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Determinants of product innovation in small firms: A Comparison Across Industries

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Determinants of product innovation in small firms: A Comparison Across Industries

Abstract
A plethora of studies has investigated the determinants of product innovation in small firms, suggesting product, firm, market and innovation process factors as its key drivers of success. Variations across industries relating to the determinants of product innovation are often suspected, but due to a lack of data this area is under-researched. In case of major differences much previous work will be flawed. Drawing upon of database of 1250 small firms across seven industries, this paper explores if any differences are found in the presence and impact of various firm-level determinants. Controlling for size and age differences, the analysis reveals some major differences to the extent small firms use innovative practices, and their connection with new product introductions.

Keywords: product innovation, determinants, small firms, industries.

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1. Introduction

Firms need to develop new products, at least on occasion, to gain competitive advantage. The rate at which they are capable to develop these new products has been linked to performance and long-term survival (*e.g.*, Soni *et al.*, 1993; Banbury and Mitchell, 1995). This is as true for small firms as it is for large ones (De Jong, Vermeulen and O'Shaughnessy, 2004). Chris Freeman, one of the authorities in innovation research, even states that 'not to innovate is to die' (Freeman and Soete, 1997). A wide variety of scholars has studied and extensively documented the success factors of product innovation in small firms, resulting in a plethora of literature suggesting product, firm, market and innovation process characteristics as determinants of product innovation (*e.g.*, Acs and Audretsch, 1988, 1990; Hyvärinen, 1990; Kim et al., 1993; Brouwer and Kleinknecht, 1996; Hadjimanolis, 2000; Freel, 2003; Rogers, 2004).

This paper explores if major differences arise when the determinants of product innovations are compared across industries. Sectoral patterns relating to innovation are fairly well established, that is, previous research has shown that sectors vary in terms of the sources, paces and rates of technological change. Evidence has been provided for both manufacturing (Pavitt, 1984) and service sectors (*e.g.*, Evangelista, 2000). Because of such patterns one may expect that firms in specific sectors will use specific innovative practices in order to innovate successfully. In fact, many theorists expressed this suspicion (*e.g.*, Oerlemans *et al.*, 1998; Huang *et al.*, 2002) but due to a lack of feasible data such differences are seldom explored. Public sources like national statistical offices do not collect detailed data on product innovation practices within small firms, while the

potential for primary data collection by researchers is always limited to financial and time restrictions.

Obviously, differences in the determinants of product innovation could imply that much of the previous research is flawed, and it would certainly limit its practical applicability to decision-makers in small firms. Although we realize that attempts at generalization are often made out of complexity reasons (see Nooteboom, 1994), we feel that the rich diversity in SMEs should not be discarded.

In the following section we present an overview of the literature into the determinants of product innovation in small firms. It shows that indeed there are few studies that have actually explored variations across industries in the determinants of product innovation. Section 3 provides the details of ours database. We used survey data of 1250 small firms across seven industries in the Netherlands. It contained information on recent new product introductions and innovative practices. Section 4 presents the analysis we have performed. Its purpose was twofold: first we explored if firms from various industries are dissimilar in the extent to which they use the innovative practices to their advantage, next we address the question of any differences in their impact on product innovation. In section 5 we proceed with our conclusions and implications, while the paper ends with limitations and suggestions for future research.

2. Overview of the relevant literature

There is a large body of literature available on determinants of product innovation in SMEs. In our literature review we have used those studies that concentrate on a wider set of variables as determinants of product innovation. We excluded studies that focus on other types of innovation (e.g. Galende and de la Fuente, 2003), the adoption of innovation (Karlsson and Olsson, 1998) and consequences of innovation like export performance (Sterlacchini, 1999). We also excluded a study by Parthasarthy and Hammond

(2002) who were more interested in the moderating effects of process variables on the relation between innovation input and output. Eventually, fourteen studies focusing on multiple determinants of product innovation were taken into account. These are listed in table 1.

[TABLE 1 ABOUT HERE]

Some papers in table 1 are conceptual and provide no empirical test (Hyvärinen, 1990; Hoffman et al., 1998). The other studies can be grouped in three groups. First, one can recognize studies that use broad samples of firms spread through various industries without comparing the results across sectors (e.g., Brouwer and Kleinknecht, 1996; Hadjimanolis, 2000; Bougrain and Haudeville, 2002). Brouwer and Kleinknecht do mention that there is little evidence of sector-specific differences in innovation output (1996:199), but they do not provide any information on differences in innovative practices. Bougrain and Haudeville acknowledge that there may be differences between sectors, but they "do not take into account the sectoral patterns of innovation" (2002:744). Hadjimanolis (2000) did include five industrial sectors in his sample, but no specific comparison of the impact of determinants on product innovation across sectors has been made. The main disadvantage of these studies is that if any variations across industries are present, composite effects may cloud our image of key determinants.

Second, some studies restrict themselves to studying determinants within a single industry. An example includes the paper of Romijn and Albaladejo (2002). They investigate a large set of determinants (for innovation capability, which is directly related to increased product innovation), but include only small electronics and software firms in their sample. Obviously, such an approach faces limited generalizability.

Third, some previous work does make comparisons, but then the focus is limited to broad categories such as manufacturing versus non-manufacturing, manufacturing versus services and high-tech versus low-tech. The seminal work of Acs and Audretsch (1988, 1990) is often referred to in studies on determinants of product innovation in small firms. They report on the innovative activities for a number of sectors, but surprisingly, they do not make a distinction across industries when discussing the independent input factors (see table 1). Covering a broad range of sectors they basically compare large and small firms and highly innovative versus innovative industries without further specifying these. Similar distinctions can be found in Kim et al. (1993), Roper (1997), Rogers (2004) and Bhattacharya and Bloch (2004). A disadvantage is that such broad categories may still blur our view of key practices. Only a very limited number of studies make more detailed comparisons. Examples include Oerlemans et al. (1998) and Freel (2003) who both use the Pavitt (1984) sectors as a basis for distinction and find some significant differences in a number of innovative practices. Unfortunately, their samples include manufacturing firms only.

Here, we explore the differences across industries in more detail by using a sample with both manufacturing and services firms. We had a dataset at our disposal that covered seven industries. Our data did not allow for an investigation of all potential determinants of product innovation, but they did enable to make a comparison across various industries.

3. Data

This paper draws upon a unique database that contains information on the innovative practices of 1250 small firms within the Netherlands. The data presented here were collected as part of the 'SME Policy Panel'. This panel exists since 1999 and is controlled by EIM, a Dutch institute for policy research (see www.eim.nl). Financed by the Dutch

Ministry of Economic Affairs, the panel collects data on policy issues such as entrepreneurship, investments, growth, employability and export. The panel consists of nearly 1800 small firms covering seven industries: manufacturing, construction, wholesale and transport, retail services, hotel and catering services, knowledge-intensive services (like consultants, researchers and engineers) and financial services. Data are collected three times a year. Below, we will elaborate on the variables we have used to explore variations across sectors in the determinants of product innovation. Next, we will discuss the data collection process and the characteristics of our sample.

In the panel data were available for seven firm-level innovative practices and two measures of product innovation (see table 2).

[TABLE 2 ABOUT HERE]

On beforehand, we stress that our data did not cover all potential determinants of product innovation by far. Our database contained information on firm-level innovative practices only. Although less attention has been devoted to internal activities (Sterlacchini, 1999), these have been identified in the literature as being extremely important (e.g. Oerlemans et al., 1998; Hadjimanolis, 2000; Freel, 2003). Nelson (2000) claims, for instance, that most of the innovation efforts are made by firms themselves, requiring specific capabilities that firms need to be successful at their innovative activities (see also Dosi, 1988). Yet, our results will provide a limited view on any differences across industries because one could also include other kinds of determinants, like product and market characteristics.

Table 2 makes clear that all innovative practices were measured with dichotomous questions. First, a *managerial focus* to innovation is regarded to be a key factor in realizing product innovations (Hoffman et al., 1998; Hadjimanolis, 2000). Managers of

small firms have a larger direct influence on employees compared to managers of large organizations. Davenport and Bibby (1999) speak of the 'entrepreneurial dynamism', which leaders in small firms can instil in the behaviours of others in the organization. Leaders in small firms who pay strategic attention to innovation can act as the main catalysts for change. Continuous attention for innovative opportunities and providing employees with support for innovative behaviour is expected to result in better innovative outcomes such as new product introductions. Second, renewal efforts that are scheduled in a documented strategy are more likely to lead to innovation outputs (Hadjimanolis, 2000). The presence of a *documented innovation plan* implies that explicit ambitions, targets and milestones are defined that may pave the road. We expect firms that have explicitly formulated and documented renewal activities will enhance product innovation results. Third, the *use of external networks* to extend a firm's knowledge base has frequently been related to successful innovation (*e.g.* Rothwell, 1977, 1991; Hoffman et al., 1998; Romijn and Albaladejo, 2002; Freel, 2003). An external network (consisting of relations with universities, suppliers and knowledge institutes) increases the innovative ability of a firm. Empirical evidence demonstrates that small firms that are aware of this and use external information perform significantly better, although it has been argued that using external networks alone without investing in internal factors will not lead to better innovative performance (Oerlemans et al., 1998; Freel, 2003). Fourth, relevant external information does not only come from suppliers or competitors, but also from customers. *Market research* may be a relevant innovative activity because it enables firms to better understand customer needs (Kim et al., 1993; Hadjimanolis, 2000). In this context, based on a research involving 500 small firms, Appiah-Adu and Singh (1998) discovered a strong positive link between innovation and customer orientation, implying that small firms should use customer-based knowledge to develop innovative products and services through a customer-pull approach. Fifth, *inter-firm co-*

operation may ease product innovation in small firms for a variety of reasons. The most dominant ones includes a lack of resources and a spread of risk. Complementary knowledge may be another reason to co-operate in innovation processes (see also Brouwer and Kleinknecht, 1996; Hadjimanolis, 2000; Hanna and Walsh, 2002; Tether, 2002). Sixth, nowadays innovation in small firms is regarded to be a collaborative effort that needs the *involvement of frontline employees.* Those who are in sales and service delivery have the best view on unsatisfied needs of customers and new initiatives of competitors (Martin and Horne, 1995; Hyvärinen, 1990). Frontline employees should be involved and empowered to occupy themselves with innovative behaviour (Davenport and Bibby, 1999). Seventh, in addition to involvement the knowledge and skills of employees are often seen as a pre-condition for highly innovative performance (*e.g.,* Roper, 1997; Hoffman et al., 1998). The presence of formal *education and/or training* programs to keep up the knowledge and skill level may enhance product innovation in small firms (Romijn and Albaladejo, 2002).

Another limitation of our data was that, due to their simplicity, our measures impede a subtle view on the connection between the innovative practices and product innovation. Yet, the data do enable a thorough analysis of variations across industries and thus are feasible for the purpose of this paper: assessing the presence of any variations across industries. Besides, simple questions are not undecidedly disadvantageous. Since respondents are asked for actual facts a better reliability and decreased risk of common-method variance may be expected. Besides, simple questions generally result in better response rates (see also Churchill, 1999).

To measure product innovation we had two indicators at our disposal. As table 1 indicates both were related to recent introductions of new products (including services). New product introduction is the short-term goal of every product innovation process (Wakasugi and Koyata, 1997; Romijn and Albaladejo, 2002). Europe‘s Community Innovation Survey in fact employs the same indicators to identify innovative firms (see

novation Survey in fact employs the same indicators to identify innovative firms (see OECD, 1997). The first indicator provides a broad measure of product innovation because it includes minor product improvements or mere competitor imitation. The second indicator excludes such improvements by focussing on new product introductions that were new to the industry. One should realise that its degree of novelty is still limited and certainly not indicative of so-called radical innovations. In the bulk of mature industries one would expect that product introductions 'new to the industry' would still build closely upon the firm's current competences and assets (Freel, 2003).

In addition, the analysis reported later on incorporated two control variables: age (measured in years) and firm size (full-time equivalents employees). One may reasonably suggest that younger firms are less likely to have established routines, technologies and products. For younger firms one may expect positive answers to the product innovation indicators by default whilst answers for some innovative practices might be biased towards 'no' (*e.g.*, formal training and education programs). With regards to size, the evidence is decidedly equivocal. Small firms react more quickly to changing market requirements than large firms. Their size makes them more internally flexible because they are free of the bureaucratic inertial forces that plague larger firms. On the other hand, large firms generally enjoy resource advantages and have better opportunities to spread risks (Vossen, 1999).

The data on our variables were collected at two points in time. In January 2001 a survey was performed that asked respondents for the seven innovative practices. Another survey that was executed in January 2003 recorded new product introductions by the sample firms. Thus our data accounted for a potential time lag between innovative practices and new product introductions. Age and firm size were recorded at both points in time, but for the present analysis we have used figures from January 2001.

Both surveys were performed by means of computer assisted telephone interviewing (CATI). All respondents were managers responsible for day-to-day business processes – usually the entrepreneur, and otherwise a general manager. In both surveys a contact person was attempted five times before he/she was marked as a non-respondent. Since all respondents are members of a panel, high response rates were reached. Eventually, 1250 respondents provided data at both points in time (the first survey had 1381 respondents out of 1782 panel members, for the second survey this was 1354 out of 1776). Table 3 shows how these respondents are distributed across various industries, size and age classes.

[TABLE 3 ABOUT HERE]

The sample makes a distinction between seven types of industries: manufacturing, construction, wholesale and transport, retail services, hotel and catering services, knowledge-intensive services (like consultants, researchers and engineers) and financial services. The response appeared to resemble with the distribution of the panel firms on all variables (industry, age and size class). Chi-square tests revealed no significant differences between both distributions at the 5% level.

One should remind that in order to enable comparisons the SME Policy Panel is stratified in such a way as to under- and over-represent particular types of firms. For instance, the smallest firms (0 to 9 employees) are under-represented. Like in all developed countries, more than 90% of the business population in the Netherlands belongs to this group (Bangma and Peeters, 2003). Another example includes under-representation of knowledge-intensive and financial services to enable comparisons across industries. Undoubtedly, these deliberate skews impact upon the 'representativeness' of the current sample. The chief consequence is that the descriptive statistics presented later on pro-

vide no reliable estimate of population figures. However, because we use age and firm size as control variables in all analyses and compare across industries, it is not anticipated that the stratified sample will impact upon our results.

4. Results

Correlations and means of all variables are shown in table 4. Except for age, all variables showed a significant positive bivariate correlation with both measures of product innovation. Besides, all pairs of innovative practices appeared to be positively related to each other, but there values did not indicate that any problems with regard to multicollinearity could be expected (results of some tests on multicollinearity are presented later on).

[TABLE 4 ABOUT HERE]

Our analysis consisted of two steps. Our first goal was to determine if the (firm-level) innovative practices were identifiable in small firms, and whether or not differences exist between various industries. Next, we addressed the question of any differences in their impact on product innovation.

Table 5 presents percentages for each of the innovative practices and both measures for product innovation across the seven industries in our sample.

[TABLE 5 ABOUT HERE]

Looking at the total sample of firms, each of the innovative practices can be identified in at least 35% of the sample, confirming that the practices are regarded as meaningful by a significant amount of respondents. With regard to the measures for product innova-

tion, recent product introductions appear to be quite common, even when they are limited to new-to-the-industry introductions (21% of the sample).

An interesting result relates to variations across industries. Using the analysis of covariance ('unianova') procedure in SPSS, we have tested for any significant differences between the seven industries in our sample. To filter out the effects of age and firm size, these control variables were entered into the analysis as covariates. The F-values in the rightmost column of table 5 indicate significant differences across industries on all variables. An analysis of contrasts (as recommended by Hair *et al.*, 1998, p. 357) revealed that compared to the other sectors firms from manufacturing, knowledge-intensive and financial services were doing significantly better on most variables (no output shown here). Indeed, visual inspection of the percentages in table 4 confirms this. Firms from manufacturing, knowledge-intensive services and financial services had more new product introductions in the past two years, also when a limitation is made towards new-to-the-industry introductions. In knowledge-intensive services such introductions are most common. Similar variations are found when the percentages on the innovative practices are interpreted. An exception includes employee training. We found an F-value that was only marginally significant. The presence of formal programs for training and educations seemed most common in knowledge-intensive and financial service firms. Here we must stress that for this particular variable our results may be biased. In many Dutch industries the provision of training is obliged due to collective employment contracts with labour unions (*e.g.*, construction, manufacturing).

The variations across industries are in line with previous theory on patterns across industries of the sources, pace and rate of innovation. An interesting result includes that large variations can exist among the various services sectors in our sample, indicating that it would make no sense to treat the service industry as being uniform when studying innovation. For example, we found that retail firms and hotel and cater-

ing services introduce new products less often. The same applies to their use of the innovative practices. This is in line with authors like Evangelista (2000) and Miozzo and Soete (2001) who postulate such firms as being 'supplier-dominated' innovators, merely being passive recipients of innovations which are developed by others (*e.g.*, by manufacturing firms). Likewise, we found that financial services score much better than average, even after controlling for age and firm size. Financial services are regarded to be a 'production-intensive' service sector where considerations of scale advantages and efficiency play a key role in innovation decisions (Miozzo and Soete, 2001). Here, innovative practices tend to be formalized more often. This would explain the high scores on variables like documented innovation plans, inter-firm co-operation, formal market research, and training and education programs.

After we had established that small firms differ in the extent to which they use innovative practices to their advantage, our next goal was to explore if the determinants were uniform across industries. If not, composite effects may blur our view of the key drivers of product innovation. In investigating the extent to which innovative practices are positively associated with the indicators for product innovation, the current paper followed the established practice of modelling innovation output using a linear regression equation, assuming that innovation output depends on the presence and volume of innovative practices (*e.g.,* Freel, 2003; Hadjimanolis, 2000). To determine the effects of the innovative activities we estimated a number of binary logistic regression models. This is a suitable analysis technique for causal analysis with dichotomous dependent variables (Hair *et al.,* 1998). Although there are significant correlations between all pairs, our predictor variables were sufficiently distinct to enable them to be used separately in the analysis. Correlations ranged from 0.01 (between age and the use of networks) to 0.51 (between managerial focus and the involvement of frontline employees) None shares more than 30% of the variance with any other, and most much less. Be-

sides, computation of variance inflation factors (VIFs) revealed values that never exceeded a 2.1 value. These are all far lower than the recommended cut-off of 10.0 (Hair *et al.,* 1998).

We have estimated various binary logistic regression models of product introductions new to the firm. The first one was calculated for our total sample. After that, to see if any composite effects were present and to make comparisons, we estimated seven models for the industries in our sample. Table 6 presents the results.

[TABLE 6 ABOUT HERE]

All models appeared to fit well with the data for small firms in general and the various industries in particular. Looking at the fit statistics, Δ -2 log likelihood (which can be compared with the F-statistic in regression analysis) indicates a statistically significant contribution of our predictors ($p<0.01$). Nagelkerke's pseudo R-square ranges from 0.27 for retail services to 0.59 for knowledge-intensive service firms, suggesting that the independent variables together explain a reasonable amount of the variation between firms with and without recent product innovations. Altogether, for our total sample and the seven industries in particular, innovative activities seem to trigger an increase in the introduction of products new to the firm.

The parameter estimates b indicate the likelihood that a firm has recent new product introductions. For the total sample, significant contributions emerge from most innovative practices and both control variables. For age we found our hypothesized effect of a negative connection ($b=-0.01$, $p<0.10$). Firm size appeared to be positively related to new product introductions ($b=0.01$, $p<0.05$). This might just be the consequence of the fact that larger firms usually have broader product offerings, so that product innovation is more common. More important was that in line with previous research all

innovative practices made a significant contribution to new product introductions, with the exception of the presence of formal training and/or education programs. If fact, this practice never made a significant contribution, also when the analysis was performed across separate industries. It may caused by the fact that our measure relates to the funding of programs to raise the *general* skill level of employees. We might have found other results if we had data on education/training related to product innovation more directly (*e.g.,* project management).

Our most interesting finding is that the various models confirm our suspicion of the determinants of product innovation being different across industries. For instance, a managerial focus on innovation was significantly connected to new-to-the firm products in five out of seven sectors, but not in manufacturing and financial service firms. In such highly innovative firms a managerial focus towards innovation might be given and thus be no discriminating practice. With the exception of training and education programs, all innovative practices had significant regression coefficients in only a subset of the industries we have investigated. In the next section we will elaborate on the implications of these findings.

To test if our results would differ with an alternative indicator for product innovation, we have repeated our causal analyses for new-to-the-industry product introductions. By using this indicator as the dependent variable, we in fact tested the impact of the innovative practices using a more narrow definition of product innovation (excluding adoption and mere competitor imitations). Estimation of these models again takes the form of eight binary logistic regression equations and is shown in table 7.

[TABLE 7 ABOUT HERE]

The binary logistic regression models again had satisfactory properties. The significance of Δ -2 log likelihood (all p's < 0.01) and the values of Nagelkerke's pseudo R-square (ranging from 0.19 up till 0.51) revealed a good fit, indicating that the innovative practices increase the likelihood of product introductions new to the industry. Like in table 6, with the exception of training and education all innovative practices had a significant impact in the total sample of firms. Again, major variations across industries were revealed that were pretty much in line with our earlier findings.

5. Conclusions and implications

This paper explored if major differences arise when the determinants of product innovations in small firms are compared across industries. Although determinants of product innovation in small firms are well documented, differences across industries are still under-researched.

Drawing upon a database that contained information on new product introductions and firm-level innovative practices of 1250 small firms, we made a comparison across seven industries (manufacturing, construction, wholesale and transport, retail, hotel and catering, knowledge-intensive service and financial service firms). First, after controlling for variations in the age and size of firms, some major differences across industries remained in the extent to which firms use innovative practices and introduce new products. This result is in line with Cefis and Orsenigo (2001) who studied the persistence of innovative activities across industries and also found major differences. As a rule-of-thumb firms from manufacturing, knowledge-intensive services and financial service industries scored better on most innovative practices and realised new product introductions more often compared to firms from construction, wholesale and transport, retail services and hotel and catering services. Second, using two different indicators for product innovation, our sample revealed similar key determinants are found as in previous research, but after a de-composition across industries their significance appeared to

differ. This result is fairly important, since it suggests that many of the previous studies that investigated broad samples of firms are likely to be flawed, while studies that focused on a specific sector cannot be generalized. Another implication is that – since large variations were present across the various services sectors in our sample - it would make no sense to treat the service industry as being uniform when studying (the determinants of) product innovation.

Although managers in small firms may regard new product development as something that just 'happens', for each industry we found a number of firm-level activities that seem to trigger product innovation. It can be achieved by spending more resources on specific key activities that can empirically be connected to new product introductions. Bearing in mind that our data are far from complete (since many important determinants of product innovation are missing) we will next elaborate on the implications.

In manufacturing, the presence of documented innovation plans and inter-firm co-operation appeared to be significant drivers of product introductions irrespective of whether they were new-to-the-firm or new-to-the-industry. Among manufacturers product innovations are usually developed in formal projects (Urban and Hauser, 1993), thus, the impact of formal planning as a success factor may not be surprising. Besides, innovation in manufacturing usually deals with physical products and processes that require financial investments. Co-operation may be the solution to gain such resources. Also, managerial focus appeared to be a marginally significant determinant for new-to-the-industry product introductions (see table 6, $p<0.10$). Due to the comparatively discontinuous nature of such innovations, management support might be more important here. Finally, market research was a driver of new-to-the-firm product introductions. Doing research into customers' unsatisfied needs and evaluations of current offerings seems to be key for such types of incremental product introductions.

In construction, a managerial focus to innovation is significantly related to both types of new product introductions. The same applies to performing market research and the use of external networks. In the Dutch construction industry, most projects are put out to tender by governments and project developers, and quite often they are governed by public procurement procedures. In this context it may be vital to be optimally informed about customer's needs, and both market research and the use of (mainly informal) networks can provide such valuable insights. Another well-interpretable result for construction firms was that co-operation with other firms appeared to make a difference for new-to-the-industry product introductions (see table 6, $b=1.32$, $p<0.01$). In the Dutch construction industry it is common for any revolutionary product (*e.g.*, building, bridge) to be developed in close consultation with customers (governments, project developers) and other contractors (*e.g.*, engineers, architects).

In wholesale and transport firms, market research and inter-firm co-operation proved to be significantly related to both indicators of product innovation. Moreover, managerial focus and the use of networks were significantly related to new-to-the-firm product introductions (see table 6). The impact of co-operation and the use of networks may be enhanced by the position of wholesale and transport firms in the value chain: as an intermediary between retail service providers and manufacturers successful new products may require such interactive processes.

In current literature retail firms are believed to be supplier-dominated firms with a focus on the adoption of other's discoveries. They are not expected to develop many innovations on their own (*e.g.,* Miozzo and Soete, 2001). In this context it is well interpretable that key determinants include managerial focus (retail managers who continuously seek for innovation and provide support gain better results), the use of external networks (including suppliers as sources of innovation), inter-firm co-operation (with suppliers to implement new products) and the involvement of frontline employees (de-

livery of most retail services is characterised by frequent, interactive contacts with customers, thus frontline employees are inevitable to make any new product successful). An interesting result was that the determinants of new-to-the-industry product introductions were somewhat different (see table 7). The involvement of frontline employees and managerial focus were still significant ($p<0.10$). Doing market research among customers proved to be another key factor ($b=1.46$, $p<0.01$). This latter result may indicate that in retail stores new-to-the-industry products are not delivered by suppliers, but instead ask for a more pro-active attitude of entrepreneurs/decision makers by being continuously focused on innovation and exploring unsatisfied needs of customers.

For hotel and catering services, managerial focus and the involvement of frontline employees appeared to be determinants of new-to-the-firm products, while managerial focus was the sole driver of new-to-the-industry product introductions (see table 7, $b=1.95$, $p<0.10$). Here, our reasoning is similar to that of retail services. Hotel and catering services are often mentioned as supplier-dominated sectors not worthy of the qualification 'innovative'. In such an environment it is well interpretable that managerial focus makes a difference in the realisation of product innovations. Likewise, since a high-quality delivery of products draws heavily on the involvement of frontline employees, we can suspect this applies to new products as well. In this context we found it somewhat unsatisfying that two practices related to opportunity exploration (market research and the use of networks) did not appear to be significant.

In knowledge-intensive services, the introduction of new products first and foremost depends on managerial focus and market research, irrespective of the degree of newness of the product. The involvement of frontline employees was a driver for new-to-the-firm products only. For long-term survival, knowledge-intensive service firms directly depend on their co-workers' knowledge and individual innovative behaviour, and their ability to maintain steady relationships with a limited number of custom-

ers (Den Hertog, 2000). Like retail services and hotel and catering services they basically provide 'high contact' products, and involving them in idea generation and the implementation of innovations seemed to make a difference. For new-to-the-industry product innovations no significant impact of employee involvement was found. We suspect the role of employees may be less pronounced here because such (discontinuous) innovations may often be initiated and implemented by the managing partners of the firm. Another counterintuitive result included that we found no effect of the use of networks. External networks are undoubtedly important in knowledge-intensive services (table 5 ranked knowledge-intensive service firms first on this practice) but it did not appear to be a factor that increases the likelihood of new product introductions. For innovative firms in this sector to extent to which they use external networks might be stable and given.

In financial services, significant factors for new-to-the-firm products were the presence of documented innovation plans ($p<0.01$), the use of networks ($p<0.10$) and doing market research ($p<0.01$). In financial services product innovation is a well-known phenomenon that is often accompanied by process innovation (Vermeulen, 2001). This implies that introducing new products must be planned for more carefully (resulting in documented innovation plans). Market research is a common practice among financial service providers to streamline new product offerings to customer's wishes (Vermeulen, 2001). Finally, networks are maintained for reasons of opportunity exploration. Past examples include the electronic wallet and electronic eye recognition. These technological inventions were picked from technical universities and knowledge-institutes and now (start to) find their applications in the financial sector.

6. Limitations and suggestions for future research

Our main suggestion for future research is rather straightforward. Since our analyses revealed that composite effects could cloud one's image of significant product innovation boosting activities, future research should investigate variations across industries in much more detail.

Of course, our research had some important limitations that should be accounted for in future studies. Because we were confined to a database that contained information on just seven firm-level innovative practices, the practical applicability of our results is limited. When other variables would be included into the regression equations, our view of the drivers of product innovation could become quite different. Future studies should investigate the full range of determinants by also including product, market and innovation process characteristics.

Another limitation was that our measures were rather simple. We only had some dichotomous questions at our disposal and these do not capture much of the depth of the phenomena investigated. While the benefit of yes/no measures is clear in terms of low bias and efficiency, these measures miss some of the complexity involved in our firm-level determinants.

Forthcoming research should also attempt to include other indicators for product innovation. Although Europe's Community Innovation Survey uses the same indicators to identify product innovation (see OECD, 1997), both indicators do not capture how successful the introductions have actually been. The modus operandi of assessing product innovation is one that surely needs improvement. A measure suggested by Brouwer (1997), the turnover share of new products, is less suitable for small firms due to data availability restrictions. Future research should be carried out to find measures of product innovation than can be applied to broad samples of firms. An idea might be to use subjective measures by means of multiple-item scales.

Finally, future research should attempt to validate our findings using a different research design. We have collected all data from a single source (owners/managers). Although the time lag of two years in the data collection process ruled out most of the risk on common method variance, obtaining information from multiple sources (for example by surveying employees and/or customers) is preferable.

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Tables

Table 1. An overview of studies into the determinants of product innovation in SMEs

Reference (1)	*Determinants investigated (2)*	*Sample (3)*	*Comparison made? (4)*
Acs and Audretsch (1988, 1990)	R&D expenditures, capital intensity, employee-union membership, four-firm concentration ration, advertising expenditures, skilled labour, large-firm industry employment, value-of-shipments	247 manufacturing firms	Yes (large vs. small firms and highly innovative vs. innovative industries)
Hyvärinen (1990)	Personnel participation, inventions, science, different technologies, information, outside know-how, timetables, life cycles, internal know-how, ideas, financial input, motivation, attitudes, working hours, education, strategy, competition, cooperation between departments, economical support, infrastructure, political input, branch, market, competition, hostility, location, interest groups	Conceptual	No
Kim et al. (1993)	Environment (dynamism, complexity), Strategy (scanning, internal control, R&D intensity, external technology linkages), Structure (formalization, centralization, professionalisation, administrative intensity), Top management characteristics (internal locus of control, risk taking propensity, tolerance for ambiguity)	49 manufacturing firms	Yes (innovative vs non-innovative firms)
Brouwer and Kleinknecht (1996)	R&D intensity, sales growth, SME presence, employees, R&D function, dependence on mother company, R&D focus, consultation of innovation center, sector, location, external knowledge, collaboration.	2110 (observations) manufacturing and service firms	No
Roper (1997)	Workforce qualification and utilization, in-house R&D capability, network factors	3629 manufacturing firms	Yes (innovative vs. non-innovative)
Oerlemans et al. (1998)	Transaction, transformation, public knowledge infrastructure, private knowledge infrastructure, production column, intermediaries, technology policy	579 manufacturing firms	Yes (supplier-dominated, scale-intensive, specialized suppliers, science-based firms)
Hoffman et al. (1998)	Qualified scientists & engineers, owner/manager leadership (and education), nature of commercialization and marketing efforts, degree of marketing involvement, macro-economics conditions, finance, external linkages	Conceptual	No
Hadjimanolis (2000)	Owner characteristics (age, education, prior experience, cosmopolitanism), SME characteristics (size, age, sales turnover, existence of written strategy, degree of internationalization, R&D expenditure, employment of scientists and engineers, environmental scanning, cooperation with technology providers), Environmental factors (intensity of competition, environmental change, importance of external barriers, level of networking)	140 manufacturing firms	No
Bougrain and Haudeville (2002)	Industrial cooperation (sector of production, technical partners, linkages to external resources), R&D intensity, number of executives, existence of design office	247 firms	No
Romijn and	Professional background of founder, skills of	33 software and	No

Albaladejo (2002)	workforce, internal efforts to improve technology (including R&D expenditures, training, licenses bought), intensity of networking, proximity advantages, institutional support	electronic firms	
Freel (2003)	Networking, R&D expenditure, Skill level of employees	597 manufacturing firms	Yes (supplier-dominated, production-intensive, science-based firms)
Rogers (2004)	Employment, age, profit margin, training intensity, management training, foreign-ownership, employee union-membership, business comparison, networking, export activity, R&D activity, R&D intensity in industry, patent intensity in industry, market share, 4-firm concentration ratio	4314 firms	Yes (manufacturing vs. non-manufacturing firms)
Bhattacharya and Bloch (2004)	Size, profit, growth, R&D expenditure, R&D intensity, 4-firm concentration ration, export and import	1213 manufacturing business units	Yes (low tech vs. high tech)

Table 2. Variables used in the analysis

Indicators for product innovation	
(1) Recent product introductions (new to the firm)	Proxy for product innovation; firm introduced at least one product new to the firm 'during the last 2 years'; coded 1, otherwise, coded 0
(2) Recent product introductions (new to the industry)	Proxy for product innovation; firm introduced at least one product new to the industry 'during the last 2 years'; coded 1, otherwise, coded 0
Innovative practices	
(3) Managerial focus	The firm had an owner/manager was continuously seeking for and providing support to innovative opportunities; coded 1, otherwise, coded 0
(4) Documented innovation plans	The firm had a formally documented plan describing the firm's renewal ambitions, targets and milestones; coded 1, otherwise, coded 0
(5) Use of external networks	The firm kept up regular contacts with an external network of universities, suppliers and/or knowledge institutes to extent its knowledge base; coded 1, otherwise, coded 0
(6) Market research	The firm performed market research among customers to explore innovative opportunities; coded 1, otherwise, coded 0
(7) Inter-firm co-operation	The firm formally co-operated with other firms or institutes to initiate or develop any renewal activities (evidenced by a formal agreement); coded 1, otherwise, coded 0
(8) Involvement of frontline employees	The firm actively involved frontline employees (other than the owners/managers) in idea generation and the implementation of innovations; coded 1, otherwise, coded 0
(9) Training and education programs	The firm was funding a program for employee training/education to raise their skill level; coded 1, otherwise, coded 0
Control variables	
(10) Age	Age of the firm in number of years
(11) Size	Size of the firm in full-time equivalents employees

Table 3. Distribution of sample firms across industries, size and age classes (n=1250)

	Number of firms	Frequency
Industry		
- manufacturing	178	14%
- construction	206	16%
- wholesale and transport	261	21%
- retail	228	18%
- hotel and catering	190	15%
- knowledge-intensive services	101	8%
- financial services	86	7%
	1250	100%
Age (number of years)		
- 0 to 4	133	11%
- 5 to 9	203	16%
- 10 to 19	307	25%
- 20 to 49	340	27%
- 50 and above	267	21%
	1250	100%
Size (full-time equivalent employees)		
- 0 to 9	394	32%
- 10 to 19	201	16%
- 20 to 49	240	19%
- 50 to 99	313	25%
- 100 to 499	102	8%
	1250	100%

Table 4. Means, standard deviations and correlations between variables (n=1250)

		Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	Recent product introductions (new to firm)	0.41	0.49										
(2)	Recent product introductions (new to industry)	0.21	0.40	0.58**									
(3)	Managerial focus	0.70	0.46	0.37**	0.26**								
(4)	Documented innovation plans	0.43	0.50	0.32**	0.27**	0.48**							
(5)	Use of external networks	0.55	0.50	0.31**	0.22**	0.29**	0.32**						
(6)	Market research	0.35	0.48	0.33**	0.28**	0.26**	0.28**	0.24**					
(7)	Inter-firm co-operation	0.46	0.50	0.32**	0.27**	0.32**	0.33**	0.40**	0.31**				
(8)	Involvement of frontline employees	0.69	0.46	0.35**	0.24**	0.51**	0.37**	0.35**	0.24**	0.40**			
(9)	Training and education programs	0.67	0.47	0.15**	0.12**	0.25**	0.29**	0.25**	0.24**	0.21**	0.27**		
(10)	Age	29.83	28.91	0.02	0.02	0.05*	0.05^	0.01	0.21**	0.03	0.08**	0.14**	
(11)	Size	39.64	51.06	0.21**	0.20**	0.21**	0.35**	0.19**	0.28**	0.20**	0.19**	0.28**	0.14**

** $p < 0.01$, * $p < 0.05$, ^ $p < 0.10$ (one-tailed)

Table 5. Presence of new product introductions and innovative practices across industries

	Total sample	Manufacturing	Construction	Wholesale and trans-port	Retail	Hotel and cater-ing	Knowledge-intensive services	Financial services	F-value
Recent product introductions									
-New to the firm	41%	59%	27%	38%	32%	37%	55%	62%	12.1**
-New to the industry	21%	34%	16%	13%	17%	13%	40%	31%	11.5**
Innovative practices									
-Managerial focus	70%	83%	62%	70%	64%	64%	80%	84%	6.1**
-Documented innovation plans	43%	62%	39%	44%	27%	28%	57%	73%	15.9**
-Use of external networks	55%	60%	45%	54%	50%	50%	73%	71%	5.4**
-Market research	35%	43%	32%	28%	31%	31%	33%	67%	4.8**
-Inter-firm co-operation	46%	56%	36%	47%	41%	37%	61%	57%	6.0**
-Involvement of frontline employees	69%	79%	56%	70%	60%	71%	78%	80%	7.1**
-Training and education programs	67%	64%	66%	66%	62%	64%	78%	88%	2.7*
n	1250	178	206	261	228	190	101	86	

** $p < 0.01$, * $p < 0.05$, ^ $p < 0.10$

Table 6. Binary logistic regressions of product introductions new to the firm

	Total sample	Manufacturing	Construction	Wholesale and transport	Retail	Hotel and catering	Knowledge-intensive services	Financial services
Parameter estimates (b):								
-Age	-0.01^	-0.02*	-0.01	-0.01	-0.01	0.00	-0.03	0.00
-Size	0.01*	0.02*	0.01	0.00	0.00	0.00	0.00	0.00
-Managerial focus	1.10**	0.18	2.15**	1.19*	1.26**	1.21**	2.60**	-0.20
-Documented innovation plans	0.26^	0.96*	-0.06	-0.20	-0.40	0.13	-0.22	3.11**
-Use of external networks	0.63**	0.15	0.93*	0.88**	0.91*	0.11	0.91	1.21^
-Market research	0.90**	0.88*	1.08*	1.08**	0.26	0.59	1.85*	2.13**
-Inter-firm co-operation	0.42**	0.98*	0.64	0.62^	0.65^	-0.13	0.81	-0.12
-Involvement of frontline employees	0.82**	0.34	0.75	0.62	0.89*	0.88^	3.02*	-1.80
-Training and education programs	-0.22	-0.16	-0.39	-0.44	-0.47	0.55	-0.16	0.75
Intercept	-2.69**	-1.51**	-4.03**	-2.51**	-2.49**	-2.86**	-5.68**	-2.79*
Model fit:								
-Nagelkerke R^2	0.34	0.38	0.46	0.31	0.27	0.28	0.59	0.53
- Δ-2 log likeihood	1328**	182**	162**	278**	236**	206**	80**	72**
n	1250	178	206	261	228	190	101	86

** $p < 0.01$, * $p < 0.05$, ^ $p < 0.10$

Table 7. Binary logistic regressions of product introductions new to the industry

	Total sample	Manufacturing	Construction	Wholesale and transport	Retail	Hotel and catering	Knowledge-intensive services	Financial services
Parameter estimates (b):								
-Age	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.01
-Size	0.01*	0.01	0.00	0.00	0.00	0.01	0.00	0.00
-Managerial focus	1.06**	1.96^	2.53*	0.40	0.88^	1.95^	2.12^	-0.62
-Documented innovation plans	0.40*	1.02*	-0.04	-0.07	0.35	-0.42	0.04	3.54*
-Use of external networks	0.36*	-0.24	1.06^	0.39	0.43	0.58	0.18	0.59
-Market research	0.85**	0.07	1.29*	1.22**	1.46**	0.15	1.65**	0.96
-Inter-firm co-operation	0.60**	0.89*	1.32*	0.77^	0.02	0.85	0.83	-0.35
-Involvement of frontline employees	0.61*	-0.33	0.62	0.75	0.93^	0.64	2.03	-0.99
-Training and education programs	-0.19	0.18	-1.11	-0.40	-0.56	0.82	0.71	-1.67
Intercept	-3.80**	-3.60**	-5.39**	-3.62**	-3.11**	-5.77**	-2.40**	-2.37^
Model fit:								
-Nagelkerke R^2	0.25	0.25	0.42	0.19	0.25	0.28	0.51	0.32
- Δ -2 log likeihood	1052**	193**	120**	177**	172**	114**	88**	85**
n	1250	178	206	261	228	190	101	86

** $p < 0.01$, * $p < 0.05$, ^ $p < 0.10$