conferences, trade fairs or exhibitions, scientific/technical journals or trade publications, *d_kno_research*
    - Information from professional or industry associations, *d_kno_proforg*
    - Information from open databases, published patents, standardisation documents or committees, *d_kno_data*
    - Social web-based networks, crowd-sourcing, open business-to-business platforms or open-source software, *d_kno_network*
    - Extracting knowledge or design information from goods or services (reverse engineering), *d_kno_other*

- *Skill management (question 7)*: a set of dummy variables indicating how important to the management of a firm were the following methods of organising work during 2016–2018:
    - Planned job rotation of staff across different functional areas, *d_worrot*
    - Regular brainstorming sessions for staff to think about improvements that could be made within the business, *d_worbra*
    - Cross-functional work groups or teams (combined across different working areas or functions), *d_worwor*
    - In-house training and/or possibility for professional development and skills upgrading through continued education and external courses, *d_worcom*

- *Product innovation (questions 8, 8.2, 8.3):* a set of dummy variables indicating whether a firm introduced any product innovation during 2016–2018 and whether this product was new to the marked[4] or only for the firm:
    - New or improved goods, *d_inpd_good*
    - New or improved services, *d_inpd_serv*
    - These new or improved products were not previously available on the local/regional market, *d_newmktloc*
    - On the national market, *d_newmktnat*
    - On the European market, *d_newmkteur*
    - On other international markets, *d_newmktoth*

[4] The broadest market is marked here, e.g. the European market in case of both the Norwegian and European market. Various answers are possible only in case of multiple innovation.

- These new or improved products were new only to the firm[5], *d_newfrm*

- *Process innovation (question 9):* a set of dummy variables indicating whether a firm introduced any of the following process innovations during 2016–2018:
  - Methods for producing goods or providing services (including methods for developing goods or services), *d_inpcs_prod*
  - Logistics, delivery or distribution methods, *d_inpcs_log*
  - Methods for information processing or communication, *d_inpcs_ict*
  - Methods for accounting or other administrative operations, *d_inpcs_adm*
  - Business practices for organising procedures or external relations, *d_inpcs_nw*
  - Methods of organising work responsibility, decision making or human resource management, *d_inpcs_hr*
  - Marketing methods for promotion, packaging, pricing, product placement or after sales services, *d_inpcs_mkt*

- *Formal R&D activities (questions 10, 10.1)*: a set of dummy variables indicating whether a firm had in-house and/or contract-out R&D activities during 2016–2018 and whether the firm performed in-house R&D continuously (had permanent R&D staff) or occasionally. The corresponding dummy variables are *d_rrd_int*, *d_rrd_ext*, and *d_rrd_cont*.

- *Other innovation activities (question 11)*: a set of dummy variables indicating whether a firm's expenditures on other innovation activities (excluding formal R&D) were above the average shares in the population of innovative firms for the corresponding type of expenditures[6]:
  - Share of expenditures on own personnel working on innovation is higher or equal 0.52, *d_invinno_pers*
  - Share of expenditures on services, materials, supplies purchased from others for innovation is higher or equal 0.2, *d_invinno_ext*
  - Share of expenditures on capital goods for innovation (acquisition of machinery, equipment, software, IPRs, buildings etc.) is higher or equal 0.2, *d_invinno_tech*
  - Firm did not have any other innovation activities, *d_invinno_zero*

- *Expectations on innovation expenditures (question 13)*: a set of dummy variables indicating whether a firm expected increase or decrease in their total innovation expenditures (including formal R&D) in 2019 compared to 2018. This question indicates the innovation ambitions of the firm.
  - Increase by more than 5 %, *d_exp_up*
  - Stay about the same (+/- 5%), *d_exp_fixed*
  - Decrease by more than 5 %, *d_exp_down*
  - No innovation expenditures expected, *d_exp_zero*
  - Don't know, *d_exp_not*

- *Collaboration (question 14.1)*: a set of dummy variables indicating whether a firm co-operated with other firms or organisations in their innovation activities (including formal R&D) during 2016–2018 by type and location of co-operation partner:
  - Enterprises within the same enterprise group (other types are outside enterprise group), *d_coop_group*
  - Consultants, commercial labs, or private research institutes, *d_coop_ consult*
  - Suppliers of equipment, materials, components or software, *d_coop_suppl*
  - Enterprises that are your clients or customers, *d_coop_custom*
  - Enterprises that are your competitors, *d_coop_compet*
  - Other enterprises, *d_coop_otherf*

[5] Identical or very similar products were already offered by firm's competitors on the market.

[6] Expenditures on innovation activities such as marketing of innovation, product design, preparation of production/distribution for innovation activities other than R&D have an average share less than 0.08, and hence are not represented by own indicator.

    - Universities or other higher education institutions, government or public research institutes, *d_coop_high*
    - Clients or customers from the public sector, Non-profit organisations, *d_coop_publ*
    - Non-innovative collaboration, *d_coop_noinno*
    - Co-operation with partner(s) from the same region, *d_coop_loc*
    - From other regions of Norway, *d_coop_norw*
    - From other Nordic countries, *d_coop_nordic*
    - From other European countries (EU or EFTA), *d_coop_eur*
    - From all other countries, *d_coop_world*

- *Hampering factors (question 15)*: a set of dummy variables indicating how important[7] the following factors were in hampering the firm's decision to start innovation activities, or its execution of innovation activities during 2016–2018:
    - Financial issues (i.e., lack of internal finance for innovation, lack of credit or private equity, difficulties in obtaining public grants or subsidies), *d_hemp_fin*
    - Costs are too high, *d_hemp_cost*
    - Competence needs (i.e., lack of skilled employees within the firm and/or lack of collaboration partners, lack of access to external knowledge), *d_hemp_skills*
    - Market and competition issues (i.e., uncertain market demand for the ideas, too much competition in the relevant market, different priorities within the firm), *d_hemp_mkt*

- *Funding for innovation activities (questions 16.2 and 17.1)*: a set of dummy variables indicating whether a firm obtained the following types of funding for its innovation activities during 2016–2018:
    - Equity finance (finance provided in exchange for a share in the ownership of the enterprise), *d_fin_owni*
    - Debt finance (finance that the enterprise must repay), *d_fin_loan*
    - Public financial support (i.e. from local or regional authorities, central government agencies or ministries and/or from the EU), *d_fin_publ*

- *Technology adoption (question 18)*: a set of dummy variables indicating whether a firm purchased machinery, equipment or software during 2016–2018 that was based on:
    - The same or improved technology that was used in the firm from before, *d_tech_pro*
    - New technology that was not used in the firm before, *d_tech_new*

As a result, we obtain a set of 88 indicators describing firms' innovation activities. We then apply factor analysis techniques to disentangle the different paths to innovation experienced by Norwegian firms *before* the Covid-19 crisis have happened. Our main assumption is that each firm can practice different approaches to innovation. By exploratory factor analysis we investigate which of the indicators are highly correlated and, hence, interdependent, thus potentially reflecting a (smaller) set of unobserved/latent variables (called *factors*) that in our case imply different approaches to innovation.

Since all our indicators are binary variables, we calculate tetrachoric correlation coefficients by tools of Stata.[8] The pairwise correlation matrix is then used to perform a factor analysis.[9] Figure 1 summarises the main output for the factor analysis, i.e. proportion of the variance in the data explained by each factor, cumulative proportion and difference in eigenvalues by the factor number.

[7] The corresponding indicator is set equal to 1 in case of high or medium importance (i.e., if the answer is 2 or 3) of at least of one of sub-indicators, and 0 otherwise.

[8] The Stata command used here is *tetrachoric d_*, posdef*. This command computes pairwise estimates of the tetrachoric correlations by the (iterative) maximum likelihood estimator obtained from bivariate probit without explanatory variables by using the noniterative estimator by Edwards and Edwards (1984) as the initial value. See Stata manual for more details.

[9] The Stata command that follows the *tetrachoric* command is *factormat r(Rho), n(6360)*. This command then displays the eigenvalues of the correlation matrix, the factor loadings, and the uniqueness of the variables.

The next step is to determine the number of factors that are reasonable to keep for the further analysis.

In total, 22 factors have an eigenvalue larger than 1 - this being the eigenvalue larger than the information accounted for by an average single item (the so-called "Kaiser criterion" for determining the number of factors: Kaiser, 1960). From Figure 1 we can see that the proportion of variance explained by each factor is sharply decreasing for the first 9 factors and flattering after that. So according to the *screen plot* criterion there are 9 factors (and, hence, main approaches to innovation) in our data to keep.

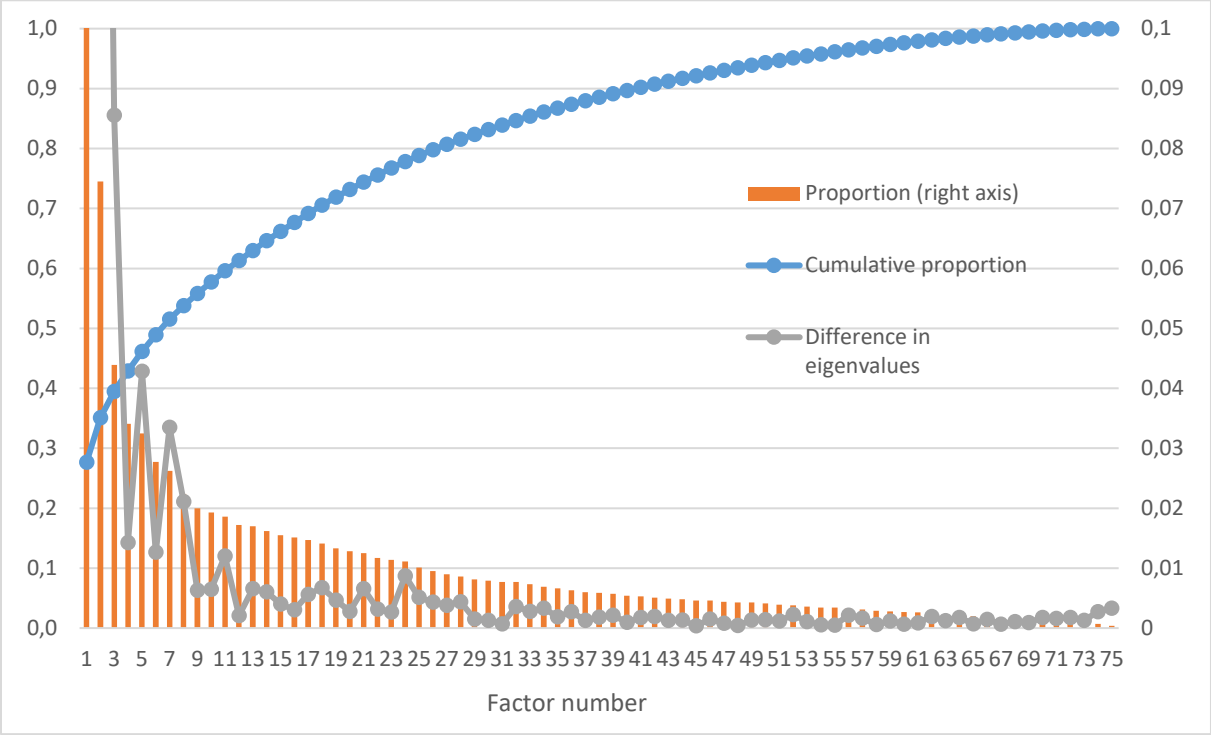

Figure 1. Proportion of variance explained by each factor, cumulative proportion of variance and difference in eigenvalues by factor number.

At the same time when we look at the differences in eigenvalues, they are quite volatile (going up and down). Then if to associate the difference in eigenvalues with drop in importance of the next factor, it would be reasonable to stop after 3, 5, 7, 8, 11 or 24 factors (i.e. when all the following factors are less important than the mentioned ones). It is unreasonable to use 24 factors since they do not hold even to the Kaiser criterion of all having eigen value larger than 1. Given the explorative nature of our analysis, we keep then 8 factors as the main innovation approaches and 3 next factors as additional innovation approaches. In total 8 factors account for about 54 per cent of variation, and 11 factors account for about 60 per cent of variation. We repeat then the factor analysis with restricting number of factors to 11 and use *varimax rotation*[10] to obtain factor loadings. Using these factor loadings, we then predict the scores for each factor for each individual firm. The higher score is, the higher is the

[10] The Stata command used here is *rotate, blanks(0.2)*, where varimax rotation is the default. This is an orthogonal rotation, which has the effect of differentiating the original variables by extracted factor. Each factor will tend then to have either large or small loadings of any particular variable.

association of the given firm with the correspondent approach to innovation. The results are presented in the next section.

4. Results

4.1 Approaches to innovation

In this section we present our main and additional approaches to innovation experienced by Norwegian firms in the period from 2016 to 2018. Table 1 presents the names and main characteristics that are implied by the corresponding approach to innovation. The names have been chosen to reflect the main features for each group of characteristics. The table with results for factor loadings from each particular indicator into the factor is reported in Appendix B.

Table 1 **Approaches to innovation base on CIS2018 for Norwegian firms**

Name	Main characteristics
1. Active R&D doers	• Have formal R&D activities on regular basis (both intramural and extramural) • Cooperate often with others • Receive mainly public support for R&D and innovation • Main marked: outside Norway
2. Process developers	• High score on all types of process innovation • Main strategy: improving existing goods or services • Cooperate within own concern on the local/regional level • Innovation expenditures go mainly to machinery, equipment and software based on new technology
3. Innovation suppliers	• Use actively different types of IPR • Sell, license out and exchange their own IPRs to/with others • Innovation expenditures go mainly to purchase services from others • Main marked: not local/regional
4. Strategical adapters	• Main strategies: focus on high-quality products, on improving existing products and satisfying established customer groups • Practice customization of their products • Implement machinery, equipment and software based on new technology
5. Radical innovators	• Have formal R&D activities on regular basis • Introduce product innovation with high novelty degree (new product on the national or international marked) • Use actively patenting and license out their IPRs • Cooperate with customers outside Norway • Main marked: outside Norway
6. Customer-oriented service suppliers	• Main strategy: focus on customer-specific solutions • Practice “co-creation” and “customization” of their products • Introduce service innovation with local/regional/national novelty degree • Cooperate with private customers and public sector
7. Hard trying innovators	• Irregular R&D-activity, innovation expenditures go mainly on own personnel • High score on all types of hampering factors to innovation • Try to cooperate with competitors locally • Introduce product innovation that is new for firm or for the local marked
8. Knowledge absorbers	• Use actively all channels for the knowledge acquisition • Offer goods and services co-created with users, often public sector organisations • Practice skills upgrading, regular brainstorming sessions, cross-functional work groups or teams • No formal R&D activities or significant innovation expenditures and introduced no innovation • Implemented machinery, equipment and software based mainly on existing technology

9. Innovation promisers	• Have not introduced any innovation, but have plans to increase their innovation expenditures • Have recently got funding for innovation (both private and public) • Have some formal R&D activities • Main strategy: Focus on one or a small number of key goods or services • Main marked: Outside EU
10. Individual standard services suppliers	• Main strategy: introducing new goods or services • Oriented towards households and individuals as main customers • Innovation expenditures go mainly on own personnel • Introduce service innovation with novelty at local/regional/national level • Main marked: Norway
11. Early technology adopters	• Have invested in machinery, equipment and software based on new technology • Expect reduction in innovation expenditures in the next period • Have recently obtained funding to innovation through the loan • Have introduced new goods that are new to the firm • Cooperate with suppliers

Further, we explore whether there is any correspondence between reviled approaches to innovation based on innovation survey data and the established industry-based taxonomies and whether some of the approaches are more common among small and some among large firms.

4.2 Correspondences with the Pavitt-Miozzo-Soete taxonomy

A first correspondence between the approaches to innovation that we have retrieved, and the traditional sectoral aggregations can be obtained by drawing the heat map in Figure 2. In the heat map, a darker colour of a cell corresponds to a relatively higher average score for the associated factor mentioned in the bottom horizontal line, as obtained by the firms belonging to the industries mentioned in the right vertical line. In particular, the industries are aggregated according to an extended sector-based taxonomy which uses the categories by Pavitt (1984) for the manufacturing industries (science-based, specialised supplier, scale-intensive, supplier-dominated) and the categories by Miozzo and Soete (2001) for the service industries (supplier-dominated services, physical network services, information network services, knowledge intensive business services). The contemporaneous use of the two taxonomies has previously been shown, among others, by Castaldi (2009). Following Capasso, Cefis, and Frenken (2014), we have reclassified optical instrument manufacturing as a specialised supplier activity; we have also included primary sectors in the extended taxonomy under the names “primary 1”, which refers to NACE sectors 01-03, and “primary 2”, which refers to NACE sectors 04-09. The heat map has been built by adopting a column normalization; in other words, the factor scored have been separately normalized for each factor, so that the heat map signals (with a colour tending towards red) the Pavitt-Miozzo-Soete sectors which have the highest average score for each specific factor; the firms belonging to the corresponding industries exhibit, on average, a higher intensity in the particular approach to innovation associated to the factor.

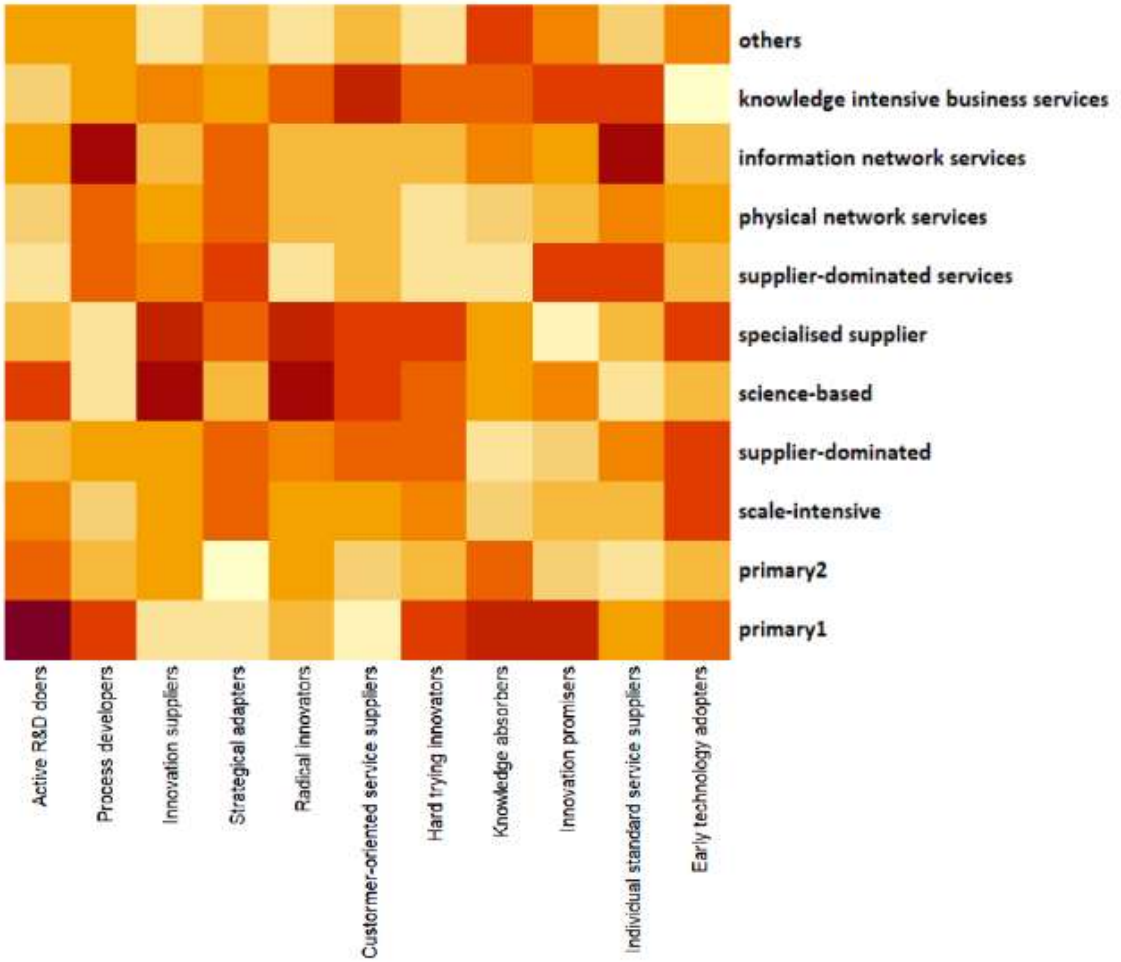

Figure 2. Heat map (column normalized): approaches to innovation (bottom, horizontal line) versus sectors in the Pavitt-Miozzo-Soete extended taxonomy (right, vertical line). High values are signaled by a red colour; low values are signalled by a yellow colour.

It is immediate to notice, in Figure 2, that specialised supplier industries and science-based industries score relatively high in both the "radical innovators" and the "innovation suppliers" factors. However, their score is substantially different in the first factor "active R&D doers", whose associated approach appears to be followed more by science-based industries. Interestingly, the primary sectors seem to also follow the "active R&D doers" approach, as shown by the darker colour of "primary 1" and "primary 2" sectors in the first column. We need here to point out that, in the Norwegian innovation survey we base our study on, the "primary 1" industries are mainly constituted by aquaculture firms and the "primary 2" industries are mainly constituted by "oil & gas" firms. Therefore, to find high levels of formal R&D in these sectors in Norway is less surprising than in other countries. Primary sectors seem also to privilege a "knowledge absorbers" approach, whereas knowledge intensive business services score high, as expected, in the "customer-oriented service suppliers" column. Notably, the same column shows high scores for several manufacturing sectors. Information network services and physical network services seem to pair up in their preference for "process developers", "strategical adapters" and "individual standard service suppliers" approaches. In general, the "Individual standard service suppliers" approach seems to be favoured by service firms, while the "strategical adapters" approach seems to be favoured by both manufacturing and service firms but not by primary firms.

The heat map in Figure 2 appears to confirm the intuitions behind the innovation taxonomies by Pavitt (1984) and Miozzo and Soete (2001) and, in general, seems to support the convenience of sector-based taxonomies. However, some firm-level patterns are missed in the averaging behind heat map: we show

now some scatter plots which, based upon the innovation approach factors we have retrieved, shed new light on the existing taxonomies.

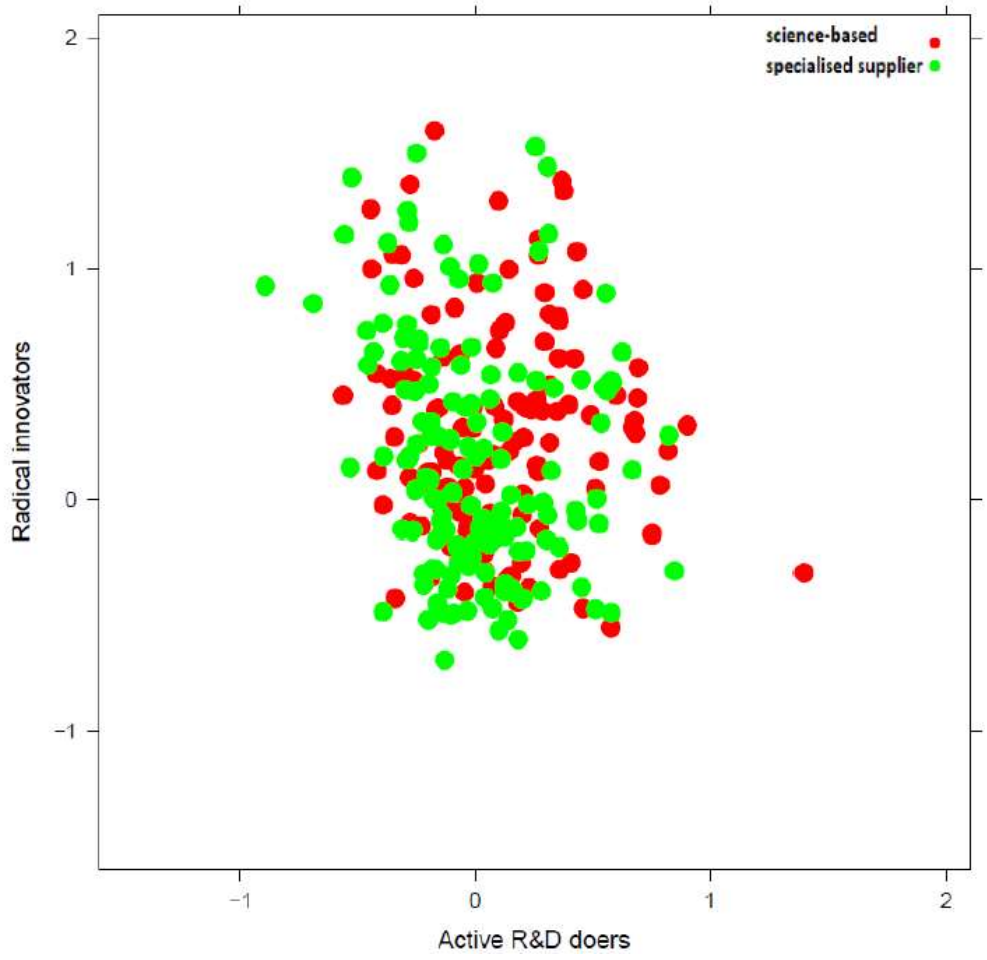

Figure 3. Scatter plot: firms from science-based industries vs. firms from specialised supplier industries; dimensions: "active R&D doers" approach, "radical innovators" approach.

In Figure 3 we can observe a scatter plot where each point corresponds to a firm belonging, respectively, to science-based industries (red points) and specialised supplier industries (green points). The horizontal axis measures the score obtained by the firm for the factor associated to "active R&D doers", while the vertical axis measures the score associated to the "radical innovators" factor. Observing the scatter plot allows to have a first glance on both the differences between sectors (different positions of the clouds) and about the firm heterogeneity within the sectors (shape of the clouds), in relation to the two factors under consideration. Figure 3 indeed shows two clouds with a similar shape, elongated towards up and reaching high scores in the "radical innovators" approach. In both cases, the body of the cloud appears to be lower and, notably, lower for specialised supplier industries than for science-based industries. The "radical innovators" approach thus appears to be a more common trait in the science-based industries, whereas the high average score in the specialised supplier industries seems to be driven by a subset of firms. The "active R&D doers" approach seems to coexist with the "radical innovators" approach especially for science-based firms which are in the medium-range of the "radical innovators" score; indeed, the red cloud shows an extension towards right which departs from the middle of its body. In other words, a group of firms stands out from other firms in the same Pavitt macrosector by following two different innovation approaches at the same time.

This would not be the case for other sectors: Figure 4 shows a scatter plot of firms in the "primary 1" sectors (depicted in blue; they are mostly aquaculture firms), in a diagram with the same axes as in the previous figure. While a cluster of firms can be observed around the origin of the diagram, overlapping with the red "dots" of the science-based industries, an extension of the blue "cloud" can be observed towards right, departing directly from the cluster and clearly inferior to the right extension of the red cloud. The extension is composed by aquaculture and fishing firms which score relatively high on their "active R&D doers" approach; however, they have a low score on the "radical innovators" approach, often even lower than the average in their same sectors. In other words, the coexistence of "active R&D doers" approach and "radical innovators" approach in a firm is more likely if the firm belongs to science-based industries than if the firm belongs to the aquaculture and fishing sector, and this observation cannot be explained only by the higher average score of science-based firms in the "radical innovators approach". The scatter plot in Figure 4 thus suggests that intersectoral differences in innovation patterns may be ascribed not only to different average firm behaviours within each sector, but also to specific roads that, differently in each sector, are available to improve on innovation.

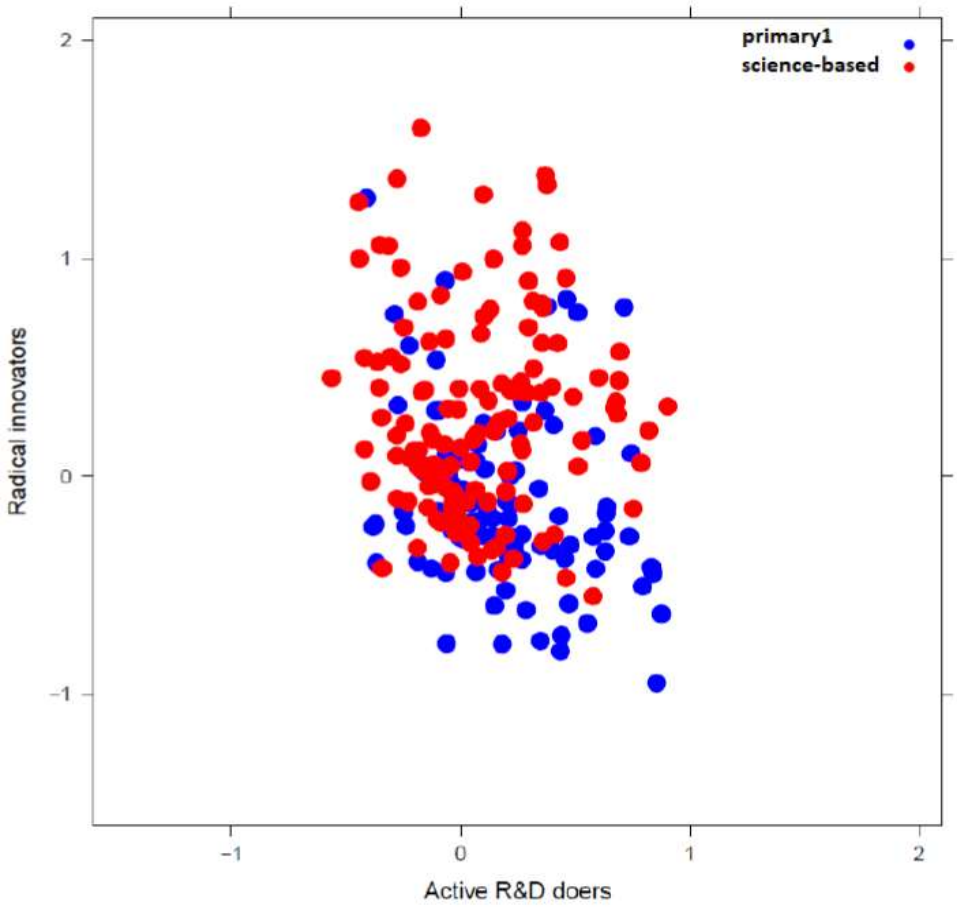

Figure 4. Scatter plot: firms from science-based industries vs. firms from fishing and aquaculture; dimensions: "active R&D doers" approach, "radical innovators" approach.

We can now go back to the comparison between science-based industries and specialised supplier industries, but this time by showing a scatter plot where the horizontal axis measures the "hard trying innovators" score. The result is in Figure 5; the red and green circles have been added to highlight where firms in, respectively, science-based industries and specialised supplier industries tend to have similar scores for both the "radical innovators" and the "hard trying innovators" factors. We need first to point out that both the green and red cloud appear relatively wide in both directions: firms can position themselves in different ways when it concerns these two approaches, even within a same

Pavitt macrosector. However, the green cloud referring to specialised supplier industries appear denser in the bottom-right corner: several firms display a low "radical innovators" score coupled with a high "hard trying innovators" score. Instead, the red cloud of science-based industries shows two clusters of firms: one in the bottom-left corner and one in the middle-right area. Firms in science-based industries can thus be low in both "radical innovators" approach and "hard trying innovators" approach, or can have a high "hard trying innovators" approach coupled with an average "radical innovators" approach. Therefore, the dispersion of the red cloud witnesses heterogeneity within the science-based industries, while the density of the red cloud in two areas suggests some degree of behaviour polarization within the same industries.

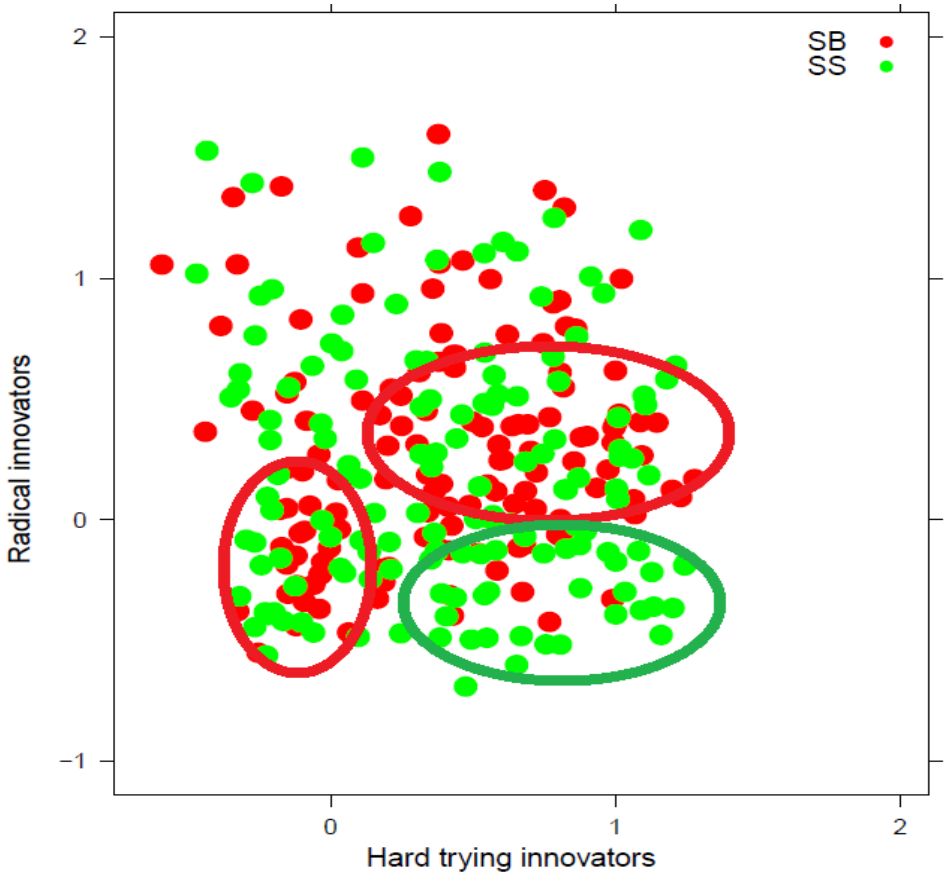

Figure 5. Scatter plot: firms from science-based industries vs. firms from specialised supplier industries; dimensions: "active R&D doers" approach, "hard trying innovators" approach.

As a final example, we show in Figure 6 the same firms with again the "radical innovators" score measured by the vertical axis; however, this time the horizontal axis measures the "innovation promisers" score. While the green cloud of firms in specialised supplier industries does not display any particular pattern, the red cloud of firms in science-based industries seems to extend along a diagonal direction, from top-left towards bottom-right. In other words, those firms which do not belong to the central denser seem to privilege one of the approaches over the other one, with some degree of substitution between the two approaches: a firm from a science-based industry scoring high on the "innovation promisers" factor is likely to score relatively low on the "radical innovators" factor. In other words, a firm in a science-based industry might be able, at a given point in time, to attract investors in the presence of high innovation expectations without displaying a propensity to radical innovation. Tentative explanations could be brought forward, including the possibility of cycles from planning to implementing innovations processes in science-based firms; in any case, a main message from the

scatter plot is the possibility of negative correlations between approaches even within the same Pavitt macrosector.

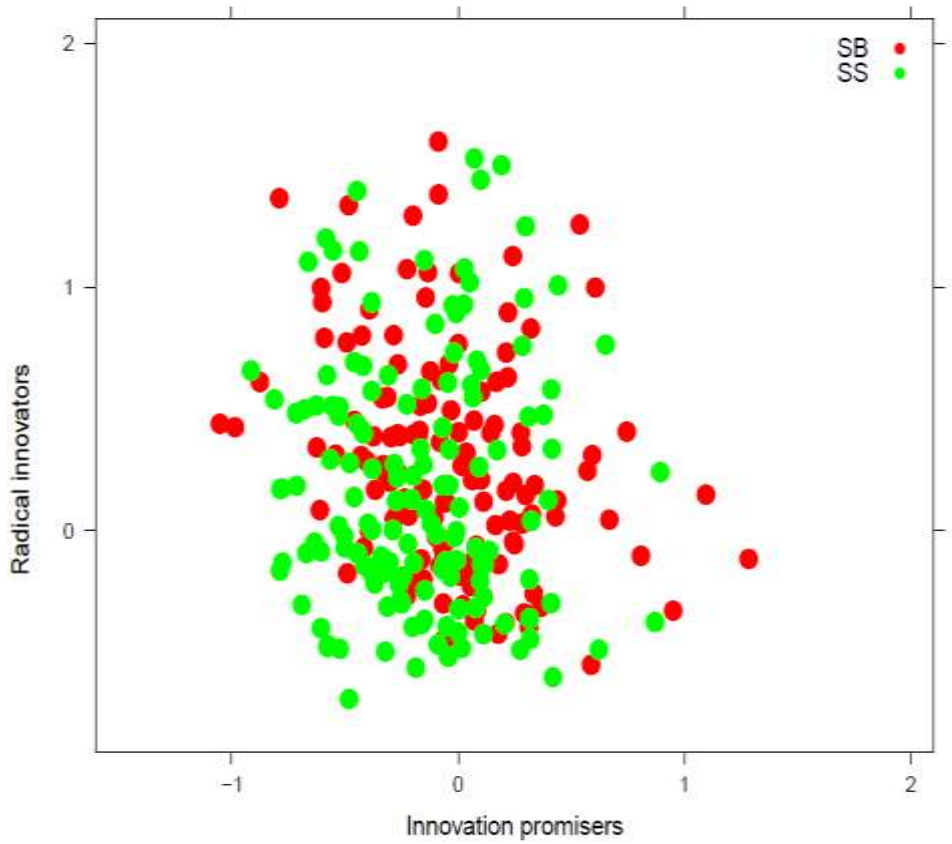

Figure 6. Scatter plot: firms from science-based industries vs. firms from specialised supplier industries; dimensions: "innovation promisers" approach, "radical innovators" approach.

4.3 Relations with firm size

In this section we explore the relationship between different approaches to innovation and the firm size measured by number of employees. Are some of the approaches more common among small and some among large firms? To do that, we first centralise the factor scores by subtracting the mean value and dividing by standard value for the corresponding factor:

$$S_{ij}^{c} = (S_{ij} - \mu_j)/\sigma_j,$$

where *i* is the number of firm (*i=1,.., 6360*), *j* is the number of factor (*j=1,…, 11*), μ_j is the mean value of all scores for factor *j* and σ_j is the standard deviation.

Then we calculate average (centralised) score for each of the factors within different groups of the firms divided by their size, i.e. firms with 5-9, 10-19, 20-49, 100-249 and 250 or more employees.[11] From Figure 7 we can see that most of the firms in the survey are small firms (only 6 % of the firms in the survey are large firms in the OECD context).[12] Figure 7 shows which of the approaches to innovation have positive correlation with the firm size. These are "active R&D doers", "process developers", "knowledge absorbers" and "early technology adopters", with "active R&D doers" and "knowledge absorbers" being approaches that have the strongest association with the firm size.

[11] Firms with less than 5 employees are not covered by the survey.

[12] The survey covers all firms with at least 50 employees and a representative sample of firms with 5-49 employees. So it reflects that most of the Norwegian firms are small.

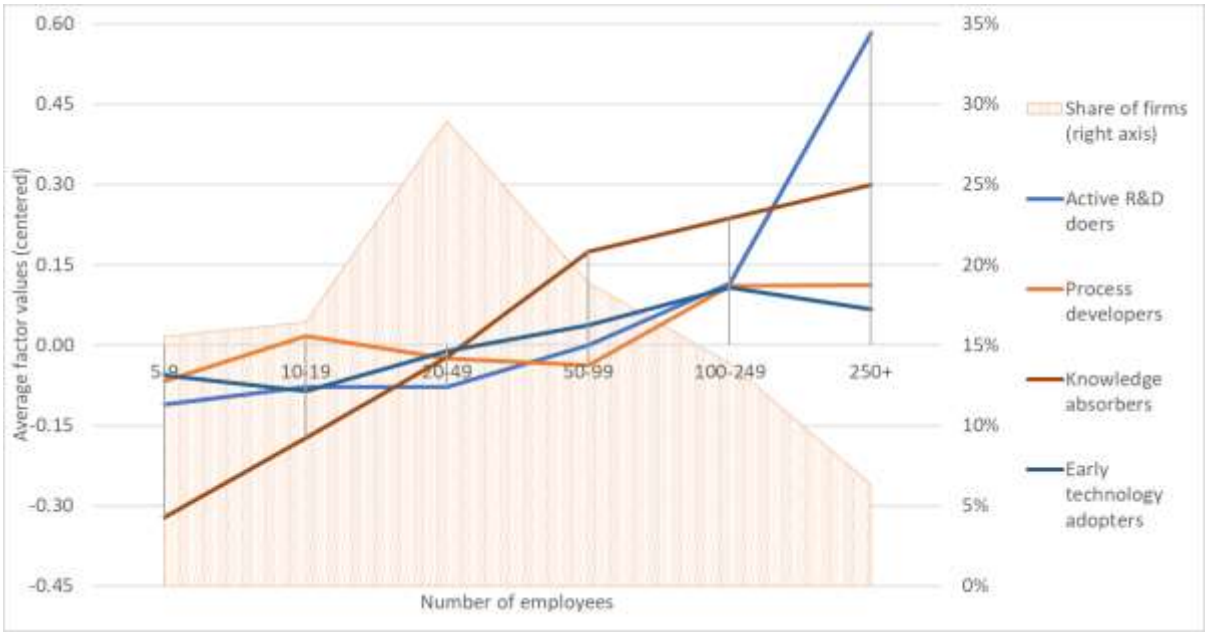

Figure 7. Approaches to innovation that have positive correlation with firm size measured in number of employees.

Figure 8 shows which of the approaches to innovation have negative or zero correlation with the firm size. The strongest negative association with firm size is demonstrated by "innovation promisers", i.e. the smallest firms are highly associated with applying this approach to innovation and largest firms do not at all. Other approaches to innovation that have stronger association with small firms rather than large firms are "customer-oriented service suppliers", "hard trying innovators" and "early technology adopters", while "strategical adapters" and "individual standard services suppliers" do not have any special pattern with respect to the firm size. As to the "innovation suppliers" and "radical innovators", these approaches have U-shaped correspondence with the firm size, i.e. demonstrating high scores for the smallest and largest firms and low scores in the middle of the size distribution.

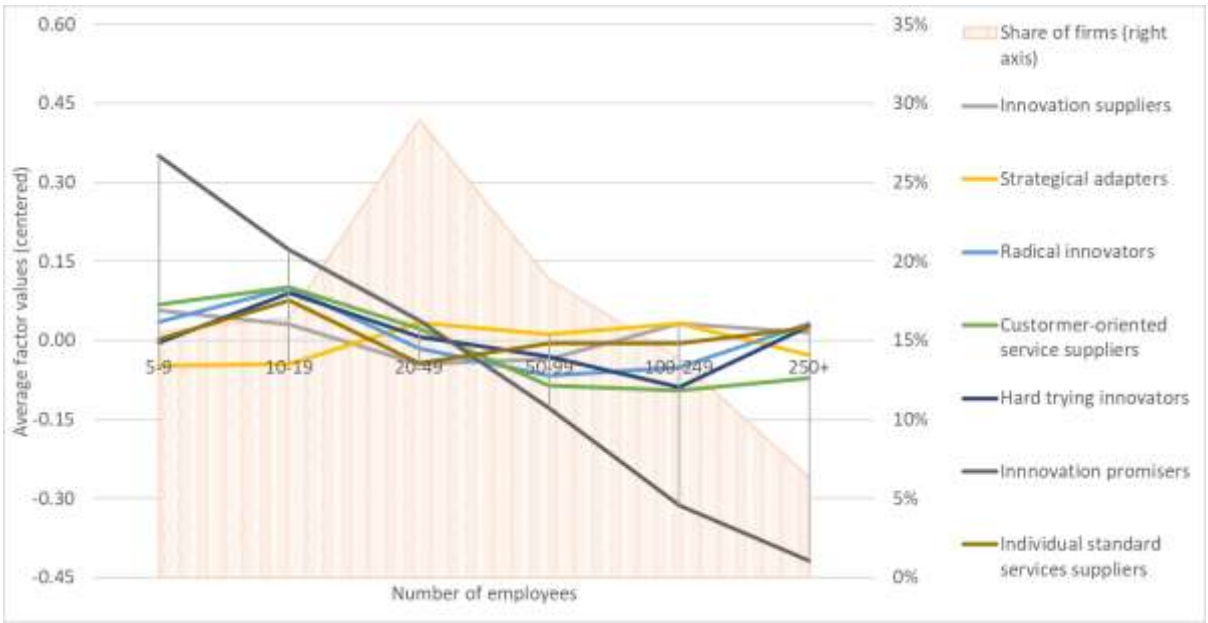

Figure 8. Approaches to innovation that have negative or zero correlation with firm size measured in number of employees.

To check whether these patterns hold irrespective the firm's industry, we construct the set of graphs for the factor scores by firm size and the Pavitt-Miozzo-Soete (PMS) sector. These are presented in Appendix C (note that the factor is measured on the vertical axis).

The first factor identified through our procedure corresponds to the innovation pattern that we have called "active R&D doers". When plotting the factor against firm size, we obtain lines with positive slopes irrespectively of the Pavitt-Miozzo-Soete (PMS) sector to which firms belong, an exception being for supplier-dominated services. In other words, no matter to which PMS macrosector the firm belongs, a larger firm size entails a likely higher "active R&D doers" approach to innovation. However, for almost every level of average firm size, science-based firms seem to adopt an "active R&D doers" approach to innovation more than all other macrosectors.

The second pattern detected by our procedure, namely the "process developers" pattern, is characterised by an increasing relation with size for supplier dominated services, information network services and supplier dominated manufacturing. For these three cases, the approach seems to be positively associated to firm size. Notably, information network services appear to generally be more inclined to have this approach than other sectors. Science-based industries display here an inverse-U shaped relation, in the sense that very small or very large science-based firms are less likely to follow a "process developers" pattern. Both science-based and specialised supplier firms display a higher tendency to adopt an "innovation suppliers" approach, with respect to firms from other macrosectors with similar size. Specialised suppliers seem to have higher likelihood to be "innovation suppliers" when their firm size is larger. Instead, a larger firm size is for science-based firms associated to a higher likelihood of being "strategical adapters". This fourth factor denomination seem also to be relevant for Information network services, but only when their average size enters the "20-49 employees" size class. Instead, this approach to innovation appears to be less common among firms in the "primary 2" group, irrespectively of their size; we do not consider here firms in the "primary 1" group, since only few observations are available for some size categories.

The association previously detected of both science-based and specialised supplier firms with the "Radical innovators" pattern seems to be confirmed for all levels of firm size. At the same time, supplier-dominated services appear not to be often in the "radical innovators" set, no matter their size. An interesting case is constituted by the knowledge-intensive business services, which are more likely to be "radical innovators" when their size is smaller. Knowledge-intensive business service also appear typically to be "customer-oriented service suppliers" (our sixth identified pattern), irrespectively of size. Interestingly, the same pattern is associated also to science-based firms, but only when their firm size is smaller: science-based firms of large size are highly unlikely to be "customer-oriented service suppliers". Such pattern can be associated to knowledge-intensive business services and to supplier-dominated manufacturers, irrespectively of size. Specialised suppliers are here in line with science-based firms, in that their identification as "customer-oriented service suppliers" holds mainly for small firm sizes. Information-network services become instead more associated to the pattern as their average firm size increases. Firms in the "primary 2" group seem to not conform to the pattern, irrespectively of size.

Information-network services, physical network services and supplier-dominated services display, on average, a low "hard trying innovators" factor, irrespectively of size. Specialised suppliers and science-based firms score high, instead, on this factor; also in these cases, firm size does not appear to play an important role. A totally different figure comes from the depiction of "knowledge absorbers" factor, in relation with firm size. Here, an increase in average firm size seems to correspond to a higher

"knowledge absorbers" factor for most macrosectors; an exception is given by firms in the "primary 2" group, whose relation to the factor is inverse U-shaped. Given firm size, knowledge-intensive business services are more likely to be "knowledge absorbers", together with science-based firms, information network services and specialised suppliers; instead, supplier-dominated services are less likely. Supplier-dominated manufacturers are unlikely to be "knowledge absorbers" when their firm size is small.

The "innovation promisers" factor seems to be negatively correlated with size, this relation holding for all PMS sectors. However, the negative correlation appears to be even stronger for supplier-dominated and scale-intensive manufacturers. Given firm size, supplier-dominated services and knowledge intensive business services are more likely to be "innovation promisers", while specialised suppliers are less likely. Firm size does not seem to play a role on the likelihood of being "individual standard service suppliers" (our tenth identified innovation pattern). Here, services like information network services, knowledge intensive business services and supplier dominated services score high, while manufacturers like science-based firms, specialised suppliers and scale-intensive firms score low, irrespectively of size. Finally, the "early technology adopters" pattern seems not to be typical of knowledge-intensive business services, irrespectively of their size. Specialised suppliers and science-based firms are more likely to be "early technology adopters" for higher levels of firm size, while scale-intensive firms are less likely to be "early technology adopters" for medium levels of firm size.

4.4 Discussion

The innovation pattern called "early technology adopters" seems to be particularly relevant for firms which would be classified as "supplier dominated" manufacturing under the PMS taxonomy. Indeed, this approach to innovation involves acquiring knowledge, as embedded in machinery, equipment and software, and profits from cooperation with suppliers, and thus appears fully in line with the formulation by Pavitt (1984) on supplier-dominated industries. We also notice that firms in the PMS supplier-dominated industries (including now also service firms, as in the extension by Miozzo & Soete, 2001) are more likely to be "process developers" when they are larger.

To understand this phenomenon, we need to go back to the work by Cesaratto and Mangano (1993), who detected two clusters of firms (named respectively Cluster 5 and Cluster 6), both relying on embodied technical change. Both clusters would be supplier-dominated according to the definition by Pavitt (1984) and to the PMS taxonomy. However, the latter cluster (Cluster 6) was comprising firms that are larger, more focused on process innovation and more able to conduct in-house research. In our study, the higher possibilities for in-house R&D (Factor 1) and for knowledge absorption (Factor 8) appear for larger firms, irrespectively of their industry. Instead, the focus on process innovation emerges from a separate dimension of innovation, as retrieved by our factor analysis, a dimension where supplier-dominated firms score higher when they are larger. The complex view by Cesaratto and Mangano (1993) on the role of firm size in supplier-dominated industries thus appears, in our work, disentangled into four separate dimensions. We can also add that smaller supplier-dominated firms seem to resort more often to an "innovation promiser" approach, characterized by a focus on a small number of key goods and services, as well as by externally financed ideas for future innovation. The "innovation promisers" high scores obtained by small firms in many economic sectors might also signal an ongoing rejuvenation of some industries, including the supplier-dominated industries, with technological opportunities caught by younger firms.

The relation between firm size and process innovation appears clearly in our data also for firms belonging to information network services, as defined by the PMS taxonomy. However, here the size correlates positively also with a factor score in the "Customer-oriented service suppliers" approach.

Therefore, while information networks services tend to score generally high as “individual standard service suppliers”, a higher firm size brings for them more possibilities for process innovations as well as for “co-creation” of products in cooperation with private customers and with the public sector.

The opposite holds for firms in the PMS-defined science-based and specialised supplier industries, whose attempts to customize products seem, according to our analysis, to diminish with firm size. Firms in both science-based and specialized supplier tend to adopt an “innovation supplier” approach (Factor 3) and a “radical innovator” approach (factor 5), in line with what Pavitt (1984) could have predicted. However, firms in specialized supplier industries tend to score even higher on the “innovation supplier” factor when they are larger, while larger firms in science-based industries become more likely to be “strategical adapters” (Factor 4) and thus to provide a higher quality of products in the market segment they serve. The different results in these two PMS macrosectors suggest that an increased firm size may translate, for science-based industries, into more direct connections with the final markets, without an increased reliance on intellectual property rights.

Another important difference between science-based industries and specialised supplier industries, already outlined in the previous section, is the former’s higher score on the “active R&D doers” factor, irrespectively of size, pointing at wider collaborations and higher access to public funding. This behaviour, consistent with the observations by Pavitt (1984), is complemented by other strategies according to firm size: for smaller science-based firms we find higher scores on Factor 5 (“customer-oriented service suppliers”), while for larger science-based firms we find higher scores on Factor 11 (“early technology adapters”). Firms in science-based industries, following the PMS taxonomy, seem therefore to be able to acquire knowledge embedded in equipment, also by resorting to loans, when they are bigger (a behaviour they share with specialized suppliers); however, when their firm size is small, they pursue more often customization of their products.

Specialised supplier industries complement instead their “radical innovator” and “innovation supplier” approaches, irrespectively of firm size, with the strategies identified by high scores on Factor 5 (“customer-oriented service suppliers”) and Factor 7 (“hard trying innovators”). Knowledge-intensive business services are also “customer-oriented service suppliers” irrespectively of size, and even more often than specialised suppliers; this observation marks a difference with respect to firms in science-based industries, for which customisation seems to become a necessity for survival only when firm size is smaller. On the other hand, knowledge-intensive business services have a higher chance to be “radical innovators” when they are smaller, unlike firms in science-based industries who have a generally high chance of being “radical innovators”. Our results seem here to confirm the vision of De Jong and Marsili (2006), whose micro-based clustering has identified some small service firms as “science-based”: with our denominations, the corresponding firms in our dataset would probably be those firms in knowledge-intensive business services which score high on factor 5 (“radical innovators”).

5. Conclusions

The main outcome of our study is a renewed view on innovation as a multifaceted concept. Many observable variables can be reconducted to a measure of innovation, which in turn appears at firm-level through a plurality of processes and products. Labelling an industry or a firm as more or less innovative may sometimes neglect the specificity that each industry and each firm has in pursuing innovation. Sectors that in traditional views would be considered supplier-dominated may give rise to

novel pathways toward innovation and, even when their innovation occurs through knowledge absorption from other sectors, must often actively foster their absorptive capacity.

Our analysis also brings forward the importance of firm size in defining innovation possibilities. Previous attempts at building taxonomies of innovation behaviour already pointed out that a higher average firm size within an industry would tend to characterize the innovation possibilities of the industry. When taxonomies were built at firm level, the association of a firm to a specific set of characteristics depended often on the size of the firm. We have shown that the interaction of size and industry has its own importance in defining the firm's approach to innovation: for instance, product and service customization may be more frequent among smaller firms in science-based industries and among larger firms in information network services. The acknowledgement of the coexistence of different approaches to innovation, even within the same firm, is also crucial to uncover the ways in which small firms may survive in sectors dominated by large firms, including the sectors traditionally labelled as scale intensive.

The increasingly blurred boundary between manufacturing and services, that is a known fact already studied in the previous literature, is shown in this study in terms of innovation behaviour. Our approach is somehow reversed with respect to studies which grouped industries according to prevailing innovation patterns. Instead, we have detected recurrent innovation patterns across firms independently of the industry where firms belong to. This research path has helped us to find commonalities in innovation behaviour across industries and, as a consequence, to better isolate those innovation patterns which differentiate industries from one another. For instance, both specialised suppliers and firms in science-based industries may pursue radical innovation and may use intellectual property rights, but the access to, and dependence, on public fundingis is higher in science-based industries while the collaboration with customers is higher for specialised suppliers. Notably, radical innovation may be approached also by business services, whose possibility of being "knowledge-intensive" depends on their approaches to innovation, decided at firm level, as much as by the type of services they provide, as marked by industry codes.

As a final note, we can bring an element of reflection to policymakers. Considering only one approach to innovation as an optimal path, to promote through innovation policies, might neglect the different needs and possibilities firms have in pursuing innovation. Instead, acknowledging the variety of paths firms enter for achieving innovation, can allow to build policies targeted at a wider range of actors.

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Appendix A. Community Innovation Survey 2018 for Norway

Markets and strategies

1. In which geographical markets did your enterprise sell goods or services during the three years 2016 to 2018? Please tick each market that applies. What was the most important market? Please tick the most appropriate alternative in the last column.

	Which markets? (Tick all that apply)	Most important market (Only one tick)
Local/regional in Norway	☐	☐
The rest of Norway	☐	☐
Other European Union/EFTA countries[1]	☐	☐
Other countries	☐	☐

1.1 Approximately what percentage of your enterprise's total turnover came from sales to clients/customers located in:

Local/regional in Norway	, , %
The rest of Norway	, , %
Other European Union/EFTA countries1	, , %
Other countries	, , %
Total turnover in 2018	1 ,0 ,0 %

[1] *Include the following EU and EFTA countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Lichtenstein, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom.*

2. During the three years 2016 to 2018, how important were the following strategies to the economic performance of your enterprise??

	High importance	Medium importance	Low importance	Not important
Focus on improving your existing goods or services	☐	☐	☐	☐
Focus on introducing new goods or services	☐	☐	☐	☐
Focus on low-price (price leadership)				
Focus on high-quality (quality leadership)	☐	☐	☐	☐
Focus on a broad range of goods or services	☐	☐	☐	☐
Focus on one or a small number of key goods or services				
Focus on satisfying established customer groups	☐	☐	☐	☐
Focus on reaching out to new customer groups	☐	☐	☐	☐
Focus on standardised goods or services				
Focus on customer-specific solutions	☐	☐	☐	☐
Focus on improving your existing goods or services	☐	☐	☐	☐
Focus on introducing new goods or services				
Focus on low-price (price leadership)	☐	☐	☐	☐
Focus on high-quality (quality leadership)	☐	☐	☐	☐

Co-creation and customization

3. During the three years from 2016 to 2018, did your enterprise offer any of the following types of goods or services to meet user requirements?

	Yes	No
Goods or services co-created* with users, i.e. the user had an active role in the creation of the idea, design and development of the product (co-creation)	☐	☐
Goods or services designed and developed* specifically to meet the needs of particular users (customisation). This excludes mass customisation, i.e. customised versions of standard products.	☐	☐
Standardised goods or services offered to different users in the same way. This includes mass customisation.	☐	☐

If 'no' to both 'co-creation' and 'customisation, go to question 4.

3.1 For the products resulting from 'customisation'* or 'co-creation', the users included**

	Yes	No
Private business enterprises	☐	☐
Public sector organisations	☐	☐
Individuals or households	☐	☐
Non-profit organisations	☐	☐

Intellectual property rights (IPR)

4. During the three years 2016 to 2018, did your enterprise:

	Yes	No
Apply for a patent	☐	☐
Register an industrial design right	☐	☐
Register a trademark	☐	☐
Claim a copyright	☐	☐
Use trade secrets	☐	☐

5. During the three years 2016 to 2018, did your enterprise:

	Yes	No
License out its own intellectual property rights (IPRs) to others	☐	☐
Sell its own IPRs (or assign IP rights) to others	☐	☐
Exchange IPRs (pooling, cross-licensing, etc.)	☐	☐
Purchase or license-in[1] patents or other IPRs from private business enterprises or individuals	☐	☐
Purchase or license-in[1] patents or other IPRs from public research organisations, universities or other higher education institutions	☐	☐

[1] Exclude licences for standard software and copies of published material covered by copyright.

Knowledge flows and work organization

6. During the three years 2016 to 2018, did your enterprise use any of the following channels to acquire knowledge?

	Yes	No
Conferences, trade fairs or exhibitions	☐	☐
Scientific/technical journals or trade publications	☐	☐
Information from professional or industry associations	☐	☐
Information from published patents	☐	☐
Information from standardisation documents or committees	☐	☐
Social web-based networks or crowd-sourcing	☐	☐
Open business-to-business platforms or open-source software	☐	☐
Extracting knowledge or design information from goods or services (reverse engineering)	☐	☐

7. During the three years 2016 to 2018, how important to the management of your business were the following methods of organising work?

	High importance	Medium importance	Low importance	Not important
Planned job rotation of staff across different functional areas	☐	☐	☐	☐
Regular brainstorming sessions for staff to think about improvements that could be made within the business	☐	☐	☐	☐
Cross-functional work groups or teams (combined across different working areas or functions)	☐	☐	☐	☐
Time allocated for education, skills enhancement or on-the-job training in the enterprise	☐	☐	☐	☐

Innovation in goods or services (product innovation)

A product innovation is a new or improved good or service that differs significantly from the firm's previous goods or services and which has been implemented on the market.

Include: significant changes to the design of a good, digital goods or services

Exclude: the simple re-sale of new goods and changes of a solely aesthetic nature

8. During the three years 2016 to 2018, did your enterprise introduce any:

	Yes	No
New or improved goods	☐	☐
New or improved services	☐	☐

If no to both, go to question 9.

8.1 Who developed these product innovations?

If the enterprise introduced more than one innovation, tick all that apply.

	Goods innovations	Service innovations
Your enterprise by itself	☐	☐
Your enterprise together with your enterprise group	☐	☐
Your enterprise together with other enterprises or organisations[1]	☐	☐
Your enterprise by adapting or modifying products originally developed by other enterprises or organisations[1]	☐	☐
Mainly other enterprises or organisations[1]	☐	☐

[1] Including research institutes, universities, higher education non-profits, and the public sector.

8.2. Were any of your product innovations new to your market or only new to your enterprise?

If the enterprise introduced more than one innovation, tick all that apply.

	Yes	No
New to your market Your enterprise introduced a product onto your market before your competitors (but it may have already been available in other markets)	☐	☐
Only new to your enterprise: Your enterprise introduced a product that was already available from competitors in your market	☐	☐

If no product innovations were new to your market, go to question 8.5.

8.3 For which markets were these innovations new?

Choose the most expansive market. If the enterprise introduced more than one innovation, tick all that apply.

- Local/regional in Norway ☐
- The rest of Norway ☐
- Other European Union/EFTA countries[1] ☐
- Other countries ☐

[1] *Include the following EU and EFTA countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Lichtenstein, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom.*

8.4 Please estimate how your turnover[1] in 2018 only was distributed between

Innovations (goods or services) introduced in the three-year period 2016-2018 that were **new to the market**	, ,	%
Innovations (goods or services) introduced in the three-year period 2016-2018 that were **only new to your enterprise**	, ,	%
Products (goods or services) that were unchanged or only marginally modified in the three-year period 2016-2018. Goods and services fully developed and produced by others should also be included here	, ,	%
Total turnover in 2018.	1 ,0 ,0	%

[1] *For Credit institutions: Interest receivable and similar income; for Insurance services: Gross premiums written*

8.5 Considering your enterprises' development, operational and financial performance, your enterprises' overall expectations for your product innovations was that they would be:

- Very important to the enterprise ☐
- Somewhat important to the enterprise ☐
- Of low importance to the enterprise ☐
- Not important to the enterprise ☐
- Too early to assess ☐

8.6 How did the new or improved product(s), introduced during 2016 to 2018, meet your enterprise's expectations by the end of 2018:

- Expectations were exceeded ☐
- Expectations were adequately met ☐
- Expectations were met only to some extent ☐
- Expectations were not met at all ☐
- Too early to assess ☐

Business process innovations

A business process innovation is a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and which has been implemented within the enterprise

9. During the three years 2016 to 2018, did your enterprise introduce any of the following types of new or improved processes that differ significantly from your previous processes?

	Yes	No
Methods for producing goods or providing services (including methods for developing goods or services)	☐	☐
Logistics, delivery or distribution methods	☐	☐
Methods for information processing or communication	☐	☐
Methods for accounting or other administrative operations	☐	☐
Business practices for organising procedures or external relations	☐	☐
Methods of organising work responsibility, decision making or human resource management	☐	☐
Marketing methods for promotion, packaging, pricing, product placement or after sales services	☐	☐

If no to all, go to question 10.

9.1 Who developed these business process innovations?

If the enterprise introduced more than one innovation, tick all that apply.

- ☐ Your enterprise by itself
- ☐ Your enterprise together with your enterprise group
- ☐ Your enterprise together with other enterprises or organisations[1]
- ☐ Your enterprise by copying, adapting or modifying processes originally developed by other enterprises or organisations[1]
- ☐ Mainly other enterprises or organisations[1]

[1] Including research institutes, universities, higher education non-profits, and the public sector.

9.2 Considering your enterprises' development, operational and financial performance, your enterprises' overall expectations for your business process innovations was that they would be:

- Very important to the enterprise ☐
- Somewhat important to the enterprise ☐
- Of low importance to the enterprise ☐
- Not important to the enterprise ☐
- Too early to assess ☐

9.3 How did the new or improved processes introduced during 2016 to 2018 meet your enterprise's expectations by the end of 2018:

- Expectations were exceeded ☐
- Expectations were adequately met ☐
- Expectations were met only to some extent ☐
- Expectations were not met at all ☐
- Too early to assess ☐

Activities for the development or introduction of product or business process innovations

10. Did the enterprise perform research and Development (R&D) in-house or purchased R&D-services from others during the three years 2016 to 2018?

Research and Development (R&D) comprises creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.

	Yes	No
In-house research and development (R&D) activities	☐	☐
Purchased or contracted-out R&D to other enterprises (include enterprises in your own group) or to public or private research organisations	☐	☐

If 'no' to in-house R&D, go to question 11.

10.1 Which option best describes how your enterprise performed in-house R&D during the three years 2016 to 2018:

Continuously (your enterprise had permanent R&D staff)	☐
Occasionally (as needed only)	☐

11. During the three years 2016 to 2018, did your enterprise have any of the following types of innovation activities that did not result in an innovation during the period because:

'Innovation activity' includes all developmental, financial and commercial activities, undertaken by a firm, which are intended to or result in an innovation.

	Yes	No
Activities were completed, but the innovation has not (yet) been introduced to the market or implemented in the enterprise	☐	☐
The activity was abandoned or suspended before completion	☐	☐
Still ongoing at the end of the 2018	☐	☐

If no to all options in question 8, 9, 10 and 11; go to question 14.

Expenditures on R&D and innovation

12. How much did your enterprise spend on innovation and research and development (R&D) in 2018?

	Expenditures in 2018 1000 NOK
R&D performed in-house (Include current expenditures including labour costs and capital expenditures (buildings, machinery, equipment, software etc.) specifically for R&D)	 000
R&D contracted out to others (including enterprises in own enterprise group)	 000
Own personnel working on innovation Excl. R&D	 000
Services, materials, supplies purchased from others for innovation Excl. R&D	 000
Capital goods for innovation (Acquisition of machinery, equipment, software, IPRs, buildings etc.) Excl. R&D	 000
All other innovation expenditures Excl. R&D	 000

include:
- Acquisition of external knowledge for innovation activities (e.g. patents, licenses, trademarks)
- Product design, service design, preparation of production / distribution for innovation activities
- Training and professional development for innovation activities (e.g. employee training or continued education)
- Marketing of innovations (marketing activities directly related to innovations, including market research)

13. How do you expect your enterprise's innovation expenditures to change in 2019 and 2020?

2019 compared to 2018

- ☐ Increase — *If yes, by approximately* ☐☐☐ %
- ☐ Stay about the same (+/- 5%)
- ☐ Decrease — If yes, by approximately ☐☐☐ %
- ☐ No innovation expenditures expected
- ☐ Don't know (yet)

2020 compared to 2019

- ☐ Increase
- ☐ Stay about the same (+/- 5%)
- ☐ Decrease
- ☐ No innovation expenditures expected
- ☐ Don't know (yet)

Co-operation with other enterprises or organisations

Co-operation is active participation with other enterprises or organisations. Partners do not need to commercially benefit. Exclude pure contracting out of work with no active co-operation.

14. During the three years 2016 to 2018, did your enterprise co-operate* with other enterprises or organisations?

	Yes	No
On R&D	☐	☐
On other innovation activities (excluding R&D)	☐	☐
On any other business activities	☐	☐

If yes to co-operation on R&D or other innovation activities, go to question 14.1; otherwise, go to question 15.

14.1 Please indicate your co-operation partner(s) for R&D and/or innovation by type of organisation and location.

Tick as many boxes as applicable. Also select the most important co-operation partner (last column).

	Locally/ regionally in Norway	Rest of Norway	Nordic countries	Other EU/ EFTA	Other countries	**Most important partner**
Other enterprises within your enterprise group	☐	☐	☐	☐	☐	☐
Consultants, commercial labs, or private research institutes	☐	☐	☐	☐	☐	☐
Suppliers of equipment, materials, components or software	☐	☐	☐	☐	☐	☐
Enterprises that are your clients or customers	☐	☐	☐	☐	☐	☐
Enterprises that are your competitors	☐	☐	☐	☐	☐	☐
Other enterprises	☐	☐	☐	☐	☐	☐
Universities or other higher education institutions	☐	☐	☐	☐	☐	☐
Government or public research institutes	☐	☐	☐	☐	☐	☐
Clients or customers from the public sector***	☐	☐	☐	☐	☐	☐
Non-profit organisations	☐	☐	☐	☐	☐	☐

[1] Include the following EU and EFTA countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, France, Germany, Greece, Hungary, Italy, Ireland, Latvia, Lichtenstein, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Switzerland, and the United Kingdom.

Factors hampering innovation activities

15. During the three years 2016 to 2018, how important were the following factors in hampering your enterprises' decision to start innovation activities, or its execution of innovation activities?

	High importance	Medium importance	Low importance	Not important
Lack of internal finance for innovation	☐	☐	☐	☐
Lack of credit or private equity	☐	☐	☐	☐
Difficulties in obtaining public grants or subsidies	☐	☐	☐	☐
Costs too high	☐	☐	☐	☐
Lack of skilled employees within your enterprise	☐	☐	☐	☐
Lack of collaboration partners	☐	☐	☐	☐
Lack of access to external knowledge	☐	☐	☐	☐
Uncertain market demand for your ideas	☐	☐	☐	☐
Too much competition in your market	☐	☐	☐	☐
Different priorities within your enterprise	☐	☐	☐	☐

Enterprise funding and public financial support

16. During the three years from 2016 to 2018, did your enterprise try to obtain the following types of funding?

Include all funding, not only funding for R&D or innovation.

	Yes	No
Equity finance (finance provided in exchange for a share in the ownership of the enterprise)	☐	☐
Debt finance (finance that the enterprise must repay)	☐	☐

16.1 If 'yes' in question 16, did the enterprise successfully obtain funding of this type?

	Yes	No
Equity finance (finance provided in exchange for a share in the ownership of the enterprise)	☐	☐
Debt finance (finance that the enterprise must repay)	☐	☐

16.2 If 'yes' in question 16.1, was this partly or fully used for R&D or other innovation activities?

	Yes	No
Equity finance (finance provided in exchange for a share in the ownership of the enterprise)	☐	☐
Debt finance (finance that the enterprise must repay)	☐	☐

17. During the three years from 2016 to 2018, did your enterprise receive any public financial support from the following levels of government?

Include financial support via grants, subsidised loans, and loan guarantees. Exclude revenues from public sector procurement contracts Exclude SkatteFUNN.

	Yes	No
Local or regional authorities	☐	☐
Central government (including central government agencies or ministries)	☐	☐
The European Union (EU) (including the Horizon 2020 Programme for Research and Innovation)	☐	☐

17.1 If 'yes' in question 17, was part of this used for R&D or other innovation activities?

	Yes	No
Local or regional authorities	☐	☐
Central government (including central government agencies or ministries)	☐	☐
The European Union (EU) (including the Horizon 2020 Programme for Research and Innovation)	☐	☐

Technology, procurements and investment

18. During the three years 2016 to 2018, did your enterprise purchase machinery, equipment or software based on

	Yes	No
The same or improved technology used in your enterprise before	☐	☐
New technology that was not used in your enterprise before	☐	☐

19. Did the enterprise have investments/expenditure in any of the following categories in 2018?

	Yes	No
Acquisition of machinery, equipment, buildings and other tangible assets	☐	☐
Marketing, brand building, advertising (include in-house costs and purchased services)	☐	☐
Training own staff (include all in-house costs including wages and salaries of staff while being trained, and costs of purchased services from others)	☐	☐
Product design (include in-house costs and purchased services)	☐	☐
Software development, database work and data analysis (include in-house costs and purchased services)	☐	☐
Intellectual Property Rights (include registering, filing and monitoring own IPRs and purchasing or licensing IPRs from others)	☐	☐

19.1 If yes to any options in question 19, how large were these expenditures/investments?

If exact figures are not readily available, please estimate. Exclude leasing costs and accounting write-offs.

	Expenditures in 2018 1000 NOK
Acquisition of machinery, equipment, buildings and other tangible assets	 000
Marketing, brand building, advertising (include in-house costs and purchased services)	 000
Training own staff (include all in-house costs including wages and salaries of staff while being trained, and costs of purchased services from others)	 000
Product design (include in-house costs and purchased services)	 000
Software development, database work and data analysis (include in-house costs and purchased services)	 000
Intellectual Property Rights (include registering, filing and monitoring own IPRs and purchasing or licensing IPRs from others)	 000

Appendix B. Factor loadings of indicators into 11 approaches to innovation

	Active R&D doers	Process developers	Innovation suppliers	Strategical adapters	Radical innovators	Custormer-oriented service suppliers	Hard trying innovators	Knowledge absorbers	Innnovation promissers	Individual standard services suppliers	Early technology adopters	
Variable	**Factor1**	**Factor2**	**Factor3**	**Factor4**	**Factor5**	**Factor6**	**Factor7**	**Factor8**	**Factor9**	**Factor10**	**Factor11**	**Uniqueness**
d_sigmarloc	**-0.2066**		**-0.2724**		**-0.4982**							0.6156
d_sigmarnat										**0.4345**		0.7199
d_sigmareur	**0.1476**				**0.2916**							0.8309
d_sigmaroth	**0.2161**				**0.3040**				**0.2364**	**-0.2970**		0.6812
d_straimp		**0.2067**		**0.7176**								0.3255
d_straint			**0.3148**	**0.5513**	**0.2022**	**0.2134**				**0.2403**		0.3641
d_stralow				**0.4775**						**-0.2647**		0.6462
d_straqua				**0.8358**		**0.1981**						0.1887
d_straran				**0.5465**					**-0.3508**			0.5017
d_strafoc				**0.4680**					**0.4137**			0.5483
d_straest				**0.7439**								0.3575
d_stranew				**0.6817**								0.4569
d_strasta				**0.6297**								0.5382
d_stracus				**0.5568**		**0.4285**				**-0.2423**		0.4207
d_specoc	**0.2585**					**0.8015**						0.2206
d_specom	**0.2578**		**0.2855**			**0.7416**						0.1690
d_specus				**0.2400**		**0.6648**						0.3908
d_spedpr					**0.2462**	**0.8076**						0.1469
d_spedpu						**0.6947**		**0.2282**				0.3501
d_spedhi			**0.2516**		**-0.4998**	**0.3568**				**0.2381**	0.1765	0.4208
d_propat	**0.3503**		**0.6092**		**0.4276**				**0.1901**			0.2134
d_prodes			**0.7123**								**0.2910**	0.3222
d_protm	**0.2250**		**0.6547**							0.1865		0.3766
d_prosec	**0.4059**		**0.4585**		**0.3097**	**0.2021**						0.4208
d_procp			**0.6893**									0.4415
d_intoth			**0.7834**									0.3127
d_intlic	**0.2591**		**0.6318**		**0.1960**						**-0.1981**	0.4310
d_intsha	**0.3934**		**0.5938**			**0.1919**					**-0.1972**	0.3934
d_intbpr	**0.3162**		**0.6271**									0.4776
d_intbpu	**0.3578**		**0.6072**						**0.2515**	**-0.2325**		0.3438
d_kno_viten	**0.4455**			**0.2138**				**0.6604**				0.2226
d_kno_bransje	**0.2457**							**0.6848**				0.4034
d_kno_data	**0.3295**		**0.2868**		**0.1974**			**0.5586**		**-0.2152**		0.3789
d_kno_nettverk		**0.2534**				**0.2038**		**0.5470**	**0.2144**			0.4504
d_kno_other								**0.5290**				0.5530
d_worrot		**0.2811**		**0.3168**				**0.2686**				0.7068
d_worbra	**0.2019**	**0.3248**		**0.3495**		**0.2019**		**0.3393**				0.4664
d_worwor	**0.2906**	**0.2943**	**0.2219**	**0.3035**				**0.4302**				0.4041
d_worcom		**0.2672**		**0.3493**				**0.5043**				0.5119
d_inpd_good	**0.3641**	**0.2173**	**0.2178**	**0.2018**	**0.4918**	**0.2581**				**0.2809**	**0.2156**	0.2669
d_inpd_serv	**0.2860**	**0.3578**		**0.1908**	**0.2693**	**0.2902**				**0.5067**		0.3093
d_newmktloc	**0.3038**	**0.2422**			**0.4080**	**0.3031**				**0.3441**		0.4410
d_newmktnat	**0.3766**				**0.5870**	**0.2991**				**0.3636**		0.2441
d_newmkteur	**0.3805**				**0.7548**							0.1763
d_newmktoth	**0.3383**		**0.2226**		**0.7831**							0.1559
d_newfrm	**0.2142**	**0.2305**				**0.1938**	**0.2249**			**0.3829**	**0.2199**	0.5661
d_inpcs_produksjon	**0.3173**	**0.5743**			**0.2100**	**0.2473**						0.3505
d_inpcs_logistikk		**0.6838**										0.4252
d_inpcs_ikt		**0.7782**										0.2695
d_inpcs_regn_adm		**0.7615**										0.3870
d_inpcs_relasjoner	**0.2008**	**0.8198**										0.2416
d_inpcs_hrm		**0.8258**										0.2564
d_inpcs_marketing		**0.7056**	**0.2142**	**0.1959**								0.3277
d_rrd_int	**0.6803**				**0.4128**		**0.2402**		**0.2267**			0.1650
d_rrd_ext	**0.6989**		**0.2241**		**0.2817**				0.1713			0.3125
d_rrd_cont	**0.5753**		**0.2344**		**0.4738**				**0.2808**			0.2511
d_invinno_perc	**0.2237**						**0.3301**			**0.3294**	**-0.2258**	0.5816
d_invinno_extj											**0.4499**	0.6209
d_invinno_tech		**0.3162**									**0.6495**	0.4018
d_invinno_null		**-0.3524**					**-0.3078**			**-0.2723**	**-0.3953**	0.3026
d_exp_vekst	**0.2251**								**0.4042**			0.7318
d_exp_fast	**0.2145**								**-0.2515**	**0.2268**		0.7333
d_exp_ned	**0.2107**										**0.3081**	0.8212
d_exp_null	**-0.2197**		**-0.2193**						**-0.2165**			0.7971
d_exp_usikker		**0.2152**								**-0.2024**		0.8308
d_coop_konsern	**0.7304**	**0.2021**							**-0.2335**			0.3160
d_coop_konsult	**0.7961**											0.2793
d_coop_leveran	**0.7937**										0.1889	0.2580
d_coop_kunder	**0.6790**				**0.2019**	**0.3004**						0.3405
d_coop_bransje	**0.6311**				**-0.2163**			**0.1946**				0.4046
d_coop_andref	**0.5576**									**0.2276**		0.5839
d_coop_fuh	**0.7826**							0.1708				0.2401
d_coop_off	**0.6634**					**0.2398**					**-0.2756**	0.3473
d_coop_ikke_inno	**0.6531**											0.4969
d_coop_lokalt	**0.7980**											0.2683
d_coop_norge	**0.8201**											0.2290
d_coop_norden	**0.7064**											0.4166
d_coop_eur	**0.7263**		**0.3228**		**0.2748**							0.2532
d_coop_verden	**0.6719**		**0.1976**		**0.3712**							0.3079
d_hemp_fin	**0.2906**						**0.7327**		**0.2408**			0.2476
d_hemp_kost	**0.2410**						**0.7966**					0.2463
d_hemp_kunn							**0.7401**					0.3464
d_hemp_mkt	**0.2141**						**0.7823**		**-0.1928**			0.2268
d_fin_owni	**0.2844**		**0.2689**		**0.2989**				**0.7480**			0.1663
d_fin_loan	**0.3157**				0.1806				**0.5067**		**0.3048**	0.4549
d_fin_publ	**0.5973**				**0.2716**				**0.3813**			0.3320
d_tech_pro	**0.2396**	**0.2071**						**0.3328**			**0.3505**	0.5920
d_tech_new	**0.3832**	**0.3240**						**0.2783**			**0.3093**	0.5286

Appendix C. Scores for each of the approaches to innovation by firm size and by the Pavitt-Miozzo-Soete sector.