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The links between determinants of innovation and organizational performance

Abstract: In the paper an analysis of how different determinants influence innovation and organizational performance is presented. The results of path analysis (structural equation modeling) show that research and development (R&D) financial resources, specialization and different leadership styles have a significant impact on product and administrative innovation. Those impacts are reflected in two measures of a firm's performance – objective financial reports and executive ratings of perceived effectiveness. Using the sample of 219 Polish firms form Silesia Region (with at least 20 full-time employees), this study contributes to the emerging literature on innovation by providing an integrated conceptual model.

Key words: determinants of innovation, path analysis, structural equation modeling

1. Introduction

An organizational ability to create, adapt and implement innovations may result from the existence of many diverse determinants, or factors determining the organization's innovation. These factors are dynamic. Their influence is diverse and concentrates on different stages of an innovation process. As they affect both an organization and its members, they may have an economic, technological or psychological nature.

The study was focused on linkages between a great variety of determinants, four types of innovation (product, process, technical, administrative) and organizational performance (two measures of a firm's performance were used: objective financial reports and executive ratings of perceived effectiveness).

A path analysis (structural equation modeling) was used to define the causal relationships between variables.

Determinants of innovations emerged in the literature relatively recently. Due to the fact that factors determining innovation are numerous, their aggregation becomes necessary. According to the Oslo methodology, determinants of innovation encompass four broad categories, which are:

1. general determinants – general conditions determining the scope and possibilities of innovation implementation;
2. scientific and technical institutions supporting innovation by providing technical and scientific knowledge;
3. technology transfer factors – human, social and cultural factors influencing transfer of information and learning processes in an organization; and
4. internal determinants, referred to as "innovation dynamo" – they include dynamic factors that influence an organization and have a direct effect on innovation.

These determinants of innovation indicate a marked multidirectional character of their influence. However, it should be stated that innovation is determined by both internal (organizational) and external factors. While an organization may have, and generally has, influence on its internal innovation potential, this influence with respect to external determinants is either negligible or non-existent (they are either independent of, or little dependent on the organization). The paper considers only internal (organizational) determinants of innovation. Based on a literature review, determinants frequently analysed in previous empirical studies have been identified. A novelty of the analysis is the simultaneous inclusion of all determinants in a single model.

The paper is organized as follows: first a review of the relevant literature is presented. This is followed by a brief discussion of the research methodology and the survey. Next, the research findings obtained from the empirical analysis are considered. A concluding section summarizes the paper.

2. Organizational determinants of innovation

Identification of determinants of innovation involves detailing resources necessary for generating or/and implementing innovations in an organization. A synthetic review of the most important studies is summarized in Table 1.

Table 1 indicates that a key role in the processes of generating or/and implementing innovations is played by financial capital (Xu, Sirmon and Gao 2010: 1–38) and human capital (Rothaermel and Hess 2007: 898–921; Wziątek-Staśko 2006: 119–127). These resources, according to the re-

Table 1. Conceptual approaches of organizational determinants of innovations

Authors	Organizational determinants of innovation
Kimberly and Evanisko (1981)	CEO tenure, CEO cosmopolitanism, CEO educational level, CEO committee participation, CEO involvement in business activities, centralization, specialization, functional differentiation, external integration
Damanpour (1991)	specialization, functional differentiation, professionalism, formalization, centralization, managerial attitude toward change, managerial tenure, technical knowledge resources, administrative intensity, slack resources, external communication, internal communication, vertical differentiation
Ayadi, Dufrene and Obi (1996)	R&D financial resources
Bhattacharya and Bloch (2004)	R&D financial resources
Wan, Ong and Lee (2005)	strategic human resources
Jamrog, Vickers and Bear (2006)	organizational culture
Zduńczyk and Blenkinsopp (2007)	strategy, structure, support mechanisms, behaviour
Vaccaro, Jansen and Van den Bosch (2008)	leadership styles (transactional and transformational leadership)
Wang and Kafouros (2008)	R&D financial resources
Puri and Bharatendu (2009)	slack resources, related diversification, mode of R&D, R&D intensity, aggressive posture
Xu, Sirmon and Gao (2010)	human, relational & financial capital
Qu, Janssen and Shi (2010)	leadership styles (transactional & transformational leadership)

source-based view of a firm (RBV), provide a basis for undertaking innovative activities, owing to their high value (uniqueness) and rare occurrence. Moreover, increasing these resources allows greater flexibility in conducting creative and experimental work, thus constituting a key factor of promoting innovation. Literature commonly points out to the primary importance of R&D financial capital in carrying out the innovation process effectively. Oftentimes, a lack of financial resources causes an innovative activity to be totally abandoned. Human capital comprises knowledge, skills and experience of employees. It combines the creativity of qualified workers with their experience in particular areas. Members of an organization constitute the main source of new idea and knowledge, whose application leads to developing new products/services. Moreover, tacit and codified knowledge positively affects innovation in an organization (Kolarz and Wziątek-Staśko 2007: 238–246).

Determinants of innovation are commonly emphasized in the literature. They also include: organizational culture promoting generation and implementation of innovations (Jamrog, Vickers and Bear 2006: 9–19), style of leader-

ship (Vaccaro, Jansen and Van den Bosch 2008: 1–38) and characteristics of top managers (including: the age of managers, their education level, previous job experience and tendency to taking the risk associated with innovative activity) (Ahuja, Lampert and Tandon 2008: 61–64). Leaders, as powerful internal actors, have a very relevant role in promoting innovations. In this context, the paper draws on a widely recognized distinction between transactional and transformational leadership (Bass and Avolio 1991). Transactional leadership emphasizes the links between a leader and followers, based on mutual benefits that come from this relation (Burns 1978), whereas transformational leadership is based not so much on the external motivation (an exchange relationship) as on the internal motivation of the followers.

Moreover, the complexity of technological changes forces organizations to take up cooperation. Owing to individual linkages, cooperation provides direct benefits to partners by providing them an access to a broader knowledge base. In addition, cooperation is conducive to the integration and reconfiguration of knowledge and may lead to positive effects of scale in the R&D area. Besides, regarding the network form of collaboration, cooperation facilitates the knowledge spillover effects. Partners gain access to information networks and, depending on their position in a network, they have a greater or lesser possibility of using knowledge and information available within that network (Quintana-Garcia and Benavides-Velasco 2009: 1–39).

The last group of the internal determinants includes structural determinants – some researchers (e.g. Damanpour 1991: 555–590) underscore their primary role as organizational innovation determinants. Structural determinants have been defined in different ways, and considered to constitute the core of the formal structure of organizations. This study focuses on six dimensions: specialization, two dimensions of differentiation in organizations (functional, and vertical differentiation), formalization, centralization, and administrative intensity. Specialization represents different specialties found in an organization (Hage and Aiken 1967: 503–519). Functional differentiation reflects the extent to which an organization is divided into different units (Aiken, Bacharach and French 1980: 631–652). Vertical differentiation represents the number of levels in an organization's hierarchy (Damanpour 1991: 555–590). Formalization reflects the emphasis on following rules and procedures in conducting organizational activities (Pierce and Dalbecq 1977: 27–37). Centralization represents the locus of authority and decision-making and is the extent to which decision-making autonomy is concentrated or dispersed in an organization (Bizzi 2009: 5). Administrative intensity is measured by the ratio of managers to total employees in an organization (Damanpour 1991: 555–590).

3. Metodology and measures

In order to define the causal relationships between variables, the structural equation modelling (path analysis) approach was used. This method is one of the best elaborated techniques of statistical data analysis – relying on causal interpretation methods. It enables verification of hypotheses on the structure of causal relationship in a specific set of variables, and it was chosen to be used in the conducted study. By using structural equations, path analysis approximates the multiple regression analysis. However, path analysis definitely surpasses the regression analysis. It admits a more complex structure of relationship among variables. It includes the analysis of direct and indirect effects relating the variables, facilitating thereby the causal interpretation of relationship. Moreover, this method does not depend on the order in which variables are input to the model – is free from the significance hierarchy of variables. In path analysis, the selection of variables for the model is not necessary. Only when a collinearity exists between independent variables, is it necessary to remove some of the variables from the model.

In path analysis, theoretically justified structure of causal relationship is a subject to verification for a given set of variables. Therefore, four basic assumptions are mentioned: (1) relationship among variables input to the model are causal, linear (or approximated to linearity) and additive (variables are not correlated); (2) residual variables are not correlated with one another, nor with the variables preceding them in the model; (3) the correlation of independent

Table 2. Types of variables included in path analysis

Independent variables			
R&D financial resources	X_1	Clan culture	K_1
Communication	X_2	Adhocracy culture	K_2
Managerial attitude toward change	X_3	Market culture	K_3
Specialization	X_4	Hierarchy culture	K_4
Functional differentiation	X_5	Transformational leadership	P_1
Vertical differentiation	X_6	Transactional leadership	P_2
Formalization	X_7	Laissez-faire leadership	P_3
Centralization	X_8	Managerial age	W
Administrative intensity	X_9	Managerial tenure	SP
Innovative collaboration	X_{10}	Managerial professional experience	DZ
Dependent variables			
Product innovations	$Y_{1,A}$	Perceived effectiveness	Z
Process innovations	$Y_{1,B}$	Return on sales	ROS
Technical innovations	$Y_{1,C}$	Return on assets	ROA
Administrative innovations	$Y_{1,D}$		

variables is treated as "given," not resulting from a common cause, and remains beyond an analysis; (4) the variables are measured on the interval scale (Gaull and Machowski 1987: 89). However, in spite of waiving some of the assumptions, the path model remains "solvable." Table 2 presents the independent and dependent variables included in path analysis.

Most of the independent variables (X_2, X_3, X_7, X_8, X_{10}, P_1, P_2, P_3) were measured on a 7-point Likert scale, from 1 – "strongly disagree" to 7 – "strongly agree." R&D financial resources were measured as annual estimated outlays on innovation activity – respondents were asked to estimate financial data in real units (PLN). The communication, as described by, e.g.: holding formal meetings of employees from different units, frequent communication between units, clearly defined project priorities, and a clearly defined hierarchy between managers involved in innovation projects, was assessed with 8 items (Koberg, Detienne and Heppard 2003: 21–45). To examine organizational culture, the OCAI (Organizational Culture Assessment Instrument) tool was employed for operationalization of four dominant culture types – hierarchy, market, clan and adhocracy (Cameron and Quinn 2003: 30–32, 139). Due to the fact that one of the most important factors of creating innovation culture is a pro-innovation attitude of managers, the questionnaire included also 5 items concerning the managerial attitude toward change (Hage and Dewar 1973: 279–290).

Items of the Multifactor Leadership Questionnaire (MLQ) Form 5X (Bass and Avolio, 1991) were included in measuring transformational, transactional leadership as well as laissez-faire leadership. Transformational leadership was assessed with 19 items (connected with five dimensions of this style of leadership: attributed charisma, idealized influence, inspirational motivation, intellectual stimulation, and individual consideration), whereas transactional leadership was assessed with 17 items (connected with three dimensions of transactional leadership: contingent reward and active or passive management-by-exception). Laissez-faire leadership was assessed with 5 items.

Managerial tenure represents the length of service that managers have with an organization, and was measured by the number of years an organization has employed a manager for. Managerial professional experience reflects the experience that managers have with an organization and it was measured by one dichotomous question on whether respondent has the experience or has not.

Specialization reflects high levels of substantive skills and education of employees and was measured by the ratio of professional and technical employees (specialists) to total employees in an organization (Collins, Hage and Hull 1988: 512–543). Functional differentiation was measured by the total number of units below the chief executive level. Vertical differentiation was measured by the number of levels below the chief executive level. Administrative intensity was measured by the ratio of managers to total employees in an organization (Damanpour 1991: 555–590). The index of formalization was based on: (1) job

codification and rules, and (2) rule observation. It was assessed with 7 items that reflect the degree of freedom available to organizational members as they pursue their functions and responsibilities versus the extent of rules that precisely define their activities (Hage and Dewar 1973: 279–290). Centralization was measured by the degree of organizational members' participation in decision-making (Hage and Dewar 1973: 279–290). Examples of questions are "I usually participate in the decision to hire new staff" and "I usually participate in decisions on the adoption of new programs." All 4 items were measured on a 7-point Likert scale, from 1 – "strongly disagree" to 7 – "strongly agree." Innovative collaboration was operationalized as the firm collaboration intensity with external parties including customers, suppliers, R&D institutes, experts, and competitors (Lee 2009: 18–19).

Dependent variables in this study were type of innovation and organizational performance. Product innovations are new products or services introduced to meet an external user or market need. Process innovation are new elements introduced into an organization's production or service operations – input materials, task specifications, work and information flow mechanisms and equipment used to produce a product or render a service. The distinction between technical and administrative innovations is important because it relates to a more general distinction between social structure and technology. Technical innovation relate to basic work activities and concern either product or process. Such innovations pertain to products, services and production process technology. Administrative innovations involve organizational structure and administrative processes; they are related to management (Damanpour 1991: 555–590). Three measures of organizational performance were used: return on assets and return on sales as objective measures of financial performance and a subjective executive rating of effectiveness. The executive rating of effectiveness was collected through the survey questionnaire. Respondents were asked to evaluate the overall effectiveness of their organization based on factors such as growth in sales, growth in market share, growth in employees, growth in profitability, return on equity, return on total assets, profit margin on sales and the ability to fund growth from profits as compared with main rival, on a 7-point Likert scale (low = 1; high = 7).

4. Data collection

Data for the study were collected by using a questionnaire survey, a part of a wide questionnaire survey conducted within the research grant No. N N115 257434, entitled "Determinants of the enterprises innovation in the industrial area – by example of the Silesian Voivodeship." Two surveying methods were

adopted: Computer Assisted Telephone Interview (CATI) and Paper And Pencil Interview (PAPI). All data were collected from January to June 2010. Complete data sets were received only from 219 Silesian companies, which makes 4% of 5,177 companies asked to fill in the questionnaire. Such a low level of a response (using the CATI technique – 3%, using the PAPI technique – 29%) resulted from a long duration of an interview, and in case of enquiries related to financial issues, from the respondendts' reluctance to reveal such information, and too detailed data required.

A sample of 219 Polish companies from the Silesia Region (with at least 20 full-time employees) was used in order to empirically test the theoretical model. A three-part questionnaire was developed (one part for the employees and two parts for their leaders). The first and the second part of the questionnaire were directed to CEO or another high-ranking executives. The first part of the questionnaire was related to demographic information and the second one to issues concerning organizational determinants of innovations. The final section of the questionnaire drew on construct used in the past studies on leadership (Bass, Avolio, Jung and Berson 2003: 207–218). In this part of the questionnaire respondents rated their CEO. Respondents were ensured of the confidentiality and offered a summary of the results.

The scope of the research carried out included the following sectors of the business activity: biotechnology, power industry, environmental protection, IT, materials processing and production, transport infrastructure as well as medical technologies. The choice of the above-mentioned sectors was imposed by the need for comparison of the results obtained with those of the questionnaire survey conducted within the project entitled: "Priority technologies for sustainable development of the Silesian Voivodeship" (The technological foresight of the Silesian Voivodeship), in the period of November-December 2007. A comparison between a foresight population and the sample used in the empirical analysis is presented in Table 3.

Table 3. A comparison between foresight population and the sample used in the empirical analysis

Sectors		Foresight population			Selected sample		
		number	accumulate number	%	number	accumulate number	%
A.	Biotechnology	23	23	9.1	25	25	11.4
B.	Power industry	35	58	13.8	16	41	7.3
C.	Environmental protection	12	70	4.7	41	82	18.7
D.	IT	47	117	18.6	46	128	21.0
E.	Materials processing and production	82	199	32.4	38	166	17.4
F.	Transport infrastructure	24	223	9.5	47	213	21.5
G.	Medical technologies	30	253	11.9	6	219	2.7
	Total	253	253	100.0	219	219	100.0

A non-response bias was tested in order to validate the sample's representativeness. In particular, differences between respondents and non-respondents were examined. T-tests indicated that there were no significant differences based on the number of full-time employees. Therefore, a non-response bias did not seem to pose a problem to the study.

5. Results

Due to the high correlation coefficients among independent variables, the preliminary reduction of their number was necessary. For this purpose, the *a posteriori* variable elimination procedure was used. Finally, those variables were included in the model, whose removal from the model would have significantly increased the residual variance at a significance level of 0.05. The only exception were variables describing the type of organizational culture and variables describing the respondents' age. These were eliminated with a whole group, if removing each of them would not increase the residual variance. Tables 4 and 5 present the values of F-statistics and the critical values of observed probabilities.

Table 4. Values of F-statistics and observed probability as obtained by elimination of variables following the *a posteriori* procedure

Variable	F-statistic	Probability	Variable	F-statistic	Probabilisty
1	2	3	4	5	6
Product innovations			Process innovations		
K_2	259.577	0.000	K_2	229.245	0.000
X_4	100.963	0.000	P_2	86.170	0.000
P_2	97.848	0.000	X_4	80.746	0.000
P_1	92.158	0.000	P_1	74.988	0.000
X_9	70.681	0.000	X_9	62.159	0.000
X_2	69.834	0.000	X_2	61.225	0.000
X_{10}	68.482	0.000	K_4	60.896	0.000
K_4	66.218	0.000	X_{10}	50.387	0.000
X_3	51.195	0.000	X_3	46.975	0.000
X_7	34.764	0.000	X_7	30.231	0.000
X_5	32.598	0.000	X_5	28.669	0.000

Table 4 continued

1	2	3	4	5	6
X_1	28.785	0.000	K_3	25.425	0.000
K_3	21.240	0.000	X_1	21.826	0.000
K_1	14.235	0.000	K_1	10.920	0.001
P_3	6.856	0.000	P_3	6.813	0.000
X_6	**3.467**	**0.064**	**X_6**	**2.906**	**0.090**
X_8	**1.627**	**0.129**	**X8**	**1.795**	**0.090**
W	**1.217**	**0.271**	**W**	**1.787**	**0.183**
SP	**0.821**	**0.619**	**SP**	**0.738**	**0.702**
DZ	**0.312**	**0.577**	DZ	**0.272**	**0.602**
Technical innovations			Administrative innovations		
K_2	208.193	0.000	K_2	151.322	0.000
K_4	65.329	0.000	X_9	39.392	0.000
P_2	59.471	0.000	P_2	35.352	0.000
X_4	57.642	0.000	P_1	34.573	0.000
X_9	54.637	0.000	X_4	33.969	0.000
P_1	52.891	0.000	K_4	33.159	0.000
X_2	47.496	0.000	X_2	30.918	0.000
X_{10}	45.908	0.000	X_{10}	24.774	0.000
X_3	37.038	0.000	X_5	23.715	0.000
X_5	28.699	0.000	X_3	20.915	0.000
X_7	26.203	0.000	X_7	20.010	0.000
K_3	20.302	0.000	K_3	17.057	0.000
X_1	19.826	0.000	K_1	14.309	0.000
K_1	10.416	0.001	X_1	10.118	0.000
P_3	5.872	0.000	P_3	7.956	0.000
X_6	**3.280**	**0.072**	**X_6**	**2.936**	**0.088**
X_8	**1.347**	**0.230**	**X_8**	**1.496**	**0.170**
W	**0.900**	**0.344**	**SP**	**1.145**	**0.328**
SP	**0.552**	**0.866**	**W**	**1.022**	**0.313**
DZ	**0.518**	**0.473**	**DZ**	**0.405**	**0.525**

Table 5. Values of F-statistics and observed probability as obtained by elimination of variables following the *a posteriori* procedure

Perceived effectiveness			Return on sales			Return on assets		
Variable	F-statistic	Probability	Variable	F-statistic	Probability	Variable	F-statistic	Probability
K_2	366.208	0.000	X_4	315.769	0.000	K_3	118.792	0.000
X_4	365.662	0.000	K_2	180.139	0.000	K_2	107.751	0.000
P_1	278.551	0.000	X_2	158.587	0.000	X_4	69.002	0.000
P_2	273.620	0.000	K_3	144.506	0.000	X_2	49.585	0.000
$Y_{1,A}$	210.926	0.000	P_1	113.601	0.000	P_1	44.106	0.000
X_{10}	206.625	0.000	P_2	99.009	0.000	P_2	41.344	0.000
X_2	173.133	0.000	X_1	65.787	0.000	X_3	36.238	0.000
K_4	153.399	0.000	X_3	65.314	0.000	X_1	31.470	0.000
X_3	145.731	0.000	$Y_{1,A}$	39.546	0.000	$Y_{1,A}$	25.510	0.000
X_9	142.344	0.000	P_3	38.568	0.000	P_3	25.010	0.000
$Y_{1,B}$	121.533	0.000	X_{10}	34.643	0.000	X_{10}	23.161	0.000
X_1	102.089	0.000	X_9	33.535	0.000	X_9	20.328	0.000
$Y_{1,C}$	85.650	0.000	$Y_{1,B}$	25.743	0.000	$Y_{1,B}$	16.495	0.000
X_7	53.680	0.000	$Y_{1,C}$	18.153	0.000	X_6	14.518	0.000
$Y_{1,D}$	39.299	0.000	X_5	16.309	0.000	$Y_{1,C}$	12.362	0.000
K_3	38.468	0.000	X_7	11.891	0.000	X_7	10.230	0.000
X_5	32.217	0.000	K_4	9.012	0.003	K_4	8.296	0.005
P_3	5.235	0.000	$Y_{1,D}$	8.892	0.000	$Y_{1,D}$	5.497	0.000
K_1	3.933	0.049	K_1	7.993	0.006	K_1	4.131	0.044
X_6	**3.403**	**0.066**	**W**	**4.948**	**0.028**	**W**	**3.926**	**0.050**
W	**2.930**	**0.088**	**X_8**	**1.482**	**0.180**	**X_8**	**2.688**	**0.063**
X_8	**1.473**	**0.178**	**SP**	**1.273**	**0.249**	**SP**	**2.184**	**0.140**
SP	**0.312**	**0.983**	**DZ**	**0.067**	**0.796**	**DZ**	**0.403**	**0.527**
DZ	**0.303**	**0.583**	**X_6**	**0.062**	**0.803**	**X_5**	**0.069**	**0.793**

In all equations, except for the ROA describing equation, the following variables were eliminated: vertical differentiation (X_6), centralization (X_8), managerial tenure (SP), professional experience (DZ) and the variable denoting the age category. In the ROA describing equation, instead of the X_6 variable (vertical differentiation), the X_5 variable (functional differentiation) was removed. Due to the fact that the multidimensional distribution of residues does not match the normal distribution, it is impossible to infer about the significance of the estimated parameters. For interpretation of the causal relationship it was assumed that the parameter estimation was characterized by high reliability if the quotient of estimated parameter value by the parameter estimation error was greater, in terms of the modulus, than 3.0 (i.e. the parameter estimation error is three times less than the parameter value).[1] Moreover, it was assumed that the

[1] Based on the Chernyshev inequality.

quotient values greater than 2.0 indicated a moderate reliability of estimation, while less than two – low reliability. Tables 6 and 7 provide the results of path analysis.

Table 6. Path analysis; dependent variable: type of innovations

Variable	Par.	B. Std.	Par./B. std	Variable	Par.	B. Std.	Par./B. std
Product innovations				Process innovations			
X_1	**0.019**	**0.008**	**2.473**	**X_1**	**0.013**	**0.006**	**2.116**
X_2	0.026	0.069	0.372	X_2	0.065	0.054	1.203
X_3	–0.084	0.136	–0.614	X_3	–0.016	0.105	–0.155
X_4	**0.088**	**0.04**	**2.202**	**X_4**	**0.046**	**0.031**	**1.496**
X_5	–0.189	0.626	–0.302	X_5	–0.366	0.486	–0.754
X_7	–0.069	0.042	–1.638	X_7	–0.04	0.032	–1.242
X_9	0.471	8.64	0.054	X_9	2.646	6.71	0.394
X_{10}	0.325	0.199	1.634	X_{10}	0.021	0.155	0.133
P_1	1.502	0.935	1.606	P_1	1.505	0.725	2.077
P_2	**–3.376**	**0.805**	**–4.196**	**P_2**	**–2.963**	**0.624**	**–4.745**
P_3	0.074	0.466	0.158	P_3	0.12	0.363	0.331
K_1	–13.534	8.321	–1.626	K_1	–10.366	5.808	–1.785
K_2	–17.183	9.922	–1.732	K_2	–13.362	7.274	–1.837
K_3	–8.001	4.963	–1.612	K_3	–6.884	3.533	–1.948
Free term	17.986	6.982	2.576	Free term	14.369	5.421	2.651
Residual deviation	1.130			Residual deviation	1.100		
Technical innovations				Administrative innovations			
X_1	**0.01**	**0.004**	**2.523**	**X_1**	**0.005**	**0.004**	**1.441**
X_2	0.015	0.036	0.416	X_2	0.049	0.032	1.508
X_3	0.018	0.071	0.252	X_3	–0.043	0.064	–0.681
X_4	0.036	0.021	1.716	X_4	0.013	0.019	0.684
X_5	–0.13	0.327	–0.396	X_5	–0.037	0.294	–0.125
X_7	–0.021	0.022	–0.975	X_7	–0.016	0.02	–0.806
X_9	–2.518	4.51	–0.558	X_9	–4.462	4.058	–1.100
X_{10}	0.154	0.103	1.492	X_{10}	–0.025	0.093	–0.264
P_1	0.213	0.488	0.437	P_1	0.979	0.437	2.239
P_2	**–0.979**	**0.419**	**–2.337**	**P_2**	**–0.889**	**0.377**	**–2.356**
P_3	0.032	0.243	0.132	P_3	–0.231	0.22	–1.052
K_1	–4.719	2.714	–1.739	K_1	–5.155	3.096	–1.665
K_2	–6.188	3.929	–1.575	K_2	–6.795	3.979	–1.708
K_3	–2.936	2.025	–1.450	K_3	–3.019	1.93	–1.564
Free term	5.72	3.637	1.573	Free term	5.298	3.273	1.619
Residual deviation	1.059			Residual deviation	1.048		

Table 7. Path analysis; dependent variable: organizational performance

Perceived effectiveness				Return on sales				Return on assets			
Variable	Par.	B. Std.	Par./B. Std	Variable	Par.	B. Std.	Par./B. Std	Variable	Par.	B. Std.	Par./B. Std
$Y_{1,A}$	0.107	0.105	1.016	**$Y_{1,A}$**	**0.001113**	**0.000489**	**2.276**	$Y_{1,A}$	–0.000517	0.001197	–0.432
$Y_{1,B}$	0.126	0.119	1.059	$Y_{1,B}$	0.000016	0.000536	0.030	$Y_{1,B}$	–0.000597	0.001309	–0.456
$Y_{1,C}$	0.008	0.159	0.050	$Y_{1,C}$	0.000418	0.000783	0.534	$Y_{1,C}$	0.002122	0.001917	1.107
$Y_{1,D}$	**–0.487**	**0.149**	**–3.272**	$Y_{1,D}$	–0.001181	0.000653	–1.807	$Y_{1,D}$	–0.003145	0.001597	–1.969
X_1	**0.019**	**0.007**	**2.887**	X_1	–0.000011	0.000027	–0.397	X_1	–0.000061	0.000065	–0.942
X_4	**0.094**	**0.031**	**3.009**	X4	–0.000266	0.000144	–1.843	X_4	–0.000205	0.000354	–0.578
X_5	–0.691	0.488	–1.416	X_5	0.001941	0.002282	0.851	**X_6**	**–0.035619**	**0.003964**	**–8.986**
X_7	**–0.123**	**0.032**	**–3.820**	**X_7**	**–0.000513**	**0.000162**	**–3.166**	**X_7**	**–0.001379**	**0.000395**	**–3.489**
X_9	–7.433	6.728	–1.105	X_9	–0.028572	0.029952	–0.954	X_9	0.007473	0.073380	0.102
X_3	0.05	0.105	0.475	**X_3**	**0.001190**	**0.000568**	**2.093**	X_3	0.002599	0.001390	1.870
X_2	0.096	0.054	1.770	**X_2**	**0.000932**	**0.000418**	**2.228**	X_2	0.001392	0.001013	1.373
X_{10}	**0.315**	**0.157**	**2.009**	X_{10}	0.000369	0.000801	0.460	X_{10}	–0.000291	0.001964	–0.148
P_1	**2.878**	**0.736**	**3.908**	P_1	0.001932	0.004063	0.475	P_1	0.007511	0.009958	0.754
P_2	–0.22	0.656	–0.335	P_2	–0.002128	0.003079	–0.691	P_2	–0.009683	0.007533	–1.285
P_3	0.254	0.365	0.694	**P_3**	**–0.015641**	**0.001926**	**–8.121**	**P_3**	**–0.033900**	**0.004725**	**–7.175**
K_1	–2.676	1.982	–1.350	K_1	0.019120	0.011454	1.669	K_1	0.045939	0.028039	1.638
K_2	–1.667	2.507	–0.665	K_2	0.022097	0.013595	1.625	K_2	0.058585	0.033285	1.760
K_3	**–4.442**	**1.604**	**–2.769**	K_3	–0.009195	0.009627	–0.955	K_3	–0.007050	0.023556	–0.299
Free term	26.888	5.467	4.918	Free term	0.043645	0.027907	1.564	Free term	0.115748	0.068193	1.697
Residual deviation	1.101			Residual deviation	0.010			Residual deviation	0.024		

Par. – estimated parameter value. B. Std. – standard parameter error (estimation error). Par./B. Std. – quotient of the parameter value by the parameter estimation error.

From the data in Tables 6 and 7 we can conclude about the direct and indirect relationship between particular determinants and the level of innovation and effectiveness.

In the equation describing product innovations, the greatest (reliable) influence have: (1) R&D financial resources (X_1), specialization (X_4), and transactional leadership (P_2). The increase in financial resources (X_1) by a unit results in an increase in the number of product innovations by 0.019. The increase in specialization (X_4) by 1% causes an increase in the number of product innovations by 0.088. Transactional leadership results in a decline in the number of product innovations (the increase in P_2 by a scale unit causes a decrease of $Y_{1,A}$ by 3.376, assuming that the values of the remaining variables do not change).

In the equation describing process innovations, the determinants for which the greatest (reliable) influence was noted, are: (1) R&D financial resources (X_1), transformational (P_1), and transactional leadership (P_2). The increase in financial resources (X_1) by a unit results in an increase in the number of process innovations by 0.013. Transformational leadership causes an increase in the number of process innovations (the increase in P_1 by a scale unit causes an increase in $Y_{1,B}$ by 1.505). Transactional leadership has the effect of decreasing the number of process innovations (the increase in P_2 by a scale unit causes a decrease in the number of process innovations by 2.963, assuming that the values of the remaining variables remain unchanged).

R&D financial resources (X_1), and transactional leadership (P_2) influence (in a reliable manner) technical innovations. The increase in financial resources (X_1) by a unit results in an increase in the number of technical innovations by 0.01. Transactional leadership has the effect of decreasing the number of technical innovations by 0.979 (assuming that the values of the remaining variables do not change).

Administrative innovations are most (reliably) affected only by leadership styles. Transformational leadership increases the number of administrative innovations by 0.979. Transactional leadership causes a decline in the number of process innovations by 0.880, assuming that the values of the remaining variables do not change.

For perceived effectiveness, variables of the greatest (reliable) influence are: administrative innovations ($Y_{1,D}$), R&D financial resources (X_1), specialization (X_4), formalization (X_7), innovative collaboration (X_{10}), transformational leadership (P_1), and market culture (K_3). The increase in the number of administrative innovations by a unit causes a decrease in perceived effectiveness by 0.487 scale points. The increase in R&D financial resources (X_1) by a unit results in an increase in perceived effectiveness by 0.019 scale points. The increase in specialization by 1% results in an increase in perceived effectiveness by 0.094 scale points. The increase of formalization by a scale

unit causes a decline in perceived effectiveness by 0.123 scale points. The increase of innovative collaboration (X_{10}) by a scale unit causes a decline in perceived effectiveness by 0.315 scale points. Transformational leadership causes an increase in perceived effectiveness by 2.878 scale points. In the case of market culture (K_3), the number of innovations is less by 4.442 compared to hierarchy culture.

ROS is most (reliably) influenced by: product innovations ($Y_{1,A}$), communication (X_2), managerial attitude toward change (X_3), formalization (X_7), and laissez-faire (P_3). The increase in the number of product innovations ($Y_{1,A}$) by a unit causes an increase in ROS by 0.0011. The increase in communication (X_2) by one scale point results in an increase in ROS by 0.00093. Increasing managerial attitude toward change (X_3) by one scale point increases ROS by 0.0012. The increase in formalization (X_7) by one scale point causes a decrease in ROS by 0.00051. The non-leadership behaviours of top managers (P_3) result in a drop in the ROS indicator by 0.0156, assuming that the values of the remaining variables do not change.

In the case of ROA indicator, the determinants for which the greatest (reliable) influence was noted, are: vertical differentiation (X_6), formalization (X_7), and laissez-faire (P_3). The increase in vertical differentiation (X_6) causes a decrease in ROA by 0.035. Increasing formalization (X_7) by one scale point decreases ROA by 0.0014. The non-leadership behaviours of top managers (P_3) result in a drop in the ROA indicator by 0.034, assuming that the values of the remaining variables do not change.

A graphical representation of significant (reliable) relationship between particular determinants, innovation and effectiveness is shown in Figure 1.

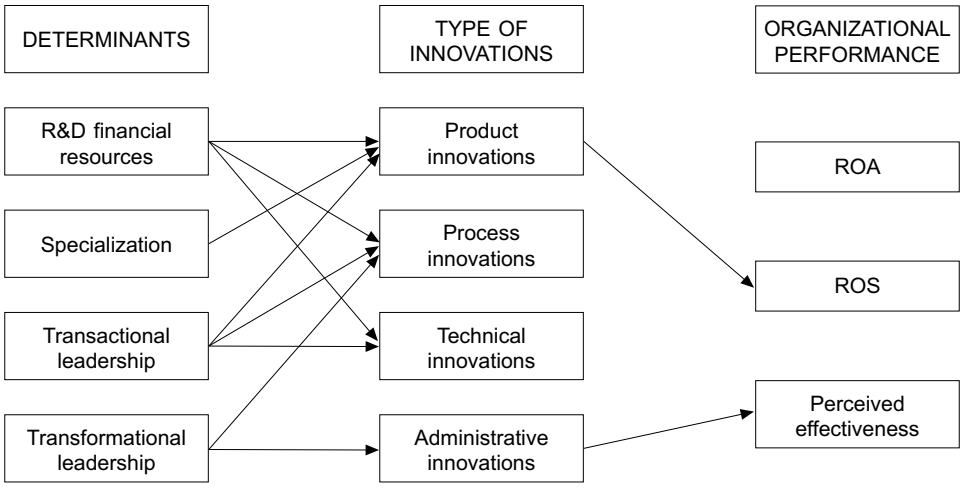

Figure 1. Significant paths

Based on conducted path analysis it can be stated that:
- R&D financial resources, specialization, and transactional leadership mediate effectiveness (as measured by the ROS indicator), and this path passes through the variable $Y_{1,A}$ (the number of product innovations);
- Leadership styles mediate perceived effectiveness, and this path passes through the variable $Y_{1,D}$ (the number of administrative innovations).

6. Conclusions

The study was focused on linkages between a great variety of determinants, four types of innovation and organizational performance. The findings of the study highlight that R&D financial resources, specialization, and different leadership styles have a significant impact on two measures of firm's performance.

When a financial measure such as ROS is taken into consideration, R&D financial resources, and specialization positively affect product innovation, whereas transactional leadership has a negative impact on product innovation. Higher R&D expenditures favour implementation of product innovation, since more resources become allocated to research. Also, a great number of innovative employees (experts) found in an organization, stimulates product innovation. The qualified employees are the essential source of new knowledge, the use of which leads to development of new products. A greater variety of specialists provides a more diversified knowledge base and increases cross-fertilization of ideas, both of which result in more product innovation. Transactional leaders are primarily concerned with gaining compliance from followers by agreeing upon the conditions and rewards that will follow the fulfillment of certain requirements. Hence this type of leadership does not stimulate the intrinsic motivation to take innovative actions. Subordinates are creative in order to gain benefits by the contractual agreement with a leader. Sometimes, an individual innovation may arise as a result of such activities, but generally transactional leadership neither stimulates product innovation nor increases a firm's financial returns.

When a executives' positive perceptions of firm performance is taken into consideration, different leadership styles have a significant impact on administrative innovations. Effective leaders stimulate employees' creativity and their opening to new knowledge acquired from internal as well as external sources. It has been acknowledged that administrative innovation is fostered in organizations which enhance employee autonomy, allow them to easily express their opinions and devise interfunctional cooperation.

Transactional leadership is directed at fulfilment of the contract with the subordinates and to exact monitoring of the innovation process, in order to prevent any deviations from proven methods. Hence, the findings of the study are not surprising, as transactional leadership emphasizes conformity with established routines and practices and would tend to discourage creative solutions. Transformational leadership assumes a strong connection between a leader and followers. It means that leader motivates subordinates to make increased efforts, by stimulating followers' emotions towards their work. Innovation-oriented companies assign the resources specifically to new ideas, support creative employees regardless of their work position, as well as reduce the bureaucracy related to the approval procedure preceding the implementation of an idea in practice. In short, such companies provide sufficient resources to fully develop and maintain product innovation on a higher level than the competitors.

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