An investigation of innovation antecedents in small firms in the context of a small developing country

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The present research was conducted in Cyprus, a small developing country. A large number (n = 140) of manufacturing small and medium sized firms were surveyed, via a questionnaire administered during personal interviews with the firms' owners or managers. A research model based on the antecedent factor approach was used. The main variables affecting innovation according to the survey results include: strategy, expenditure on R&D, co-operation with external technology providers, use of technological information sources and overall performance of the firm. Contrary to expectations and literature claims, some environmental variables, e.g. intensity of competition, were not correlated to innovation. Managers and public policy makers in similar contexts can increase the innovativeness of firms by paying attention to its main determinants, as identified by the above research.

1. Introduction

Innovation has been initially studied in the context of large firms. Major innovations were traditionally associated with the large multinationals (Vossen, 1998). Although Schumpeter (1939) in his early writings already recognized the role of the small firm in innovation, the 'revival' of interest in small firms is relatively recent. While large firms have an innovative advantage in capital-intensive industries with scale economies, small firms are more successful in industries with a high percentage of skilled labour (Acs and Audretsch, 1990). Small firms have been identified as important innovators in such high technology fields as computers and biotechnology (Rothwell, 1991), but also instruments and other sectors.

Small and large firms play different roles in innovation activity according to the required resources and skills (Rizzoni, 1991). Small firms have a number of unique features such as scarce resources, low market influence and informal communications, which differentiate them from large firms (Dickson *et al.*, 1997). They have then to adopt different innovation strategies from those used by large organizations (Yap and Souder, 1994). The strength of the small firms lies not in resources (at least physical ones), but their behavioural characteristics, such as flexibility and motivated management (Vossen, 1998).

Most studies of innovation for large or small firms have been made in the context of industrialized countries, such as USA, UK, or Germany. There is still, however, a considerable *gap* in our knowledge of innovation, especially at the level of the firm, in developing countries (Bell and Pavitt 1992, p. 271). Kim *et al.*, (1993) suggest further research on small firms innovation in developing countries. According to Tidd *et al.* (1997, p. 98) the innovativeness of a small firm 'is strongly conditioned by the national and regional context in which it finds itself embedded'.

The gap in the literature is even larger for small developing countries (SDC) (i.e. those with less than 10 million people, Streeten, 1993, p. 197) where the existing studies are sparse. The latter, although they have a relatively small contribution to the world trade,

and especially that of technologically intensive goods, in absolute terms, they have however a significant presence in the world scene, just by their sheer number. Of the thirty-two countries, for example, in Latin America and the Caribbean, twenty-three are small, i.e. under ten million people (Argenti *et al.*, 1990). Similarly in Africa and Asia there are many small states.

The size of a country although not necessarily the only or most important factor, is however significant in understanding the relative disadvantages and obstacles to innovation and the few relative advantages (Argenti *et al.*, 1990). For SDC even small improvements in their achievements in the adoption of technological innovation can have significant contributions to the upgrading of their overall poor economic performance.

The importance of small firms in small developing countries lies not so much in their complementarity to large ones, e.g. by supplying inputs as subcontractors or in other roles of coexistence. They are of vital importance because they represent the dominant force in the industrial fabric. Although such firms in developing countries are very rarely, if ever, the pioneers in new technological fields as, e.g. small biotechnology firms in USA, technological innovation is still important for their survival and growth. In this case technological innovation implies adoption of new production methods or development of improved products rather than first-to-the world innovations. Admittedly the term technological innovation has to be used more liberally, i.e. extended to less novel forms in this case.

The empirical test-ground for the research, i.e. Cyprus, its specific characteristics and their effect on innovation antecedents is briefly considered below. Then the theoretical background for the study is outlined, followed by the methodology and the results of the study. Finally these results are compared with those of the literature and some conclusions are presented.

2. Cyprus and its innovation environment

Cyprus is a small developing country. It is an island in the eastern end of the Mediterranean Sea, with an open economy and rather impressive growth rates in recent years. It also has a low unemployment rate and a low level of inflation (both around 3% in 1996). Cyprus has a relatively high GNP per capita (around US$13,000 in 1997) for a developing country. It lags behind however the more prosperous industrialized countries, e.g. most members of the European Union. It has a customs union agreement with the European Union and has currently advanced accession talks to become a full member in the near future.

As an environment for technological innovation Cyprus can be compared with the so-called 'less advanced' or peripheral small European countries as Portugal, Greece or Ireland. These countries have a number of specific characteristics (Fontes and Coombs, 1996, Jones-Evans and Pandya, 1996), which are briefly summarized below. Cyprus (and possibly other small developing countries as well) shares many of these characteristics, although it displays them in a more extreme form:

- The national innovation system is weak with many innovation related institutions missing or under-developed (Argenti *et al.*, 1990). They include technology parks, venture capital firms, specialized local technology supply sources. Their scarcity implies lower technological opportunities (Fontes and Coombs, 1996).
- The local market is small and there is prejudice and lack of trust against the local suppliers of innovative products. There is therefore limited demand for technology-based products (Fontes, 1997).
- The industrial structure is dominated by small firms. There are relatively few medium and large firms, and as a consequence of that, a small number of sophisticated 'lead users' which could stimulate innovation (Fontes and Coombs, 1996). Potential dynamic complementarities of small firms with large firms, as noted in advanced countries, are also missing.
- There is a low interaction with the local science and technology infrastructure and institutions of higher education (Jones-Evans and Pandya, 1996; Laranja, 1997).
- Innovation refers mainly to 'creative adaptive improvements' to products (or services) which are based on new technologies first introduced in industrialized countries (Laranja and Fontes, 1998). Technology transfer through external linkages is therefore of major importance.

In Cyprus new technology based firms are relatively rare. The few examples are in computer software, manufacturing related services and electronics. The emphasis of the present research is on relatively innovative firms in traditional sectors, which are of more economic importance.

The above characteristics of the specific context of the research had some repercussions on the research design. Relatively simple measures for the innovation activities and capabilities of small, unsophisticated firms were used, while structural variables as centralization, formalization, etc., more relevant for large firms, were ignored. Some emphasis was also given to the internationalization aspect. This is an important growth aspect for firms of a small country (Fontes and Coombs, 1997, Molero *et al.*, 1998). Such firms, in order to overcome the limited local market constraint, have to turn abroad for new markets. The process of internationalization usually starts in the form of exporting. Internationalization is also important for

some innovative firms for technology acquisition from foreign firms or for both above reasons (Fontes and Coombs, 1997). The technology transfer aspect is not further probed here.

3. The antecedents approach to innovation research

According to Wolfe (1994) the unit of analysis in this approach is the organization and a variance research model is used usually based on survey data collection. The dependent variable is the organizational *innovativeness*. The influence of a host of independent variables including individual, organizational and environmental, on the dependent variable is examined.

The antecedents are distinguished in the following categories (Damanpour, 1991, Wolfe, 1994):

(i) Organizational members i.e. those controlling innovation such as leaders, managers and change agents;
(ii) The organization itself (e.g. size, structure);
(iii) Extra-organizational (environmental) factors.

A model illustrating the effects of antecedents on innovativeness and eventually performance is depicted in Figure 1. The classical antecedents model, as described by King (1990), is extended here to show the link of innovativeness and performance and emphasize the influence of national innovation policy (NIP) and inter-firm linkages which are certainly environmental factors, but too important to be lumped together with the other extra-organizational factors. The model recognizes that there is a two-way relationship between performance and innovativeness. Performance is affected by innovativeness and at the same time it is one of its determinants.

The antecedents model is in principle a contingency model based on sets of factors and their interactive effects under various circumstances. The use of the model here assumes the strategic adaptation perspective, i.e. that managers have, within certain limits, the choice to influence certain of the variables by adapting the strategy and structure of the firm to fit with certain

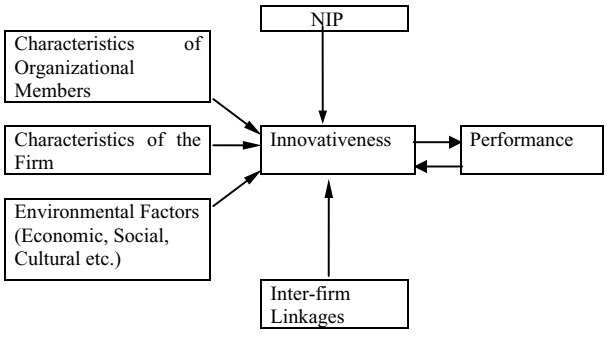

Figure 1. The 'antecedents' model of innovation. *Source*: Adapted from King (1990), Wolfe (1994) and Avlonitis *et al.*, (1994).

environmental conditions. This approach is in contrast, for example, to the population ecology view, which assumes that the environment pre-selects the types of firms which will survive, leaving managers little, if any, chance to manoeuvre (Hannan and Freeman, 1977).

This model can be criticized, in common with many other models of innovation, for its sequentiality. The single direction of arrows was only used for a simplified presentation. It is expected that in reality influence acts in both directions and there are feedback loops among the variables. The influence of national innovation policy, being an important issue on its own, is not discussed in this paper due to space restrictions.

Innovativeness can be defined in various ways. Rogers (1983, p. 22) defines it as follows: 'Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system'. Some measures of innovativeness based on this definition are the elapsed time of adoption, the subjective opinion of 'expert' judges and the number of innovations adopted by the firm out of a list of innovations. Alternatively a simple dichotomous measure of adoption or not of an innovation in a specified time period can be used.

There are however problems when a single innovation is used as the criterion in that it may prove to be a biased measure favouring certain types of firm. Experts prefer multiple innovations as providing a more reliable criterion. For example Damanpour (1991, p. 556) states: 'Organizational innovativeness is more accurately represented when multiple rather than single innovations are considered'. Avlonitis *et al.*, (1994) consider innovativeness as a multidimensional concept with both technical and behavioural components.

Since ideal measures are difficult to be applied in practical research a compromise is usually arrived at, adapted to the needs of the specific study. For our purposes the broad product innovation activities of the firm are considered. Innovativeness is indicated by subjective measures based on perceptions of managers, as explained in the methodology section.

The selection of antecedent variables for the study was guided by a combination of theoretical approaches and the consideration of the special context of a developing country as described above. Published research on innovation in small firms was also used as guide and the relevant articles are mentioned in the following. Since no single theoretical approach was judged as adequate the following three were used. They connect the empirical conceptual model, which was described above, with established theories of the firm:

1. Entrepreneurship/small firm theory;
2. The resource-based view of strategy;
3. The environmental approach to strategy with special emphasis on inter-organizational relationships.

The three research streams roughly correspond to the above classification of antecedents into individual, characteristics of firm (internal) and environmental. It is impossible to review these approaches here therefore they are only briefly discussed. Similarly the extended literature on antecedents (innovation predictors) is not reviewed here, with the exception of a few representative examples. Some explanation is, however, given for the reasons of selection of certain variables and the exclusion of others found in the literature. The sheer number of antecedents in the extant literature, even if grouped into few categories, makes the inclusion of all of them in a research design impossible.

The *entrepreneurship theory* focuses on the characteristics of the owner/manager as the main figure in a small firm (Amit *et al*., 1993). The owner/manager identifies technological opportunities and co-ordinates the process of obtaining resources (Fontes and Coombs, 1996). Furthermore he/she uses his/her managerial competencies to direct the work of others within the firm and establish beneficial links with outside organizations (Lipparini and Sobrero, 1994).

Mainly objective variables were included, e.g. age, education, cosmopolitanism (Avlonitis *et al*., 1994), and previous work experience. The behaviour of the entrepreneur and as a consequence his attitude to innovation is influenced by his background (Rizzoni, 1991). Personality and attitude variables like locus of control, tolerance for ambiguity and attitude to risk were not included. The rationale was that mixed results were obtained in previous studies (e.g. Khan and Manopichetwattana, 1989; Kim *et al*., 1993) and their measurement scales, developed in the context of advanced industrial countries, would probably be unsuitable for the entirely different context of a small developing country. It is also probable that they are related to characteristics like age and education.

The *resource-based view* of strategy emphasizes the importance of resources and capabilities in the development of competitive advantage for the firm (Barney, 1991). Innovation is a key route to competitive advantage, therefore innovation related resources and organizational capabilities have to be assessed (Autio *et al*., 1998).

'R&D expenditure' and 'employment of scientists and engineers' can be considered as basic measures of innovation related resources. They are measures of knowledge intensity and of the absorptive capacity of the firm (Koschatzky and Zenker, 1999). According to Autio *et al*. (1997) technical personnel is a core technology resource of the firm, which is firm specific and cumulative. Meeus *et al*. (1999, p. 4) have also used R&D intensity, percentage of higher educated workforce and size of the firm as 'knowledge based indicators for the quality of the internal resource base'.

Then strategy variables, like environmental technological scanning, the existence of a written strategy (Avlonitis *et al*., 1994; Keogh and Evans, 1999) and the degree of internationalization, an important aspect of strategy in a small country (Fontes and Coombs, 1997), can be considered as crude measures of organizational capabilities. While structural variables, as centralization and formalization, were excluded as not very relevant for small firms, some included demographic characteristics like size and age of the firm can be considered as indirect structural measures and at the same time indirect resource measures.

Size can be considered as a surrogate measure of several dimensions that lead to innovation, e.g. total resources, slack resources and organizational structure (Rogers, 1983, p. 359). Since some of them can not be easily measured, e.g. slack resources, size is a convenient stand-in variable for these factors. There is considerable controversy in the literature on the size-innovation relation, i.e. whether it is positive or negative, and its moderators (Damanpour, 1996; Vossen, 1998). Age of the firm is an indirect indicator of its life-cycle stage, accumulated resources and market knowledge.

The *environmental approach* complements the resource-based view of strategy by emphasizing the importance of structural forces in the operating environment of the firm and wider socio-economic influences. The well-known structure-conduct-performance paradigm was developed by Porter into his five forces model (Porter, 1980; Autio *et al*., 1998). Another research stream, which can be included in the environmental approach is that of the link of the firm to its environment through its participation in inter-organizational relations and networks (Rothwell, 1991). Innovation is currently viewed as an interactive process. The network perspective goes beyond economic relations (and mere resource exchange) to include socio-cultural interactions and learning aspects (Amit *et al*., 1993).

Some environmental variables selected are the intensity of competition, the extent of change in the environment as perceived by the owners/managers, the intensity of networking, the external barriers to innovation and the extent of external technology linkages.

The intensity of competition is a measure of market pressure to innovate (Birchall *et al*., 1996) and environmental hostility (Kim *et al*., 1993). Environmental change is related to uncertainty and dynamism (Damanpour, 1996). The intensity of networking (horizontal in this case) explores the *local* embeddedness of the firm. It can be considered as an indirect indicator of inter-organizational knowledge flow and communication (Decarolis and Deeds, 1999). In the case of technological linkages both local and international dimensions are included.

Rothwell and Dodgson (1991) have found that external technology linkages are positively associated with technological innovation. Kim *et al*. (1993) consider building of external technological linkages

Table 1. Empirical hypotheses.

H1:	Innovativeness is influenced by the characteristics of the SME owner/manager.
H1a	Education level
H1b	Age
H1c	Prior business experience
H1d	Cosmopolitanism
H2:	Innovativeness is influenced by the characteristics of the SME.
H2a	Size
H2b	Age of firm
H2c	Sales Turnover
H2d	Existence of written strategy
H2e	Degree of internationalization
H2f	R&D expenditure
H2g	Employment of scientists and engineers
H2h	Environmental scanning
H2I	Cooperation with technology providers
H3:	Innovativeness is influenced by environmental factors.
H3a	Intensity of competition.
H3b	Environmental change
H3c	Importance of external barriers
H3d	Level of networking
H4:	Innovativeness affects positively the performance of firms.

as part of the strategic efforts of the firm and have found it as a significant predictor of technological innovation, although not a predictor in their discriminant model. Tidd and Trewhella (1997) emphasize the learning aspect of external technology acquisition and its importance for innovation. The 'external barriers to innovation' variable indicates how the firm perceives its constraints to innovate (Keogh and Evans, 1999).

In the discussion section the results of the present research are compared with the findings in various previous studies. The main, empirically testable, hypotheses are summarized in Table 1. Several of them contain a number of sub-hypotheses.

4. Methodology

4.1. The sample and the questionnaire

There is no universally acceptable definition of small and medium size firms. For the purposes of this study small and medium size firms were defined as those with 10–100 employees (Hadjimanolis, 1997). Small are those with 10–50 employees and medium between 51 and 100. Even medium size firms in Cyprus are relatively small by European standards. Small firms, according to the latest (January 1995) definition adopted by the European Union, are those with up to 50 employees and medium 51–250. A number of micro-businesses (below 10 employees) and 'large' firms (over 100 employees) was also included for comparison purposes and in order to have a fuller picture of the Cyprus economy as a whole.

While a random sample is the ideal for a research project, in this case it was difficult to be achieved for two main reasons. The first reason is that a balance was aimed in terms of innovative/less innovative firms in the sample (or at least the inclusion of several truly innovative firms, which are a rather rare species in the Cypriot context). Kim *et al*., (1993) also state that a probability sampling plan would result in the inclusion of too few innovative firms due to the low level of technological capability/innovation of small firms in Korea. The second reason is that access to firms was important for completion of a long (20 pages) and detailed questionnaire. Information from industry experts (e.g. from the Industrial Extension Unit of the Ministry of Trade and Industry and other sources) was used for the inclusion of innovative firms.

A large (140 firms), judgmental (purposive) sample was then used. It was carefully balanced across a variety of features of the survey firms such as size, innovative record, performance, sector, etc. The distribution of the selected firms reflects the structure of the Cyprus industrial enterprises in general and the sample is believed to be fairly representative of the population of manufacturing firms.

The use of a cross-sectoral approach aimed to determine any variations in innovation performance and its determinants caused by sector-specific factors. Five industrial sectors were chosen, i.e. Chemicals, Plastics, Food, Clothing/Textiles and Metal. They reflect a broad and representative range of business environments and technological innovation practices and represent together over 70% of the manufacturing value added.

The questionnaire was pre-tested with twelve (12) firms. The results of pilot testing were *not* incorporated in the survey data. The questionnaire was then adjusted, corrected and re-worded, according to the results of the pilot testing, in order to increase its content validity. Face-to-face interviews were used for the questionnaire completion, because the response rate with a postal questionnaire of such length and complexity would be unacceptably low. The interviewees were owners wherever possible (100) or senior managers (general managers or production/technical managers) of the firms (40).

Table 2. Innovativeness scale. In a new product introduction how often is your company:

		Never				Always
a.	First-to-market with new product	1	2	3	4	5
b.	Later entrant in established, but still growing markets	1	2	3	4	5
*c.	Entrant in mature, stable markets	1	2	3	4	5
d.	At the cutting edge of technological innovation	1	2	3	4	5

* Scores for item three (c) are reversed.

Table 3. Reliability measures.

Scale	Variable	No: of Items	Cronbach's Alpha
1. Innovativeness	NPDINSU	4	(0.53*)
	NPDIN	3	0.68
2. Performance	BENCHSUM	4	0.86
3. Network Intensity	LINKIMSU	3	0.58
4. External Barriers	EXBARSUM	25	0.82
5. Environmental Change	CHANGSU	7	0.65
6. Competition Intensity	COMPINTSU	5	(0.60**)
	COMPINT	4	0.72
7. Frequency of Technical Co-operation	COOPFSU	5	0.70
8. Significance of Technological Information Sources	SITINFSU	7	(0.46***)
	SITINF	4	0.71

Notes:
* Scale reliability of NPDINSU is improved by dropping item 2, and using the new variable NPDIN.
** Scale reliability of COMPINTSU is improved by dropping item 1 and using the new variable COMPINT.
*** Scale reliability of SITINFSU is improved by dropping items 1, 3, 5 and using the new variable SITINF.
Source: Survey data analysis.

4.2. Main variables and their operationalization

Innovativeness is the key dependent variable. A scale is included in the questionnaire for measuring innovativeness in terms of the *subjective* evaluation of the owner/manager of the extent to which the firm is a pioneer in new product introduction. It has been adapted from Deshpande *et al*., (1993). The innovativeness scale (Table 2) measures indirectly the novelty of the firm's products and aspects of the innovation strategy of the firm. It measures only product innovativeness. Innovativeness is a multi-dimensional concept (Avlonitis *et al*., 1994), but since product innovativeness is usually of more importance for small firms (Damanpour, 1996) a simple measure was preferred. The measure was, however, checked and found to have a good correlation with an independent indicator of process innovativeness.

The scale for performance was adapted from the same source as above. It is based on a comparison of the firm's position against the largest competitor regarding profitability, size, market share and sales growth as perceived by the owner/manager. The scales for the other variables were specially constructed for the needs of this study. The reliability (Cronbach's alpha) of the above scale and those for other variables are highlighted in Table 3.

5. Results

5.1. Correlation and multiple regression

Table 4 summarizes the correlation coefficients and the corresponding significance levels between the predictor variables and innovativeness.

An investigation of the relative impact of several independent variables on *innovativeness* (NPDIN) as the *dependent* variable is made through multiple regression analysis. The *independent* variables include five interval-level variables for example performance (BENCHSUM), co-operation with external technology providers (COOPFSUM), etc. and sixteen independent dummy variables (representing seven ordinal level variables) e.g. number of employees, percentage spent on R&D, number of scientists and engineers etc.

A stepwise procedure was used. *Six* variables were found to be 'good' predictors of the Innovativeness (NPDIN). These are the following in order of importance (in explaining the variance of NPDIN) (Table 5). The total amount of variance explained by all six variables is 38% ($R^2 = 0.38$) and adjusted 35% (Adjusted R square = 0.35).

The residuals were examined in order to make sure that none of the basic multiple regression statistical assumptions (normality, linearity, lack of multicollinearity etc.) has been violated. The histogram of the standardized residuals is very close to normal and the normal P-P plot of Regression Standardized Residuals is almost a straight line. Also inspection of the plots of studentized residuals against the predicted values of Innovativeness and the partial correlation plots of independent variables versus the dependent variable do not suggest any violation of the assumptions. Tolerances and VIF values are in the accepted range. Therefore the statistical assumptions for multiple regression are met.

5.2. Multiple discriminant analysis

A multiple discriminant analysis (MDA) was run with Innovativeness (NPDINMNN) as the dependent variable. The latter was suitably re-coded for the MDA by the polar extremes approach (Hair *et al*., 1995)

Table 4. Correlation coefficients.

Independent variable	Dependent variable	Correlation coefficient	Significance level
Education Level	Innovativeness	$\rho = 0.29$	$p = 0.001$
Age of Owner	Innovativeness	$\rho = -0.17$	$p = 0.045$
Business Experience	Innovativeness	$\rho = -0.03$	$p = 0.725^*$
Cosmopolitanism	Innovativeness	$\rho = 0.19$	$p = 0.023$
Size	Innovativeness	$\rho = 0.17$	$p = 0.042$
Age of Firm	Innovativeness	$\rho = 0.05$	$p = 0.556^*$
Sales Turnover	Innovativeness	$\rho = 0.18$	$p = 0.03$
R&D Expenditure	Innovativeness	$\rho = 0.45$	$p = 0.000$
Employment of S&E	Innovativeness	$\rho = 0.28$	$p = 0.01$
Existence of Strategy	Innovativeness	$\rho = 0.32$	$p = 0.000$
Internationalization	Innovativeness	$\rho = 0.18$	$p = 0.003$
Environmental Scanning	Innovativeness	$r = 0.32$	$p = 0.000$
Technological Cooperation	Innovativeness	$r = 0.31$	$p = 0.000$
Competition Intensity	Innovativeness	$r = 0.13$	$p = 0.121^*$
Environmental Change	Innovativeness	$r = 0.32$	$p = 0.000$
Networking Horizontal	Innovativeness	$r = 0.05$	$p = 0.517^*$
External Barriers	Innovativeness	$r = 0.12$	$p = 0.17^*$
Performance	Innovativeness	$r = 0.39$	$p = 0.000$

Notes:
(1) ρ = Spearman's rank coefficient, r = Pearson's coefficient
(2) * = Not significant at the 0.05 level

Table 5. Multiple regression analysis results.

Variable	Standardized Regression Coefficient	Significance
1. STRATEXR (Existence of Strategy)	(b = 0.30)	Sign T = 0.0001
2. RDPRCX11 (R&D Expenditure as Percentage of Sales)	(b = 0.30)	Sign T = 0.0002
3. BENCHSUM (Performance)	(b = 0.29)	Sign T = 0.0001
4. EMPLNOX1 (Number of People Employed)	(b = 0.23)	Sign T = 0.0033
5. SITINF (Significance of Technological Information sources).	(b = 0.22)	Sign T = 0.0032
6. COOPFSUM (Co-operation with Technology Providers).	(b = 0.15)	Sign T = 0.045

Table 6. Discriminant function loadings.

Variable	Name	Discriminant Loading
1. BENCHSUM	(Performance)	0.46637
2. STRATEXR	(Existence of strategy)	0.43876
3. SITINF	(Significance of Technological Information sources)	0.43052
4. COOPFSUM	(Co-operation with Technology Providers)	0.41420
5. RDPRCX11	(R&D Expenditure as percentage of Sales)	0.32262
6. RDPRCX22	(R&D Expenditure as percentage of Sales)	0.20511
7. RDPRCX33	(R&D Expenditure as percentage of Sales)	0.19262
8. EMPLNOX1	(Number of people employed)	−0.14368
9. EMPLNOX2	(Number of people employed)	0.05114

Note: The last two variables i.e. EMPLNOX1 and EMPLNOX2 have a very low discriminating power.

i.e. the extreme two groups of values (3–6) = 1 and (11–15) = 2 were used, while the middle group (7–10) = 0 was excluded from the analysis.

Nine independent variables (representing six original variables) were used. The independent variables were those which were proved as predictors in multiple regression analysis. The method used was the simultaneous estimation, i.e. all independent variables used (Hair *et al*., 1995). The canonical discriminant function is highly significant. It displays a canonical correlation of 0.77, which means that *60%* of the variance in the dependent variable (Innovativeness) can be accounted for (explained) by this model, which includes 9 independent variables. The group centroid for non-innovative firms (group 1) is 1.14052, while the group centroid for the innovative firms (group 2) is 1.25089.

Box's M test is *significant* (differences in the group covariance matrices). Therefore the statistical assumptions for MDA are met. The classification matrix has a classification accuracy of 90.77%, which is quite high compared with the proportional chance criterion of 50%. The order of importance of independent variables in discriminating between innovative/non innovative firms (based on their Discriminant Function Loadings) is shown in Table 6. It is based on the structure matrix (pooled – within groups – correlations between discriminating variables and canonical discriminant functions).

6. Discussion

Although owner characteristics are not among the main factors as they have been determined in the multiple regression and multiple discriminant analysis models they are still very important. Some of them, e.g. education and cosmopolitanism are positively correlated to innovativeness, while age has a weak negative correlation. Prior business experience is not significantly correlated (as indicated by the Spearman's correlation coefficient) with innovativeness (Table 4).

There is a low, but statistically significant, correlation of the *size* of firms (as measured by the number of people employed) to their innovativeness (H2a). It implies that, in the Cyprus context, medium and large firms, which are better resource equipped (i.e. can employ more scientists and engineers, spend more on development and have slack resources) than their smaller counterparts can innovate more. The low correlation, however, suggests that size is not a major barrier and small firms can be innovative as also Acs and Audretsch (1990) report. Size (measured by the number of employees) is one of the predictor variables of innovativeness in the multiple regression model, although fourth in importance. It has, however, a very low discriminating power in the multiple discriminant model. The *age of firm* is not significantly correlated to innovativeness, while the *sales turnover*, which is another indicator of size has a weak positive association.

Firms with a *written strategy* tend to show higher innovativeness (H2d). The confirmation of the hypothesis H2d seems to suggest that better organized firms with specific plans for the future pay more attention to innovation. Similarly the existence of a written strategy is the second most important discriminating variable in the multiple discriminant model. Cooper (1984) found strategy to be a significant predictor of firms' product innovation. *Internationalization* (e.g. through exports) as a component of strategy is weakly correlated to innovativeness (H2e). Molero and Buesa (1996) also report a positive relationship.

There is a medium level positive correlation ($p = 0.45$ $p = 0.000$) (one of the highest in this study) between *R&D expenditure* and innovativeness (H2f) as expected and widely mentioned in the literature. R&D expenditure is also one of the discriminating variables in the multiple discriminant analysis. Cooper (1984) in the research cited above has found that innovative firms place more emphasis than less innovative ones on R&D. Khan and Manopichetwattana (1989) have found the 'percentage of research and development expenditure to cost of goods sold' as a significant predictor of innovativeness. Kim *et al*., (1993) similarly report a highly significant positive association, although R&D intensity does not enter as a predictor in their discriminant model.

Most firms (64%) in the sample have some R&D activity although a substantial proportion (36%) have no R&D. The majority spend less than 2% of their sales turnover on it. For the vast majority of firms there is no separate R&D department and to be precise one should speak of various types of development rather than research in the Cyprus context. Cypriot firms, as shown by their answers, make substantial efforts to improve their products, adapt formulations to local needs and substitute foreign with locally available raw materials or more frequently raw materials from alternative lower cost sources. They adapt imported machinery and equipment and sometimes construct locally their machinery, usually with the help of local machine workshops. They also use extensively the factory as a laboratory (Leonard-Barton, 1991). Production trials are probably the most important form of development efforts in Cyprus since many firms do not have well equipped laboratories or the required specialized personnel for carrying out extensive tests before the actual production trial.

The '*employment of scientists and engineers*' variable has a significant positive correlation to innovativeness, although it is not included in the multiple regression or the discriminant model. Avlonitis *et al*., (1994) have found a similar relationship to innovative leadership. In contrast Khan and Manopichetwattana (1989) have found a negative coefficient in their regression model.

Firms, which use more *sources of technological information* and make higher use of them tend to be more innovative (H2h), therefore environmental scanning seems to be a positive factor for innovation. Kim *et al*., (1993) have similarly found that environmental scanning for ideas of technological innovation, technological information etc., which they consider a strategic factor, has a highly significant association with technological innovation. It is also a predictor in their discriminant model between innovative and non-innovative SME.

Firms with higher levels of *cooperation with technology providers* (universities, technical institutes, etc.) are higher in innovativeness (H2i). There is, however, in absolute terms, a *low* level of co-operation of Cypriot firms especially with universities and other academic centres and a somewhat higher one with testing centres. The limited demand for technological services is a usual situation in developing countries as also Lall *et al*., (1994) report for Ghana.

Gemünden *et al*., (1992) report that what they call 'technological interweavement' is important for innovation success. They have found, through both bivariate and multivariate analyses, for a sample of German manufacturing companies that:

> Close contacts with lead users, cooperations with universities and research institutes as well as R&D cooperations with other companies, all show a highly significant influence on technological innovation success (Gemünden *et al*., 1992, p. 372).

The *intensity of competition* does not seem to be correlated to innovativeness (H3a). This is a surprising finding taking into account the results of reported research in the literature as detailed below. Kim *et al*., (1993) for example, have found a highly significant positive association between environmental hostility and technological innovation, although this variable is not a predictor in their discriminant model. Cypriot firms probably tend to use other measures, e.g. cost cutting, marketing techniques etc. to defend against strong competition rather than innovate. This explanation is reinforced by the fact that the majority of owners/managers believe that price competition (81%) in their sector is strong or very strong. A high percentage of them (66%) believe the same for competition in distribution against only 40% stating that product development competition is strong or very strong in their sector. It is interesting that the STRATOS, 1990 research project among European SME has also shown that the most intensive type of competition is price competition. *Environmental change* as expected (Kim *et al*., 1993) is significantly associated to innovativeness.

The '*external barriers to innovation*' and the '*intensity of horizontal networking*' variables were not significantly correlated to innovativeness. They are not further considered here, as they are discussed in separate articles (Hadjimanolis 1999a, b).

Performance was shown to be positively correlated to innovativeness although this association is *not* proof of causation. Performance is also not necessarily influenced *through* innovativeness, e.g. size may have a direct effect on performance, while performance may have direct effects on some of the variables mentioned above. Innovativeness possibly influences some of the supposedly antecedent variables in a latter phase of the firm's life cycle. The inadequacies of a static simplified model, such as the antecedents model, are obvious.

7. Conclusions

Cyprus in common with other small less advanced countries presents a less than favourable environment for innovation as explained above. Small firms in such environments face serious constraints in their effort to innovate. It is therefore interesting to know the discriminating features between innovating and non-innovating firms.

The survey research presented in this article has identified the main factors, which affect innovativeness in small firms in Cyprus. They are all organizational characteristics. They include technological resources as indicated by the factor 'research and development intensity' and organizational capabilities as the extent of technological information scanning and strategic planning. External networking capabilities, as shown by the extent of co-operation with technology providers, have a significant influence on innovativeness. Other factors as the size and the overall economic performance of the firm are also important.

Most of these variables are related to strategy. Several of them are under the, at least partial, control of the firm. It seems then, that innovativeness can be influenced by attention to these strategic issues. The implications and strategy options for managers and policy makers are discussed below.

Although internationalization, as indicated by the percentage of export sales, was not among the discriminating factors or even the main factors in the regression model, it was weakly correlated to innovativeness. Perhaps its effect is masked by other variables.

The finding that the main influences on innovativeness are organizational factors does not of course imply that individual and environmental variables are unimportant. They probably affect organizational characteristics, and through them innovativeness. It should not also be forgotten that 65% (100–35) of the variance of innovativeness is not explained by the variables in the multiple regression model. It was a surprising finding that the intensity of competition is not correlated to innovation. An explanation was offered based on the nature of a small country where

innovation is relatively rare, while pricing and marketing are the main competitive weapons of local firms.

An attempt was made in this study to test a mid-range theoretical model, specifying sets of variables that influence innovativeness, in the context of a small developing country where it had not been tested so far. The adapted antecedents model proved in general valid for the case of Cyprus. Attention to the differentiated meaning of the constructs in some cases, e.g. that of R&D intensity was drawn to avoid improper comparisons. The different potency of some explanatory variables in the settings of a small developing country was pointed out.

The above conclusions are based on results from self-reported data, of a sample of firms in a single country in a specific time period. These limitations have to be kept in mind. Further research is required in the context of other small developing countries for comparison and corroboration of the findings.

The fact that some of the important variables are to a considerable extent within the control of the firm has both managerial and policy implications. Managers of small firms wishing to increase the innovation performance of their firms have first to put innovation among the strategic issues requiring constant attention and preparation. Technological information scanning activities can provide the necessary base for innovation planning and implementation. Among the innovation influencing factors are resource-related ones, e.g. R&D resources and capabilities like technological networking which require gradual learning and sustained effort over time, under the direction of the owner/manager, in order to build up. Managers should also pay attention to the internationalization issue as a possible way out of the constraints of the local market, but also for access to technological sources not available locally.

Knowledge of the innovation determinants facilitates the selective targeting of innovation measures within the frame of a national innovation policy. Measures for non-innovators would include awareness-raising ones like training, while for innovators they would include help in exporting efforts and facilitation of contact with higher educational institutions and other technology providers.

The research results could also be useful to other countries of a similar size and in a similar economic situation, at least as a rough guide since each country has its own specific features. Further research in such contexts could better illuminate common problems.

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