8. THE ROLE AND DETERMINANTS OF INNOVATION SOURCES IN ESTONIAN WOOD SECTOR COMPANIES[1]

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Abstract

This paper uses the data of the Estonian innovation survey from 1998–2000 to address the question about the role of different innovation sources and the factors underlying firms' choices of these innovation sources in the Estonian wood sector. Separate logit models are constructed for ten different innovation sources. The results are commented in the light of the information obtained by interviewing industry leaders in 2003. The article confirms supplier-dominated innovation in wood industries and also the lower absorptive capacities for external R&D information in Estonian wood sector companies compared to the Finnish wood sector. There is an advantage identified for larger firms and firms with foreign ownership in using several external innovation sources. Lack of funds is found to be a discouraging factor and collaborative activities an encouraging factor in the use of several external innovation sources.

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Introduction

From single industry innovation studies almost all tend to deal with science-based industries, while learning and innovation aside them is rarely studied. On the other hand, the aforementioned science-based industries generally account for a small portion of economy, while, for instance, wood-based industries comprise an important part of the economy in Finland, Sweden, Austria and also Estonia. Additionally, the bulk of commercially significant innovations are incremental rather than radical (Audretsch, 1995; Love and Roper, 1999). Since wood-based industries are in the maturity phase of their product life cycle, it is relevant to study how one can rejuvenate these mature businesses and create advantages through innovations (see also Leifer *et al.*, 2000; Baden-Fuller and Stopford, 1994 for this discussion).

Innovation comprises the generation and implementation of new ideas, processes, products or services, which can largely be viewed as entrepreneurial behavior for the sake of improving a company's profitability. Feldman and Francis (2004), however, argue that innovation, entrepreneurship and technological change are interlinked but distinct concepts. Underlying their differentiation is the idea that providing the components of one does not guarantee the development of others. Innovation without entrepreneurship does not result in (regional) growth, if innovations are not implemented and marketed. On the other hand, entrepreneurship without innovation does not result in technological development. Hence, the terms should be seen as somewhat concurrent, but also complementary. In the empirical part of this article, those innovation sources[2] will be analyzed that have been carried into practice by entrepreneurs in Estonian wood sector firms.

This paper addresses the questions: What are the relevant innovation sources in the innovation of Estonian wood sector firms and

[2] Primary sources of specific information that was used in implemented innovation projects.

which factors stimulate or hinder the use of different innovation sources at the microeconomic level? The perception of the role of different innovation sources and the underlying firm-level decisions will allow for a more adequate description of industry-level innovation activities, also contributing to the assessment of a respective sectoral innovation system. In this article, it is possible to analyze only *ex post* decisions concerning the choice of the innovation sources that have successfully led to an innovation (both product and process innovations are considered). The paper explores the behavior of Estonian wood sector firms belonging to the wood-based value-network (i.e. the wood processing, paper and furniture industries).

The role and determinants of innovation sources

Innovation is usually not a single-firm activity; it increasingly requires an active search process in order to tap new sources of knowledge and technology and apply them in product and production processes (Roelandt and den Hertog, 1999). It requires the creation of new knowledge or combination of the existing knowledge in a new way and hence is based on learning, which is largely a social process, especially by transferring and accumulating tacit knowledge (Howells, 1995). According to Lundvall (1995), interactive learning and collective entrepreneurship are both important for innovation; hence one should look at innovation as an iterative, cumulative and cooperation-based phenomenon (Freel, 2003). Innovation opportunities exist because of information asymmetry. Firms that have access to a large variety of sources of information are in a better position to identify and develop innovation opportunities (Venkataraman, 1997).

Industrial firms are gaining ideas for innovation from different sources and their innovative performance depends on how successful they are at appropriating knowledge from these sources

(Von Hippel, 1988; Cohen and Levinthal, 1990). Both, internal capabilities and openness towards knowledge sharing are important for upgrading innovative performance (Caloghirou *et al.*, 2004). The use of external resources depends on the absorptive capacity of companies (Cohen and Levinthal, 1990).

According to Pavitt's taxonomy (1984), wood, furniture and paper industries belong to supplier-dominated sectors by their characteristics of technological development and innovation. This means that the dominant sources of technology and information are the suppliers, government-financed research institutions and less frequently large users. In these industries, competitor collaboration may often be present. Since supplier-dominated firms are believed to make only a minor contribution to their product and process technology (Pavitt, 1984), one would anticipate limited association between internal resources and innovation (Freel, 2003). According to Maillat (1991), in contrast, external resources are of little use for firms with incremental innovations, because the resources needed for these innovations can usually be found inside the firm. Firms with radical product and process innovations would require more than their limited internal resources could provide. Oerlemans *et al*. (1998) find that firms with incremental innovations use both types of sources – internal as well as external. The reason is that the gradual development of technology makes it easier to join internal and external resources, since the gap is smaller. Oerlemans *et al*. (1998) found that in supplier-dominated industries, important innovation partners include large suppliers and buyers, but also other companies in the same industry. They additionally found public technology policy to be an important contributing factor to these sectors' innovation.

The role of clients as a source of information for innovation has been recognized since the 1970s (Von Hippel, 1988; Rothwell, 1977; Kline and Rosenberg, 1986). According to Amara and Landry (2005), clients influence the product and process innovations in the following ways: by providing complementary knowledge and access to tacit knowledge; by establishing a precise set of user requirements; by providing information about new or evolving needs; by giving information about post-launch improvements; and by enhancing the likelihood that the innovation will be adopted by other firms within the same user community. Amara and Landry (2005) suggest that clients are used as information source by firms that initiate innovations as the world's first introductions rather than as incremental innovations.

Suppliers are also sources that are used similarly with clients for getting innovation information (Teubal *et al*., 1991; Bruce *et al*., 1995). However, the information linkage is based on either making or buying relations. The tendency in recent decades has been on downsizing and focusing on core competencies, which is likely to increase the role of suppliers in innovation processes (Amara and Landry, 2005). Suppliers and customers are sources of foreign knowledge for a firm through exporting goods and services or importing materials and technology.

A competitor as a source of innovation has been studied in the literature of strategic alliances. Openness of knowledge may speed up the pace of innovation as competitors are able to build on other innovators' advances rather than being allowed to block the progress of others (Foray, 1997). Amara and Landry (2005) have concluded on the basis of the existing literature that the information obtained from competitors is related to the increased complexity and intersectoral nature of new technologies, the reduction of uncertainty and R&D costs associated with market access, or the development of product and process innovations (by acquisition and appropriation of the partner's tacit knowledge, uptake of codified knowledge; by reduction of the period between invention and market introduction). Caloghirou *et al*. (2004) argue that innovativeness is increased by partnerships in alliances or strategic collaborations.

The exploitation of universities as a source of innovation depends on the average absorptive capacity of firms in the sector (Cohen and Levinthal, 1990). According to Laursen and Salter (2003), larger firms and firms with stronger R&D intensity use universities as an innovation source relatively more often. However, there are large differences across industries in this respect.

From the theoretical discussion in this section, we expect to get support to the empirically lower intensity of information utilization by the Estonian wood sector compared to the Finnish one. From sectoral specifics, the dominance of suppliers, customers and R&D institutions in innovation sources can also be expected. The relative importance of internal *vis-à-vis* external innovation sources remains unclear in the theoretical discussion.

Innovation sources of the companies in the Estonian wood sector

According to the Estonian innovation survey, the relative importance of innovation sources used by the wood sector companies compared to their Finnish counterparts is given in the following table. The Finnish wood cluster is among the most advanced and competitive ones in the world (see also Blomström and Kokko, 2002) and is therefore used for comparison here.

If we look at the general picture, the relative importance of the information linkages with innovation activities has similar patterns in the Estonian and Finnish wood and paper industries. Generally, the use of innovation sources in the Finnish wood and paper industry is more intensive than in the Estonian industry. The intensity of the internal sources of the company is very similar in both countries' wood sectors. However, some interesting differences can be noticed when the strong and mature wood cluster of Finland and the developing industry of Estonia are compared.

In case of wood industries, the predominant information sources (besides the internal ones) are customers and suppliers, which is completely in line with the sectoral results of Pavitt (1984) and

Oerlemans *et al*. (1998). Some aspects of the relatively important role of competitors for Estonian companies can be revealed by interviews: Estonian companies are not real competitors (as exceptions here only domestically competing sawmills can be considered), but sell on very diverse foreign market niches.

Table 1. Comparison of the relative importance of innovation sources in Finnish and Estonian wood-based industries[3]

Innovation source	Paper Industry		Wood Industry	
	Finnish	Estonian	Finnish	Estonian
The company itself	2.42	2.43	1.82	1.81
Competitors	1.42	1.14	1.43	1.31
The parent company	1.11	1.00	0.61	0.57
Customers	2.11	1.43	1.75	1.57
Suppliers	1.53	1.71	1.68	1.60
Exhibitions	1.26	1.29	1.50	1.35
Conferences and meetings	1.16	1.00	1.18	0.86
Consulting companies	0.79	0.29	0.82	0.33
Universities	1.21	0.29	1.07	0.12
Research institutes	1.00	0.12	0.89	0.13

Very often the companies collaborate in order to strengthen their competitiveness in foreign markets (Kull, 2003; Kuldkepp, 2003; Agasild, 2003). The almost non-existent innovation sources for Estonian wood and paper companies are universities and other research institutions (the means being 0.12 and 0.13). The problem is characteristic of the whole cluster and was stressed in the inter-

[3] The Finnish data are from 1999 (Viitamo, 2001), the Estonian data from 1998–2000 (Innovation in Estonian Enterprises in the Years 1998–2000). In both cases, the respondents were asked to rank alternative innovation sources by importance (0 = no importance, to 3 = very important). In the table are shown mean scores of the responses. The wood industry here also involves furniture manufacturing.

views (Botvinkina, 2003), because wood technology research and schooling is lagging behind the industry's needs. In fact, the Estonian universities prepare hardly any pulp and paper technology or wood material technology specialists at all. The minor role of R&D institutions reflects the technology absorption phase characterizing the development of the Estonian wood sector.

From the results above one can conclude that firms' internal sources are most important for determining the innovation in both Finnish and Estonian wood sectors. Other dominant sources confirm Pavitt's results and include suppliers, customers and competitors.

Data and methods

In the following analysis, the database Innovation in Estonian Enterprises (on CIS methodology) covering the years 1998–2000 is used. Only those wood sector firms are included in the sample which had realized their product or process innovation in the period 1998–2000. The sample includes 114 companies (6 from the paper industry, 66 from the wood and wood processing industry and 48 from the furniture industry).

Binary logit models are constructed for every innovation source separately, whereby one can model a particular choice behavior, explaining it by the set of explanatory variables describing the company and its operating environment. The dependent variable has two values: 1 – if the information source is chosen, and 0 – if it is not chosen. The probability of choosing the innovation source is *p* and the probability of not choosing the respective innovation source is *1–p*. For the estimation, the maximum likelihood method is used[4]. The theoretical considerations underlying this

[4] The likelihood function estimated has the following form (which assumes linearity in parameters): $L = \beta_0 + \beta_1 X_1 + ... + \beta_i X_i$. The link function estimated is: $\eta = \ln \frac{p}{1-p}$, where $\begin{matrix} p \in [0,1]; \\ \eta \in [-\infty, \infty] \end{matrix}$, from which we have:

model assume that the preferences or tastes that are leading to a decision about the choice of a single firm are implicitly contained in the form and parameter estimates of the logistic function (Ben-Akiva and Lerman, 1985).

The independent variables, i.e. the factors that influence the probability of choosing one specific innovation source, are formed considering the survey. From the set of individual variables only those are considered which changed the likelihood more than 0.01% (the backward stepwise method in SPSS is used).

The following variables are entered in the models:

LNTURNOVER: the logarithm of the annual turnover in 2000;

SPECIALISTS: the ratio of workers with a higher (including higher professional) or secondary professional education based on secondary general education to total labor in 2000;

EXPORT: the share of export in turnover in 2000;

FOREIGN: a binary variable equals 1 if the foreign ownership was present, and 0 if not);

INNOVCOST: the total cost of innovation concerned the activities in this period.

The variables describe different barriers to innovation. All of them can take 4 values (0 − no barrier, 1 − low barrier, 2 − medium barrier, 3 − high barrier): B_RISK: innovation is too risky; B_LAW: insufficient flexibility of regulations or standards; B_LABOUR: lack of qualified personnel; B_CONSUMERS: lack of customer responsiveness to new goods or services;

$\frac{p}{1-p} = e^{\beta_0+\beta_1 X_1+\ldots\beta_i X_i}$ and hence $p_i = \frac{e^{\beta_o+\sum\beta_i X_i}}{1+e^{\beta_0+\sum\beta_i X_i}}$ is the logistic function (Aldrich and Nelson, 1984). This function is continuous and can take the values from 0 to 1. The probability approaches 0 if the function approaches negative infinity, and 1 in the case when this function approaches infinity, in between the function is monotonically growing.

B_NOFINANCE: lack of funds for innovation; B_KNOWTECH: lack of information on technology; B_KNOWMARKET: lack of information about markets; B_COSTS: innovation costs are too high. B_ORG: organizational barriers to innovation.

Also variables are included to describe the cooperation arrangements of innovation activities with other enterprises or institutions during the period 1998–2000. Here the variables have a binary form, i.e. are equal to 1 if the firm cooperated with the following partners: C_SUPPLIERS: suppliers of equipment, materials, components of software; C_UNIVERSITIES: universities and higher schools, their units and institutes; public and private non-profit R&D institutions; C_COMPETITORS: competitors and other firms from the same industry; C_CONCERN: other enterprises within the concern; C_CLIENTS: clients or customers; C_CONSULTANTS: consulting firms.

The results for the estimated models are presented in Table 2. Here only the coefficients are discussed which were entered into the final models and marked by bold figures). There are problems connected with the interpretation of the regression coefficients. The effect of change in X_i on the probability $Y_i = 1$, for example, is clearly related to, though not completely determined by β_i. The sign of βi determines the direction of the effect, and the effect tends to be the larger the larger is β_i (Aldrich and Nelson, 1984). But since the magnitude of the effects varies with the values of the exogenous variables, it is not so simple to describe the effect. For its better description, the odds ratio (describing the odds of one event relative to another) is used[5].

[5] In order to interpret the logistic coefficients, in SPSS the factor *exp(B)* is computed, which shows how much the odds ratio changes when the *i*th independent variable increases by one unit. Based on this factor, the independent variables in Tables 1 and 2 are differentiated as:
Variables that do not influence significantly the respective probabilities (i.e. confidence intervals of *exp(B)* include 1 and this factor leaves the odds unchanged);

As can be seen from Table 2, larger companies choose several different innovation sources (within the company, suppliers, conferences, fairs). This is generally the expected result as discussed in the OECD (1999), smaller firms tend to have more limited financial and human resources, are less ready to access the information, and have shorter time horizons. In addition, they are more risk-averse and reluctant to engage outside help, except for very specific short-term needs. In the furniture industry, the industry interviews revealed also the opinion that small firms fail to acquire the information about innovation because they are not able to make use of it for their absorptive capacity is low (Kull, 2003). Export-oriented innovative wood companies use to a lesser degree R&D institutions, which could show the relative incremental development of their products and processes.

Companies with foreign ownership have chosen their mother companies as innovation source (the alternative was only available to companies with foreign ownership, and most of the innovative wood companies (72.4%) had at least some foreign ownership). Having foreign ownership increases the possibilities for choosing the innovation source from among public and private non-profit R&D institutions and universities. Since Estonian public and private non-profit R&D institutions are almost non-existent in the Estonian wood and forest field, the companies use the respective sources of foreign countries. The fact that foreign institutes in Finland and Great Britain are used for innovations was supported by the industry interviews (Botvinkina, 2003; Kuldkepp, 2003).

Variables that influence the results but are not risk-factors (i.e. confidence intervals of *exp(B)* are under 1 and this factor will decrease the odds ratio);
Variables that influence the results significantly or risk factors (i.e. confidence intervals of *exp(B)* are over 1 and this factor will increase the odds ratio).

Table 2. The results of innovation source choice models

	within firm	concern	suppliers	clients	competitors	consultants	universities	R&D institutions	confer-ences	fairs
Lnturn	**0.577***	1.414*	**0.671***	0.184	0.295	0.213	0.075	-0.407	**0.608***	**0.969***
Export	3.093	0.822	1.253	0.302	**1.878***	**0.709**	**1.075**	**-3.461***	**1.647***	**1.635****
Foreign	-3.212	**2.466***	0.034	0.645	-0.692	0.601	**1.376****	**3.094***	-0.703	-0.959
Innovcost	64.231*	**0.476**	0.288	17.259**	0.052	0.186	0.135	0.327	0.107	0.06
Specialists	6.329**	-1.875	-0.774	0.927	-0.306	0.214	1.068	**-6.037****	-1.35	0.704
B_risk	**1.391***	0.258	0.813	**0.5****	**0.528****	0.671	**0.759****	10.76	0.45	-0.26
B_costs	1.081	**0.596***	0.017	-0.098	-0.173	**0.476***	0.054	-4.102	0.073	0.447
B_labour	**1.527***	-1.527	-0.173	0.688	0.202	-0.296	-0.096	**-1.679***	-0.027	**0.798***
B_nofinance	**-0.502****	-0.98	-0.124	**-0.481***	-0.033	-0.087	0.01	**-2.516***	-0.273	0.012
B_law	**-1.083***	0.766	0.325	0.248	0.513	0.325	0.522	**1.152****	0.283	**-0.628****
B_consumers	-1.284	**0.42**	0.1	-0.067	-0.536	0.442	-0.448	-3.943	-0.555	-0.172
B_org	-1.764	0.383	**1.619***	0.142	**0.809***	**0.112**	**-0.46**	**2.601**	**0.645****	**0.145**
B_knowmarket	1.052	0.208	-0.806	**0.739***	-0.414	-0.775**	0.101	16.642	-0.374	-0.021
B_knowtechn	-0.807	0.466	0.74	-0.38	-0.061	-0.39	0.188	**2.625***	0.556	0.045
C_supplier	5.129	-9.225	-1.668	-2.695	-3.066**	-7.16	**3.26***	17.915	-0.096	-0.758
C_competitors	0.092	-4.259	**2.412***	-0.851	**3.348***	**1.392**	**0.99**	**-48.479**	**-2.625**	**-0.302**
C_concern	3.022	35.774	2.044	-2.337	**-3.134***	**-11.362**	**-12.88**	**-38.472**	**-2.536***	**2.642***
C_clients	-7.563	-9.12	-2.069	5.258**	0.594	7.537	**-4.589***	-69.495	-0.487	**-1.572***
C_universities	9.706	5.162	0.965	-1.102	-0.75	-3.532	**3.672***	22.001	7.403	2.051
C_consultants	27.473	-10.349	8.246	14.298	-0.999	**1.657***	-14.923	**7.493***	**3.442***	5.848
Northern	5.325	11.085	-1.253	**1.078****	-0.779	-0.012	4.886	54.327	**1.215***	**1.242***
Northeast	14.485	4.361	-1.232	-2.31	-0.581	-29.556	-6.137	115.572	**0.021***	**2.433****
Central	-0.997	9.745	**-2.111***	0.115	-1.512	-2.32**	3.194	29.209	0.012	-0.193

Table 2 continued

	within firm	concern	suppliers	clients	competitors	consultants	universities	R&D institutions	confer-ences	fairs
Southern	2.566	9.25	-1.336	0.649	-1.339	-1.986	4.573	**2.448****	1.117	-0.636
ASC	**-4.344***	**-3.769***	**-5.378***	**0.615**	**-0.55**	**-2.14***	**-3.925***	**-1.878**	**-6.883***	**-8.906***
Nagelkerke R2	0.452	0.435	0.379	0.241	0.307	0.142	0.409	0.585	0.375	0.392
-2LL	67.089	89.393	91.647	104.868	106.335	111.249	54.315	33.122	120.322	100.647

Risk factor
* Significant at 5% level

Non-risk factor
** significant at 10% level

As concerns regional aspects, one can see that companies in North- and North-Eastern Estonia (where also most of the largest wood sector companies are located) have relied more on conferences and fairs as innovation sources.

The companies in the wood sector that admittedly lacked qualified personnel for innovation, tended to choose more readily internal sources and fairs rather than R&D institutions as innovation sources. Such a result could be expected, indicating a generally lower level of absorptive capacity of the firms.

Lack of funds decreases the probability of being able to choose clients and R&D institutions as innovation sources. Organizational obstacles encourage firms to look for innovation information from their suppliers and competitors. Those companies, who claimed to have too little market knowledge, have a higher probability of choosing clients as innovation sources and those with too little technological knowledge look for information from R&D institutions.

One interesting finding is also, that having an innovation cooperation within the concern decreases the probability of using competitors as an innovation source – this seems to support the idea, that domestically-owned companies are working together in order to compete on export markets (higher share of export in sales increases the likelihood of choosing competitors as innovation source).

Conclusions and discussion

In general terms, the results of the paper coincide with the sector-specific use of innovation sources found by earlier work. The overall intensity of information use is lower in the Estonian wood sector than in the respective Finnish sector. Internal innovation sources predominate in both sectors with similar intensity. From among external sources, suppliers, customers and also competitors are important. As could be expected, the use of R&D institutions and universities as information sources was low, on the one hand, because of presumably low absorptive capacity, and on the other, because of shortcomings in the Estonian educational system. Confirmation was found to the claim that larger and foreign-owned companies have better access to innovative information, but the companies in general claim to lack funds for using external innovation sources. The use of various external resources seems to be encouraged by cooperation agreements.

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