Marketing and Organisational Innovations in Entrepreneurial Innovation Processes and their Relation to Market Structure and Firm Characteristics

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Abstract: This paper analyses the influence of marketing and organisational changes on the innovation process. Using data from the German Community Innovation Survey (CIS) 2007, two questions are investigated. Firstly, do certain firm and market characteristics trigger certain innovation strategies? This allows the examination of whether product/ process (PP) and marketing/ organisational (MO) innovations are more likely to occur in monopolistic or competitive markets, whether there is an "innovation-maximising" degree of competition, but also how important human capital is for the implementation of specific innovation strategies. Secondly, are MO innovations complementary to PP innovations or do they substitute them?

Our results suggest that firms choose broad innovation strategies, if they have high internal resources and if they have intermediate market power. We also find that marketing innovations make product and process innovations more successful on the market (product innovations) and in terms cost reductions (process innovations), while there is no positive apparent effect of organisational innovations and product and process innovations.

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1 Introduction

In July 2005, the 3rd version of the OSLO Manual, a handbook for interpreting innovation data forming the conceptual basis for designing and conducting the Community Innovation Survey (CIS), was published (OECD, 2005). It now defines the term innovation more broadly than before. Apart from product and process innovations (often called technological innovations), marketing and organisational innovations (non-technological innovations) are also included. The precise definitions of the latter are as follows:

> *An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations (OECD, 2005, p.51)*
>
> *A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing (OECD, 2005, p. 49).*

This broad understanding of innovation has however also brought opponents into the arena, who argue that this definition blurs the boundary between (technological) innovation, on the one side, and marketing as well as organisational change on the other side. In essence, the dispute is not about whether these activities are important, but about whether they can be classified as innovations.

In any case, whether marketing and organisational change are true innovations or not is a very conceptual question, where the sceptics would argue that it is technological progress that secures long-term growth and economic well-being. On the contrary, the proponents argue that, since also MO innovations have the potential to reduce costs or increase the willingness-to-pay just like PP innovations, they should be classified as innovations.

Because the (technological) innovation process is embedded both in the firm's organisational setting and the firm's market environment it is, however, undisputed that both marketing and organisational innovations are economic activities which are highly interrelated with the technological innovation process.

The aim of this paper is thus to explore the role of marketing and organisational innovations, when firms introduce product or process innovations. Specifically, the paper tries to give answers on two questions.

Firstly: how do firms decide on their innovation strategy in terms of technological and non-technological innovations as a response to internal resource and external market constraints?

Secondly: What is the internal relationship between technological and non-technological innovations, i.e. do both types of innovations complement or substitute each other? As a simple example, we could think of marketing innovations (e.g. a new packaging) that replaces the introduction of a new product. But we could also think of a situation, where a marketing innovation is a necessary follow-up of a product innovation and increases its market success.

Providing answers to these questions – some of them certainly tentative – allows a deeper understanding of how firms facing specific internal and external constraints choose their innovation strategies. It is also argued that the relationship between innovative activity (more precisely scope of the strategy) and the degree of competition depends on the innovation type. Furthermore, it is shown that especially marketing innovation increase the success with PP innovations, which indicates that marketing innovations complement PP innovations rather than substitute them.

The remainder of this paper is organised as follows: Section 2 provides a literature review of the issues raised and gives some background on non-technological innovations. Section 3 presents the hypotheses to be tested. In Section 4 we introduce the data set, give the details of the econometric methodology, and provide the rationale for our variable selection. Section 5 presents and discusses the results. Section 6 concludes.

2 Literature review

This paper addresses two issues: firstly, the paper tries to relate the choice of innovation strategy to market and resource constraints. Secondly, we ask whether MO and PP innovations are complements or substitutes. In the following, we will shortly review the literature dealing with these two questions.

Concerning the first, Schumpeter (1934, 1943) emphasised the role of the market as a dominant force for innovation activity. Many branches of economic literature were affected by Schumpeter's ideas. Especially industrial economics has advanced the analyses of the linkage between innovation and market structure.

One of the most important contributions in the field of market structure and technological innovation dates back to Arrow (1962), who showed that monopolists have smaller incentives for innovation, because they cannibalise the profits from their old technology. This is also called the replacement effect (see Tirole, 1997). On the other hand, a traditional counterargument suggests that perfect markets are dynamically inefficient (despite their static allocative efficiency), because no profits can be made in competi-

tive markets. Therefore, if innovations cannot be effectively protected (resulting in a monopolisation) there is no incentive to innovate.

Both arguments taken together suggest that maybe an intermediate market power might maximise incentives for innovation, trading off the replacement effect and the lack of necessary market power to reap the profits.

However, Scherer (1967) has claimed postulated just the opposite: an inverted u-shape This is taken up by Aghion et al. (2004) who formalise his idea and argue that firms trade-off two effects: on the one hand, for low initial competition firms try to search for niches to evade competition. On the other hand, high competition might increase the incremental profits from innovation, because it lowers pre-innovation rents more than post-innovation rents.

In fact, there are many more economic arguments, predicting a variety of relationships. This becomes especially obvious in Scott (2009) who develops a theory which is compatible with almost any relationship. Thus, theory does not give a clear statement about what to expect, which is why we will not go into further details and refer to the literature. Two old, yet worthwhile, summaries of the theoretical approaches can be found in Kamien and Schwartz (1982) and Scherer (1984). A more recent and concise overview is given by van Cayseele (1998).

Focussing on more empirical papers, we have diverse results as well. Crepon et al. (1998) find that R&D activities increase in the market share of a firm. Similarly, Nickel (1994) finds a positive correlation between competition and innovative output. Differently Vossen (1999) concludes that greater market power might be detrimental for innovative efforts. A third position is taken by Chang and Robin (2006) who demonstrate the existence of an inverted u-shaped pattern for the case of R&D intensity as a function of firm size (proxying market power) in Taiwanese manufacturing.[3]

Coming to the internal resources and capabilities, more agreement in the literature can be found. Penrose (1959) was the first to draw attention to the firm-specific resources for innovation. This was later on popularised as the resource-based view in management literature (see Wernerfelt, 1984, 1995), where a resource is understood as being any asset, whether tangible or not, that can be attributed to the domain of the firm. In

3 Of course the market structure has more characteristics than just market share: in this vein, using an older CIS survey Aschoff et al. (2007) observe positive effects of greater technological dynamics, and shorter product cycles. They also observe that the firms which have a large share of turnover with their three main customers have lower innovation activites.

this understanding, this includes amongst others, technological knowledge, human capital and management capabilities, but also very tangible assets like financial resources. We will not go into more details here, because the agreement in the literature is quite intuitive and states that firms tend to be more innovative, if their resources are higher.

So, especially for the market structure, literature does not give clear guidance. Things are made even more complex, if one takes into account that firms also have to choose between different types of innovation. I.e. they may change characteristics of their product or they might want to change their production processes. Some papers analyse the optimal choice between cost reductions and product differentiation (compare Bonanno and Harworth, 1998, Lambertini and Mantovano, 2009).

Yet non-technological innovations are usually not taken into account. To my knowledge, the only paper that addresses MO innovations explicitly is written by Rammer et al. (2009), who show that small firms may substitute R&D by organisational change.

In essence, concerning the first question, from the literature we know something about how innovation as an aggregate is determined by competition and the resources (although the results are not univocal). There are at least some analyses of how firms choose between product and process innovations, but we know almost nothing about the choice between technological and non-technological innovations.

How firms choose between MO and PP innovations certainly depends on how both types of innovation interrelate. This brings up the question of complementarity. Concerning this, most researchers argue that changes in marketing as well as organisational restructuring are often continuous processes and important activities to maintain a firm’s competitiveness. In this context, Brown and Duguid (1991) used the term 'co-production' of technological and organisational innovations, which implicitly indicates that both types of innovations are not independent. Moreover, if their notion were right, then they would be self-enforcing and, in economic terms, complementary.

The same argument is taken up by Brown (2002) who states that technological and organisational architectures must be re-designed to make a continuously innovating company possible. A similar conclusion could be drawn from the wording "techno-organisational innovations", which is used by Kishore and McLean (2002), again indicating that the two actually belong together. More explicitly, Strambach (2002) argues that the economic performance of he Stuttgart region derives from the generation of synergy effects of technological and institutional innovations.

Djellal and Gallouj (1999) as well as Tether et al. (2002) observe for the service sector that technological and organisational innovations are highly correlated. The interdependency also extends to the link between technological innovations and new marketing practices. Lewis and Wackowski (2006) argue that it was the co-development of product and marketing innovations that made the tobacco industry so successful in the past. Though clearly a less desirable innovation from a societal point of view, they name the example of flavoured cigarettes, where large-scale marketing campaigns greatly supported market penetration.

And yet, apart from this interdependency, there are other voices in the literature, saying that firms can be quite successful with MO innovations only. In a study in the food industry, Bhaskaran (2006) finds that SMEs focussing on marketing innovations are profitable and can compete also with larger enterprises. Yeh and Chou (2007) regard organisational innovations as appropriate measures for sustaining competitive advantage, without making an explicit linkage to technological innovations. In essence, this would mean that there must be more to MO innovations than just being an auxiliary activity for technological innovations. Maybe in some cases they are substitutes rather then complements. Yet most of the literature would argue in favour of complementarity.

In the next section we present our research hypotheses, which are guided by the literature overview.

3 Research hypotheses

As the literature review has argued, firms' innovation processes are shaped by internal (the resources a firm can command) and external constraints (the supplier and markets and their structures a firm faces). Especially when firms are pure MO innovators (i.e. they do not innovate in a technological dimension), we would expect this event to be related to very special kinds of firm and market characteristics. Thus, our first expectation is that that the model explaining why a firm is an MO innovator differs significantly from a model explaining whether or not a firm is a product innovator. Because it is often taken for granted that manufacturing and services are fundamentally different, we will also expect a difference between these sectors. We summarise in Hypothesis 1.

> *H1: a) Resource and market constraints have influence on whether firms choose to be an MO or a PP innovator. Pure MO innovators differ fundamentally from firms conducting also technological innovations in their resource endowment and their market environment. b) Manufacturing and service firms act differently when faced with similar resource and market constraints.*

In fact, there is no overwhelming support for H1b (see Section 5.1). That is why we will not make explicit distinctions between service and manufacturing firms from now on.

So far we have hypothesised on how non-technological differ from technological innovators. But firms of course have much more detailed decisions to make. On the one side of the spectrum, they may follow the strategy not to innovate at all, while on the other side they could combine MO and PP innovations. This allows at least a partial ordering of innovation activities along their scope or breadth. Since broad innovation activities require considerably more resources, we expect a positive association, while firms with no or narrow innovation activities are expected to be endowed with only few resources.

> *H2: The greater a firm's resources are, the broader its innovation strategy is. Inasmuch as MO innovations are thought to be less demanding than technological change, we expect to observe a positive association between resources and technological innovations and a negative between resources and MO innovations.*

With respect to the market structure, we saw that economic theory and empirical estimations give very diverse results. Thus, in the light of so many theories it does not seem to be useful to give detailed expectations about specific effects of different aspects of the market structure. Therefore, leaving the details to the data analysis, we prefer to be exploratory here, and summarise in a "minimal" expectation as follows:

> *H3: The market structure plays a decisive role in determining the scope of the innovation strategy.*

Turning to the linkage between technological and non-technological innovations, the literature review has shown that, although occasionally there may be a substitutive relationship, usually the non-technological innovations are thought to complement each other. This leads once again to a "signed" expectation, namely:

> *H4: MO innovations and PP innovations are complementary. Especially: MO innovations (causally) make the introduction of PP innovations more successful.*

4 The data source and econometric methodology

4.1 The data source

The data source used in this paper is the German Community Innovation Survey 2007 (CIS 2007). CIS is set of national surveys conducted every two years (up to 2005 every

four) in all Member States of the EU. The CIS survey which was conducted for the fifth time in 2007 is largely harmonised across all participating countries, which allows country comparisons.[4]

Concerning the data structure, the CIS survey is a moving cross-section, comprising in 2007 a sample of 5,561 firms (participation rate of about 20%) from each sector, including besides manufacturing firms also services.[5] To be sampled firms must have at least 5 employees. Also note that a stratified sampling scheme with respect to eight firm size categories, two regional categories (east and west Germany), and 59 sectors is employed.

The main focus of the survey is on the innovative activities, including product and process innovations and lately also marketing and organisational innovations. But it contains many questions which are deemed to be relevant for the entrepreneurial innovation process, such as market conditions, public subsidies, hampering factors, and other firm-specific details.

Concerning the MO innovations, firms were asked whether different types of marketing and organisational innovation had been introduced within the period 2004-2006. Marketing innovations were split into changes to design or packaging, product promotion, product placement, and pricing, whereas in the area of organisational innovations distinctions were made between changes to business practices (e.g. quality management or lean production), knowledge management, organisation of work responsibilities and decision-making, and organisation of external relations.

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4 In fact, the German survey is broader than in the rest of the EU. The harmonised part for example does not include variables on market structure. Therefore, many of the analyses of this paper cannot be performed with CIS surveys from other countries.

5 In fact CIS suffers from severe item non-response. For example, in Sections 5.1 and 5.2 we have a net-sample of 2,197 observations, while in Section 5.3 we have with 1,930 (explained variable: share of turnover with new products) and 1,914 (explained variables: cost reductions) cases even less than that. (The difference emerges, because in Section 5.3 we incorporate additional instrumental variables.) Item non-response can result in biased estimation. However, Rubin (1976) has shown that, if parameters are estimated by Maximum Likelihood and the missing-generating process is a missing at random process (so-called MAR), we are safe. MAR means that the probability that a value on a specific item is missing does not depend on the actual (possibly unobserved) value itself. Even though MAR cannot be tested empirically, it does not seem readily conceivable why the status of a variable (missing or not) should depend on itself; a case we typically have, when there is some social (un)desirability attached to the value. (E.g.: “Do you have prior experience with narcotics?”). Since this does not seem to be a relevant problem, we can have some hope that the missings are generated by a MAR process. Since all of the subsequent analyses are based on ML, MAR ensures the absence of estimation bias.

4.2 Econometric methodology

We will quickly go through the econometric methodologies by the order of the hypotheses (see Section 3), since each of them requires a different econometric approach.

H1:) H1a and H1b make statements about how firms respond in terms of their innovation strategy to resource and market constraints. We define two events: 1) a firm is a pure MO innovator, 2) a firm conducts also PP innovations. We try to explain these variables by a set of variables (compare Section 4.3) by the use of probit models. Since H1a states being either an MO or a PP innovator can be explained by resource and market constraints, we would expect the coefficients on both models to jointly differ significantly.

Testing the latter of course requires tests on cross-restrictions. That is why we run both regressions as bivariate probits. Further, since H1b states that additionally there is a difference between manufacturing and service firms, the model is not only run for the pooled sample of all firms, but also for the subsample of manufacturing and services separately.

Constructing a formal test statistic on the equality of the manufacturing and service models is most easily by running a probit regression on a pooled sample, where we allow all slope coefficients to be different across manufacturing and service firms by using dummies. After that an F-test (or a Chi-2-test) on joint equality can be computed in a straightforward manner. Space restrictions force us to focus on visual inspections, because this already tells most of the story. The formal test results are just mentioned as a side-note.

H2) and H3): These hypotheses go somewhat beyond H1 as they distinguish between more than two choices of innovation strategy simultaneously. To this end, we have a setting of a discrete choice model with innovation strategy as explained variable and market and resource characteristics as the explaining factors. We regarded it as reasonable to distinguish between product and process innovations, on the one side, and marketing and organisational innovations on the other. From this we define four strategies which firms may choose to conduct:

- no innovations at all,
- only MO innovations,
- only PP innovations and

- both PP and MO innovations.

With the explaining variables at hand (see Table 5 and Section 4.3), we could run a multinomial logit model. However, because of the well known problem of independence of irrelevant alternatives (IIA) forced upon the data by multinomial logit models (MNL), a multinomial probit (MNP) framework is preferred. In fact, IIA has been tested for and it was rejected at any reasonable level of statistical inference.

H4): This hypothesis postulates complementarity between PP and MO innovations. Testing this seems straightforward at first sight - simply regress some variable of PP innovation success on MO innovations. To be specific, we will use the share of turnover with new products and cost reductions in percent. It follows that if the coefficients on the MO variables are insignificant, there is no relation. If they are negative, we have substitutes. If, on the contrary, they are positive, then PP and MO form complements.

However, if PP and MO innovations are interrelated (clearly implied by H4), firms will not choose PP and MO innovations independently from one another. Rather, a firm will optimise over both, yielding several first order conditions where PP innovations will in some of them pop up on the right hand side and in others on the left hand side. The same is true for MO innovations. Thus, MO innovations are endogenous.[6]

Furthermore, the problem is made more severe, because we work with firm rather than project-level data. Thus, we are not sure whether in a given firm with MO and PP innovations they have anything to do with each other, making it even harder to distinguish between causality and correlation.

Thus, if this endogeneity is not taken into account, all that can be measured is some degree of association between MO and PP innovations that emerges along firms' optimal choices on MO and PP innovations. However, it does not measure complementarity understood as a causal effect of MO on PP innovations.

Therefore MO innovations have to be instrumented, where we use a FIML tobit model, because of censoring of the explained variables. Finding appropriate instruments is usually a hard task, where the first guess should come from some theoretical reasoning. In any case, the exclusion restrictions should be tested afterwards, comprising weak instrument and exclusion restriction tests. Since however such tests are only

6 By the way, this fact is perfectly reflected by the MLP approach of H2 and H3, where MO innovations as strategy appear as explained variables.

available in linear models, we ran the endogenous tobit models also as a simple IV-regression to extract the tests. In all cases, the relevance criterion suggested by Staiger and Stock (1997) was over-accomplished by more than a factor of two, while excludability could not be rejected. Thus, the instruments are both backed by economic reasoning and statistical tests.

4.3 The selection of the exogenous variables

The exogenous variables can be split into explanatory variables and the instruments. The construction of all variables is outlined in detail in Table 5 in the appendix. In this subsection we will shortly review the rationale underlying the selection of the explanatory variables and the instruments used

In every regression model we use the same set of explanatory variables. We have already argued that market and resource characteristics are important factors influencing innovation activities.

Concerning the market, the first three are metric variables (market share in main product group, share of turnover in main product group, and exports) while the others were based on the interviewees' subjective opinions concerning the importance of price competition, quality competition, pressure to introduce new products, advertising, and customer-specific solutions.

With respect to resources, the percentage of employees with tertiary education was selected, since it is believed to constitute a reasonable, though possibly partial, proxy of human capital and knowledge. Whether a company belongs to a group was chosen because it is tentatively believed to be positively related to the professionalism in management, where we assume firms part of a group and may have a more sophisticated management. It could clearly also be classified differently, as it may provide a measure for “true” company size.

A proxy for technological competencies could be seen in the innovation expenditures per employee. Eventually they should contribute to the building of a knowledge base, although they measure input rather than output. Turning to the financial resources, we chose two variables. The first was the equity ratio because it measures the degree to which firms may finance innovation activities internally. Additionally, we used a dummy for whether the firm received public innovation subsidies in the past, because this clearly would change the financial constraints.

Apart from the market Schumpeter regarded technological opportunities as important. Apart from other factors that may be contained in these variables, sector dummies based on the OECD technology classification (OECD, 2003), ranking sectors along their R&D intensity, can capture a good deal of these opportunities.

Finally, and although somehow related to market power, Schumpeter believed that size would play a major role. So we included the firm's size measured by employees. Additionally, a stable result from the literature seems to be an inverted u-shaped pattern with respect to innovation. Thus we also included a squared term on employees.

Lastly, a dummy for whether a firm was located in eastern Germany was included, because differences in the industrial structure, management philosophy, and market behaviour are still likely be pertinent.

Turning to the instruments (used in Section 5.3), we chose the return on sales, the statement that product acceptance by the customers is irrelevant, the statement that organisational obstacles are irrelevant, and the fact whether firms use cash flow as a financing source for innovations.

The reasons for using these four instruments are as follows: suppose a firm tries to introduce MO innovations, it will usually have to do so out of internal funds (say cash flow), because often banks are reluctant to finance such intangible assets. If there are few internal resources, then MO innovations may be postponed or are simply not conducted. That is why cash flow is important for financing MO innovations. On the contrary, if capital markets are more efficient for the more tangible PP innovations, cash flow can be excluded from the structural equation.

Similarly, if a firm is very profitable (measured by return on sales), banks might be more willing to provide the firm with capital. Thus, external financing should be become easier, again making MO innovations more likely. On the other hand, the same argument as above applies for the relation to PP innovations: if capital markets for tangible innovations are roughly efficient, profit on sales can be excluded.

Turning to the other variables: if there are no problems with market acceptance, we would not expect great pressure to change the marketing. Similarly, if the firm faces few organisational obstacles, we would not expect a great need for organisational innovations. On the contrary, we do not see immediate reasons, why these variables should have a direct effect on the introduction of product or process innovations. Clearly, this reasoning gives some justification for the chosen instruments, but testing the quality of them would increase their credibility.

5 Econometric results

5.1 Differences in characteristics of technological and non-technological innovators (H1)

H1a states that being an MO or PP innovator is explained by the constellation of resource and market characteristics. Translated into the language of regression, this hypothesis implies that the coefficients explaining the fact that a firm also conducts technological innovations differ significantly from the coefficients on the variables explaining the fact that a firm is a pure MO innovator. Looking at Tables 1 and 2, we would therefore expect that model (Ia) differs from (Ib), (IIa) differs from (IIb), and (IIIa) differs from (IIIb). The Wald test on identical slope coefficients indicates exactly that. The coefficients are jointly different. We conclude that pure MO innovators and firms engaging also in technological innovation are different, deciding in favour of H1a. We will discuss the coefficients and their meaning in the next subsection using a more encompassing model.

Furthermore, H1b states that service and manufacturing firms are different. That basically states that the coefficients in (Ia) and (IIa) as well as in (Ib) and (IIb) are different. By visual inspection, we do not find very great differences, except for a few variables (e.g. importance of quality as well as product competition and total innovation expenditures in the case of Table 1 and only importance of quality competition and innovation expenditures in Table 2).[7] Additionally, the differences do not emerge because of an opposite sign but because of differences in magnitude.

So what can we say about H1b? Well, of course H1b needs to be corroborated. Thus manufacturing and service sectors are different, but probably not as different as one could have expected. Because of this, making an explicit distinction between service and manufacturing firms in the subsequent analyses will probably not make a great difference except for complicating the presentation.

Table 1: PP innovators in manufacturing and services (Probit regressions)

7 This is also corroborated when running a model on the whole sample with additional service sector dummies introduced on all explanatory variables (table omitted for space restrictions). Significant differences are solely due to the mentioned variables, otherwise the models do not differ substantially.

	Also PP innovations		
	Manufacturing (Ia)	**Services (IIa)**	**Total (IIIa)**
Constant	---	---	---
Eastern Germany	-0.0317	-0.0784 **	-0.0575 **
Market structure			
Market share	0.0057 ***	0.0068 ***	0.0067 ***
Squared market share (coef times 100)	-0.0061 ***	-0.0062 **	-0.0064 ***
Share turnover in main product group	-0.1550 ***	-0.2564 ***	-0.2031 ***
Market concentration (Gini)	-0.0195	0.0847	-0.0051
Squared market concentration (Gini²)	0.0001	-0.0004	0.0000
Importance of price competition	-0.0163	0.0049	-0.0104
Importance of quality competition	-0.0683 ***	-0.0154	-0.0413 ***
Importance of the introduction of new products	0.0771 ***	0.0462 **	0.0715 ***
Importance of customer specific solutions	0.0198	0.0271	0.0176 *
Importance of advertising	0.0270 *	0.0128	0.0242 **
Exports per employee	0.0680	0.0104	0.0180
Size			
Employees in 1000	0.0391	0.1352 *	0.0141 ***
Squared employees in 1000 (coef times 100)	-0.0014	-0.0708	-0.0018 ***
Resources			
Share of employees with tertiary education	0.2433 **	0.1448 *	0.1894 ***
Firm member of a group	0.0763 ***	0.0019	0.0741
Equity ratio	0.0007	0.0008	0.0006 ***
Total innovation expenditures	0.0000	0.0568 ***	0.0022 ***
Firm received public innovation funds	0.2767 ***	0.4487 ***	0.3517 ***
Technological opportunities			
Medium-high-tech manufacturing	-0.0849 *	---	-0.0741
Low-medium-tech manufacturing	-0.1863 ***	---	-0.1860 ***
Low-tech manufacturing	-0.1827 ***	---	-0.1508 ***
Knowledge-intensive service	---	---	-0.1954 ***
Other services	---	-0.1716 ***	-0.3396 ***
Observations	1263	928	2197
Wald test model signifcance	366.61 ***	406.05 ***	793.21 ***
Wald-test identical slope coefficients	166.49 ***	152.98 ***	346.69 ***

* significant at 10% level, ** significant at 5% level, ***significant at 1% level

Table 2: Pure MO innovators in manufacturing and services (Probit regressions)

	MO innovations only		
	Manufacturing (Ib)	**Services (IIb)**	**Total (IIIb)**
Constant	---	---	---
Eastern Germany	0.0235	0.0744 **	0.0602 ***
Market structure			
Market share	-0.0019 **	-0.0026	-0.0030 ***
Squared market share (coef times 100)	0.0021 **	0.0024	0.0028 ***
Share turnover in main product group	0.0476 **	-0.0048	0.0691 **
Market concentration (Gini)	0.0248	0.0062	0.0203
Squared market concentration (Gini²)	-0.0001	-0.0001	-0.0001
Importance of price competition	-0.0015	0.0010	-0.0011
Importance of quality competition	0.0202 **	-0.0019	0.0137
Importance of the introduction of new products	-0.0223 ***	-0.0239 *	-0.0348 ***
Importance of customer specific solutions	-0.0061	0.0112	-0.0021
Importance of advertising	0.0043	-0.0070	0.0026
Exports per employee	-0.0263	0.0071	-0.0017
Size			
Employees in 1000	0.0019	-0.0313	0.0074
Squared employees in 1000 (coef times 100)	-0.0073	0.0065	0.0000
Resources			
Share of employees with tertiary education	-0.0703 *	-0.0720	-0.0943 **
Firm member of a group	0.0090	0.0689 **	0.0239
Equity ratio	-0.0002	-0.0001	-0.0002
Total innovation expenditures	-0.0002	-0.0402 ***	-0.0018 ***
Firm received public innovation funds	-0.0791 ***	-0.1972 ***	-0.1725 ***
Technological opportunities			
Medium-high-tech manufacturing	0.0271		0.0512
Low-medium-tech manufacturing	0.0559 **		0.0959 **
Low-tech manufacturing	0.0515 **		0.0780 *
Knowledge-intensive service	---		0.0585
Other services	---	0.1127 ***	0.1737 ***
Observations	1269	928	2197
Wald test model significance	366.61 ***	406.05 ***	793.21 ***
Wald-test identical slope coefficients	166.49 ***	152.98 ***	346.69 ***

* significant at 10% level, ** significant at 5% level, ***significant at 1% level

5.2 Factors influencing the choice of innovation strategy (H2 and H3)

As argued in Section 3, firms' choices of innovation strategies are more complex than just deciding to be an MO or a PP innovator. We will therefore distinguish also between

no, only MO, only PP, and MO and PP innovations simultaneously. Thus, we end up with four mutually exclusive categories, where we try to let the choice be explained in a MNP model. The marginal effects resulting from this analysis are presented in Table 3, where the baseline category is no innovations.

Turning to the research hypotheses, H2 states that higher resources lead firms to increase the scope of their innovation activities. Especially this implies that firms disposing valuable resources are more likely to be simultaneously MO and PP innovators.[8] Furthermore, H2 stated that the probability of being a pure MO innovator is significantly reduced when resources are substantial.

In fact, the coefficients in Table 3 corroborate this prediction. If they are significant, all the variables measuring some sort of resource have a negative marginal effect on the probability of being a pure MO innovator, but have a positive marginal effect on being a simultaneous MO and PP innovator. So we find great evidence in favour of H2.

H3 actually is only a very weak hypothesis, which only states that the market environment is important. And indeed we find evidence for this, because many variables are significant. However, more important than that simple statement are the effects in detail.

Looking at the market share in the main product group, we find a very interesting pattern. Being simultaneously a PP and MO innovator (that is, having a broad innovation strategy) is made considerably more probable, for medium shares of the market, which can be read off the positive linear and negative quadratic effect. The maximum actually occurs at 28.5% of market share. Very dominant and very weak firms are less likely to be both MO and PP innovators. They on the contrary are more likely to be pure MO innovators.

Table 3: Determinants of the innovation strategy (Multinomial Probit)

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8 This does not necessarily mean that these firms are more innovative in a suitable sense, because from the fact that a firm conducts both types of innovations, we cannot infer on the degree of substantiality; i.e. have they been large or small innovations. We rather have a statement about the scope or broadness of the innovation strategy. In essence, it might even be true that the same variables increase the scope of the innovation strategy but decrease the innovation expenditures. In fact, running a Tobit model with the same exogenous variables and innovation expenditures as explained variable resembles very closely the results for the group of simultaneous PP and MO innovators. Especially, the signs on market share, squared market share, importance of new products remain the same. The only marked difference that shows up is an inverted u-shape in size, which is, as argued above, a common finding.

	MO innovations only Marginal effect		*PP innovations only* Marginal effect		*MO&PP innovations* Marginal effect	
Constant	---		---		---	
Eastern Germany	0.0799	*	0.0077		-0.0857	***
Market structure						
Market share in main product group	-0.0055	***	0.0001		0.0057	***
Squared market share in main product group (coef t	0.0052	***	0.0000		-0.0056	***
Share turnover in main product group	0.1450	***	-0.0044		-0.1586	**
Market concentration (Gini)	0.0208		0.0039		-0.0223	
Squared market concentration (Gini²)	-0.0001		0.0000		0.0001	
Importance of price competition	0.0053		-0.0020		-0.0042	
Importance of quality competition	0.0307	**	-0.0011		-0.0329	*
Importance of the introduction of new products	-0.0626	***	-0.0033		0.0707	***
Importance of customer specific solutions	-0.0127		-0.0005		0.0155	
Importance of advertising	-0.0137		-0.0067		0.0247	
Exports per employee	-0.0058		0.0015		0.0059	
Size						
Employees in 1000	0.0014		-0.0071		0.0215	
Squared employees in 1000 (coef times 100)	0.0028	**	-0.0072	***	0.0019	
Resources						
Share of employees with tertiary education	-0.1490	**	0.0024		0.1614	**
Firm member of a group	-0.0172		-0.0136		0.0418	
Equity ratio	-0.0005		0.0000		0.0005	
Total innovation expenditures	0.0002		0.0003		0.0046	
Firm received public innovation funds	-0.2502	***	0.0134		0.2599	**
Technological opportunities						
Medium-high-tech manufacturing	0.0711		-0.0063		-0.0701	
Low-medium-tech manufacturing	0.1453	**	-0.0081		-0.1579	**
Low-tech manufacturing	0.1204	**	-0.0094		-0.1245	
Knowledge-intensive service	0.1154	*	-0.0160		-0.1262	
Other services	0.2791	***	-0.0202		-0.2896	**
Observations	2197					
Wald test joint significance	509.03					

* significant at 10% level, ** significant at 5% level, ***significant at 1% level

Explaining this entails some degree of hypothesising. However, combining the arguments of dynamic inefficiency of the perfect market and the Arrow's replacement effect for monopolists (see Section 2) somehow suggests, that a medium market share might

be “innovation-maximising”, which is reflected in our result, that at least the scope of the innovation strategy becomes broadest at intermediate market shares.[9]

On the contrary, if the firm is either very weak or very dominant, it is more likely to conduct only non-technological innovations. One way of explaining this, is that weak firms tend to engage in less challenging forms of innovation, maybe because it is harder for them to promote technological innovations. Dominant firms instead might intend to secure their market position by product differentiation, which could be achieved by marketing innovations. This somehow suggests that there is a “competition escape” effect via product differentiation postulated by Aghion et al. (2004), but it is realised through MO innovations (probably marketing changes) and not by PP innovations.

Thus, in terms of the literature, we find that Scherer’s (1965) and Aghion et al.'s (2004) claim to apply to MO innovations, while the combination of the replacement effect (Arrow, 1962) and dynamic inefficiency of the complete market are in accordance with the pattern observed for simultaneous MO and PP innovators. So in a way, we might conjecture that the seemingly contradictory theories are both true, but for different types of innovation.

Concerning the question of the competition type, we observe a very obvious pattern. If there is a need for new products, firms are much more likely to be simultaneous PP and MO innovators and much less likely to be pure MO innovators. Thus, if the market calls for new products and service, firms’ innovation strategies become broader. In fact, the converse is true for intensive quality competition.

All other variables in the model including relative market concentration[10] are not significant in this model.

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9 Obviously, this variable only relates to the main product group. But firms may sell multiple products, where the respective market conditions might differ significantly. We try to control at least partly for distorting effects of multiple products by including the variable of share of turnover of main product group. This should increase the credibility of the variable of market share in the main product group.

10 We have chosen a relative concentration measure (instead of the more common HHI) for technical reasons. Specifically, because of data limitations, we needed the invariance with respect to number of firms in a market. Absolute concentration measures like the HHI do not have this property.

5.3 Linkage between technological and non-technological innovations – complements or substitutes

H4 stated that there is a causal effect of MO innovations making PP innovations more successful, which means that MO innovations complement rather than substitute PP innovations. If this were true, we would expect a positive coefficient in a regression of PP innovations on MO innovations.

As argued already, we need to take care of endogeneity, where indeed Table 4 indicates severe problems (see Wald-test for exogeneity) when uncontrolled.

We find that marketing innovations significantly help to increase turnover share with new products and help to reduce costs. This suggests a complementary relationship on average. On the contrary, organisational innovations are not significant at all.[11]

How should this be interpreted? For product innovations the positive effect of marketing is quite intuitive. If a new product is introduced into the market, this requires adjustment to marketing. But this is true also for process innovations: suppose for example, costs decrease. Then firms may choose a different pricing strategy, which is part of marketing innovation. Anyhow, the link is more stable between marketing and product innovations.

On the contrary, organisational innovations do not seem to be closely linked to technological innovations. Maybe this is due to the fact that not every product or process innovation needs a corresponding change in organisation, while we would almost always require a change in marketing. In any case: H4 can be confirmed for marketing innovations. It cannot be confirmed for organisational innovations.

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11 We tested whether both models are equal by the use of bivariate tobit estimation. The resulting Wald-statistic was 248 at 25 degrees of freedom, which is clearly significant at 1%, implying the the models differ. This test was endogeneity corrected by including the reduced form residuals for the endogenous variables as additional regressors. This procedure delivers consistent results (Wooldgridge, 2002, p. 543), implying a consistent test.

Table 4: Degree of complementarity between PP and MO innovations (FIML IV-Tobit)

	Share turnover new products Marginal effect	Cost reductions Marginal effect
Constant	---	---
Eastern Germany	0.0091	0.0045
Market structure		
Market share	-0.0001	-0.0001
Squared market share (coef times 100)	0.0002	0.0003
Share of turnover in main product group	-0.0006	0.0061
Market concentration (Gini)	0.0044	0.0047
Squared market concentration (Gini²)	0.0000	0.0000
Importance of price competition	-0.0013	0.0016
Importance of quality competition	-0.0034	0.0002
Importance of the introduction of new products	0.0018	-0.0014
Importance of customer specific solutions	0.0056 **	0.0016
Importance of advertising	-0.0093 **	-0.0070 **
Exports per employee	-0.0030	-0.0011
Size		
Employees in 1000	-0.0013	0.0038
Squared employees in 1000 (coef times 100)	0.0000	-0.0063
Resources		
Share of employees with tertiary education	0.0189 *	-0.0109
Firm member of a group	0.0047	0.0004
Equity ratio	0.0000	0.0000
Innovation expenditures	0.0000	0.0001 *
Firm received public innovation funds	0.0064	0.0017
Technological opportunities		
Medium-high-tech manufacturing	-0.0125	0.0030
Low-medium-tech manufacturing	-0.0127	0.0072
Low-tech manufacturing	-0.0229	0.0028
Knowledge-intensive service	-0.0110	0.0056
Other services	-0.0225 **	-0.0126 *
Complementary innovation		
Organisational innovations introduced	-0.0080	0.0008
Marketing innovations introduced	0.0183 ***	0.0122 *
Observations	1930	1914
Wald test joint significance	59.23 ***	49.33 ***
Wald test of exogeneity	105.86 ***	67.82 ***
Quality of instruments based on LIV		
minimum F-test	22.11	21.36
Sargan test	0.92	0.22

* significant at 10%-level, ** significant at 5%-level, ***significant at 1%-level

6 Conclusions

In this paper we have investigated the role of marketing and organisational innovations in the entrepreneurial innovation process. We have analysed how particular innovation strategies are triggered by market and resource constellations.

We find that higher resources make technological innovations more likely and decrease the probability for a firm to engage only in MO innovations. Furthermore, the market environment has considerable influence on how firms choose their innovation strategy. Especially interesting is the effect that firms with a particularly weak or particularly dominant position on the market tend to become pure MO innovators, while firms with an intermediate market share are much more likely to have a broad innovation strategy consisting of both MO and PP innovations.

Finally, we were able to show that marketing innovations increase success with PP innovations, suggesting a complementary relationship, while organisational innovations have no significant effect.

Appendix

Table 5: Variable construction and descriptive statistics

Variable notation	Question and/ or construction	mean	s.d.
Explained variables			
Product innovators	Has your company internally introduced new or significantly improved products in 2004-2006? 1 if yes.	0.51	0.50
Process innovators	Has your company introduced new or significantly improved processes to the market in 2004-2006? 1 if yes.	0.40	0.49
Marketing innovators	Has your company introduced changes on product design, brands or advertisement, distribution channels, pricing policy in 2004-2006. 1 if yes on at least one item.	0.53	0.50
Organisational innovators	Has your company introduced changes in organisation of business processes, knowledge management, organisation of labour, external relationships in 2004-2006. 1 if yes on at least one item.	0.66	0.48
Pure MO innovators	1 if firm introduced at least one marketing or organisational innovation but no technological innovations	0.22	0.41
Pure PP innovators	1 if firm introduced at least one product or process innovation but no non-technological innovations.	0.07	0.26
Firms with technological innovations	1 if firm introduced at least one product or process innovation (and possibly technological innovations)	0.61	0.49
Simultaneous PP and MO innovators	1 if firm has introduced at least one product or process and at least one marketing or organisational innovation.	0.54	0.50
Turnover new products	Estimate the share of turnover due to new or improved products (%)	0.13	0.22
Cost reductions	Estimate the cost reductions to to process innovations (%)	0.02	0.08
Explaining variables			
Eastern Germany	1 if company is in Eastern Germany	0.30	0.46
Market share in main product group	Estimate your market share in the main product/service group	21.89	27.77
Market concentration (Gini)	Gini index based on turnover. Constructed for the following sectors with NACE codes in brackets: Food, drink, tabacco (15-16); Textiles, leather (17-19); Wood, paper (20- 21); Chemistry, drugs (23-24); Rubber, plastics (25); Stone, glas, ceramics, mining (26, 10-14); Metal working (27-28); Mechanical engineering (29); Electronics (29), Automotives (34-35); Furniture, sports, games (36); Energy, environment (37, 40-41, 90); Retail (51); Transport, postal services (60-64.1); Media services (22, 92.1, 92.2); Data processing, telecommunication (72, 64.3); Financial services (65-67); Consultants, Advertisement (74.1, 74.4); Technical service, R&D services (73, 74.2, 74.3); Company services (74.5-74.8)	0.67	0.26

Share of turnover in main product group	Estimate the share of turnover of your main product/service group. (%)	89.75	6.13
Importance of quality competition	Rate the intensity of competition with respect to price. Likert scale: 1 (very weak) to 5 (very strong)	3.95	0.88
Importance of price competition	Rate the intensity of competition with respect to quality of products. Likert scale: 1 (very weak) to 5 (very strong)	4.01	1.00
Importance of new products	Rate the intensity of competition with respect to frequency of introduction of new products. Likert scale: 1 (very weak) to 5 (very strong)	2.63	1.08
Importance of customer-specific solutions	Rate the intensity of competition with respect customer-specific solutions. Likert scale: 1 (very weak) to 5 (very strong)	3.69	1.11
Importance of Advertisement	Rate the intensity of competition with respect to advertisement. Likert scale: 1 (very weak) to 5 (very strong)	2.57	1.04
Exports per employee	Constructed as exports in 1,000 € divided by employees	0.10	0.42
Employees	Number of employees	549.80	753.63
Share of employees with tertiary education	Estimate the share of employees with tertiary education. (%)	21.98	24.01
Public research subsidies	Has your company received public subsidies for innovation from federal states or Länder governments. 1 if yes on at least one item.	0.16	0.37
Equity ratio	Estimate your equity ratio in 2006. (%)	35.30	25.94
Total innovation expenditures	Estimate your total innovation expenditures. Innovation expenditures include: R&D contracts with external firms; investment in machines, software; product design, construction, preparation for outlet; training of staff; market introduction. Measured in 1,000 Euros.	11.05	230.64
Firm member of a group	Is your company part of a national or international multicorporate enterprise? 1 if yes.	0.37	0.48
High-tech manufacturing	1 if firm belongs to high-tech-manufacturing as defined by OECD technology classification	0.09	0.28
Med-high-tech manufacturing	1 if firm belongs to med-high-tech-manufacturing as defined by OECD technology classification	0.18	0.38
Med-low-tech-manufacturing	1 if firm belongs to med-low-tech-manufacturing as defined by OECD technology classification	0.15	0.36
Low-tech-manufacturing	1 if firm belongs to low-tech-manufacturing as defined by OECD technology classification	0.15	0.36
Knowledge-intensive services	1 if firm belongs to knowledge-intensive services as defined by OECD technology classification	0.22	0.42
Other services	1 if firm belongs to other services as defined by OECD technology classification	0.20	0.40

Instruments			
Cash flow finance source for innovation	Has your firm used cash flow as a financing source for innovation? 1 if yes.	0.52	0.50
Lack of customer acceptance relevant	Has a lack of customer acceptance influenced your innovation activities? 1 if not relevant.	0.78	0.41
Organisational obstacles relevant	Are organisational burdens important for your innovation activities. 1 if not relevant	0.73	0.44
Return on sales	Estimate your return on sales. Classed are smaller 0, between 0 and 2%, between 2 and 4%, between 4 and 7%, between 7 and 10%, betweem 10 and 15%, larger than 15%. Metric variable constructed with class means or upper and lower bounds.	10.51	0.42

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