Paper to be presented at the DRUID 2012

on

June 19 to June 21

at

CBS, Copenhagen, Denmark,

Does collaborating with customers enhance the benefits of R&D and marketing investments for innovation performance?

Elif Bascavusoglu-Moreau
University of Cambridge
Centre for Business Research
e.bascavusoglu@cbr.cam.ac.uk

Bruce Tether
Manchester Business School
Institute of Innovation Research
Bruce.Tether@mbs.ac.uk

Abstract

Collaborating with customers is widely advocated as crucial for firms to improve their innovative performance. However, previous empirical research has found mixed results for the impact of collaborations with customers on innovative performance. We consider that these ambiguous results may be due to omitted interaction effects between investing in R&D, in marketing, and in collaborative arrangements with customers. Drawing on a panel dataset of over 2,000 manufacturing firms, we extend this line of research by distinguishing between the introduction of innovations and innovation performance measured as the share of turnover due to innovations. Furthermore, we distinguish between radical and incremental innovators. We find that overall investing in R&D and cooperating with customers increase the likelihood of introducing innovations, but not the innovative sales. Marketing investments have the opposite effect. Cooperating with clients drives the introduction of innovations when R&D investments and marketing investments are low, but not when they are high. These collaborations do not increase the share of innovative sales. We also find significant differences between factors influencing radical and incremental innovator performance. Our results identify

important variations in the effective allocation of firms? resources and also the conditions under which cooperation with customers generates benefits to the firm.

Jelcodes:O32,D83

DOES COLLABORATING WITH CUSTOMERS ENHANCE THE BENEFITS OF R&D AND MARKETING INVESTMENTS FOR INNOVATION PERFORMANCE?

Abstract

Collaborating with customers is widely advocated as crucial for firms to improve their innovative performance. However, previous empirical research has found mixed results for the impact of collaborations with customers on innovative performance. We consider that these ambiguous results may be due to omitted interaction effects between investing in R&D, in marketing, and in collaborative arrangements with customers. Drawing on a panel dataset of over 2,000 manufacturing firms, we extend this line of research by distinguishing between the introduction of innovations and innovation performance measured as the share of turnover due to innovations. Furthermore, we distinguish between radical and incremental innovators. We find that overall investing in R&D and cooperating with customers increase the likelihood of introducing innovations, but not the innovative sales. Marketing investments have the opposite effect. Cooperating with clients drives the introduction of innovations when R&D investments and marketing investments are low, but not when they are high. These collaborations do not increase the share of innovative sales. We also find significant differences between factors influencing radical and incremental innovator performance. Our results identify important variations in the effective allocation of firms' resources and also the conditions under which cooperation with customers generates benefits to the firm.

Key Words:
Cooperation with Customers, R&D, Marketing, Innovative performance, Radical vs incremental innovations

Introduction

In this increasingly competitive and global environment, innovation is the key engine for the firm growth. As it has been stressed by many scholars over the recent years, firms innovate more openly and globally (Chesborough, 2003; Laursen and Salter, 2006). This new strategy of innovation implies participating in collaborative arrangements with number of partners. In this paper, we're interested in the impact of collaboration with customers on innovative performance.

Collaborating with its customers is an important way for a firm to improve its innovative capabilities and performance (Tether, 2002; Belderbos, Carree & Lokshin, 2004a). By learning about lead customers' needs and expectations, firms are better able to identify market opportunities, new trends and solutions (Von Hippel, 2005). In the UK, firms are increasingly choosing to engage in collaborative agreements with their customers, over the other types of partners[1]. Users, as both firms and individual customers, may also be actively involved in the innovation process, by creating and/or modifying products and services according to their own needs. It is estimated that UK consumers, as a group, spend more on consumer product development than commercial enterprises (von Hippel, Ogawa & de Jong, 2011).

However, despite the growing theoretical evidence, the empirical studies show mixed results regarding the impact of cooperation with clients on innovation both the propensity of innovation and on innovative performance. In a cross-country study across four European countries, Freitas, Clausen, Fontana and Verspagen (2011) find a positive benefit to engaging with customers, both as a source of knowledge and as partners in the innovation process. Freel (2003) corroborates this positive impact on product innovation performance in small and medium sized firms. However, Nieto and Santamaría (2007) find that the benefits of collaborating with customers only prevail for incremental innovations. Monjon and Waelbroeck (2003) fail to find any significant effect, whilst, with respect to innovative sales, Belderbos, Carree and Lokshin (2004a) show that collaboration with clients had no impact on innovation performance. Meanwhile Lööf and Heshmati (2002) find a negative relationship between customer collaboration and product innovation performance.

Recently, it has been argued that these mixed results may be due to the omitted moderator effects of firms' absorptive capacity (Escribano, Fosfuri & Tribo, 2009; Tsai & Hsieh, 2009; Tsai and Wang, 2009). The availability of external sources of knowledge does not itself imply that firms can easily use them; they need a certain level of absorptive capacity in order to identify, adopt and apply this external knowledge (Cohen and Levinthal, 1990). The direct impact of absorptive capacity on firms' innovation, performance, and/or alliances has been extensively studied in the literature (e.g., Gambardella, 1992; Arora &

[1] During the period 2002-2004, the most frequent partner for cooperation was suppliers, followed closely by customers. However, in the following waves of UKIS customers appear to be the first choice of UK firms (UKIS-2007 and UKIS-2009). Although it seems that the absolute share of cooperation has decreased, customers remain the first choice as partners.

Gambardella, 1994; Cockburn & Henderson, 1998; Cassiman & Veugelers, 2006). However there are few studies on the indirect (moderator) effects of absorptive capacity.

This paper builds on this idea of omitted moderator effect, but from the opposite perspective. Rather than focusing on the moderator effect of absorptive capacity, we take a novel approach and put forward the direct and indirect effects of customer collaborations. We argue that collaborating with customers will increase innovative performance both directly (as extensively reported by previous research) but also indirectly via its moderating effects. Extending previous research, we also posit that as well as firms' internal research and development (R&D) level, their marketing investments will also have a crucial role on innovative performance.

In this paper, we argue that collaborating with customers will affect performance by enhancing the positive impact of firms' R&D and marketing investments. We also contribute to the existing research by distinguishing between different measures of innovative performance (i.e., introduction of new products versus innovative sales) and different types of firms (i.e., radical innovators versus incremental innovators).

The analysis in this paper is based on a sample 2,272 manufacturing firms that responded to the UK Innovation Surveys of 2005 and 2007 (hereafter UKIS-2005 and UKIS-2007 respectively). These surveys were the UK versions of the 4th and 5th Community Innovation Surveys (CIS-4 and CIS-5) that now are carried out in many European and other countries according to a common framework. We use a type 2 Tobit estimation given the truncated nature of the share of innovative sales, and correct for the sample selection problem. This methodology also allows us to assess the impact of customer collaboration both on the propensity to innovate and on innovative sales.

The paper is organized as follows: Section 2 reviews to literature and lays out the main hypothesis to be tested. Section 3 describes the data and presents the variables used in the analysis. Section 4 discusses the empirical method and presents the results, whilst Section 5 provides a discussion of the findings, outlines the limitations, and concludes the paper.

Literature review and hypothesis development

R&D investments and innovation performance:

The relationship between firms' research and development (R&D) activities and its performance has been a subject of analysis since Schumpeter (1942). Commitment to R&D activities not only enables firms to create new knowledge, but also to understand and use it in order to transform new knowledge into marketable products (Hall, Griliches & Hausman, 1986; Rosenberg, 1990; Penner-Hahn & Shaver, 2005). Hence, R&D is acknowledged as one of the key drivers of innovation (Cohen, 1995; Kleinknecht and Mohnen, 2002; Mairesse and Mohnen, 2002), especially if firms engage in innovative activities systematically (Ebersberger, Marsili, Reichstein & Salter, 2010). Since the seminal works of Mansfield (1962), there has been a long tradition of empirical studies that explore the impact of R&D spending; R&D spending has been found to have a positive impact on firm productivity growth (Mansfield, 1980; Griliches, 1986), on patenting activities (Pakes & Griliches, 1984; Hall et al., 1986; Cardinal & Hatfield, 2000, Ahuja & Katila, 2001, Artz, Norman, Hatfield & Cardinal, 2010), on new product announcements (Hitt, Hoskisson, Johnson & Moesel, 1996; McMillan, Mauri & Hamilton, 2003; Artz et al., 2010) and on the introduction of the new products (Peters, 2005). Furthermore, it has long been acknowledged that internal R&D investments not only increase firms' innovative outputs, but also their absorptive capacity (Cohen & Levinthal, 1989), a key driver of their competitive advantage (Escribano et al., 2009). Internal R&D may also act as an isolating mechanism (Wang, He & Mahoney, 2009) when firms open their innovation process. By increasing the internal stock of firm-specific knowledge, which, when combined with external knowledge sources, would yield to less generic knowledge, internal R&D investments thus reduce the likelihood of imitation by competitors (Dierickx and Cool, 1989). This leads us to hypothesize that:

H1. *Internal R&D investments will have a positive impact on innovation performance.*

Marketing Investments and Innovation Performance:

The resource- and capabilities-based views of the firm (RBV, CBV) argues that the performance differences among firms result from knowledge resources that can be used to create idiosyncratic, inimitable internal capabilities (Amit & Schoemaker 1993; Teece, Pisano and Schuen, 1997). Therefore, competitive advantage results from the idiosyncratic internal competencies by which a firm translates its routines and resources into superior customer value (Nelson and Winter, 1982; Amit & Schoemaker, 1993; Barney, 1991). These internal competencies are a function of firms' interaction customers and suppliers, the market opportunities, and the limitations of its technologies (Schroeder, Bates & Junttila, 2002). Market knowledge is a resource that enables firms to find out about emerging market opportunities, as well as firms' current deficiencies (Atuahene-Gima, 2005). Market orientation has been found to increase firms' product development

capabilities (Day, 1994), to enhance capabilities in innovation (Atuahene-Gima & Ko, 2001; Slater & Narver, 1995), as well as to anticipate future market conditions (Slater & Narver, 1995). Accessing new knowledge on current and future customers and competitors leads to investments in new capabilities (Huff, Huff & Thomas 1992) and to strategic changes (Noble, Sinha & Kumar 2002, p. 35). A firm cannot exploit its existing innovation capabilities or develop new ones without knowledge of market conditions (Atuahene-Gima, 2005). Thus we hypothesize that:

H2. *Marketing investments will have a positive impact on innovation performance.*

Cooperation with Customers:

It's argued that innovative firms are shifting from a closed to a more open model of innovation, where a firm can and should use external as well as internal ideas, and internal and external paths to the market (Chesbrough 2003; 2006). Using external sources of knowledge, and cooperating with other firms and institutions is considered an important innovation stimulus, which reduces uncertainty, increases access to complementary knowledge and new markets, enhances economies scale and scope, and allows cost sharing and risk spreading (Ahuja, 2000; Cassiman & Veugelers, 2002; Miotti & Schwald 2003).

Resource based theory suggests that the choice of partner for collaboration depends on their potential to provide additional resources (Kogut, 1992). Interaction with customers can bring additional knowledge to firm that is not otherwise available. Customers can be an excellent source of information on new product development, highlighting areas where the offerings can be improved or suggesting activities that are not currently provided by the firm.

Understanding customer preferences is particularly important to the creation of successful new products (Hamel and Pralahad, 1991; 1994). It has been reported that the failure rate of new products ranges from 40% to 75% (Stevensen and Burley, 1999), while some of the new products do not even make it to the launch phase (Cooper and Kleinschmidt, 1986). New product development efforts depend on recognizing the potential winners amongst a large number of product concepts and ideas, gathering the necessary resources, and supporting the development of those ideas through various stages until the commercial launch (Stevens & Burley, 2003). New products are especially likely to fail if they do not reflect the customers' needs or preferences (Joshi and Sharma, 2004). Therefore customer interactions can be source of both incremental and radical product and service innovations (Leiponen 2005, Tether 2002). Recent empirical evidence has shown that prior linkages involving customers seem particularly important to boost the effect of current boundary spanning linkages on innovation performance (Love et al., 2011).

Although based mainly on case and small sample studies[2], there is also an important body of research on the importance of users in the innovation process (von Hippel, 1976, 1977, 2005; Bogers, Afuah & Bastian, 2010). User-innovators are firms or individual customers that expect to benefit from using a novel product or a service they develop; they may create of modify the products in order to address needs that are not catered for by commercially available products (von Hippel, 2005). In some industries, products are often invented, prototyped and/or first applied by the users as demonstrated by a number of studies since the early seventies (See for example, Enos, 1962; Freeman, 1968; Rosenberg, 1976; von Hippel, 1976, 1977). Information asymmetries between users and producers, lower innovation costs, and the sticky nature of information are amongst the reason why users innovate (von Hippel, 1994; Luthje, Herstatt & von Hippel, 2005). Previous research shows that engaging 'lead users' in innovation activities increases the likelihood of introducing commercially attractive new products and services that are generally preferred over other solutions (Urban & von Hippel, 1988; Morisson, Roberts & von Hippel, 2000; Luthje et al. 2003).

Based on these arguments from different streams of literature, we propose the following hypothesis:

H3. *Collaboration with customers will increase innovative performance.*

However, using external sources of knowledge may have disadvantages. Issues related to intellectual property, monitoring problems and the so-called not-invented-here syndrome are amongst the problems associated with 'open innovation'. Recent empirical evidence points to an inverted U-shaped relationship between the breadth of knowledge sources (Laursen and Salter, 2006) or boundary-spanning linkages (Love et al., 2011) and innovation performance. Furthermore, Christensen and Bower (1996) argue that failure to innovate amongst established firms may be linked to their customer relations. Resource allocation in firms often follows customers' demand, and therefore firms may fail to innovate if they perceive a lack of demand.

Some of the difficulties associated with open innovation practices may be overcome by firms' internal capabilities. Both theoretical and empirical literatures emphasize the intertwined relationship between firms' internal capabilities and their external knowledge sourcing. Firms need especially to have a certain level of absorptive capacity in order to search for, identify, assimilate and exploit external knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002). A large number of studies have been looking into the relationship between the absorptive capabilities, generally measured by internal R&D commitments, and the use of external sources of knowledge, particularly external R&D. However the empirical evidence is mixed as some find a substitution effect (Arora & Gamberdella, 1990; 1994; Love & Roper, 1999; 2002; Veugelers & Cassiman, 1999) whilst others find these investments to be complementary (Cassiman & Veugelers, 2006; Griffith et al., 2003). In order to test this interdependent relationship between customer cooperation and the internal R&D investments, we hypothesize that:

[2] Two recent exceptions are a study on Liechtenstein by Fuchs et al. (2011) and on UK, US and Japan by von Hippel et al. (2011).

H4. *Collaborating with customers will enhance the positive effect of R&D investments on innovation performance.*

Recently, it has been suggested that the nature of the relationship between the internal and external knowledge will depend on the stage the of innovation process (Love & Roper, 2009). Different stages of product development process motivate different types of searches, thus different interactions between internal and external sources, but also different types of collaborations (Rothaermel & Deeds, 2004). Although openness is suggested to be most beneficial at the early, exploratory stages of innovation process, it also very relevant for the commercialization phase (Vanharverbeke & Cloodt, 2006). Particularly at the later stages of innovation, external sources may be considered as a mean of getting access to marketing and sales channels (Lee et al. 2010). In this context, investments in marketing will boost the positive impact of these external sources, by contributing to the innovation process through market exploitation and tests. Critical information on market needs and well-developed distribution channels are crucial for the exploitation side of innovation, and can be gained by collaborating with customers. Thus we propose:

H5. *Collaborating with customers will enhance the positive effect of marketing investments on innovation performance.*

In the field of new product development research, it has been long recognized that R&D-marketing interface is a crucial factor for the success of new products (Brown and Eisenhardt, 1995; Griffin and Hauser, 1996; Gupta et al., 1986). As observed by Leenders and Wierenga: "It is now generally accepted that, all else being equal, more integration between marketing and R&D leads to a better new product development" (Leenders and Wierenga, 2002, p.306). The success of a new product resides in both its technological advantages and its ability to meet customers' needs. Therefore, collaboration and/or integration between marketing – that generates the market knowledge- and R&D – that generates the technological knowledge- is considered as a strategic resource, leading to more successful products (Li and Calantone, 1998; Calantone and Rubera, 2011). Furthermore, previous research has also highlighted that a strong customer orientation (via sales department) within the R&D-marketing collaboration would result in greater product success (Ernst et al. 2010). We therefore hypothesize that:

H6a. *Collaborating with customers will enhance the positive effect of simultaneously investing in R&D and the marketing.*

Radical versus Incremental Innovations:

Firms' innovation success can be characterized as radical or incremental. Radical innovation is defined as major changes to products, services or processes that transform existing markets and/or industries. They disrupt technological trajectories and lead to obsolescence existing designs (Gatignon, Tushman, Smith & Anderson, 2004). Incremental innovations, on the other hand, are minor improvements on existing

technology. Aside from their impacts, the main difference between radical and incremental innovations is the degree of new knowledge embedded in the innovation (Dewar and Dutton, 1986), and therefore the way firms exploit their existing knowledge base as well as the way they search for external knowledge is thought to differ between the two types (Kohler, Sofka & Grimpe, 2009). Radical innovations are thought to draw more heavily on new scientific knowledge, generated in universities and research organizations (Todtling, Lehner & Kaufmann, 2008). Firms that have introduced "new to the market" innovations have been found to engage more in cooperative arrangements, as radical innovations imply a greater knowledge exchange between the firm, its customers and suppliers (Tether, 2002). Focusing especially on mainstream customers increases the likelihood of radical product innovations (Christensen and Bower, 1996; Govidarajan et al., 2011). A close relationship with the customers will lead to a deeper understanding of their needs, thus encouraging firms to explore new technologies. However, it has also been argued that radical innovations requires a greater technological input than market input, and a focus on existing customers would lead to incremental innovations (Nieto and Santamaria, 2007; O'Connor and Veryzer, 2001; O'Connor, 1998; Bennet and Cooper, 1981; Levitt, 1960). We will therefore expect that the impact of internal R&D investments to be higher for radical innovators compared to the incremental innovators, but not necessarily for marketing expenditures and cooperation with customers.

Innovative performance: Product innovation versus Innovative Sales

A central issue in innovation analysis is to understand how firms transform their existing knowledge inputs and resources into new products that will be successfully commercialized. Therefore, it is important to distinguish between two types of innovative performance; the introduction of innovative products and the sales achieved by innovative products, as the factors that lead to product innovations may or may not also enhance innovative sales. Therefore, in this paper we will test each of our hypotheses with regard to the propensity to introduce one or more product innovations, and with regard to the share of total sales due to innovative products.

INSERT FIGURE 1 HERE

Data and Variables

We use the fourth and fifth waves of the UK version of the Community Innovation Survey (UKIS-2005 and UKIS-2007). Both surveys cover innovation related activities over the 3 year period just prior to the survey, i.e. 2002-2004 period for UKIS-2005, and 2004-2006 period for the UKIS-2007. The UK innovation survey is based on the core European Community Innovation Survey (CIS) that is co-ordinated by Eurostat, and which itself is based on general guidelines set out in the OECD's 'Oslo Manual' (OECD, 2005). In the UK, the Innovation Surveys are conducted by the Office for National Statistics (ONS), the UK's National Statistical Agency, on behalf of the Department for Business Innovation and Skills of the UK Government. The surveys cover enterprises with 10 or more employees whose primary activity is recorded as being in sections C-K of the 2003 Standard Industrial Classification (SIC). For manufacturing firms (i.e., those whose primary activity is recorded as being in Section D of the SIC), the achieved sample was 4,923 firms in the UKIS-2005 and 4,664 firms in the UKIS-2007; 2,272 manufacturing firms responding to both these surveys, providing the panel dataset that is used in this paper. In order to avoid the simultaneity bias and other problems, we draw the independent variables from the first survey and the dependent variables from the second.

Dependent variables:

The aim of this study is to assess the impact of collaborative arrangements with customers on firms' innovative performance. Two measures of innovative performance are used. First, the introduction of innovations, which is derived from the firm's answer to the survey question survey that asks whether or not they introduced at least one new and/or significantly improved product. This product may be a good or a service. Secondly, innovative sales performance is taken from the reported share of turnover due to new and/or significantly improved products. We can also distinguish between radical and incremental innovators: radical innovators are firms that introduced innovations that were not only new to their firm, but also new to their industry or market. Incremental or innovative imitators, meanwhile, are those innovators which only introduced innovation that were new to themselves, as firms, but that were essentially similar to innovations already available within their industry or market.

Independent variables:

We use the question that asks firms whether or not they had collaborated, and with which type(s) of partner, in order to construct two dummy variables. The first reflects cooperation with clients or customers, and equals one if the firm had formally cooperated with its customers and/or clients on any innovation related activities. The second equals one if the firm had engaged in any formal collaboration activities related to innovation with any other type of partner (e.g., suppliers, competitors, universities, etc.) We also aggregated these two variables together to provide an overall, general indicator as to whether or not the firm

had formally cooperated for innovation with any type of partner. We used a lagged variable here to allow for the delay between collaboration activities and realizing benefits from these.

Absorptive capacity is conventionally measured by a firm's expenditures of intra-mural (in-house) R&D. Since Cohen and Levinthal's seminal article (Cohen and Levinthal, 1990), internal R&D investment is seen as the key determinant of a firm's absorptive capacity.

We measure firms' commitment to commercialization of their innovation through their spending on marketing. We argue that customers' input gained by the collaboration activities will be particularly important to enhancing their marketing and sales skills, and therefore increase the innovative sales.

Control variables:

Our research model includes also several control variables. Two variables; market orientation and cost orientation have been constructed in order to take into account the different objectives of firms' innovation strategies. These orientations are drawn from a multi-item question which asked about the importance various actual and expected 'effects' of innovation. These are measured between 'not relevant' (scored 0) and very important (scored 3). Following Belderbos et al.'s (2004) similar classification, we identify a sub-set of these as being associated with an external, market orientation: i.e., increasing the range of goods or services, entering new markets or increasing market share, and improving the quality of goods or services. And we identify another sub-set - improving the flexibility of production or service provision, increasing capacity for production or service provision, and reducing unit costs of production or provision, as being associated with an internal, cost orientation. In each case, the scores on the three items are summed, allowing the aggregated external and internal orientation score to vary between zero and nine.

Previous research (e.g., Veugelers and Cassiman, 2002; Belberdos 2004) also shows that informal knowledge spillovers may increase the likelihood of innovation, and of obtaining innovative sales. Following Belberdos, (2004a;b), we therefore measure informal knowledge spillovers by the residuals obtained from regressing external knowledge sources on one-period lagged cooperation variable.

We also control whether firms are part of a multinational group, and whether they are start-ups (i.e. founded after 2002). Independent and/or younger firms are generally thought to not to have the same access information, knowledge and even contacts as older firms and those that are part of multi-unit businesses. Firm size, is also known to be an important factor that influences both innovative (Cohen, 1995) and collaborative (Rosenfeld, 1996; Bougrain & Haudeville, 2002) behaviours, and is therefore controlled for. For selection equation, we also take into account the barriers to innovation as perceived by the firms.

We control for five industry dummies, based on the UK Standard Industrial Classification of Economic Activities[3]. These industry groupings also provided one of the stratification criteria for the survey (Stockdale, 2003). The reference group is Manufacture of fuels, chemicals, plastics, metals and minerals (SIC 23-29). The four dummies relate to the following sector groups: manufacture of food, clothing, paper, publishing and printing (SIC 15-22); manufacture of electrical and optical equipment (SIC 30-33); manufacture of transport equipment (SIC 34-35); and manufacturing not elsewhere classified (SIC 36-37).

Methodology and Results

The selection of innovating firms is likely to create a selection bias (Heckman, 1979). In order to correct for this, and given the truncated nature of innovative sales, we use a two-stage generalized Tobit model. The first stage (the selection equation) explains to propensity to innovate, and the second stage (the intensity equation) explains the share of innovative sales. Besides other control variables, the second stage model also includes the inverse Mills ratio, which was obtained through the estimation of the first model. Although estimated together, here we present our results in two separate steps, distinguishing between the first step probit specification, and the second step tobit specification. The definition of variables, descriptive statistics and correlation table can be found in the Appendix (A1, A2 and A3).

Results:

Model 1 contains only the control variables plus internal R&D and marketing investments, and the aggregated cooperation variable. In Model 2, we distinguish between the particular case of cooperating with customers and cooperation with other types of partner. In Model 3, we introduce the interaction terms between cooperating with customers and, separately, R&D investments and marketing investments. Model 4 evaluates the interaction between engaging in both marketing and R&D and cooperating with customers. As mentioned before, the two steps of the estimation procedure is discussed separately, in order to facilitate the presentation of our results, and so as to emphasize the distinction between the introduction of innovations and the resulting innovative sales. All the models are estimated for the whole sample: Tables 1a and 1b; for the radical innovators: Tables 2a and 2b; and for the incremental innovators: Tables 3a and 3b. A summary of hypotheses and findings is presented in Table 4.

Whole Sample:

Table 1a present the results for the first stage of the estimation for the whole sample, i.e. the selection model. The dependent variable here is a binary variable which equals to 1 if the firm has introduced a new or significantly improved product. Among the control variables, we find the expected positive impact

[3] We also controlled for the industrial difference using 2-digit sectoral dummies, however, except for the SIC Code 28, none of the sectoral dummies was found to be significant, separately and altogether.

on the likelihood of innovation of engaging in international markets, having a market orientation and informal knowledge spillovers. Unsurprisingly given the fast pace of technological progress in electronics, firms that manufacture electrical and optical equipment (SIC30-33) are also found to be more likely to innovate than other manufacturing firms. Meanwhile, firms with a cost orientation are, understandably, less likely to introduce a product innovation.

INSERT TABLE 1a HERE

The first model shows that engaging in cooperative agreements, regardless of the type of the partner increases the likelihood of innovating. In the second model, where we distinguish between customers and other types of partners, we find that cooperating with customers increases the likelihood of innovation slightly more than collaborating with other partner types.

All the models show that investing in internal R&D increases the probability of introducing a new product, thus confirming previous literature and our first hypothesis. They also point to positive coefficients for marketing investments, although, with the exception of Model 4, this fails to achieve the statistical significance.

In the models 3 and 4, we evaluate the interaction of the cooperating with customers, with respectively, investing in R&D, in marketing, and in both investing. However, there are several well-known issues that arise when interpreting interaction variables in non-linear models (Ai & Norton, 2003; Hoetker, 2007; Zelner, 2009). Therefore, following Hoetker's suggestion and the method developed by Zelner (2009) we decided to illustrate the results of the interaction terms graphically. Figure 2 depicts the predicted probabilities of the estimated interaction terms in Model 3, surrounded by 95 percent confidence intervals. We see that both cooperating with customers and investing in R&D decreases the probability of innovation, relative to only investing in R&D. Meanwhile, both cooperating with customers and investing in marketing has a positive impact on the propensity to innovate (relative to not cooperating). Model 4 assesses the case of firms that invest in both internal R&D and in marketing, and whether cooperating with customers enhances these investments with respect to the likelihood of introducing innovations. Although firms engaged in cooperative agreements with their customers seem to perform better, Figure 3 shows a negative impact of cooperation while investing in both R&D and marketing.

INSERT FIGURE 2 & 3 HERE

Having accounted for the potential selection problem, Table 1b presents the results for firms' innovative performance, measured as the share of sales due to innovative products, and does this by running

the second stage of the estimation for the whole sample. Results are very different from those associated with the propensity to innovate. This emphasizes the importance of taking into account the selection bias when evaluating innovative performance. Amongst the control variables, we find that larger firms and those that are part of a multi-unit group have higher innovative performance.

INSERT TABLE 1b HERE

We do not find any impact of internal R&D investments on innovative performance, however, marketing investments are found to be highly significant. These results do not support hypothesis 1 but do provide support for hypothesis 2 with regard to innovative sales. We do not find any evidence that cooperation with customers (or others) increases the innovative sales. Results also show that there are no moderating effects of customer' cooperation on the impact of R&D investments or marketing expenditures, thus we find no support for hypotheses 3 to 6 with regard to innovative sales.

Radical Innovators:

Tables 2a and 2b present the results for the firms that introduced radical innovations (i.e. firms that have introduced one or more products that were new to their market or industry). Previous empirical studies have found differences between radical and incremental innovators in terms of their cooperative behaviour (Belberdos et al. 2004; Monjon and Woelbroeck 2003, Tether, 2002). Our results also confirm that incremental and radical innovators are different, especially with respect to the determinants of innovation. In line with the previous literature, radical innovators are found to endure more obstacles or barriers to innovation. The impacts of the remaining control variables are very similar to findings for the whole sample.

INSERT TABLE 2a HERE

Model 3 shows that radical innovators benefit from cooperation with customers and with other types of partner, with the impact of the other cooperations being found to be slightly higher than cooperations with customers. Results also show that both R&D investments and marketing expenditures are positively and significantly associated with the likelihood of introducing a product new to the market. This is a difference with the overall model, which found that R&D investments but not marketing investments were associated with the introduction of innovations. In relation to the introduction of radical innovations, we therefore found support for our first three hypotheses (1, 2 and 3).

INSERT FIGURE 4 & 5 HERE

Figure 4 and 5 display the interactions effects (respectively for Model 3 and Model 4) for radical innovators. We see that cooperating with customers has a positive impact on investments in R&D and in marketing in enhancing the likelihood of innovation, particularly where these investments are relatively small (Figure 4). However, investing in both R&D and marketing has a slight negative impact on the likelihood of innovation (Figure 5), and firms with cooperative arrangement with customers are more likely to innovate, particularly when the combined investment in R&D and marketing is small.

Table 2b presents the results for innovative sales amongst radical innovators. Larger firms perform better, and being part of a group is also found to have a positive effect. However the first model points to a negative impact of cooperation on innovative sales. Furthermore, this negative impact seems to be related to cooperation with customers, as it can be seen in Model 2. Neither investing in R&D nor in marketing seems to enhance innovative sales. Furthermore, cooperation with customers has a negative effect on the impact of R&D investments (Model 3).

INSERT TABLE 2b HERE

Incremental Innovators:

Finally, Tables 3a and 3b present the results for incremental innovators. The results are strikingly different from those for radical innovators. Table 3a shows a positive effect of market orientation and for informal knowledge spillovers on the likelihood of introducing and incremental innovation. However, engaging in cooperative agreements, regardless of the choice of partner, does not have any significant effect. It appears that incremental innovators only benefit from informal knowledge spillovers and not from formal collaborative agreements. The interaction effects as depicted in Figures 6 and 7 confirms these results, with firms that did not engage in cooperative agreements always performing at least as well as those that did cooperate. Furthermore, collaborating with customers decreases the otherwise positive effect of R&D investments on the likelihood of introducing a product innovation.

INSERT TABLE 3a & 3b HERE

INSERT FIGURE 6 & 7 HERE

Table 3b presents the results for the innovative sales amongst the incremental innovators. Size, market orientation, engaging in international markets, and informal knowledge spillovers are all found to increase innovative sales. Furthermore, we also find a positive impact of R&D investments, marketing

expenditures and cooperation, especially with customers. However, no moderator effect of cooperative agreements on R&D or marketing investments has been found.

Table 4 presents a summary of the findings, relating the hypotheses to the results of the estimations, and differentiating according to the measure of innovation performance and type of innovator.

INSERT TABLE 4 HERE

Discussion and Conclusion

Collaborating with customers is considered to be an important way for firms to improve their innovative performance. This behaviour is universally recommended in textbooks on innovation management. And firms are increasingly choosing to engage with their customers in collaborative arrangements for innovation. However, previous empirical research has found mixed results on the impact of cooperation with customers. We argue that these ambiguous results may be due to omitted interaction effects (Escribano et al., 2009; Tsai & Hsieh, 2009, Tsai & Wang, 2008). We advance the existing research by arguing that further to its direct impact on innovation performance, collaboration with customers will act as catalyst to enhance the performance effect of not only internal R&D, but also marketing expenditures. Furthermore, we integrate two additional elements in this line of research, by distinguishing between different types of innovative performance (the introduction of a new product innovation, versus achieving innovative sales) and between different types of innovator firms (radical, new to the market innovators, versus incremental, new to the firm innovators).

Our results show that there is indeed a great heterogeneity between different types of firms and with regards to different innovative performance measures. Overall, engaging in cooperative agreements with customers is found to have a positive effect on the likelihood of innovating. Firms also benefit from knowledge spillovers that do not result from formal collaborative agreements. Although collaboration with customers may positively moderate the impact of investing in R&D or in marketing depending on the type of innovation, it has always a negative effect when investing in both R&D and marketing. These results emphasize the importance of appropriate resource allocation within the firm, showing that the benefits of cooperation with customers only arise when coupled with the right type of investments.

More particularly, and specifically for the introduction of ‘new to the market’ radical innovations, we found that the positive impact of cooperative agreements with customers occurs only for the introduction of these innovations. This is also the case for R&D and marketing investments, and, when taken separately, both of these investments increase this positive effect of cooperation on the likelihood of product innovation.

However, this positive moderator is particularly apparent at low levels of R&D investment, suggesting a potential complementary relationship between collaborative agreements and limited (but not extensive) internal R&D. activities. Furthermore, this positive impact does not translate into higher innovative sales; on the contrary, cooperative agreements appear to have a negative impact on the share of sales due to innovations.

We find almost the opposite effects amongst the incremental innovators (i.e., amongst firms that only introduced product innovations new to themselves, and hence essentially imitative or products already available from others). The introduction of incremental innovations amongst firms is found to benefit from informal knowledge spillovers, but not from formal collaborative agreements. Furthermore, R&D investments coupled with customers collaborations decreases the likelihood of innovation in these firms. In other words, formal collaborations with customers do not appear to be beneficial to achieving innovations amongst incremental innovators. However, there is strong positive impact of cooperative agreements on innovative sales. Although we failed to find any moderator effects of cooperation, both R&D investments and marketing seem to increase innovative sales amongst incremental innovators. This suggests that R&D, marketing and collaborating with customers play different roles amongst radical and incremental innovators. With the former, they are primarily important in helping the firm to achieve innovations, but do not seem to influence the share of sales attributable to innovations. Amongst incremental innovators, on the other hand, these factors do not tend to increase the likelihood of achieving innovations, but are beneficial in terms of the share of income earned from innovations.

Overall, our results show the importance of taking into account different types of firms and different types of performance measures. They also indicate the significance of other types of moderator effects besides R&D investments. Firms, having limited resources, do not benefit automatically from collaborative agreements. Rather than blindly following text book recommendations, managers should therefore take into account their specific innovation strategies and internal resources before committing scares resources to engaging in formal collaboration arrangements with customers. We plan to pursue this line of research in future work, by exploring in more details other potential moderator effects that impact on the propensity to innovate and on the share of income due to innovations.

Tables

Table 1a: Two-Stage Generalized Tobit – Whole Sample; Selection Equation

Innovation (1\0)	**(1)**	**(2)**	**(3)**	**(4)**
Being part of a group	0.0176	0.0163	0.00351	0.0151
	(0.07)	(0.07)	(0.07)	(0.07)
Being a start-up	0.0121	0.0239	0.0218	0.0235
	(0.10)	(0.10)	(0.10)	(0.10)
Size	0.00103	-0.00651	-0.00673	-0.0105
	(0.03)	(0.03)	(0.03)	(0.03)
Cost orientation	-0.0546***	-0.0528***	-0.0539***	-0.0525***
	(0.01)	(0.01)	(0.01)	(0.01)
Market orientation	0.116***	0.118***	0.118***	0.117***
	(0.01)	(0.01)	(0.02)	(0.01)
Engaging in international markets	0.181***	0.197***	0.187***	0.192***
	(0.07)	(0.07)	(0.07)	(0.07)
Aggregated spillovers	0.0590***	0.0583***	0.0576***	0.0579***
	(0.00)	(0.00)	(0.00)	(0.00)
Cooperation	0.305***			
	(0.08)			
R&D Investments	0.206***	0.210***	0.323***	0.246***
	(0.05)	(0.05)	(0.07)	(0.06)
Marketing investments	0.0616	0.0657	0.0307	0.152*
	(0.06)	(0.06)	(0.08)	(0.09)
Barriers to innovation	-0.0273	-0.0194	-0.0202	-0.0196
	(0.05)	(0.05)	(0.05)	(0.05)
Cooperating with customers		0.308***	0.405***	0.290***
		(0.09)	(0.10)	(0.09)
Other types of cooperation		0.296**	0.272**	0.304**
		(0.13)	(0.13)	(0.13)
Cooperation X R&D			-0.239***	
			(0.09)	
Cooperation X Marketing			0.121	
			(0.13)	
R&D X Marketing				-0.0897
				(0.06)
Cooperation X R&D X Marketing				0.0510
				(0.06)
Constant	-1.332***	-1.345***	-1.338***	-1.326***
	(0.12)	(0.12)	(0.12)	(0.12)
Number of observations	2272	2218	2218	2218
Censured observations	1443	1401	1401	1401
Chi squared	191.06	201.22	210.59	204.77
p<0.005	0.00	0.00	0.00	0.00

Marginal effects . * $p < .10$, ** $p < .05$, *** $p < .01$

Table 1b: Two-Stage Generalized Tobit – Whole Sample; Outcome Equation

Share of Innovative Sales	**(1)**	**(2)**	**(3)**	**(4)**
Being part of a group	0.424**	0.471**	0.458**	0.456**
	(0.21)	(0.21)	(0.21)	(0.21)
Being a start-up	0.103	0.104	0.113	0.111
	(0.30)	(0.30)	(0.29)	(0.29)
Size	0.731***	0.747***	0.740***	0.738***
	(0.09)	(0.09)	(0.08)	(0.09)
Aggregated spillovers	-0.0252	-0.0202	-0.0100	-0.0171
	(0.03)	(0.03)	(0.02)	(0.03)
Aggregated Cooperation	-0.227			
	(0.25)			
R&D Investments	-0.0675	-0.0706	0.0271	-0.0415
	(0.12)	(0.12)	(0.17)	(0.15)
Marketing investments	0.332**	0.327**	0.402**	0.391*
	(0.15)	(0.15)	(0.20)	(0.22)
Cooperating with customers		-0.264	-0.0495	-0.185
		(0.26)	(0.32)	(0.27)
Other types of cooperation		-0.0666	-0.0714	-0.105
		(0.38)	(0.37)	(0.38)
Cooperation X R&D			-0.162	
			(0.21)	
Cooperation X Marketing			-0.0550	
			(0.28)	
R&D X Marketing				0.0598
				(0.15)
Cooperation X R&D X Marketing				-0.108
				(0.13)
Constant	5.544***	5.323***	4.977***	5.225***
	(0.80)	(0.78)	(0.78)	(0.79)
Mills/Lambda	-2.080***	-1.993***	-1.757***	-1.912***
	(0.49)	(0.48)	(0.49)	(0.50)

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 2a: Two-Stage Generalized Tobit –Radical Sample; Selection Equation

Selection Equation : Innovation (1\0)	(1)	(2)	(3)	(4)
Being a multinational	-0.0648	-0.0586	-0.0621	-0.0577
	(0.09)	(0.09)	(0.09)	(0.09)
Being a start-up	-0.0536	-0.0485	-0.0496	-0.0477
	(0.12)	(0.12)	(0.12)	(0.12)
Size	-0.00816	-0.00777	-0.00696	-0.0134
	(0.04)	(0.04)	(0.04)	(0.04)
Cost orientation	-0.0580***	-0.0575***	-0.0579***	-0.0570***
	(0.02)	(0.02)	(0.02)	(0.02)
Market orientation	0.122***	0.123***	0.124***	0.122***
	(0.02)	(0.02)	(0.02)	(0.02)
Engaging in international markets	0.429***	0.420***	0.418***	0.415***
	(0.09)	(0.09)	(0.09)	(0.09)
Aggregated spillovers	0.0473***	0.0473***	0.0471***	0.0469***
	(0.01)	(0.01)	(0.01)	(0.01)
Cooperation	0.407***			
	(0.09)			
R&D Invesments	0.173***	0.174***	0.194***	0.212***
	(0.05)	(0.05)	(0.07)	(0.06)
Marketing investments	0.156**	0.156**	0.135*	0.247***
	(0.06)	(0.06)	(0.08)	(0.09)
Barriers to innovation	-0.157***	-0.154***	-0.155***	-0.158***
	(0.06)	(0.06)	(0.06)	(0.06)
Cooperating with customers		0.401***	0.413***	0.369***
		(0.10)	(0.11)	(0.10)
Other types of cooperation		0.428***	0.425***	0.447***
		(0.14)	(0.15)	(0.15)
Cooperation X R&D			-0.0434	
			(0.09)	
Cooperation X Marketing			0.0527	
			(0.12)	
R&D X Marketing				-0.107*
				(0.06)
Cooperation X R&D X Marketing				0.0768
				(0.05)
Constant	-2.007***	-2.021***	-2.021***	-1.995***
	(0.16)	(0.16)	(0.16)	(0.16)
Number of observations	2253	2199	2199	2199
Censured observations	1898	1847	1847	1847
Chi squared	83.28	82.97	95.25	86.74
p<0.005	0.00	0.00	0.00	0.00

Marginal effects . * $p < .10$, ** $p < .05$, *** $p < .01$

Table 2b: Two-Stage Generalized Tobit – Radical Sample; Outcome Equation

	(1)	(2)	(3)	(4)
Being part of enterprise group	0.600*	0.623*	0.480	0.579*
	(0.32)	(0.32)	(0.31)	(0.32)
Being a start-up	-0.133	-0.124	-0.199	-0.122
	(0.46)	(0.46)	(0.45)	(0.46)
Size	0.752***	0.751***	0.725***	0.736***
	(0.12)	(0.12)	(0.12)	(0.12)
Aggregated Spilovers	-0.0470	-0.0459	-0.0387	-0.0422
	(0.03)	(0.03)	(0.03)	(0.03)
Aggregated Cooperation	-0.612*			
	(0.36)			
R&D Investments	-0.179	-0.176	0.242	-0.156
	(0.16)	(0.16)	(0.22)	(0.20)
Marketing investments	0.0559	0.0602	0.292	0.143
	(0.18)	(0.18)	(0.28)	(0.29)
Cooperating with customers		-0.631*	0.0436	-0.459
		(0.38)	(0.45)	(0.39)
Other types of cooperation		-0.513	-0.712	-0.622
		(0.55)	(0.53)	(0.55)
Cooperation X R&D			-0.590**	
			(0.26)	
Cooperation X Marketing			-0.182	
			(0.34)	
R&D X Marketing				0.177
				(0.19)
Cooperation X R&D X Marketing				-0.225
				(0.16)
Constant	5.282***	5.225***	4.677***	4.988***
	(1.20)	(1.22)	(1.21)	(1.23)
Mills/Lambda	-1.733***	-1.700***	-1.415**	-1.552**
	(0.59)	(0.60)	(0.60)	(0.61)

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 3a: Two-Stage Generalized Tobit –Incremental Sample; Selection Equation

	(1)	(2)	(3)	(4)
Being part of a group	0.0700	0.0652	0.0516	0.0621
	(0.07)	(0.08)	(0.08)	(0.08)
Being a start-up	0.0573	0.0667	0.0665	0.0666
	(0.10)	(0.10)	(0.10)	(0.10)
Size	0.0180	0.00914	0.00590	0.00527
	(0.03)	(0.03)	(0.03)	(0.03)
Cost orientation	-0.0139	-0.0119	-0.0126	-0.0116
	(0.01)	(0.02)	(0.02)	(0.02)
Market orientation	0.0533***	0.0549***	0.0529***	0.0534***
	(0.02)	(0.02)	(0.02)	(0.02)
engagement in int. markets	-0.0420	-0.0174	-0.0328	-0.0227
	(0.07)	(0.07)	(0.07)	(0.07)
Aggregated spillovers	0.0390***	0.0378***	0.0373***	0.0376***
	(0.01)	(0.01)	(0.01)	(0.01)
Cooperation Dummy	0.00150			
	(0.08)			
R&D investments	-0.000165	0.00438	0.113*	0.0246
	(0.05)	(0.05)	(0.06)	(0.05)
Marketing expenditures	-0.116*	-0.111*	-0.0793	-0.0635
	(0.06)	(0.06)	(0.08)	(0.09)
Perceived barriers to innovation	0.0870*	0.0947**	0.0964**	0.0948**
	(0.05)	(0.05)	(0.05)	(0.05)
Cooperation with customers		0.00298	0.158	0.0261
		(0.09)	(0.11)	(0.10)
Other types of cooperation		-0.0142	-0.0554	-0.0285
		(0.14)	(0.14)	(0.14)
Cooperation X R&D			-0.241***	
			(0.09)	
Cooperation X Marketing			-0.0135	
			(0.13)	
R&D X Marketing				0.00941
				(0.06)
Cooperation X R&D X Marketing				-0.0553
				(0.06)
Constant	-1.519***	-1.526***	-1.509***	-1.508***
	(0.13)	(0.13)	(0.13)	(0.13)
N	2266	2212	2212	2212
r2_p	0.06	0.06	0.06	0.07
chi2	129.57	125.10	133.68	137.90
P	0.000	0.000	0.000	0.000

Marginal effects . * $p < .10$, ** $p < .05$, *** $p < .01$

Table 3b: Two-Stage Generalized Tobit – Incremental Sample; Outcome Equation

	(1)	(2)	(3)	(4)
Being part of a group	0.151	0.0888	0.0929	0.0922
	(0.16)	(0.15)	(0.15)	(0.15)
Being a start-up	0.0649	-0.0468	-0.0495	-0.0327
	(0.21)	(0.20)	(0.20)	(0.20)
Size	0.284***	0.271***	0.275***	0.248***
	(0.06)	(0.06)	(0.06)	(0.06)
Cost orientation	-0.0872***			
	(0.03)			
Market orientation	0.170***			
	(0.07)			
engagement in int. markets	0.260*			
	(0.14)			
Aggregated spillovers	0.0904**	0.0172	0.0158	0.0199
	(0.04)	(0.02)	(0.02)	(0.02)
Cooperation Dummy	0.583***			
	(0.17)			
R&D investments	0.370***	0.365***	0.382***	0.553***
	(0.10)	(0.10)	(0.14)	(0.11)
Marketing expenditures	0.325*	0.536***	0.437**	0.995***
	(0.17)	(0.13)	(0.17)	(0.18)
Cooperation with customers		0.741***	0.657***	0.621***
		(0.19)	(0.23)	(0.19)
Other types of cooperation		0.349	0.357	0.397
		(0.28)	(0.28)	(0.28)
Cooperation X R&D			0.0160	
			(0.21)	
Cooperation X Marketing			0.209	
			(0.25)	
R&D X Marketing				-0.449***
				(0.12)
Cooperation X R&D X Marketing				0.286***
				(0.11)
Constant	-1.005	3.605***	3.645***	3.396***
	(2.47)	(0.87)	(0.90)	(0.88)
Mills/ Lambda	0.0260	-2.366***	-2.391***	-2.208***
	(1.29)	(0.47)	(0.49)	(0.48)

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 4: Summary of Hypotheses

	Introduction of a new product			Innovative sales		
	Whole Sample	**Radical Innovators**	**Incremental Innovators**	**Whole Sample**	**Radical Innovators**	**Incremental Innovators**
Hypothesis 1	supported	supported	not supported	not supported	not supported	supported
Hypothesis2	supported	supported	not supported	supported	not supported	supported
Hypothesis 3	supported	supported	not supported	not supported	not supported	supported
Hypothesis 4	not supported	supported	not supported	not supported	not supported	not supported
Hypothesis 5	supported	supported	not supported	not supported	not supported	not supported
Hypothesis 6	not supported	not supported	not supported	not supported	not supported	not supported

Figures

Figure 1: Theoretical model

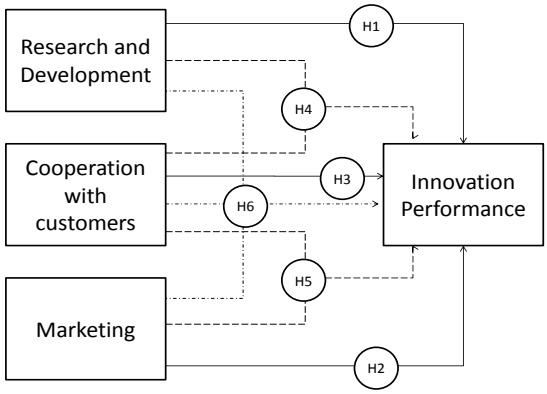


Figure 2: Interaction terms for Model 3; Cooperation with customers and R&D / Marketing – Whole Sample

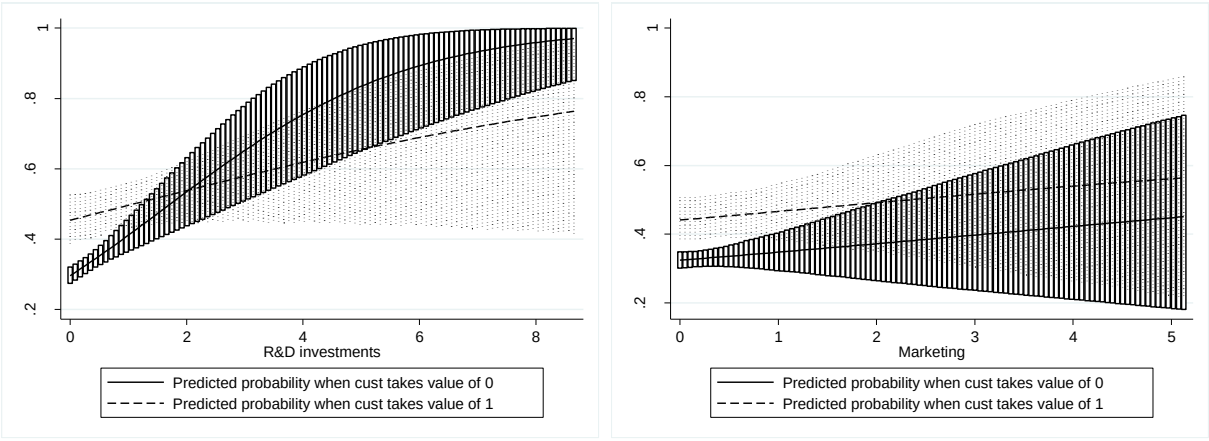


Figure 3: Interaction terms for Model 4; Cooperation with customers, R&D and Marketing – Whole Sample

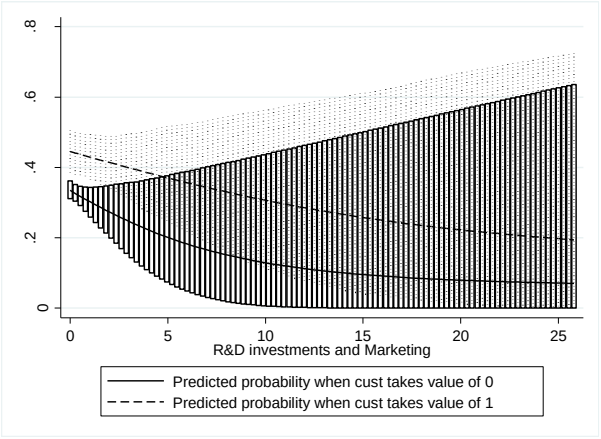


Figure 4: Interaction terms for Model 3; Cooperation with customers and R&D /Marketing – Radical Innovators

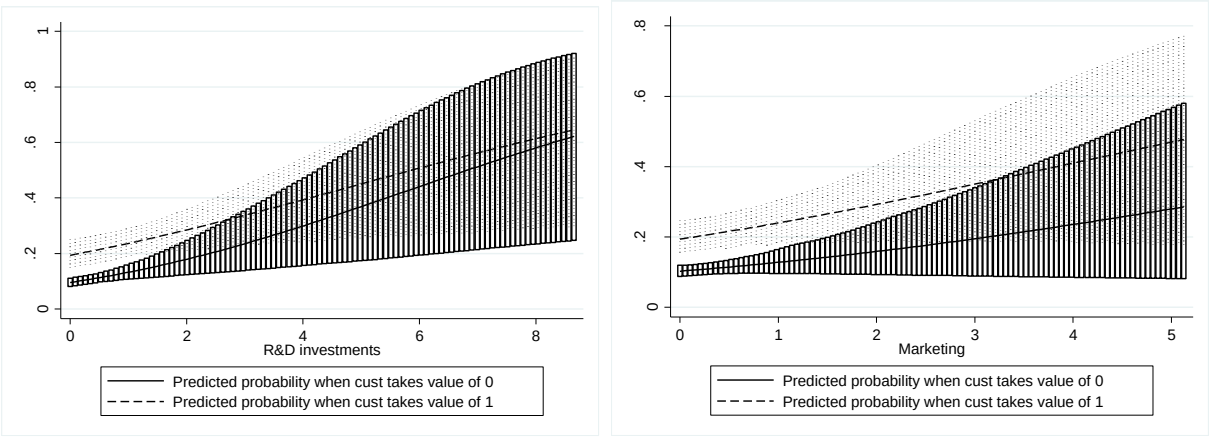


Figure 5: Interaction terms for Model 4; Cooperation with customers, R&D and Marketing – Radical Innovators

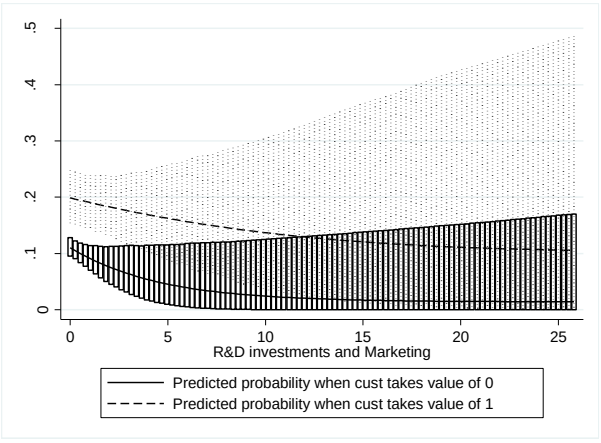


Figure 6: Interaction terms for Model 3; Cooperation with customers and R&D /Marketing – Incremental Innovators

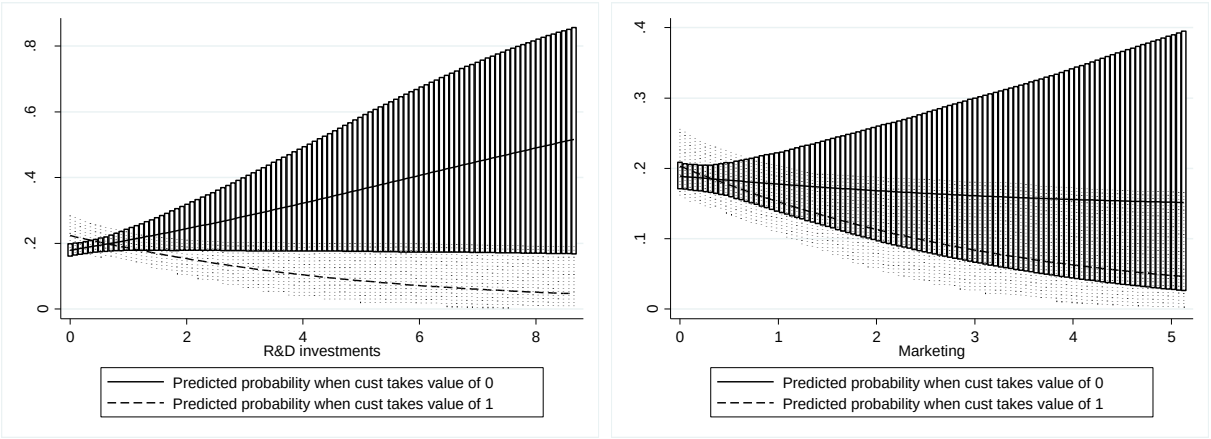
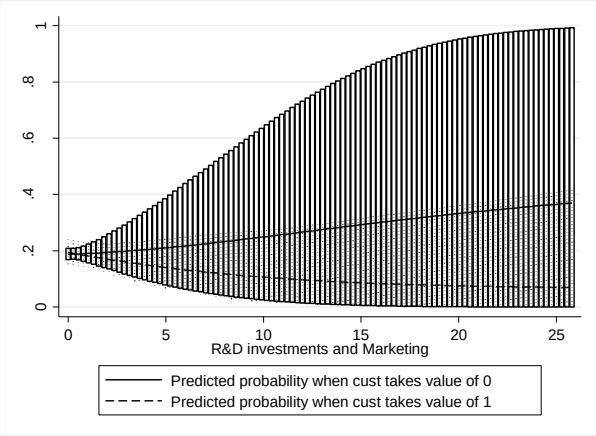


Figure 7: Interaction terms for Model 4; Cooperation with customers, R&D and Marketing – Incremental Innovators



References:

Ahuja, G. 2000. Collaboration networks, structural holes and Innovation: A longitudinal study, ***Administrative Science Quarterly,*** 45: 425-55.

Ahuja, G. and Katila, R. 2001. Technological Acquisition and the Innovative Performance of Acquiring Firms: A Longitudinal Study. ***Strategic Management Journal,*** 22(3):197–220.

Ai, C. and Norton, E.C. 2003. Interaction terms in logit and probit models, ***Economics Letters***, 80 (1): 123-129

Amit, R. and Schoemaker, P.H. 1993. Strategic Assets and Organizational Rent. ***Strategic Management Journal,*** 14: 33–46

Arora A., A. Fosfuri and A. Gambardella. 2004. ***Markets for Technology: The Economics of Innovation and Corporate Strategy***, MIT Press Books, The MIT Press, edition 1, volume 1.

Artz, K., H. Norman, D.E. Hatfield & L.B Cardinal, 2010. A Longitudinal Study of the Impact of R&D, Patents, and Product Innovation on Firm Performance. ***Journal of Product Innovation Management,*** 27: 725-740

Atuahene-Gima, 2005. Resolving the Capability-Rigidity Paradox in New Product Innovation. ***Journal of Marketing,*** 69: 61-83

Atuahene-Gima and Ko, A. 2001. An Empirical Investigation of the Effect of Market Orientation and Entrepreneurship Orientation Alignment on Product Innovation," ***Organization Science,*** 12 (1): 54–74.

Barney, Jay B. 1991. Firm Resources and Sustained Competitive Advantage," ***Journal of Management***, 17 (1): 99–120.

Belderbos, R., Carree, M., Lokshin, B. 2004a. Co-operative R&D and firm performance. ***Research Policy,*** 33 (10), 1477–1492.

Belderbos, R., Carree, M., Diederen, B., Lokshin, B., Veugelers, R., 2004b. Heterogeneity in R&D co-operation strategies. ***International Journal of Industrial Organization,*** 22 (8/9), 1237–1263.

Bell, M., Pavitt, K., 1993. Technological accumulation and industrial growth: contrasts between developed and developing countries. ***Industrial and Corporate Change,*** 2 (2): 157–210.

Bennett, R. C., and R. G. Cooper. 1981. The misuse of marketing: An American tragedy. ***Business Horizons*** 24 (6): 51–61.

Bogers, M., Afuah, A. and Bastian, B. 2010. Users as Innovators: A Review, Critique, and Future Research Directions. ***Journal of Management***, 36(4): 857-875.

Bonaccorsi, A., Lipparine, A., 1994. Strategic partnerships in new product development: an Italian case study. ***Journal of Product Innovation Management,*** 11 (2): 134–145.

Bozeman, B., 2000. Technology transfer and public policy: a review of research and theory. ***Research Policy,*** 29 (4/5): 627–655.

Brockhoff, K., 2003. Customers' perspectives of involvement in new product development. ***International Journal of Technology Management,*** 26 (5/6): 464–481.

Brown, S. L. and K. M. Eisenhardt. 1995. Product Development: Past Research, Present Findings, and Future Directions. ***Academy of Management Review***, 20 (2), 343–78.

Cassiman. B., Veugelers, R. 2002. R&D Cooperation and Spillovers: Some Empirical Evidence from Belgium. ***American Economic Review***, 92(4): 1169-118.

Cassiman, B., Veugelers, R., 2006. In search of complementarity in innovation strategy: internal R&D and external knowledge acquisition. ***Management Science,*** 52: 68–82.

Cardinal, L.B. and Hatfield, D.E. 2000. Internal Knowledge Generation: The Research Laboratory and Innovative Productivity in the Pharmaceutical Industry. ***Journal of Engineering & Technology Management,*** 17(3–4):247–271.

Chesbrough, H. 2003a. **Open innovation: The new imperative for creating and profiting from technology**. Boston: Harvard Business School Press.

Christensen, C. M., and J. L. Bower. 1996. Customer power, strategic investment, and the failure of leading firms. ***Strategic Management Journal*** 17 (3): 197–218.

Cohen,W.M., Levinthal, D.A., 1990. Absorptive capacity: a new perspective on learning and innovation. ***Administrative Science Quarterly,*** 35 (1): 128–152.

Cohen, W.M. 1995. ***Empirical studies of innovative activities. In Handbook of the economics of innovation and technological change***, (eds). P. Stoneman, 182–264. Oxford: Basil Blackwell.

Cockburn I. A, Henderson RM, Stern S., 2000. Untangling the origins of competitive advantage. ***Strategic Management Journal,*** 21(10):1123–45.

Cooper, R. G. and Kleinschmidt, E. 1986. An Investigation into the New Product Process: Steps, Deficiencies, and Impact, ***Journal of Product Innovation Management*** 3(2):71–85

Day, George S. 1994. The Capabilities of Market-Driven Organizations. ***Journal of Marketing***, 58: 37–52.

Dewar, R. D. & Dutton, J. E. 1986. The adoption of radical and incremental innovations: an empirical analysis. ***Management Science***, Vol. 32(11):1422-1433.

Dierickx, I. and Cool, K. 1989. Asset stock accumulation and sustainability of competitive advantage. ***Management Science***, 35: 1504–11.

Escribano, A. Fosfuri & J.A. Tribó. 2009. Managing external knowledge flows: the oderating role of absorptive capacity ***Research Policy,*** (39): 96–105

Ebersberger B., O. Marsili, Reichstein, T. and A. Salter, 2010. Into thin air: using a quantile regression approach to explore the relationship between R&D and innovation. ***International Review of Applied Economics***, 24(1): 95-102.

Freel, M.S., 2003. Sectoral patterns of small firm innovation, networking and proximity. ***Research Policy,*** 32 (4), 751–770.

Freitas, I.M.B., Clausen, T., Fontana, R. and Verspagen, B. 2011. Formal and Informal External Linkages and Firms' innovative strategies. A cross-country comparison. ***Journal of Evolutionary Economics***, 21:91–119

Gambardella, A., 1992. Competitive advantages from in-house scientific research: the US pharmaceutical industry in the 1980s. ***Research Policy,*** 21: 391–407.

Gatignon, H., M.L. Tushman, W. Smith and P. Anderson. 2004. A Structural Approach to Assessing Innovation: Construct Development of Innovation Locus, Type and Characteristics, ***Management Science***, 48: 1103-1123.

Griffin, A. and John R. Hauser. 1996. Integrating R&D and Marketing: A Review and Analysis of the Literature. ***Journal of Product Innovation Management***, 13 (3): 191–215.

Govindarajan, V., P. K. Kopalle, and E. Danneels. 2011. The Effects of Mainstream and Emerging Customer Orientations on Radical and Disruptive Innovations. ***Journal of Product Innovation Management***, 28(1):121-132

Gupta, A. K., S.P. Raj, and D. Wilemon. 1986. A Model for Studying R&D–Marketing Interface in the Product Innovation Process. ***Journal of Marketing***, 50 (April): 7–17.

Griffith, R., Redding, S., Van Reenen, J., 2004. Mapping the two faces of R&D: productivity growth in a panel of OECD countries. ***Review of Economics and Statistics,*** 86: 883–895.

Hall, B.J., Griliches, Z., and Hausman, J.A. 1986. Patents and R and D: Is There a Lag? ***International Economic Review,*** 27(2):265– 283.

Hamel, G., Prahalad, C. 1994. ***Competing for the Future***. Boston: Harvard Business School Press.

Hitt, M.A., Hoskisson, R.E., Johnson, R.A., and Moesel, D.A. 1996. The Market for Corporate Control and Firm Innovation. ***Strategic Management Journal,*** 39(5):1084–1119.

Hoetker G. 2007. The use of logit and probit models in strategic management research: critical issues. ***Strategic Management Journal,*** 28*(*4*):* 331–343

Huff, James O., Anne S. Huff, and Howard, T. 1992. Strategic Renewal and the Interaction of Cumulative Stress and Inertia. ***Strategic Management Journal,*** 13: 55–75.

Kleinknecht, A., and P. Mohnen, (eds.) 2002. ***Innovation and firm performance. Econometric explorations of survey data***. New York: Palgrave.

Leenders, M. and B. Wierenga. 2002 The effectiveness of different mechanisms for integrating marketing and R&D. ***Journal of Product Innovation Management***. 19:305-317

Levitt, T. 1960. Marketing myopia. ***Harvard Business Review*** 38 (4): 45–56.

Lööf, H., Heshmati, A., 2002. Knowledge capital and performance: a new firm level innovation study. ***International Journal of Production Economic,*** 76 (1), 61–85.

Love, J.H., Roper, S., 2001. Location and network effects on innovation success: evidence for UK, Germany and Irish manufacturing plants. ***Research Policy,*** 30 (4): 643–661.

Love, J. H., Roper, S. 2004. The organisation of innovation: collaboration, cooperation and multifunctional groups in UK and German manufacturing. ***Cambridge Journal of Economics,*** 28(3):379-395.

Love J H and Roper, S. 2009. Organizing the Innovation Process: Complementarities in Innovation Networking. ***Industry and Innovation***, 16: 273-290.

Love, J. H., Roper, S., and Hewitt-Dundas, N. 2010. Service innovation, embeddedness and business performance: Evidence from Northern Ireland. ***Regional Studies***, 44: 983-1004.

Love J H, Roper, S and Bryson J R., 2011. Openness, knowledge, innovation and growth in UK business services. ***Research Policy***, 40(10) 1438-1452

Lüthje, C., Herstatt, C., and von Hippel, E. 2005. User-Innovators and ‘‘Local’’ Information: The Case of Mountain Biking. ***Research Policy,*** 34(6): 951–965

Lüthje, C., Herstatt, C., and von Hippel E. 2003. Patterns in the development of minor innovations by users: Bricolage in mountain biking. ***MIT Sloan School of Management Working Paper***, Cambridge MA

Mansfield, E. 1962. Entry, Gibrat’s Law, Innovation, and the Growth of Firms. ***American Economic Review,*** 55(5):1023–1051.

Mairesse, J., and Mohnen, P. 2002. Accounting for innovation and measuring innovativeness: An illustrative framework and an application. ***American Economic Review,*** 92(2): 226–31.

McMillan, C.S., Mauri, A., and Hamilton, R.D. 2003. The Impact of Publishing and Patenting Activities on New Product Development and Firm Performance: The Case of the US Pharmaceutical Industry. ***International Journal of Innovation Management,*** 7(2): 213–221.

Monjon, S., and Waelbroeck, P., 2003. Assessing spillovers from universities to firms: evidence from French firm-level data. ***International Journal of Industrial Organization,*** 21 (9): 1255–1270.

Morrison, P., Roberts, J., and von Hippel E. 2000. Determinants of user innovation and innovation sharing in a local market. ***Management Science***, 46(12): 1513-1527

Nieto MJ, Santamaría L. 2007. The importance of diverse collaborative networks for the novelty of product innovation. ***Technovation,*** 27(3):367–77.

Noble, Charles H., Rajiv K. Sinha, and Kumar, A. 2002. Market Orientation and Alternative Strategic Orientations: A Longitudinal Assessment of Performance Implications. ***Journal of Marketing***, 66: 25–39.

O'Connor, G.C. 1998. Market learning and radical innovation: a cross case comparison of eight radical innovation projects. ***The Journal of Product Innovation Management***, 15, 2, 151–166.

O'Connor, G.C. and Veryzer, R. 2001. The nature of market visioning for technology-based radical innovation. ***The Journal of Product Innovation Management***, 18, 231–246.

Penner-Hahn, J. and Shaver, J.M. 2005. Does International Research and Development Increase Patent Output? An Analysis of Japanese Pharmaceutical Firms. ***Strategic Management Journal,*** 26(2):121–140.

Peters, B., 2006. Persistence of Innovation: Stylised Facts and Panel Data Evidence. ***ZEW Discussion Paper*** 05(81).

Rosenberg, N. 1990. Why Do Firms Do Basic Research (with Their Own Money)? ***Research Policy,*** 19(2):165–174.

Schroeder, Roger G., Kimberly A. Bates, and Mikko A. Junttila. 2002. A Resource-Based View of Manufacturing Strategy and the Relationship to Manufacturing Performance. ***Strategic Management Journal,*** 23 (2), 105–117.

Slater S.F., and Narver, J.C. 1995. Market Orientation and the Learning Organization. ***Journal of Marketing***, 59: 63–74.

Stevens, G. A., J. Burley and R. Divine. 1999. Creativity + Business Discipline = Higher Profits Faster from New Product Development. ***Journal of Product Innovation Management***, 16(5): 455–468.

Stevens, Gregory A. and Burley, J. 1997. 3000 raw ideas= 1 commercial success! ***Research Technology Management,*** 40(3), pp. 16–27

Tsai, K-H and Hsieh, M-H. 2009. How different type of partners influence innovative product sales: Does technological capacity matter?' ***Journal of Business Research,*** 62: 1321-1328

Tsai, K-H and J-C Wang. 2009. External Technology Sourcing and innovation performance in LMT Sectors: An analysis based on the Taiwanese Technological Innovation Survey. ***Research Policy***, 28: 518-526

Tether, B. 2002. Who co-operates for innovation, and why: an empirical analysis. ***Research Policy***, 31(6): 947-967

Urban, G., von Hippel, E. 1988. Lead user analysis for the development of new industrial products. ***Management Science***, 34(5): 569 – 581

Von Hippel, E. 1976. The dominant role of users in the scientific instrument innovation process. ***Research Policy***, 5(3): 212-239

Von Hippel, E. 1977. Transferring process equipment innovations from user-innovators to equipment manufacturing firms. ***R&D Management,*** 8: 13–22

Von Hippel, E. 1994. "Sticky Information" and the Locus of Problem Solving: Implications for Innovation. ***Management Science,*** 40(4): 429-439

Von Hippel, E. 2005. ***Democratizing innovation***. Cambridge: MIT Press

Von Hippel, S. Ogawa and R.P.J de Jong. 2011. The Age of the Consumar-Innovator. ***MIT Sloan Management Review,*** (53)1:25-35

Wang, H. C., He, J. and Mahoney, J. T. 2009. Firm-specific knowledge resources and competitive advantage: the roles of economic- and relationship-based employee governance mechanisms. ***Strategic Management Journal,*** 30: 1265–85.

Weigelt, C. 2009. The impact of outsourcing new technologies on integrative capabilities and performance.***Strategic Management Journal,*** 30: 595–616.

Zahra, S.A and George, G. 2002. Absorptive capacity: a review, reconceptualization, and extension. ***Academy of Management Review***, 27 (2): 185–203

Zelner, B. A. 2009. Using simulation to interpret results from logit, probit, and other nonlinear models. ***Strategic Management Journal,*** 30(12):1097-0266

APPENDIX

A1. Description of Variables

Being a multinational:	1 if the firm is part of a corporate group, else 0
Start-up dummy:	1 is the firm has been founded after 01/01/.2000
Size:	Logarithm of number of employees
Cost Orientation:	Sum of scores on cost-saving objectives of the firm.
Market Orientation:	Sum of scores on demand enhancing objectives of the firm.
Engagement in international markets:	1 if the firm performed in international markets , else 0
Aggregated spillovers:	Average of sources of knowledge for the firm's innovation process. Constructed as residual from the auxiliary regression of spillover taken from 2004-2006 survey on the cooperation dummy taken from 2002-2004 survey
Cooperation:	
Investing in internal R&D:	Logarithm of internal R&D expenditures
Investing in marketing:	Logarithm of marketing expenditures
Barriers to innovation:	Average sum of scores on barriers question
Cooperating with customers:	1 if firm cooperates with its customers
Other types of cooperation:	1 if firm cooperates with other partners

A.2 Summary Statistics

		Obs.	Mean	Std. Dev.
1	Innovative sales	2272	2.54	3.73
2	Radical innovative sales	2253	1.22	2.69
3	Incremental innovative sales	2255	1.74	3.11
4	Innovation	2272	0.36	0.48
5	Radical innovation	2266	0.16	0.37
6	Incremental innovation	2266	0.20	0.40
7	Being part of a group	2272	0.49	0.50
8	Being a start-up	2272	0.10	0.30
9	Size	2272	4.09	1.38
10	Cost orientation	2272	4.54	3.09
11	Market orientation	2272	4.72	3.04
12	Engagement in int. Markets	2272	0.58	0.49
13	Aggregated spillovers	2272	5.64	6.92
14	Cooperation with customers	2218	0.15	0.36
15	Other types of cooperation	2272	0.05	0.22
16	R&D investments	2272	0.32	0.79
17	Marketing expenditures	2272	0.16	0.55

A.3 Correlation Table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1																
2	0.69															
3	0.83	0.47														
4	0.91	0.60	0.74													
5	0.59	0.79	0.38	0.58												
6	0.54	-0.01	0.53	0.67	-0.22											
7	0.21	0.15	0.20	0.13	0.11	0.06										
8	-0.01	-0.02	-0.01	0.00	-0.02	0.02	-0.06									
9	0.32	0.24	0.29	0.18	0.17	0.06	0.53	-0.06								
10	0.19	0.14	0.16	0.18	0.11	0.11	0.11	-0.04	0.20							
11	0.32	0.24	0.26	0.30	0.23	0.15	0.15	0.00	0.19	0.72						
12	0.23	0.18	0.19	0.19	0.20	0.05	0.30	-0.07	0.33	0.17	0.22					
13	0.37	0.27	0.30	0.35	0.25	0.20	0.15	0.00	0.21	0.29	0.31	0.16				
14	0.24	0.23	0.21	0.19	0.21	0.04	0.19	0.00	0.24	0.16	0.23	0.21	0.08			
15	0.06	0.06	0.04	0.06	0.07	0.00	0.01	-0.04	0.04	0.04	0.08	0.04	-0.01	-0.10		
16	0.37	0.33	0.29	0.26	0.29	0.05	0.26	-0.02	0.49	0.15	0.21	0.24	0.22	0.35	0.07	
17	0.29	0.28	0.24	0.19	0.23	0.02	0.20	-0.04	0.36	0.12	0.19	0.14	0.18	0.25	0.05	0.47