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Formal and informal external linkages and firms' innovative strategies. A cross-country comparison

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Abstract

Firms increasingly rely upon external actors for their innovation process. Interaction with these actors may occur formally (i.e. through a collaboration agreement) or informally (i.e. external actors acts as sources of knowledge). This paper analyses the reasons why firms consider it to be important to develop formal and informal external linkages in the innovation process by looking at the role played by firms' innovative strategies and by taking into account that a complementarity or substitutive relationship might exist between formal and informal linkages. Data come from the Third Community Innovation Survey (CIS 3), where we have access to firm level micro-data from Norway, Sweden, the Netherlands and the UK.

Keywords: External knowledge sources, Innovation strategy, Formal cooperation, Multinomial Probit

JEL codes: O31, O33, O38

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1. Introduction

Recent empirical and theoretical contributions in the literature on innovation have highlighted the importance of external linkages to improve the innovation potential of firms (Chesborough, 2003). In particular, these analyses have highlighted the presence of a positive relationship between the extent of reliance upon external linkages and firm performance (Laursen and Salter, 2006). Empirical research on this issue has either looked at the role of formal linkages such as technological agreements and R&D joint ventures (Freeman, 1991; Hagedoorn, 2002) or at the role of specific actors in the process of innovation such as suppliers, customers (von Hippel, 1988), and universities (Cohen *et al.*, 2002; Laursen and Salter, 2004). A shortcoming in this literature is that knowledge sources have been examined in isolation from one another, which provides a rather simple view of the innovation process. The importance of some knowledge sources may also have been overestimated when they have been examined in isolation from other sources of knowledge. A better understanding of the role of external linkages in the innovation process should therefore result from taking into account that firms may simultaneously use several actors and knowledge sources as 'inputs' to the innovation process. This perspective opens up the possibility that complementarity or substitution relationships exist between different knowledge inputs. Moreover, a significant relation between reliance on external information flows and the decision to engage in formal cooperative R&D agreements seems to exist (Cassiman and Veugelers, 2002). Thus, the study of the role of external linkages on innovation development seems to require the overview of the several possible types of interactions, both formal and informal.

Previous research has also highlighted how firms' reliance upon external linkages depends on internal research capabilities as well as on innovative investments (Cabagnols and Le Bas, 2002; Laursen and Salter, 2004). However, there is little evidence on whether and how such reliance is specific to certain institutional settings (i.e., comparable across industries and countries), as well as on whether firms' innovation strategies (i.e., doing product or process innovation) affect their use of specific linkages. Indeed, on the one hand, the literature on both national (Nelson, 1993) and sectoral (Malerba, 2004) systems of innovation stresses that the institutional context shapes the pattern of innovation of firms. On the other hand, recent contributions (Srholec and Verspagen, 2008) suggest that significant differences exist with regard to innovative strategies of firms. Finally, little is also known on whether

firms use informal linkages from different sources in certain combination (i.e. bundles) for obtaining a specific innovative outcome as well as on whether firms can substitute missing sources and knowledge.

In this paper we investigate the determinants of firms' reliance on two types of external linkages: informal linkages (i.e. when actors are a source of information for innovation) and formal linkages (i.e. when actors are formal partners in R&D projects). An important part of our analysis is to look at whether specific innovation strategies are more or less conducive to access to specific sources of knowledge. Moreover, we analyse whether and how specific innovation strategies are associated to the presence of formal interactions with specific external partners. The paper also explores to what extent reliance upon formal and informal linkages is consistent across countries and industries. To what extent do national differences in the institutional and economic structures lead to systematic differences in the use of external partners both as sources of information for innovation and as partners for collaboration? Our paper sheds empirical light over this issue. By considering several countries with different institutional organisations and market structures, we examine whether systematic differences exist and why. Very few cross-country comparative studies exist on this topic.

To analyse these issues, we rely on data from the CIS 3. The sample consists of firms that have innovated during the period 1998-2000 in four European countries: the Netherlands, Norway, Sweden and the UK. We consider the impact of the innovative strategies of firms on their reliance on external actors (i.e. other enterprises of the group, suppliers, customers, competitors, universities, governmental institutes) as sources of information for innovation and as partners for innovation development. To account for the possibility that firms rely simultaneously upon several partnerships and knowledge sources as 'inputs' to the innovation process, a Multivariate Probit analysis (Galia and Legros, 2004) is carried out for each country separately, and then compared. The paper shows that firms with different innovative strategies rely upon different portfolios of formal or informal sources of knowledge. Moreover, we find that reliance on different formal and informal knowledge sources varies across countries and industries, consistent with the view that national and industrial contexts shape the uses of knowledge sources and formal co-operations by firms.

The paper is organised as follow. Section 2 reviews the literature on the role of formal and informal linkages for the firms' innovative activities. In Section 3, we describe the data and the methodology. Section 4 presents the results. Section 5 discusses the main findings and concludes this study.

2. Background literature

Innovative activity does not take place in a business world where firms are isolated from each other and other organizations such as universities and suppliers. Institutional and technological contexts shape the organisational context in which innovation and technical change occur (Whitely, 2000). Indeed, industrial innovation can be understood as a process that involves search for information and interaction with both market based actors (i.e. customers, suppliers, competitors) and research institutions (i.e. universities and government) (Etzkowitz, 1998; Salter and Martin, 2001). These interactions may be the consequence of formal alliances and/or cooperation agreements or they may occur in a more informal way. In both cases, they usually entail some form of knowledge and/or information exchange between the partners involved. Knowledge acquired from either informal or formal external linkages differs on the form of access as well as on the content being transferred (Swann, 2002; Monjon and Waelbroeck, 2003). In particular, the use of informal sources of knowledge seems associated with the internal capabilities of firms to access and absorb the knowledge produced by other market or research actors more or less immediately. Instead, the knowledge derived from formal collaborations seems associated with the use of ideas and developments that result from the access to infrastructures, human capital, and innovative capabilities of partners. Finally, the existing literature has highlighted that formal and informal linkages seem to be very closely connected. In particular, the intensive use of external sources of knowledge seems to enhance cooperation, especially with public research organisations (Cassiman and Veugelers, 2002; Van Beers *et al.*, 2008) or with external actors that are already considered to be an important source of knowledge for innovation (Belderbos *et al.*, 2004).

Besides the distinction between formal and informal external linkages, another important aspect is the issue of the specific role of the external sources of knowledge for the specific type of innovation. Traditionally, the capability to translate external inputs of knowledge into successful innovations has been associated with the presence

of high absorptive capacity at the firm level (Cohen and Levinthal, 1989; Cohen *et al*., 2002; Swann, 2002). However, the capabilities required to successfully innovate may vary depending on the type of innovation that firms want to develop. Many empirical analyses have stressed that in order to pursue specific innovations strategies, firms are required to interact with specific actors. User-producer interaction, for instance, is widely acknowledged as crucial for product innovation (von Hippel, 1988). To develop and market a novel product innovation, getting knowledge and collaborating with customers is as important as performing internal R&D investments, since customers are an important source of information that may boost product innovation (Levin and Reiss, 1988; Belderbos *et al.*, 2004). When product innovation is based on a recent scientific discovery, it often entails a formal collaboration with universities (Beise and Sthal, 1999; Tether, 2002; Monjon and Waelbroeck, 2003). Firms that mainly pursue an imitation strategy instead seem to prefer horizontal technological information from competitors (Baldwin *at al.*, 2002; Cabagnols and Le Bas, 2002). Firms pursuing process innovation, which entails investments in machinery and equipment, seems to require mainly interaction with suppliers (Pavitt, 1984; Malerba, 1992). Similarly, Swann (2002) finds that British process innovators tend to use universities both as a knowledge source provider and R&D partners when compared to product innovators. Reichstein and Salter (2006) further find that knowledge from suppliers enhance process innovations in firms with a cost-focus strategy, while the probability of doing process innovation is negatively associated to the use of customers as a source of knowledge.

The need to develop specific external linkages may also depend on the type of industry and technology (Pavitt, 1984; Marsili, 2001). Firms active in science-based industries generally tend to benefit most from interactions with public research organisations and focus on (novel) product innovation (Cabagnols and Le Bas, 2002; Leiponen, 2002; Belderbos *et al.*, 2004). In supplier-dominated industries, firms rely mainly on suppliers as source of process-innovations (Leiponen, 2002). Specialised-suppliers rely mainly on customers as sources of information to develop customised product-innovation and solve technological problems to their clients (Riggs, and von Hippel, 1994). In scale-intensive activities, which are also high-capital-intensive, firms achieve competitive advantage by exploiting economies of scale and firms tend to innovate more in product than in process (Martínez-Ros and Labeaga, 2002).

Altogether, existing contributions hint at the following: engaging in a specific type of innovation strategy may require the integration of several specific types of knowledge and therefore firms need to interact with several actors at the same time. There are two possible explanations for this evidence, none of them much researched in the literature so far. On the one hand, interaction with several actors might be the consequence of the presence of a relationship of complementarity or substitution between *several knowledge sources*. In other words, different knowledge sources reinforce each other (i.e. complementarity) or firms tap different sources to acquire knowledge that is difficult to access such as knowledge possessed by competitors (i.e. substitution). On the other hand, interaction with several actors might be the consequence of the fact that a firm may do *several types of* innovation that differ in terms of novelty and integration of market and production (i.e. firms have different innovation strategies). In this paper, we analyse both the impact of different innovation strategies on the use of formal and informal knowledge sources, as well as the complementarity and substitution relationship among sources of knowledge.

3. Method and data

The discussion in the previous section has highlighted the presence of a relationship between firms' innovative strategies and reliance upon external linkages. A key objective in this paper is then to analyze whether and how different innovation strategies go together with the use of informal and formal knowledge sources. We have, in addition, stressed that firms seem to rely upon several external linkages at the same time. In the analysis we will therefore examine whether a substitutive or complementary relationship exists between informal and formal knowledge sources, and between the different types of sources. Our analysis is done separately for each country, following a system of simultaneous equations:

$$\begin{cases} \Pr\left(Inf_{ij}\right) = f_i\left(\sum_{k\neq j} Inf_{kj}, \sum_k For_{kj}, X_i\right) \\ \Pr\left(For_{ij}\right) = f_i\left(\sum_k Inf_{kj}, \sum_{k\neq j} For_{kj}, X_i\right), \end{cases} \quad (1)$$

where *Pr* indicates the probability that a (formal or informal) link is used by the firm, *Inf* indicates informal knowledge sources, *For* indicates formal cooperation linkages, *j* subscripts for the actor relationships we identify (other enterprises part of the same group, suppliers, customers, competitors, universities, government research institutes),

Σ_k indicates a set including the elements subscripted by k, X is a vector of explanatory variables, $i = 1, \ldots, N$ indicates the individual firm, and f indicates a function that we will approximate by the probit model. Thus, the model states that the probability for each (formal or informal) linkage is a function of the other linkages and a set of explanatory variables. For estimation purposes, we append an error term to each equation, and we allow these error terms to be correlated between the equations.

Our dependent variables are binary and have been constructed on the basis of two questions contained in the CIS 3 survey. Firms were asked to evaluate the importance of the sources of knowledge or information used for technological innovation in the three years preceding the survey. We employ this question to identify the informal linkages (INF).[1] The second question asked firms whether they had any co-operation arrangements on innovation activities with other enterprises or institutions during the same time period and to indicate the type of partner. We employ this question to identify the formal linkages (FOR). Among the several sources, we focus on those that appeared both as sources of knowledge and as partners in R&D (i.e. collaboration with consultants and in-house sources of information were excluded). Hence, we focus on Other enterprises within the group (INF_OTH, F_OTH), Suppliers (INF_SUP, FOR_SUP), Customers (INF_CUST, F_CUST), Competitors (INF_COMP, F_COMP), Universities or other higher education institutes (INF_UNI, F_UNI), and Government research organisations (INF_GOV, F_GOV).

As explanatory variables we use four sets of covariates. First, we employ a set of variables describing the innovation strategy of the firms. NEW_PDT is a dummy equal to one if the firm introduced a product that was new to the market (i.e. it is a 'novel innovator'). IMP_PDT is a dummy equal to one if the firm only introduced a product that was new to the firm. PDT_PRC is a dummy equal to one if the firm introduced both a new product and a new process in the same time period. Firms that declared to have introduced only process innovation are the reference category. Following Swann (2002) and Tether (2002), we consider that the development of different types of innovations is not accidental, but reflects the innovative strategies of firms. Thus we treat the innovation types as independent variables that reflect firms' choices, rather than

[1] The question asked firms to evaluate the importance on a 4 items scale ('not used', 'low importance', 'medium importance', 'high importance'). Responses were recoded into a binary variable equal to zero if the source was not used or rated as having a low importance and equal to 1 if it was considered of medium or high importance.

dependent variables that follow from other variables. In particular, we expect that the development of innovations with certain characteristics, in terms of product novelty and degree of integration between process and product innovation, requires specific learning and R&D efforts. Consequently different innovation strategies are expected to rely on different external linkages to access specific information and knowledge to innovate.

As suggested by the literature, when compared to firms that make process innovations only, we expect 'novel product innovators' to rely more on formal and informal linkages with Customers, Universities and Governmental research institutes. Innovators with improved products instead should rely more on informal linkages with Customers and Competitors. Finally, we expect firms that made both product and process innovations to rely relatively more than 'only process innovators' on formal linkages with Suppliers and Customers, and more on informal and/or informal linkages with public research organisations.

Second, we introduce a set of variables to account for firms' investment strategy. Several studies have found that firms with different investment portfolios might develop different learning processes, forge different types of external linkages for innovating, and engage in specific types of innovation. The variable INV_INT is the total share of innovative investments (i.e. investment in intramural, extra-mural R&D, other knowledge, design and training) on the turnover of the firm. The variable INV_MAC is the share of total investment in machinery on the total turnover.[2] INV_INT controls for the firm's efforts in building internal capabilities to improve internal efficiency and to respond to markets. INV_MAC controls for the impact of 'embodied innovation' on the probability to set up external linkages. To better capture the differentiation of innovative investment strategy of firms, we also created a variable INV_VAR that is a count variable of the different types of investment activities which the firm has been involved in. This variable varies between 0 and 5.

To these variables we add a set of industry and firm level controls. Concerning industry controls, it is widely acknowledged that firms in different industries seem to engage in diverse types of technical change and innovative activities, and focus on a

[2] Investment strategies reflect the two factor loadings obtained when running a factor analysis on the intensity of investment in each innovative activity surveyed.

variety of potential learning processes (Malerba, 1992). Thus, the specific industrial activity of firms might influence the reliance upon use of specific sources of knowledge both formal and informal. Firms are grouped into five categories of industries, according to the taxonomies proposed by Pavitt (1984) and Marsili (2001): fundamental process (FUND), complex-product (COMPX), product-engineering (PDT_ENG), and science-based (SCIE).[3]

Firm level controls include firm size and an indication of the largest market in which the firm operates. SIZE is measured as the logarithm of total the number of employees. Large firms, which invest highly in innovative activities and adopt wide search strategies, are expected to adopt wider search strategies, to rely relatively more upon university research, and to cooperate relatively more with several actors to innovate (Cohen *et al.*, 2002; Leiponen, 2002; Swann, 2002, Laursen and Salter, 2004; Fontana *et al.*, 2006). MKT is an ordinal variable that identifies the regional scope of the (largest part of the) market of the firm. It ranges from local to regional to national and international. The list of variables and their description is summarised in Table 1.

[Insert Table 1 about here]

The estimation method is a Multivariate Probit maximum likelihood in which the decisions to engage in formal and informal linkages with a set of external organisations are estimated simultaneously. Formal or informal linkages data are binary but they have as many 'dimensions' as the number of external partner/ sources. The choices are not mutually exclusive. This method allows the simultaneous estimation of more than one binary probit equation with correlated disturbances. By allowing disturbances across equations to be freely correlated, the method allows to test for the correlation between dependent variables conditional on a certain number of common explanatory variables (Galia and Legros, 2004, p. 1193), thus providing also insights into the extent of complementary of substitution between them. A positive (negative) correlation of the error terms between two equations is taken as an indication of complementarity (substitution) between the two dependent variables.[4]

[3] Fundamental-process activities include chemicals, plastic and rubber industries. Complex-products include transport equipment. Product-engineering include machinery and equipment industries. Science-based activities include represented pharmaceutical and electrical and optical industries. Continuous-process includes all the other manufacturing activities. This is also the reference category.

[4] As a robustness check we have also performed for each country twelve separate Probit regressions one for each type of linkage. Results in terms of sign and significance of the estimators of multivariate and

3.1. Data

The data used in this paper come from the Community Innovation Survey 3 (CIS 3) that investigates the process of innovation development by firms in the period 1998-2000, in four European countries: The Netherlands, Norway, Sweden and the UK. The CIS survey asks firms about the type of innovation introduced in the three years preceding the survey, the sources of knowledge they drew upon, their formal collaborative arrangements in order to innovate as well as their investments in several types of innovation activities. The innovation development process in services and in manufacturing has been found to be quite different (Miozzo and Soete, 2002; Savona *et al.*, 2006). Therefore, the analysis undertaken in this paper concentrates on manufacturing firms with more than 9 employees, which have introduced at least one innovation in the period covered by the survey. As the CIS survey does not collect data on the sources of information and collaborative arrangements for non-innovators, we cannot proceed, as we wished, with the analysis for the non-innovative firms. Our sample includes a total of 3963 firms (1633 firms for The Netherlands, 1005 firms for the UK, 559 for Sweden, and 766 for Norway) who have established a total of 11198 linkages with external actors between 1998 and 2000. The majority of links are established with customers (25.48% of the total), followed by suppliers (23.87%), competitors (15.90%), and other firms of the same group (15.59%). Fewer links are established with universities (9.50%) and governmental research institutions (9.66%). Table 2 reports the distribution of number of linkages by countries.

[Insert Table 2 about here]

The Netherlands is the country with the highest number of total established links. It accounts for slightly more than one third of the total. The UK follows with a share of 25.47%. The two Scandinavian countries account for the remaining 40.89%. It has to be noted that in general firms in our sample establish more informal than formal linkages.

Statistically significant differences across countries are found in terms of the average number of links established (see Table 3).

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binary Probit are very similar. Major differences between Multivariate and Binary Probit estimators, which relate to the significance of the correlation between linkages, are found only for Norway (especially on the use of linkages with Other enterprises of the group and Competitors, as well as on the use of informal linkages with University) and to a lesser extent for The Netherlands. These results are available upon request from the corresponding author.

[Insert Table 3 about here]

Firms in our sample establish on average 2.82 linkages. Swedish firms establish the highest number of linkages on average (3.62) followed by Norwegian (3.33), British (2.83) and Dutch (2.30) firms. Norwegian firms tend to establish the highest number of formal linkages on average (0.86) while Swedish firms have the highest number of informal linkages on average (3.02).

Finally we look at the distribution of linkages by country and innovation strategy. The majority of the linkages (58.90%) are established by firms pursuing both product and process strategy. Firms that introduced improved products (i.e. a product that was new to the firm) follow with 15.44% of total linkages. The rest of the other linkages are distributed more or less equally across firms that introduced novel products (i.e. a product that was new to the market) (14.24%) and firms that introduced only process innovation (11.44%). Figure 1 depicts the distribution of the linkages by innovation strategies across countries.

[Insert Figure 1 about here]

Concerning Dutch firms, the majority of the linkages are established by firms doing both product and process innovation followed by firms introducing new products (both novel and improved ones). The same applies to Norwegian firms. A slightly different pattern emerges for UK and Sweden. In the case of UK, a large majority of linkages are established by firm doing process innovation only. In the case of Swedish firms instead firms introducing novel product are those that show the highest share of the total linkages.

All in all, our descriptive results point to the presence of a certain heterogeneity across countries concerning both the type of linkages (formal vs. informal) and the pattern of innovative strategies. In the remaining section of the paper we will look at the way in which different innovation strategies impact on the choice of specific types of linkages. We will estimate the system of equations (1) for each of the four countries individually, and compare the coefficients across countries. In particular, using the adjusted Wald Chi-square test, significant differences in the national coefficients will be identified and

analysed (Allison, 1999; Liao, 2004).[5] As the purpose of our analysis is to identify national specificities in the use of formal and informal linkages, we run this test for the six country combinations.[6] Third, we analyse the estimated correlation matrices for the error terms in the equations in each country. Each matrix provides information on the complementary or substitutive relation between each type of linkages in the country.

4. Informal and formal sources of knowledge and the innovative strategies of firms

Estimates are reported in four separate tables (4 to 7), one for each country. However, for the purpose of cross country comparison, we will comment on the results for each set of explanatory variables across the tables.

[Insert Tables 4 – 7 about here]

Results for innovative strategies

We start by looking at the relationship between firms' innovation strategies and reliance upon formal and informal linkages. Concerning novel product innovators (NEW_PDT), our results suggest that firms pursuing this strategy are generally relatively more likely than only process innovators (the reference category) to set up linkages with customers and governmental research institutes. This result holds across countries, although for Scandinavian firms only in the case of formal linkages. British and Swedish novel product innovators are also relatively more likely to engage in formal collaborations with competitors. Norwegian and Dutch novel product innovators tend to rely upon (formal) collaborations with suppliers and other firms of the group. In the UK, novel product innovators are less likely to use informal linkages with suppliers.

Firms that have introduced improved products (IMP_PDT) present a different profile. These firms are still generally more likely to rely upon formal collaboration with customers than firms that introduced only process innovators, however, especially in

[5] The Wald chi-square test for the similarity of coefficients is the following one.

$$\frac{(b_M - b_W)^2}{[s.e\,(b_M)]^2 + [s.e\,(b_W)]^2}$$

b_M is the coefficient for regression 1 , b_W is the coefficient for regression2, and s.e. is the estimated standard error. Each statistic has 1 degree of freedom.

[6] Again our analysis of significant national differences is robust to the choice of a different estimation strategy (i.e. running using separate binary Probits instead of Multivariate regression). Also these results are available upon request from the corresponding author.

the UK and the Netherlands, they also tend to draw knowledge informally from competitors reflecting the importance of imitation for this type of firms. 'Improved product innovators' are also more likely to rely upon informal linkages with customers in the Netherlands and Norway, and less likely to tap informally into suppliers in the UK. Norwegian and Dutch firms again seem relatively more likely to engage in formal collaboration with other enterprises of the group, contrary to British firms. In Sweden, firms that have introduced improved products do not seem to differ significantly from our reference category.

Finally, firms that have introduced both a new product and a process (PDT_PRC) are relatively more likely than 'only process' innovators, to engage in formal collaboration with customers and public research organisations (governmental institutes in Norway and the UK, universities in Sweden and the Netherlands). Competitors are also an important source of knowledge for all firms but for the Swedish innovators, which are less likely to use them. (Formal) interaction with suppliers is relevant only for Dutch firms in this group. Informal linkages with customers are important for product and process innovators, in Norway and the Netherlands.

All in all, firms with 'sophisticated' innovation strategies in terms of degree of novelty and/or in terms of integration between product and process innovation, tend to use a more complex mix of external actors (both formally and informally) as sources of innovation in the innovation process. Still, we found that national differences are relevant. When compared to the other innovative strategies, the portfolio of knowledge sources for firms that do improved product innovation is the most similar across the four countries.

Results for investment strategies

Firms' investment strategies are captured by three variables. The first variable is the innovative investment intensity (INV_INT) measured as the share of innovative investment on the firms' turnover. Our results suggest a positive relationship between innovative investment intensity and reliance upon some informal and formal external actors in all the four countries. For instance, the greater the firms' investments in internal innovative capabilities, the more firms are able to interact (formally and informally) with governmental institutes and universities. The more firms invest in innovative activities, the more they interact with competitors, in the Netherlands and

in the UK. Negative and significant coefficients are instead found for formal interactions with customers in UK, competitors in Norway and informal interactions with customers and supplier in Norway.

Concerning investment in machinery (INV_MAC), our results indicate that the share of total investment in machinery on the total turnover generally does not significantly influence the likelihood of engaging in formal linkages, although Dutch and Swedish firms with higher investments in machinery tend to cooperate less with governmental institutes. When we look at informal relationships, firms with a relatively higher share of investment in machinery are less likely to tap universities as source of knowledge especially in The Netherlands. Higher investment in machinery makes relatively more likely to interact with other enterprises of the group as well as with suppliers in the UK contrary to Sweden and Norway. These results suggest that relationships with governmental institutes may allow firms to use specific equipment for their innovation. Moreover, they also suggest that in some countries (i.e. Norway) knowledge acquired from research organisations may substitute for investment in machinery.

Finally, concerning investment variety (INV_VAR) our results indicate that the more diversified is the investment portfolio of firms, the more likely they are to rely upon external actors both as source of knowledge (except for suppliers) and as cooperation partners.

Results for industry controls

We analyse now in detail the impact of industrial control variables on the reliance upon formal and linkages with external actors for innovation. Results suggest that there are some national differences across industrial sectors competences and strategies. The number of national differences is higher for some activities such as complex-product, science-based and product-engineering. On the contrary, few cross country differences exist in the portfolio of knowledge sources tapped by firms active in fundamental-process activities. Moreover, when compared to other countries, Norwegian firms active in continuous-process activities are more likely to draw upon external actors than firms doing complex-product or fundamental-process industrial activities.

Concerning firms active in science-based activities (SCIE), our results suggest that in the UK and Norway they are generally more likely to use informal linkages with customers, but less likely in Sweden. Dutch and British science-based firms tend to establish formal relationships and Swedish to rely on informal linkages with governmental research institutes. Dutch science-based firms are also more likely to use informal linkages with universities. Instead Norwegian science-based firms are less likely to collaborate with enterprises of the group. Consequently, science-based activities seem to be more R&D intensive and more dependent on public research in the Netherlands and Sweden, and carried on in a more 'market-oriented' way in the UK and in Norway.

The picture appears more variegated in the case of complex-product firms (COMPX). In the UK and the Netherlands firms active in complex-product activities focus upon the use of informal customer information to innovate and improve market share by applying university knowledge and collaborating with governmental institutes. In Sweden instead, firms are less likely to use informal linkages with customers and formal collaborations with governmental institutes. Norwegian firms in complex-product activities are less likely to collaborate with other enterprises of the group, suppliers and clients, and to establish informal linkages with customers. British firms also seem to avoid leaking information to competitors. Dutch and Swedish firms seem to collaborate with competitors instead. All in all, our results seem to reflect that the nature of the activity of complex product firms is different across the four countries analysed, revealing that they might focus on the integration of different bundles of knowledge, as well as on the outsourcing of different steps of the production process.

Firms active in product-engineering industries (PDT_ENG) are more likely than firms active in continuous-process activities, to interact informally with universities and suppliers in the UK and Sweden, and with customers in Norway and the Netherlands. Instead, they rely less on informal linkages from governmental research institutes in Norway, from suppliers in the Netherlands, and from customers in Sweden. Thus, product-engineering firms seem to rely more on public research results in the UK and Sweden, while they rely more on customer- relationships in the Netherlands and Norway.

Finally, our results suggest that British and Dutch firms active in fundamental-process activities rely more than firms in continuous-process activities upon relationships with other enterprises of their group to innovate. We find the opposite for Norwegian firms. Swedish firms active in fundamental-process activities do not differ much on the reliance on informal linkages with firms in continuous-process activities. Fundamental-process activities seem to present a similar pattern of reliance upon external linkages across the four countries.

Results for control variables

Results for the impact of control variables, capturing the organisational and market characteristics of firms, are quite consistent with the existing literature. Still, some national peculiarities are found. In the four European countries analysed, large firms are generally more likely than smaller ones to engage in formal collaborations as suggested by the positive and significant coefficient of SIZE. This relationship holds for any actor except for supplier and customers in the UK, and for competitors in Norway. Moreover, the larger the firm, the higher is the probability to draw upon informal sources of knowledge from all actors, except for suppliers and customers.

Concerning the location of the largest market (MKT) the more international is the focus of the firm (i.e. the less local is their focus) the higher is the propensity to interact with public research organisation (universities in the UK, and governmental institutes in Norway and the Netherlands) and customers. Instead, the more local the focus of Swedish firms the more they tend to rely informally upon governmental institutes.

4.1. Significant differences across countries

The second step of our empirical exercise involves the identification analysis of cross-country differences in the reliance upon formal and informal external linkages. To perform this analysis, we employ a simple adjusted Wald Chi-square test, on the estimated coefficients from the previous regressions. The test is run for all the six possible country combinations and results are reported by type of linkage in Tables 8 – 10.

[Insert Tables 8 – 10 about here]

Table 8 reports the results of the test for the variables: OTHER ENTERPRISES OF THE SAME GROUP (top panel of the table) and SUPPLIERS (bottom panel). Concerning interaction with other firms of the group, the UK seems to display the greatest differences with respect to the other countries in the sample, and hence appears as the country that stands out most with regard to the institutional context of the innovation process. British firms that benefit from *informal linkages* with other firms of their group, differ from Swedish and Norwegian firms concerning their investment strategies (INV_MAC and INV_VAR). British firms that rely on *formal collaboration* with other firms of their group also differ from Norwegian and Dutch firms, where this type of collaboration seems instead to play an important role for some innovation strategies (NEW_PDT, IMP_PDT and PDT_PCS).

Concerning suppliers, British firms who differ from the Norwegian firms in terms of innovative strategy (NEW_PDT) and from Dutch and Swedish firms (NEW_PDT and IMP_PDT). Other significant differences are found in terms of investment strategies between UK and the Scandinavian countries and within the Scandinavian countries themselves. Cross-country differences in the use of Suppliers as informal source also arise from the different composition of the industrial sectors.

Table 9 reports the results of the test for the variables: CUSTOMERS and COMPETITORS. Concerning customers (top panel) here the major differences across countries arises when we look at informal interactions. Swedish firms that interact with customers are significantly less ambitious in terms of innovation strategy. Significant differences seem to exist also among British, Dutch and Norwegian firms. Cross country differences in the use of customers as informal sources also arises from the different composition of the industrial sectors with Swedish firms in complex-product (COMPX), product-engineering (PDT_ENG), and science-based (SCIE) sectors that seem to behave significantly differently from their British, Norwegian and Dutch counterparts. Differences are less evident when we look at formal collaborations with customers.

Concerning formal and informal interactions with competitors (bottom panel), some differences in terms of innovative strategies exist. The use of informal linkages is less attractive for Swedish product and process innovators (PDT_PCS) than for other countries. Instead, the use of formal linkages is more attractive for Swedish novel product innovators (NEW_PDT) than for the Dutch or Norwegian.

Finally the results for the variables UNIVERSITIES and GOVERNMENTAL RESEARCH INSTITUTES are reported in Table 10. Concerning firms that interact with universities, (top panel) the major differences can be found among British, Norwegian and Dutch firms in terms of innovative strategies (PDT_PRC). British product and process innovators tend to interact less with Universities. Moreover, in the UK the impact of the most important market (MKT) is different from all the other countries indicating that interaction with universities is an activity mainly done by British firms that compete in international markets. The impact of the investment strategies is different among Norway, the UK and the Netherlands. Finally, some differences arise from the different composition of the industrial sectors especially between Norwegian, Dutch and British firms. When we look at the interactions with governmental research institutes (bottom panel) variety in the industry composition and investment strategies are the main causes of the presence of significant differences across countries.

All in all, the following results seem to emerge from our previous results. First, the four countries in our sample differ most in the use of informal linkages with customers and suppliers, followed by universities and governmental research institutes. Concerning the use of informal collaboration, they seem to display a more similar pattern (except for collaboration with enterprises of the same group). Second, our analysis also found more cross-country differences at the industry level than at the level of firms' innovative strategies. We will now move forward and analyse whether further differences exist in the complementarity or substitution relationships across external linkages.

4.2. Complementarity and substitution among external linkages

Our estimation strategy allows us to produce from each estimation a matrix of correlation coefficients of the error terms in the equations for each of the dependent variables. For each country separately these coefficients are reported in Tables 11 – 14.

[Insert Tables 11 – 14 about here]

Looking at the sign of the coefficients provides an indication of whether the external linkages are complementary (positive coefficient) or substitutes (negative coefficient)

for the firms in the sample. For clarity we have reported in the table only the significant (at 95% level) coefficients.

Coefficients for *formal linkages* are generally significant and positive thus suggesting the presence of a complementarity between these external sources of knowledge. In other words, firms that engage in formal collaborations do so with more than one actor. Complementarity exists also for *informal linkages* with competitors, suppliers and customers and between informal linkages with competitors and informal linkages with governmental research institutes and universities, though to a lesser extent. This result suggests that interactions with competitors may be more efficient if combined with interactions with public research organisations.

The degree of complementarity is stronger among formal collaborations, and weaker in the case of informal linkages with customers and competitors, linkages with governmental research institutes and university. In addition, in Norway, we also find strong complementarity between formal and informal linkages with other enterprises of the group, informal linkages with customers and formal collaboration with universities.

Contrary to previous findings (Belderbos *et al.*, 2004), firms in our sample do not tend to collaborate with actors that they use as source of knowledge. Indeed, our results show that complementarity between formal and informal linkages with the same actor is weak and can be found only in the Netherlands and in the UK. In Norway, formal and informal linkages with competitors are not significantly complementary. In Sweden, only formal and informal linkages with other enterprises of the group are complementary.

In the UK, the Netherlands, and Norway, we do not find evidence of a significant relationship of substitution among any actor. In Sweden, instead, there are five substitution relationships, four of which involve informal linkages with competitors. This finding suggests that Swedish firms in our sample use competitors as substitutes for engagement in formal interactions with different actors (customers, suppliers, universities, and governmental research institutes). Alternatively, this result may suggest that Swedish firms in our sample are able to use different types of collaboration with public research organisations and other market actors to gain the

same type of knowledge they can obtain from informal linkages with competitors. Additionally, governmental research institutes seem to provide similar information as those provided by collaborations with suppliers.

Interestingly, linkages with research organisations tend to exhibit the highest number of significant complementarities, reflecting that firms rely upon knowledge from research organisations to improve their access to an even wider pool of sources. The Netherlands is the country in which we find the highest number of complementarities among all types of external linkages except for informal linkages with other enterprise of the group and government research institutes, as well as for collaboration with customers and competitors. Sweden instead has the smallest number of significant correlations, followed by Norway. In particular, in Sweden the number of complementarities is the smallest for interactions among universities and governmental research institutes and other informal sources. In Norway, the number of number of complementarities is the smallest for informal interactions with suppliers and Customers. These results suggest that Swedish firms are eventually more able to absorb external knowledge from informal interactions without the need to collaborate with these actors or access other sources. Dutch and British firms instead need to use a wider mix of external sources and strategies to innovate effectively.

5. Conclusions

This paper has started from the observation that firms tend to rely upon the contribution of different external actors in their innovation process. This empirical fact may either be due to the presence of a relationship of complementarity or substitution between several knowledge sources or the consequence of the fact that firms do several types of innovations that differ in terms of novelty and integration of market and production (i.e. firms have different innovation strategies). In this paper, we have empirically analysed both these possibilities using a sample of innovating firms from four European countries (Norway, Sweden, the Netherlands and the UK).

Concerning the complementarity/ substitutability issue, our estimation approach allowed us to account for the simultaneous use of several external linkages. In this respect, our results have suggested that cross-countries differences exist and that they are substantial. In Norway, the Netherlands and UK there are no substitution relations across different external actors. Swedish firms are instead able to substitute

information from competitors by developing several forms of collaboration, as well as to substitute collaboration with suppliers with information provided by governmental institutes. Moreover, in the Netherlands, the UK, and to a lesser extent in Norway, firms tend to cooperate formally with actors that they also use to screen on the market. The same strategy is not undertaken by firms in the Sweden.

Concerning the role of different innovation strategies, our results have shown that firms with different innovation strategies tend to rely on different mixes of external actors and that some differences exist across countries. In particular, novel product innovators tend to have formal and informal interaction with customers and governmental institutes to a much higher extent. Firms that introduce only improved products seem to regard informal linkages with competitors as well as with customers (both formal and informal) as more important in the innovation process. In comparison, firms that innovate in both product and process tend to rely relatively more on customers and public research organisations. We have also found differences in the portfolio of external linkages across firms active in different industrial and technological contexts, though again national differences exist.

All in all our results have provided novel insights into the role of firms' innovative strategies in establishing formal and informal external linkages. Moreover, they underline the importance of country - and industry - differences in firms' capability to learn from different linkages. These results, although preliminary and in need of further corroborations, suggest some managerial and policy implications. On the managerial side, if firms' capabilities to use certain types of linkages and the adequacy of knowledge provided by external actors differ across countries and sectors, then firms' decision to entry in new markets (internationalization, delocalization or diversification) may create problems of identification, access and process of external sources of knowledge. Therefore, firms may need to complement these decisions with investment in wider search and collaborative activities, as well as in new routines for enhancing the processing of external knowledge. On the policy side, our results have suggested that not only public research organisations in different countries have different capabilities to provide specific relevant innovative knowledge, but also that their capabilities depend on the quality and function of the interaction among different market actors. It should be the task of policy makers to nurture and reinforce these interactions.

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LIST OF TABLES

Table 1: Variable description

	Variable Name	Description
	Dependent variables	
	INF_OT	Rated as medium or highly important Other Enterprises of the same group as source of information to innovate
	INF_SUP	Rated as medium or highly important Suppliers as source of knowledge of information to innovate
	INF_CUST	Rated as medium or highly important Customers as source of knowledge of information to innovate
	INF_COMP	Rated as medium or highly important Competitors as source of knowledge of information to innovate
	INF_UNI	Rated as medium or highly important Universities as source of knowledge of information to innovate
	INF_GOV	Rated as medium or highly important Governmental research institutes as source of knowledge of information to innovate
	F_OT	Did a co-operation arrangement with Other enterprises of the same group
	F_SUP	Did a co-operation arrangement with Suppliers
	F_CUST.	Did a co-operation arrangement with Customers
	F_COMP	Did a co-operation arrangement with Competitors
	F_UNI.	Did a co-operation arrangement with Universities
	F_GOV	Did a co-operation arrangement with Governmental research institutes
	Explanatory variables	
INNOVATION STRATEGY	NEW_PDT	The firm introduced a product that was new to the market
	IMP_PDT	The firm introduced only a product that was new to the firm
	PDT_PRC	The firm introduced a new product and process
INVESTMENT STRATEGY	INV_INT	Total share of innovative investments (i.e. investment in intramural, extra-mural R&D, other knowledge, design and training) on the turnover
	INV_MAC	Share of total investment in machinery on the total turnover
	INV_VAR	Count of the different types of investment activities the firm has been involved in (Max 5 – Min 0)
INDUSTRY CONTROLS	FDT	Fundamental process firm
	COMPX	Complex-product firm
	PDT_ENG	Product-engineering firm
	SCIE	Science-based firm
FIRM CONTROLS	SIZE	Logarithm of the total number of employees
	MKT	Firm's largest market (0 = Local, 1 = Regional, 2 = National, 3 = International)

Table 2: Distribution of linkages by country

Country	Total	Formal	Informal	%
NL	3765	616	3149	33.61
UK	2853	492	2361	25.47
NW	2553	659	1894	22.79
SW	2027	338	1689	18.10
Total	11198	2105	9093	100

Table 3: Average number of linkages by country

Country	Total firms	Number by firm	Formal	Informal
NL	1633	2.30	0.38	1.93
UK	1005	2.83	0.49	2.35
NW	766	3.33	0.86	2.47
SW	559	3.62	0.60	3.02
Total	3963	2.82	0.53	2.29

Table 4: Multivariate Probit estimations of reliance upon formal and informal external linkages. Results for Sweden.

	INF_OT	INF_SUP	INF_CUST	INF_COMP	INF_UNI	INF_GOV	F_OT	F_SUP	F_CUST	F_COMP	F_UNI	F_GOV
NEW_PDT	-0.12	0.12	0.14	0.16	0.03	0.05	0.26	0.09	0.46**	0.75**	0.07	0.38*
	[0.13]	[0.13]	[0.13]	[0.13]	[0.13]	[0.13]	[0.16]	[0.14]	[0.15]	[0.26]	[0.18]	[0.15]
IMP_PDT	0.12	0.17	0.11	0.02	0.04	0.01	0.00	-0.09	0.36[a]	0.42	0.14	-0.11
	[0.17]	[0.17]	[0.16]	[0.17]	[0.17]	[0.17]	[0.24]	[0.20]	[0.20]	[0.36]	[0.25]	[0.21]
PDT_PRC	-0.08	-0.18	0.00	-0.27*	0.11	0.11	0.12	0.21	0.46**	0.31	0.33 [a]	0.23
	[0.13]	[0.13]	[0.13]	[0.13]	[0.13]	[0.13]	[0.16]	[0.15]	[0.14]	[0.22]	[0.19]	[0.15]
INV_INT	0.00	0.01	0.01	-0.01	0.01	0.01	0.02*	0.02*	0.01	0.02	0.02*	0.03**
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
INV_MAC	-0.04	-0.04 [a]	-0.01	0.03	-0.03	0.00	0.00	0.00	0.01	0.02	-0.05	-0.06 [a]
	[0.03]	[0.02]	[0.01]	[0.02]	[0.02]	[0.01]	[0.02]	[0.02]	[0.01]	[0.01]	[0.05]	[0.03]
INV_VAR	0.08*	0.04	-0.03	0.08*	0.12**	0.1**	0.12**	0.19**	0.14**	0.04	0.17**	0.20**
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]	[0.04]	[0.05]	[0.04]	[0.04]
FDT	-0.02	0.38	-0.18	0.12	0.35	0.25	-0.37	0.07	-0.04	0.28	0.47	0.02
	[0.23]	[0.24]	[0.22]	[0.22]	[0.23]	[0.22]	[0.32]	[0.25]	[0.25]	[0.33]	[0.29]	[0.27]
COMPX	-0.18	0.12	-0.45 [a]	0.19	-0.07	0.18	-0.46	0.39	0.28	0.76*	-0.17	-0.77*
	[0.27]	[0.27]	[0.27]	[0.28]	[0.27]	[0.28]	[0.33]	[0.28]	[0.26]	[0.32]	[0.34]	[0.32]
PDT_ENG	-0.23	0.39*	-0.36*	0.26	0.32 [a]	0.02	-0.25	0.01	0.12	0.16	0.01	0.02
	[0.18]	[0.19]	[0.17]	[0.18]	[0.18]	[0.17]	[0.23]	[0.19]	[0.19]	[0.28]	[0.22]	[0.20]
SCIE	-0.05	0.08	-0.52**	-0.08	0.14	0.34*	-0.17	0.00	-0.11	-0.27	-0.34	-0.01
	[0.15]	[0.15]	[0.16]	[0.15]	[0.15]	[0.15]	[0.19]	[0.17]	[0.17]	[0.29]	[0.21]	[0.17]
SIZE	0.20**	0.00	-0.04	0.11**	0.24**	0.25**	0.31**	0.10*	0.11*	0.12*	0.23**	0.34**
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]	[0.05]	[0.04]	[0.04]	[0.06]	[0.05]	[0.05]
MKT	0.05	0.12 [a]	-0.03	0.17**	0.06	-0.14*	-0.09	-0.04	-0.05	-0.02	0.03	0.10
	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.07]	[0.09]	[0.08]	[0.08]	[0.13]	[0.11]	[0.09]
CONSTANT	-1.54**	-0.19	0.16	-0.90**	-1.76	-1.48**	-2.86**	-2.07**	-2.16**	-3.10**	-3.39**	-3.77**
	[0.28]	[0.26]	[0.25]	[0.26]	[0.28]	[0.26]	[0.37]	[0.31]	[0.31]	[0.52]	[0.44]	[0.40]

Obs: 559
Wald Chisq: 509.30**
Log Likelihood: -3742**

Note: ** significant at 99%; * significant at 95%, [a] significant at 90%

Table 5: Multivariate Probit estimations of reliance upon formal and informal external linkages. Results for Norway.

	INF_OT	INF_SUP	INF_CUST	INF_COMP	INF_UNI	INF_GOV	F_OT	F_SUP	F_CUST	F_COMP	F_UNI	F_GOV
NEW_PDT	0.05	-0.06	0.03	-0.11	0.14	0.01	0.29*	0.35**	0.35**	0.09	0.05	0.43**
	[0.11]	[0.11]	[0.11]	[0.10]	[0.12]	[0.12]	[0.13]	[0.12]	[0.12]	[0.18]	[0.14]	[0.13]
IMP_PDT	0.16	-0.24	0.52**	0.28	0.08	-0.05	0.57*	0.07	0.21	0.19	-0.05	0.43
	[0.19]	[0.18]	[0.19]	[0.19]	[0.25]	[0.23]	[0.27]	[0.25]	[0.25]	[0.41]	[0.30]	[0.27]
PDT_PRC	0.12	0.20	0.49**	0.41**	0.26	0.16	0.54**	0.24	0.28 [a]	0.49 [a]	0.17	0.50**
	[0.14]	[0.13]	[0.13]	[0.13]	[0.17]	[0.16]	[0.20]	[0.17]	[0.17]	[0.30]	[0.20]	[0.19]
INV_INT	0.01	-0.02**	-0.01*	0.00	0.02**	0.02**	0.01*	0.01	0.00	-0.06*	0.01**	0.01*
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.03]	[0.01]	[0.01]
INV_MAC	-0.04 [a]	0.01	0.00	-0.01	0.01	-0.03	0.01	-0.03	-0.01	-0.04	0.01	0.00
	[0.02]	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]	[0.01]	[0.02]	[0.01]	[0.06]	[0.01]	[0.01]
INV_VAR	-0.03	0.02	0.11**	0.05 [a]	0.08*	0.12**	0.10**	0.20**	0.19**	0.09	0.22**	0.13**
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.03]	[0.03]	[0.05]	[0.04]	[0.04]
FDT	-0.02	-0.38 [a]	-0.28	-0.55*	-0.50	-0.16	-0.83[a]	-0.20	0.34	-0.10	-0.03	-0.04
	[0.25]	[0.23]	[0.24]	[0.26]	[0.36]	[0.28]	[0.45]	[0.30]	[0.27]	[0.44]	[0.34]	[0.31]
COMPX	-0.56	-0.18	0.39	-0.08	-0.84 [a]	-0.64	-0.8[a]	-0.72 [a]	-0.63[a]	-0.02	-1.37 [a]	-0.36
	[0.35]	[0.28]	[0.33]	[0.28]	[0.45]	[0.41]	[0.48]	[0.40]	[0.38]	[0.52]	[0.77]	[0.36]
PDT_ENG	-0.10	-0.08	0.43*	0.06	-0.09	-0.52**	-0.57**	-0.13	0.25	0.04	-0.05	-0.15
	[0.16]	[0.15]	[0.17]	[0.15]	[0.18]	[0.19]	[0.21]	[0.17]	[0.17]	[0.27]	[0.20]	[0.18]
SCIE	0.21	-0.07	0.50**	0.23	-0.22	-0.32 [a]	-0.36*	-0.13	-0.19	0.18	-0.32	-0.25
	[0.16]	[0.15]	[0.18]	[0.15]	[0.17]	[0.17]	[0.19]	[0.17]	[0.17]	[0.26]	[0.20]	[0.18]
SIZE	0.35**	0.07	0.03	0.07 [a]	0.19**	0.12**	0.26**	0.14**	0.13**	0.00	0.21**	0.18**
	[0.04]	[0.04]	[0.05]	[0.04]	[0.05]	[0.05]	[0.05]	[0.05]	[0.05]	[0.07]	[0.05]	[0.05]
MKT	0.06	-0.03	0.14**	0.05	0.15*	0.10 [a]	0.12[a]	-0.04	0.03	-0.06	0.06	0.29**
	[0.05]	[0.05]	[0.05]	[0.05]	[0.06]	[0.06]	[0.07]	[0.06]	[0.06]	[0.08]	[0.07]	[0.07]
CONSTANT	-2.08**	0.00**	-0.69**	-1.09**	-2.77**	-2.13**	-3.46**	-2.30**	-2.53**	-2.05**	-3.22**	-3.76**
	[0.26]	[0.23]	[0.24]	[0.23]	[0.31]	[0.28]	[0.36]	[0.29]	[0.30]	[0.43]	[0.36]	[0.35]
Obs: 766												
Wald Chisq: 549.11**												
Log Likelihood: -2920**												

Note: ** significant at 99%; * significant at 95%, [a] significant at 90%

Table 6: Multivariate Probit estimations of reliance upon formal and informal external linkages. Results for The Netherlands

	INF_OT	INF_SUP	INF_CUST	INF_COMP	INF_UNI	INF_GOV	F_OT	F_SUP	F_CUST	F_COMP	F_UNI	F_GOV
NEW_PDT	-0.03	-0.09	0.32**	-0.08	0.19 [a]	0.07	0.29*	0.26**	0.17 [a]	0.00	0.11	0.18 [a]
	[0.08]	[0.07]	[0.07]	[0.07]	[0.10]	[0.09]	[0.11]	[0.10]	[0.09]	[0.12]	[0.15]	[0.11]
IMP_PDT	0.19[a]	-0.15	0.54**	0.24*	0.10	0.07	0.45*	0.10	0.42**	-0.07	0.17	0.12
	[0.12]	[0.11]	[0.11]	[0.11]	[0.17]	[0.14]	[0.18]	[0.19]	[0.15]	[0.22]	[0.32]	[0.20]
PDT_PRC	0.11	-0.01	0.31**	0.17*	0.24*	0.10	0.16	0.33**	0.33**	0.12	0.36 [a]	0.18
	[0.08]	[0.08]	[0.08]	[0.08]	[0.11]	[0.10]	[0.13]	[0.12]	[0.11]	[0.14]	[0.20]	[0.13]
INV_INT	0.01	-0.06	0.01	0.01*	0.02**	0.02**	0.01*	0.01	0.01	0.014 [a]	0.01	0.02**
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
INV_MAC	0.01	0.01	0.00	0.00	-0.04*	-0.01	-0.03	-0.03[a]	-0.02	-0.03	-0.04	-0.06*
	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]	[0.01]	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.02]
INV_VAR	0.03*	0.05	0.06**	0.07**	0.09**	0.09**	0.10**	0.12**	0.09**	0.08**	0.11**	0.12**
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.03]	[0.03]	[0.02]
FDT	0.36**	-0.16	0.07	0.00	-0.04	-0.10	0.01	0.14	0.24*	-0.14	0.13	0.26 [a]
	[0.10]	[0.10]	[0.10]	[0.10]	[0.13]	[0.12]	[0.14]	[0.13]	[0.11]	[0.17]	[0.19]	[0.13]
COMPX	0.06	-0.04	0.36*	0.03	0.31 [a]	0.07	0.23	0.14	-0.08	0.41*	0.06	0.38 [a]
	[0.16]	[0.15]	[0.16]	[0.15]	[0.18]	[0.18]	[0.19]	[0.19]	[0.19]	[0.19]	[0.29]	[0.20]
PDT_ENG	-0.19[a]	-0.20	0.27**	0.13	0.13	-0.10	-0.26[a]	-0.02	-0.14	-0.27	-0.07	0.07
	[0.11]	[0.10]	[0.10]	[0.10]	[0.13]	[0.12]	[0.16]	[0.14]	[0.13]	[0.19]	[0.23]	[0.15]
SCIE	0.13	-0.44	0.13	0.17	0.42**	-0.03	-0.43*	-0.10	0.04	-0.12	0.09	0.47**
	[0.12]	[0.12]	[0.12]	[0.11]	[0.13]	[0.13]	[0.19]	[0.16]	[0.14]	[0.19]	[0.22]	[0.14]
SIZE	0.22**	-0.03	0.05[a]	0.10**	0.16**	0.17**	0.17	0.16**	0.13**	0.14**	0.23**	0.24**
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]	[0.03]	[0.04]	[0.05]	[0.04]
MKT	0.13**	0.00	0.07*	0.03	0.07	0.02	0.02	-0.05	-0.08*	-0.15**	-0.09	0.12*
	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]	[0.05]	[0.04]	[0.04]	[0.05]	[0.06]	[0.05]
CONSTANT	-2.18	-0.05	-0.91**	-1.23**	-2.74**	-2.27**	-2.87**	-2.66**	-2.19**	-2.21**	-3.42**	-3.70**
	[0.17]	[0.15]	[0.15]	[0.15]	[0.22]	[0.19]	[0.26]	[0.23]	[0.20]	[0.26]	[0.37]	[0.28]

Obs: 1633
Wald Chisq: 703.46**
Log Likelihood: -6976.78**

Note: ** significant at 99%; * significant at 95%, [a] significant at 90%

Table 7: Multivariate Probit estimations of reliance upon formal and informal external linkages. Results for the UK

	INF_OT	INF_SUP	INF_CUST	INF_COMP	INF_UNI	INF_GOV	F_OT	F_SUP	F_CUST	F_COMP	F_UNI	F_GOV
NEW_PDT	-0.01	-0.35**	0.32**	-0.01	-0.02	0.00	-0.14	0.13	0.32**	0.30 [a]	-0.08	0.52*
	[0.10]	[0.10]	[0.10]	[0.10]	[0.12]	[0.15]	[0.15]	[0.12]	[0.12]	[0.17]	[0.14]	[0.18]
IMP_PDT	-0.15	-0.49**	0.15	0.35**	-0.09	-0.26	-0.50*	-0.20	0.29 [a]	-0.03	-0.14	0.43 [a]
	[0.12]	[0.12]	[0.12]	[0.12]	[0.15]	[0.20]	[0.25]	[0.17]	[0.16]	[0.27]	[0.18]	[0.26]
PDT_PRC	0.04	-0.01	-0.04	0.12	-0.10	-0.11	0.20	0.11	0.16	0.15	-0.18	0.40*
	[0.10]	[0.10]	[0.10]	[0.10]	[0.12]	[0.15]	[0.15]	[0.12]	[0.12]	[0.18]	[0.14]	[0.18]
INV_INT	0.00	-0.01	-0.01	0.00	0.01	0.00	0.00	-0.01	-0.03*	0.02**	0.02*	0.00
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
INV_MAC	0.02**	0.04**	0.01	0.01	0.00	0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.02]	[0.01]	[0.02]
INV_VAR	0.08**	0.04	0.10**	0.07**	0.16**	0.11**	0.15**	0.21**	0.18**	0.12**	0.24**	0.14**
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.04]	[0.03]	[0.03]	[0.05]	[0.04]	[0.04]
FDT	0.33*	0.12	-0.12	-0.24 [a]	0.18	-0.01	0.15	-0.04	-0.03	-0.16	0.46*	-0.09
	[0.14]	[0.15]	[0.14]	[0.15]	[0.17]	[0.23]	[0.22]	[0.18]	[0.17]	[0.26]	[0.19]	[0.27]
COMPX	0.27 [a]	0.10	0.29*	0.05	0.26	0.16	-0.22	0.29 [a]	-0.23	-0.03	0.07	0.34
	[0.14]	[0.15]	[0.15]	[0.14]	[0.17]	[0.22]	[0.27]	[0.17]	[0.19]	[0.24]	[0.21]	[0.24]
PDT_ENG	-0.01	0.33*	0.17	0.14	0.57**	0.21	0.00	0.03	0.12	-0.76*	0.05	0.44 [a]
	[0.16]	[0.16]	[0.16]	[0.15]	[0.17]	[0.23]	[0.25]	[0.19]	[0.18]	[0.32]	[0.20]	[0.23]
SCIE	0.18	0.11	0.25**	-0.06	0.08	0.18	0.21	0.19	0.15	-0.44 [a]	0.16	0.34 [a]
	[0.11]	[0.12]	[0.11]	[0.11]	[0.14]	[0.17]	[0.18]	[0.14]	[0.14]	[0.23]	[0.16]	[0.20]
SIZE	0.26**	0.07*	-0.01	0.07*	0.11**	0.17**	0.16**	0.04	0.00	0.10 [a]	0.10*	0.19**
	[0.03]	[0.03]	[0.03]	[0.03]	[0.04]	[0.05]	[0.05]	[0.04]	[0.04]	[0.06]	[0.05	[0.05]
MKT	-0.03	-0.17**	0.17**	0.09	0.23**	0.05	-0.07	0.00	0.07	-0.08	0.33**	0.05
	[0.06]	[0.06]	[0.06]	[0.06]	[0.07]	[0.09]	[0.09]	[0.08]	[0.08]	[0.10]	[0.09]	[0.11]
CONSTANT	-1.70**	0.71**	-0.64**	-1.28**	-2.8**	-2.93**	-2.62**	-2.10**	-2.07**	-2.55**	-3.71**	-4.08**
	[0.21]	[0.22]	[0.21]	[0.21]	[0.29]	[0.35]	[0.35]	[0.28]	[0.28]	[0.39]	[0.36]	[0.44]

Obs: 1005
Wald Chisq: 539.34**
Log Likelihood: -4096.65**

Note: ** significant at 99%; * significant at 95%, [a] significant at 90%

Table 8: Wald test of differences across countries. Results for other enterprises and suppliers

	Informal other enterprises of the same group						Formal other enterprises of the same group					
	Sweden - Norway	**Sweden - UK**	**Norway - UK**	**NLs –UK**	**NLs - Norway**	**NLs – Sweden**	**Sweden - Norway**	**Sweden - UK**	**Norway - UK**	**NLs -UK**	**NLs - Norway**	**NLs – Sweden**
NEW_PDT	0.93	0.44	0.15	0.04	0.37	0.31	0.01	**3.2**[a]	**4.46***	**5.23***	0	0.03
IMP_PDT	0.03	1.67	1.89	**4.09***	0.02	0.15	2.59	2.06	**8.40****	**9.17****	0.15	2.27
PDT_PRC	1.03	0.48	0.23	0.32	0	1.4	2.75	0.14	1.89	0.04	2.62	0.04
INV_INT	0.37	0.05	0.16	0.32	0.04	0.56	0.32	1.32	0.70	0.77	0.01	0.22
INV_MAC	0.03	**4.25***	**6.65****	0.93	**3.67** [a]	2.6	0.03	0.00	0.11	1.94	2.74	1.19
INV_VAR	**5.46***	0.01	**6.22****	1.46	**3.3** [a]	1.29	0.23	0.20	0.89	1.40	0.01	0.43
FDT	0	1.63	1.47	0.03	2	2.25	0.68	1.76	**3.82***	0.26	**3.23** [a]	1.21
COMPX	0.74	2.23	**4.86***	0.99	2.59	0.59	0.33	0.32	1.10	1.86	**3.92***	**3.28** [a]
PDT_ENG	0.28	0.87	0.19	0.99	0.24	0.02	1.06	0.53	**2.93** [a]	0.76	1.35	0
SCIE	1.42	1.47	0.03	0.11	0.19	0.83	0.5	2.16	**4.94***	**6.17****	0.08	0.95
SIZE	**5.92***	1.46	2.24	0.71	**5.13***	0.27	0.49	**4.76***	2.17	0.06	2.05	**5.04***
MKT	0	0.80	1.20	**5.86***	1.56	1.06	**3.63** [a]	0.02	**2.95** [a]	0.76	1.63	1.14
CONSTANT	2.03	0.21	1.28	3.05a	0.11	**3.84***	1.37	0.21	**2.78** [a]	0.34	1.74	0

	Informal suppliers						Formal suppliers					
	Sweden - Norway	**Sweden – UK**	**Norway - UK**	**NLs –UK**	**NLs - Norway**	**NLs – Sweden**	**Sweden - Norway**	**Sweden - UK**	**Norway - UK**	**NLs -UK**	**NLs - Norway**	**NLs - Sweden**
NEW_PDT	1.14	**7.74****	**3.77***	**4.17***	0.05	1.93	1.81	0.04	1.61	0.75	0.26	0.97
IMP_PDT	2.76	**10.16****	1.33	**4.12***	0.16	2.62	0.26	0.19	0.84	1.37	0	0.44
PDT_PRC	**4.29***	1.11	1.58	0.00	1.89	1.31	0.02	0.27	0.41	1.62	0.17	0.4
INV_INT	**6.69****	2.02	1.38	0.12	2.78	1.46	2.34	**4.18***	0.97	1.27	0.09	1.33
INV_MAC	**4.12***	**9.41****	**3.23** [a]	2.69	0.04	**4.6***	1.4	0.29	0.78	1.12	0.01	1.78
INV_VAR	0.16	0.02	0.33	0.01	0.6	0.05	0.03	0.15	0.05	**5.0***	**3.9***	**2.83** [a]
FDT	**5.29***	0.84	**3.38** [a]	2.47	0.82	**4.35***	0.48	0.13	0.21	0.66	1.09	0.06
COMPX	0.59	0.01	0.76	0.41	0.19	0.27	**5.19***	0.08	**5.46***	0.35	**3.8***	0.53
PDT_ENG	**3.9***	0.08	**3.34** [a]	**7.69****	0.51	**7.95****	0.29	0.00	0.35	0.03	0.25	0.01
SCIE	0.46	0.03	0.88	**11.14****	**3.74** [a]	**7.16****	0.28	0.83	2.12	1.91	0.02	0.17
SIZE	1.37	1.73	0.00	**5.13***	**3.75** [a]	0.35	0.37	1.21	2.75	**5.04***	0.09	1.03
MKT	**3.39** [a]	**10.24****	**3.13** [a]	**5.68***	0.2	2.91	0	0.11	0.16	0.29	0.01	0.01
CONSTANT	0.3	**6.85****	**4.87***	**8.0****	0.04	0.2	0.31	0.01	0.24	2.34	0.92	2.33

Table 9: Wald test of differences across countries. Results for customers and competitors

	Informal customers						Formal customers					
	Sweden - Norway	**Sweden - UK**	**Norway - UK**	**NLs -UK**	**NLs - Norway**	**NLs - Sweden**	**Sweden - Norway**	**Sweden – UK**	**Norway - UK**	**NLs -UK**	**NLs - Norway**	**NLs - Sweden**
NEW_PDT	0.4	1.25	**3.78***	0.00	**4.56***	1.43	0.32	0.56	0.04	1.00	1.47	**2.91** [a]
IMP_PDT	2.67	0.05	2.61	**5.61***	0.01	**4.8***	0.22	0.08	0.07	0.35	0.51	0.05
PDT_PRC	**6.93****	0.07	**10.40****	**8.07****	1.3	**4.26***	0.63	2.58	0.37	1.09	0.05	0.52
INV_INT	**4.33***	**3.91***	0.02	**3.42** [a]	**4.01***	0.16	0.08	**4.08***	**4.45***	**5.88***	0.44	0.04
INV_MAC	0.39	1.68	0.43	0.41	0.01	0.57	1.33	2.71	0.29	0.16	0.7	**3.1** [a]
INV_VAR	**8.68****	**9.09****	0.02	1.81	1.85	**5.63***	0.84	0.56	0.03	**4.69***	**5.79***	1.36
FDT	0.1	0.05	0.32	1.29	1.81	1.08	1.04	0.00	1.33	1.72	0.12	1.01
COMPX	**3.83***	**5.72***	0.07	0.12	0	**6.7****	**3.81***	2.44	0.84	0.31	1.63	1.26
PDT_ENG	**10.26****	**5.22***	1.18	0.27	0.62	**9.85****	0.27	0.00	0.28	1.41	**3.37** [a]	1.31
SCIE	**18.23****	**16.24****	1.35	0.53	**2.88** [a]	**11.57****	0.09	1.55	2.42	0.34	1.09	0.52
SIZE	1.24	0.21	0.60	1.90	0.08	**2.9** [a]	0.18	**3.28** [a]	**4.60***	**6.73****	0	0.27
MKT	**4.4***	**5.51***	0.17	2.69	1.64	1.79	0.6	1.13	0.17	**2.98** [a]	2.3	0.13
CONSTANT	**5.81***	**5.94***	0.03	1.08	0.56	**12.98****	0.79	0.04	1.30	0.10	0.96	0.01
	Informal competitors						**Formal competitors**					
	Sweden - Norway	**Sweden - UK**	**Norway - UK**	**NLs -UK**	**NLs - Norway**	**NLs - Sweden**	**Sweden - Norway**	**Sweden – UK**	**Norway - UK**	**NLs -UK**	**NLs - Norway**	**NLs - Sweden**
NEW_PDT	2.67	1.08	0.53	0.34	0.07	2.57	**4.35***	2.01	0.74	2.07	0.17	**6.82****
IMP_PDT	1.09	2.51	0.08	0.45	0.05	1.12	0.18	1.03	0.20	0.01	0.3	1.37
PDT_PRC	**12.91****	**5.55***	**3.07** [a]	0.16	2.35	**7.95****	0.24	0.32	0.96	0.02	1.28	0.53
INV_INT	1.1	0.73	0.00	1.31	2	**4.46***	**5.57***	0.24	**7.56****	0.58	**6.06****	0.01
INV_MAC	2.69	0.64	2.51	0.53	0.73	1.32	1	2.37	0.18	0.24	0.04	**3.68** [a]
INV_VAR	0.49	0.06	0.27	0.00	0.39	0.07	0.32	1.34	0.29	0.51	0	0.52
FDT	**3.96***	1.90	1.10	1.88	**4.00***	0.27	0.49	1.12	0.01	0.00	0.01	1.31
COMPX	0.48	0.19	0.19	0.01	0.13	0.25	1.61	**3.27** [a]	0.01	1.57	0.61	0.84
PDT_ENG	0.75	0.24	0.17	0.01	0.18	0.39	0.09	**4.7***	**3.66** [a]	1.74	0.87	1.59
SCIE	2.09	0.01	2.40	2.11	0.09	1.75	1.33	0.23	**3.13** [a]	1.16	0.87	0.19
SIZE	0.32	0.63	0.03	0.64	0.26	0.02	1.61	0.06	1.15	0.37	**2.82** [a]	0.09
MKT	2.11	0.74	0.35	0.93	0.1	**3.52** [a]	0.06	0.13	0.03	0.31	0.79	0.82
CONSTANT	0.3	1.30	0.37	0.04	0.24	1.19	2.43	0.72	0.74	0.51	0.11	2.34

Table 10: Wald test of differences across countries. Results for universities and governmental research institutes

	Informal universities						Formal universities					
	Sweden - Norway	Sweden - UK	Norway - UK	NLs -UK	NLs - Norway	NLs - Sweden	Sweden - Norway	Sweden – UK	Norway - UK	NLs -UK	NLs - Norway	NLs - Sweden
NEW_PDT	0.36	0.09	0.90	1.84	0.08	0.86	0.01	0.47	0.44	0.88	0.09	0.03
IMP_PDT	0.02	0.33	0.36	0.75	0.01	0.08	0.22	0.79	0.07	0.73	0.26	0.01
PDT_PRC	0.49	1.41	**3.09** [a]	**4.53***	0.01	0.58	0.37	**4.75***	2.08	**4.80***	0.47	0.01
INV_INT	0.98	0.41	**3.23** [a]	2.67	0.01	0.75	0.3	0.03	0.16	0.64	0.3	0.82
INV_MAC	1.7	1.22	0.18	**3.60** [a]	**4.35***	0.14	1.62	0.52	1.87	0.75	2.58	0
INV_VAR	0.64	0.95	**3.26** [a]	**3.67** [a]	0.07	0.48	0.77	1.66	0.17	**6.32****	**4.06***	0.95
FDT	**4.02***	0.36	**2.91** [a]	0.99	1.49	2.18	1.26	0.00	1.57	1.57	0.15	1.01
COMPX	2.18	1.03	**5.27***	0.04	**5.65***	1.31	2.08	0.36	**3.32** [a]	0.00	**3.06** [a]	0.26
PDT_ENG	2.63	0.96	**7.31****	**4.40***	0.99	0.78	0.05	0.02	0.13	0.15	0	0.06
SCIE	2.35	0.07	1.85	**3.04** [a]	**8.41****	1.87	0.01	**3.77***	**3.51** [a]	0.07	1.89	2.09
SIZE	0.51	**5.08***	1.82	0.85	0.37	2.26	0.07	**3.65** [a]	2.44	**3.69** [a]	0.07	0
MKT	0.96	2.54	0.53	**3.40** [a]	1.33	0	0.05	**4.50***	**5.24***	**14.18****	2.68	1.08
CONSTANT	**5.86***	**6.7****	0.01	0.03	0.01	**7.48****	0.1	0.30	0.92	0.30	0.16	0
	Informal governmental research institutes						**Formal governmental research institutes**					
	Sweden - Norway	Sweden - UK	Norway - UK	NLs -UK	NLs - Norway	NLs - Sweden	Sweden - Norway	Sweden - UK	Norway - UK	NLs -UK	NLs - Norway	NLs - Sweden
NEW_PDT	0.07	0.07	0.00	0.14	0.15	0	0.05	0.34	0.18	2.46	1.99	1.11
IMP_PDT	0.05	1.08	0.46	1.74	0.19	0.06	2.49	2.59	0.00	0.91	0.87	0.6
PDT_PRC	0.05	1.30	1.60	1.46	0.1	0	1.2	0.46	0.15	0.91	1.94	0.07
INV_INT	2.04	0.17	**2.85** [a]	1.06	0.91	0.43	2.57	**3.85***	1.08	1.92	0.48	1.04
INV_MAC	1.98	0.35	**4.07***	2.13	0.72	0.51	**3.23** [a]	2.11	0.17	**2.82** [a]	**4.89***	0.02
INV_VAR	0.18	0.09	0.01	0.25	0.49	0.04	1.76	1.18	0.01	0.23	0.16	**3.63** [a]
FDT	1.3	0.67	0.15	0.09	0.04	1.9	0.02	0.07	0.01	1.32	0.79	0.64
COMPX	2.67	0.00	**2.96** [a]	0.12	2.46	0.11	0.7	**7.69****	2.71	0.01	**3.27** [a]	**9.08****
PDT_ENG	**4.3***	0.46	**5.99****	1.53	**3.27** [a]	0.35	0.41	1.85	**3.94***	1.73	0.94	0.05
SCIE	**8.34****	0.46	**4.23***	0.93	1.77	**3.32** [a]	0.99	1.77	**4.89***	0.30	**10.11****	**4.74***
SIZE	**4.32***	1.64	0.44	0.00	0.65	2.64	**5.77***	**4.29***	0.04	0.54	1.04	2.7
MKT	**6.94****	**2.81** [a]	0.18	0.08	1.11	**4.32***	2.73	0.08	**3.19** [a]	0.30	**3.58** [a]	0.06
CONSTANT	2.75	**10.64****	**3.12** [a]	2.70	0.17	**5.76****	0	0.28	0.33	0.47	0.01	0.01

Table 11: Correlation matrix for the use of informal and formal linkages: Results for Sweden

	Inf_ot	F_ot	Inf_sup	F_sup	Inf_cust	F_cust	Inf_comp	F_comp.	Inf_uni	F_uni.	Inf_gov	F_gov
Inf_ot	1	0.19	.	.	0.14	.	0.15	.	.	.	.	.
F_ot		1	.	0.49	.	0.46	.	0.37	.	0.25	.	0.34
Inf_sup			1	.	0.14	.	0.29	.	0.24	.	0.31	.
F_sup				1	.	0.59	-0.16	0.50	.	0.47	-0.13	0.5
Inf_cust					1	.	0.34	.	.	.	0.15	.
F_cust.						1	-0.15	0.51	.	0.65	.	0.64
Inf_comp							1	.	0.28	-0.24	0.29	-0.17
F_comp								1	.	0.57	.	0.63
Inf_uni									1	.	0.72	0.27
F_uni.										1	.	0.72
Inf_gov											1	.
F_gov												1

Note: Only correlation coefficients significant at least at 95% are reported

Table 12: Correlation matrix for the use of informal and formal linkages: Results for Norway

	Inf_ot	F_ot	Inf_sup	F_sup	Inf_cust	F_cust	Inf_comp	F_comp.	Inf_uni	F_uni.	Inf_gov	F_gov
Inf_ot	1	0.45	.	.	.	.	0.13	.	.	0.15	.	.
F_ot		1	.	0.42	.	0.37	.	0.36	.	0.39	0.16	0.24
Inf_sup			1	0.25	.	.	0.20	.	.	.	.	.
F_sup				1	.	0.59	.	0.55	0.22	0.40	0.17	0.48
Inf_cust					1	0.33	0.4	.	.	.	.	.
F_cust.						1	.	0.64	0.32	0.34	0.16	0.52
Inf_comp							1	.	.	.	0.12	.
F_comp								1	0.24	0.39	0.23	0.45
Inf_uni									1	0.36	0.55	0.60
F_uni.										1	0.25	0.59
Inf_gov											1	0.42
F_gov												1

Note: Only correlation coefficients significant at least at 95% are reported

Table 13: Correlation matrix for the use of informal and formal linkages: Results for the Netherlands

	Inf_ot	F_ot	Inf_sup	F_sup	Inf_cust	F_cust	Inf_comp	F_comp.	Inf_uni	F_uni.	Inf_gov	F_gov
Inf_ot	1	0.27	.	.	0.08	.	0.09	.	.	0.15	.	.
F_ot		1	.	0.5	0.11	0.577	.	0.55	0.25	0.41	0.21	0.54
Inf_sup			1	0.31	0.18	0.14	0.15	.	0.17	0.17	0.15	0.15
F_sup				1	0.13	0.65	.	0.6	0.14	0.49	0.11	0.64
Inf_cust					1	0.22	0.27	0.156	0.12	0.22	0.17	0.14
F_cust.						1	.	0.65	.	0.48	.	0.57
Inf_comp							1	0.19	0.18	0.16	0.13	.
F_comp								1	0.16	0.46	.	0.57
Inf_uni									1	0.21	0.66	0.48
F_uni.										1	0.28	0.52
Inf_gov											1	0.33
F_gov												1

Note: Only correlation coefficients significant at least at 95% are reported

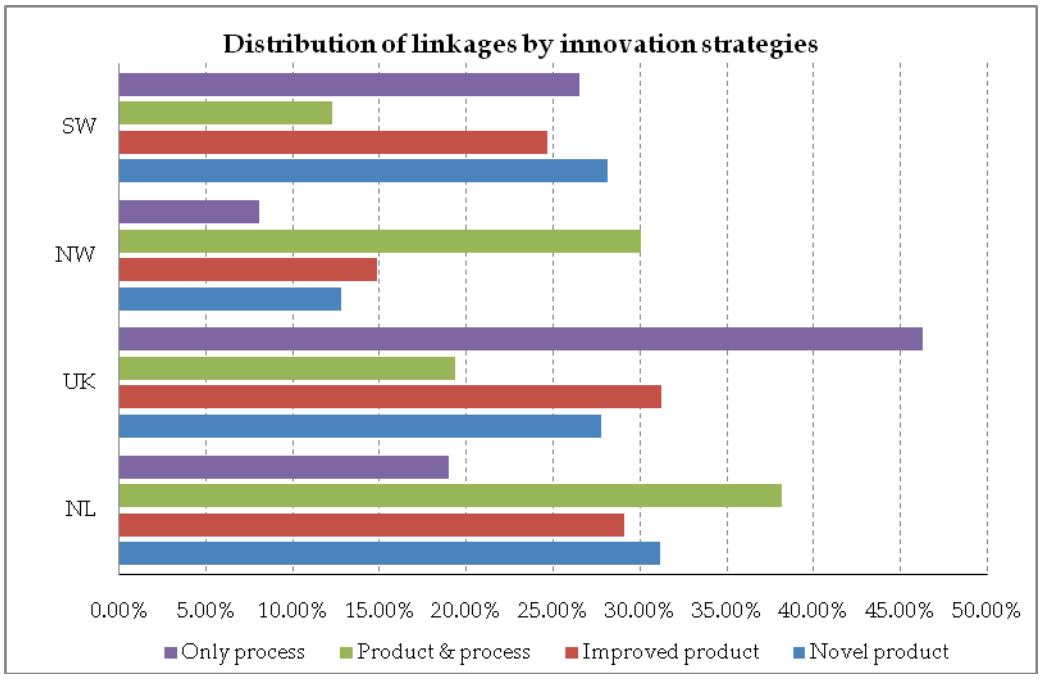
Table 14: Correlation matrix for the use of informal and formal linkages: Results for the UK

	Inf_ot	F_ot	Inf_sup	F_sup	Inf_cust	F_cust	Inf_comp	F_comp.	Inf_uni	F_uni.	Inf_gov	F_gov
Inf_ot	1	0.26	.	.	0.21	0.22	0.24	0.23	0.18		0.33	.
F_ot		1	.	0.48		0.49	.	0.44	0.19	0.42	.	0.35
Inf_sup			1	0.21	0.22		0.14	.	0.18	.	0.16	0.18
F_sup				1	0.14	0.7	.	0.66		0.56	0.16a	0.58
Inf_cust					1	0.31	0.47	0.23	0.21	0.2	0.32	0.35
F_cust.						1	.	0.75	0.16	0.6	0.2	0.61
Inf_comp							1	0.25	0.16	.	0.31	.
F_comp								1		0.45	0.23	0.54
Inf_uni									1	0.56	0.38	0.31
F_uni.										1	0.29	0.58
Inf_gov											1	0.68
F_gov												1

Note: Only correlation coefficients significant at least at 95% are reported

LIST OF FIGURES

Figure 1: Distribution of linkages by innovation strategies



Each colour sums up to 100%.