ABS 1999
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NATIONAL TECHNOLOGY POLICIES AND STABILITY OF NTS INDEXES

The paper examines stability of Indexes of systems, which are used, at a country level, in order to develop technology. It is shown, based on statistical analyses of data from 1993 through 1997, that the set of variables, which form the model of National Technology System (NTS), is stable over the studied period of time. As well, stable are country membership in clusters, which characterize similar technology policies, factors that describe NTS, and finally NTS Indexes. The impact of these findings upon further studies is explored.

1. INTRODUCTION

Technology[1] is viewed as a catalyst for a progress of quality and competitive position. Some $500 billion is spent on R&D: much more is spent on technology acquisition, development, diffusion, and implementation. Consequently, managerial type questions related to technological change are of immediate interest to scientists, managers, and politicians. This paper focuses on examination of selected items of stability (dynamics) of National Technology Systems (NTS) that are used as a model of national technological efforts. Research of changes in national technology policies requires a model. Such a model should allow for identification of key aspects that impact upon technology policies, as well as upon results, which these policies produce. Examination of aspects of stability/dynamics of these elements is important for several reasons.

First, results of analyses of models of NTS in different countries and changes in these models permits identification of responses to technological challenges adopted in different surroundings. Also, such an analysis may assist in the development of Indexes of NTS. These Indexes[2] may be used to assess efficiency of respective systems. For example, the situation when patterns embedded in Indexes for a set of countries are similar denotes that cumulatively somehow similar policies were followed. Conversely, changes in those patterns would suggest technological policies shift. As well, clarification regarding stability of NTS (i.e., their Indexes) will have implication for further studies: e.g., regarding the impact of NTS on productivity levels and the efficiency of NTS.

Second, typologies of technological policies can be identified. The examination of typologies over period of time allows monitoring shifts from one type of a solution to another. In such a manner one may recognize more precisely areas where changes were made. Thus, the scope of required studies to be undertaken in order to identify both reasons for change and results produced will be reduced. For example, if selected countries follow one type of policy, and another set of countries another type of policies, and these sets remain constant over period of time, one gets more grounds to investigate reasons and rationality for adopting certain solutions. Again changes in membership in such strategic groups (clusters) points more accurately to those areas, which need further analysis. This approach may prove particularly useful when examining adjustment measures.

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[1] Any product, process, or person-embodied solution can be regarded technology (Kedia & Bhagat, 1988). Technological progress is interpreted as an application of a technological solution which leads to betterment (e.g., in terms of performance results) and which can be attributed to the application of this specific solution.

[2] A measure of intensity of a group of elements which form the NTS will be considered an Index of NTS.

It is expected result of this study to have implications for the crafting of technology-related policies. The outcomes will shed more light on the underlying features of specific needs for technology and its management.

In order to discuss above mentioned aspects more in details the following approach will be used. The concept of NIS will be outlined along with the new approach that is based on quantitative methods. Aspects of the assessment of National Innovation Systems (NIS) and their determinants will be explored. To this end a concept of National Technology Systems (NTS) will be introduced. Methodology used in the paper will be presented in the third part. Results of examination of membership in strategic technological groups, along with identification of types of technology policies will be presented in part four. Examination of stability of Indexes will be presented in part five that will be followed by a comprehensive discussion of findings and outline for further research.

2. THE NEW MODEL OF NIS

At the national level, technology related issues could be conceptualized in the form of (NIS). Following Dosi et.al. (1988), and Nelson (1993) it is accepted that NIS "is a network of agents, set policies and institutions which affect the introduction of technology that is new to the economy. The key aspects of NIS are the extend to which the economy acquires technology from abroad, the intensity of domestic technological effort it undertakes, and the level of technical human capital" (Dahlman, 1994, pp.541-542). NISs are formed in order to foster application and diffusion of technology, thereby improving productivity.

Albeit a wide acceptance of this interpretation of NIS, it exhibits several shortcomings. Measurement of variables related to the “set policies”, for example specialization patterns, is close to impossible. Studies on NIS within such a framework are largely based on experts’ opinions, case studies, and qualitative approaches. Thus, issues of bias may become dominant, suggestions for transfer of specific solutions between countries are intuitive, and results of studies do not pinpoint directly areas which need changes.

The NTS model utilized in this study is based upon several approaches designed to examine the efficiency of technology systems. Early ideas in this field tested the relationship between selected 'Inputs' (e.g., expenditures on R&D, quality of engineers/scientists) on selected 'Outputs' (e.g., patents and publication counts) (e.g., Stahl & Steger, 1977; Schainblatt, 1982; Pavitt, 1985; Saviotti, 1985; Soete & Wyatt, 1983; Evenson, 1991). Recently, more attention has been focused on examining the efficiency of selected countries systems (e.g., Reich, 1989; Deutouzos, 1989; Nelson, 1993, a Special 1995 Issue of Research Evaluation), fundamentals of efficiency of technology systems (Porter, 1990), and comparisons between national solutions (Nelson, 1993; Maital et.al., 1994; Grupp, 1991; Soete & Verspagen, 1991). In addition, the Frascati Manual (1980) and its Supplement (1989) identify factors hypothesized as important to management of technological development at the national level.

The model of NTS used in this study is unique in several aspects. First, the interpretation of new technology is different to that traditional. By new technology we mean any solution which is new to the specific economy: it need not be the novelty in global terms. Second, the current study focuses on country related technological issues, and the importance and the impact of contextual items (e.g., existing level of technology development/adoption capability, culture characteristics, size of the country/company) on productivity and competitiveness levels. Third, our model suggests the use of three broad categories of variables, namely: Inputs (GERD, employment in R&D), Moderators (country size and its culture characteristics), and Outputs (patents and publication counts). Moderators are assumed to be uncontrollable elements that impact upon Inputs and Outputs, as well as at Input-Output relationships.

Such an approach provides for an extension of 'classical' (here: Frascati and Oslo Manuals) views on technology management through the introduction of moderators directly into the model. A better understanding of the role Moderators play in NTS allows for a more focused discussion on the efficiency of specific technology related policies. Initially, the model was tested on the basis of data from 1992, providing results that support methodological underpinnings of the approach (Nasierowski & Arcelus, 1999a, Nasierowski 1997).

While taking into account conclusions/recommendations of the previous study (Nasierowski & Arcelus 1999a, 1999; Nasierowski 1998, 1997), the current project is intended to verify a more comprehensive model based on data from 1993 through 1997. Given the data restrictions, the suggested selection of the I/M/O proxies represents the best effort for the measurement of the main variables described in the literature as components of NTS. The resulting data set is detailed enough for the purpose of formulating research hypotheses. Our model embraces a cross-country approach to the development of NTS. To this effect, it organises the various NTS components into three groups: inputs, moderators, and outputs.

Inputs (I)

The factors directly responsible for the present and future development of technology. The set of inputs includes elements:

- devoted to the acquisition of technology - we refer this term to the incidence of each country's ability (i) to develop technology by itself or to acquire it from abroad; and (ii) to involve private industry in this endeavour. The proxies used to these effects are described as: Gross Domestic Expenditure on Research and Experimental Development (GERD); Foreign Direct Investment (FDI) and purchases of “goods and commercial services” (IMPO) which are assumed to bring technology from abroad (IMPO+FDI = PUR); and the degree of private business sector involvement in R&D (BRD);
- reflecting the contribution of the human component to technology development – the proxy of this item is reflected by employment in R&D (EM); and,
- devoted to the training of qualified human resources – the assessment of educational expenditures is measured by the funds dedicated to education in general (EDU) and to 3rd level education in particular (EDUT). Whereas education in general forms the basis for technology use, third level is more directly related to innovation, the core of R&D.

Moderators (M)

In addition to the inputs described above, our model considers a set of elements, hypothesised as having an impact upon I and/or O or the relationship between I and O. These include:

- accumulated S&T capability - it is accepted that economic prosperity depends upon innovations resulting from investments in scientific and educational advancement. Innovation reflects learning, experience, and know-how, and is firmly rooted in the prevailing economic and social structure which has been established over long periods of time (TEP, 1992). It is assumed that countries which have developed cultural, technical, and institutional infrastructures which support S&T should be more efficient in R&D. Hence, a measure of S&T stock is desirable to assess each country's past commitment to the technological development. There are no widely acceptable proxies for measurement of this phenomenon. The Purchasing Power Parity (PPP) is used as a proxy for accumulated S&T capability;
- cultural characteristics - culture has been proven to be a determinant in the adoption of management solutions. Although several works have hypothesised such a relationship (Hofstede, 1991; Kedia & Bhagat, 1988), it has remained empirically untested whether NTS can be explained on the grounds of cultural dimensions. At issue here is whether analyses of cultural underpinnings may shed more light on the reasons for specific solutions in a technical development effort. This paper uses Hofstede's four dimensions of culture (Individualism (IDV), Masculinity (MAS), Power Distance (PDI), Uncertainty Avoidance UAV)) (Hofstede, 1991); and,
- size of a country in terms of people or economic size - is important as a measure of a country's ability to absorb and to generate novelties. Gross Domestic Product (GDP), and the size of a country by

population (POPU) are used as proxies of size.

Outputs (O)

Outputs represent the degree of proficiency of the usage of inputs and the impact of moderators in the generation of technology. Two sets of outputs may be identified (beyond the final outputs, which may be the contribution of NTS to the economy, as measured, for example, by productivity (PROD), increased export in high-technology sectors, or increased standard of living):

- solutions – measured by patent counts of various types (patents by residents (PATR) and external patents (PATE)). These proxies are widely used despite of their potential pitfalls (e.g., Pavitt, 1988), and despite the fact that they manifest a relatively short-term results of R&D strategies (e.g. FM, 1981);

- knowledge base - which is a more long term measure of S&T efforts and deals with the building of the country's R&D knowledge base. Proxies of this factor include publication (PUB) and citations (CIT) counts.

Selection of the I/M/O proxies described above represents the best effort of measuring the main variables described in the literature as components of a country's NTS, given the customary data restrictions. Certainly, other dimensions could have been ideally included in the study, such as those related to governmental involvement in technological development (e.g., incentive and protectionistic measures), or those related to patterns of R&D specialisation. The lack of relevant data, as well as unresolved dilemmas in operationalisation, resulted in dropping these concepts from this study. This remains an unresolved issue, which requires re-evaluation as better data sources become available.

3. METHODOLOGY

The model of NTS will be cross-validated through the use of data from 1993 through 1997. The World Competitiveness Report (WCR), although it is a secondary source, is relatively accessible and has been used to create the data-base for the study. For data not listed in the Report, unless evidence to the contrary is made available, the minimum value (according to the measurement scale in the Report) has been accepted as the value of a specific data-item. This solution is justified in order to avoid (i) missing values and (ii) a value of 0, which would decrease the number of countries examined. Changes to the data will be made only if documentary evidence is available to prove that WCR data is incorrect. If the missing item is identified and cannot be explained by "a practice to report values up to a certain minimum value" the following three methods have been used: (i) the regression model to estimate the missing data-item (regression to the most closely correlated dimension); (ii) an average for surrounding (x+1; x-1) data is calculated; or (iii) intra/extra-polation.

Although NTSs are crafted in a country specific manner (Nelson, 1993,pp.512-515), some similarities in technology ma management strategies exist among industrialized countries. These affinities include an increased ratio of business-to-government R&D spending, the reduction of defense-oriented R&D, a focus on high-technology sectors, better access to appropriate qualifications for the general population (TEP, 1991; OECD, 1989). Even a cursory look at the data regarding technological performance of countries suggests that a few countries contribute disproportionately more of Inputs and Outputs. It is therefore justified to examine whether or not groups of countries with similar I/O/M structure can be identified. To this end cluster analysis will be used. ANOVA analyses on variables included in the model will be examined in order to justify inclusion/elimination of these selected variables. Certainly, there is a serious danger that some other important variables, because they cannot be quantified or data is not a available, will not be examined. Thus, "the end result may be that the analysis misses important elements of what is going on" (Dahlman, 1994, p.544). Changes in the variables set included into the model (if any), as well as changes of membership in identified clusters, will be used to elucidate reasons for membership and their changes over time.

3.1. Identifying Patterns of Technology-Development across Countries

The I/M/O data set consists of 6 inputs, 4 outputs and 7 moderators. For statistical purposes, this may appear at first glance too large a data set, given that there are only 45 countries under consideration in the WCR. As a result, the first step in the modelling of the I/M/O system is the study of potential interrelationships within the NTS of the various countries. Results of such an examination should permit to identify similarities of behaviour across subgroups of countries and/or across NTS components. As well, results may allow decreasing the number of constructs utilised and are expected to be indicative of patterns of country's position regarding generation and consumption of technology.

The question is whether it is possible to identify groups of countries with similar I/M/O structure when the data is weighted by size – GDP or POPU. Specifically, the answers to four questions are sought:

(i) are there I/M/O structures which characterise groups of countries, when the data is weighted by market size?;

(ii) are there I/M/O structures which characterise groups of countries, when the data is weighted by wealth?;

(iii) do the resulting I/M/O structures differ from each other?; and

(iv) does the composition of country groupings differ on the basis of the weighting scheme utilised?

To answer these questions, two cluster analyses, one per weighting scheme, were conducted. For each case, the following five-step procedure was utilised (e.g. Hair et. al., 1995):

(i) perform a hierarchical cluster analysis to identify the appropriate number of country groupings, using the cluster agglomeration coefficient as the criterion;

(ii) select the number of clusters on the basis of the largest percentage increase in the agglomeration coefficient;

(iii) validate the results with a non-hierarchical cluster procedure; and,

(iv) carry out an analysis of variance (ANOVA), in order to identify the I/M/O variables primarily responsible for the resulting groupings;

(v) repeat the first four steps for variables responsible for the groupings.

Results of these statistical analyses will be discussed in section four of the paper.

3.2. Identify Indexes of NIS - Patterns of Behavior across NIS Components

Statistical tests ran in the previous study (Nasierowski & Arcelus, 1999, Nasierowski, 1966), have revealed the existence of statistically significant correlation between some variables. Keeping in mind number of variables and the number of cases further data reduction is needed before one can explore Indexes of countries' involvement in technology development. The point of departure is the evidence (e.g. Scherer, 1983) in favour of significant correlation among various NTS inputs and outputs. A similar situation occurs with the NTS components of the present study. Most p-values are below .1, with substantial minorities under .01 and even under .001. One of the consequences of the high degree of collinearity among the I/M/O variables is the impossibility of isolating the independent effects of individual variables. Thus, it is only feasible to identify patterns of relationships across NTS components. This situation not only strengthens the advisability of further data reduction but also suggests a principal component analysis as the appropriate technique to extract non-correlated factors based on available data. Such an analysis can be carried out in four steps (e.g. Hair, et al, 1995):

(i) first, examine the anti-image correlation matrix to exclude from further consideration all variables with sample adequacy below .6;

(ii) second, repeat the analysis with the remaining variables, until the Kaiser-Meyer-Olin measure of sampling adequacy reaches the .7 (for "g" tests .6 plateau was accepted). If it does not, stop: no statistically significant factor analysis is feasible. Otherwise, continue;

(iii) third, identify the number of factors to be extracted, through a selection yardstick which combines the latent-root and the percent-of-variation-explained criteria. A factor is selected if (a) its eigenvalue exceeds 1; or (b) it explains at least 10% of the variation; or (c) the values for the two criteria simultaneously exceed .75 and 5%, respectively;

(iv) fourth, interpret the factors on the basis of those variables with factor loadings above .6. Factors arrived at using above described approach can be interpreted as Indexes of country's commitment to technological progress.

Again, the question is whether factors identified for data from different years are similar or inherently different. The answer will either indicate constant patterns or will suggest reasons of changes. Results of statistical tests described above will be presented in section five of the paper.

4. PATTERNS OF TECHNOLOGICAL BEHAVIOUR OF COUNTRIES

Results presented in Table 1 and Table 2 suggest the presence of several consistent patterns, regardless of the weighing scheme utilised. The first is characterised by two clusters with the same distribution of countries, irrespective whether GDP or POPU are used as weights. As a result, a new binary variable can be added to the NTS data set to identify the cluster membership of the various countries in the sample. This variable, denoted by **CT**, has a value of 0 for included countries with substantial dedication to technology development, such as the U.S., Switzerland, etc., and of 1 for the other. Cluster 0.

The second pattern is reflected in the similarity among the set of variables responsible for the groupings. Large p-values for both weighting schemes indicate that the clusters are not statistically significantly different in population (POPU), wealth (GDP), or assertiveness (MAS). The lack of statistical significance for POPU and GDP, together with the statistical significance of other variables when weighted by POPU or GDP, imply their role in terms of cluster differentiation to be appropriately defined as part of a weighting scheme, rather than as an independent indicator of market size. Masculinity appears to be a cultural characteristic with universal appeal. Thus, it fails to characterise either group exclusively. This is in contrast to the other three cultural variables, for which substantial differences exist among groups. Cluster-0 countries are more likely to favour low power Distance, high individualism, and low uncertainty avoidance. Countries' cluster membership is shown in Table 2.

The third pattern is manifested by results of statistical analyses. It indicates stability over the period of five years, of the set of variables responsible for cluster-groupings and stability of cluster membership. Thus, either policies remain largely unchanged, or shifts in these policies is characteristic of clusters – i.e., changes may occur, yet are followed consistently and independently by cluster members. Another explanation will have to accept the existence of a substantial gap between the two clusters (set of policies) that cannot easily be bridged by any country.

Most variables do characterise the groupings to judge by the low p-values in Table 1. With respect to the moderators, on average Cluster-0 countries tend to enjoy higher purchasing power parity (PPP). As for the inputs, Cluster-0 countries are more likely to be more involved in purchases of technologies from abroad (PUR), exhibit a higher incidence of business involvement in R&D activities (BRD), and have a larger commitment to employment in R&D and in the education of people. Cluster-0 countries dominate the generation of outputs, especially in terms of overall quality, quantity, export potential, acceptability by others, and the ultimate economic reward of increased productivity. As a consequence of the predominance of Cluster-0 countries in new technology development and acquisition, CT may be interpreted as an index variable denoting overall commitment to technological progress.

TABLE 1. **RESULTS OF ANOVA ANALYSES FOR ITEMS IN THE NTS MODEL** (items bolded are eliminated from further analysis)

Weighting by "p" (population)

	1993	1994	1995	1996	1997
PURP	.077	.074 (.710)*	.081	.069	.035
GERD	.000	.000	.000	.000	.000
BRD	.004	.001	.001	.000	.001
EMP	.000	.000	.000	.000	.000
EDUP	.000	.000	.000	.000	.000
EDUT	.000	.000	.000	.000	.000
POPUR	**.165**	**.162**	**.160**	**.143**	**.137**
GDPR	**.282**	**.329**	**.361**	**.494**	**.448**
PPP	.000	.000	.000	.000	.000
PDI	.000	.000	.000	.000	.000
UAV	.015	.015	.015	.018	.018
MAS	**.505**	**.505**	**.505**	**.450**	**.450**
IDV	.000	.000	.000	.000	.000
PATE	.000	.000	.000	.000	.000
PATR	.057	.027	.027	.003	.003
PUB	.000	.000	.000	.000	.000
CIT	.000	.000	.000	.000	.000
PRODA	.000	.000	.000	.000	.000

* in this instance, after cluster analysis with all variables, cluster analysis was repeated with variables which 'remained' in the model. Apparently, PURP($ should be eliminated from further considerations. Because this outcome is somehow 'atypical' (unexpected, and may result from spurious relationships between variables), it was considered a 'spurious' result, which was ignored from further considerations ---- PURP($ has remained within the model.

Weighting by "g" (GDP)

	1993	1994	1995	1996	1997
PUR	**.338**	**.342**	**.339**	**.375**	**.482**
GERD	.000	.000	.000	.000	.000
BRD	.007	.003	.001	.000	.003
EM	**.951**	**.819**	**.641**	**.745**	**.696**
EDU	.002	.001	.001	.000	.000
EDUT	.001	.000	.000	.000	.608
POPUR	**.209**	**.205**	**.202**	**.210**	**.204**
GDPR	**.219**	**.259**	**.287**	**.362**	**.325**
PPP	.000	.000	.000	.000	.000
PDI	.000	.000	.000	.000	.000
UAV	.073	.073	.073	.073	.073
IDV	.000	.000	.000	.000	.000
MAS	**.531**	**.531**	**.476**	**.531**	**.531**
PATE	.000	.000	.000	.000	.000
PATR	**.607**	**.414**	**.448**	**.172**	**.155**
PUB	.000	.000	.000	.000	.000
CIT	.000	.000	.000	.000	.000
PRODA	.000	.000	.000	.000	.000

Table 2. Information about clusters of countries according to NTS examined in the paper

	CTSP (cluster membership for 'p' Indexes)				
COUNTRY	1993	1994	1995	1996	1997
ARGENTINA	1	1	1	1	1
AUSTRALIA	0	0	0	0	0
AUSTRIA	0	0	0	0	0
BELGIUM/LUX.	0	0	0	0	0
BRAZIL	1	1	1	1	1
CANADA	0	0	0	0	0
CHILE	1	1	1	1	1
CHINA	1	1	1	1	1
COLOMBIA	1	1	1	1	1
CZECH REP.	1	1	1	1	1
DENMARK	0	0	0	0	0
FINLAND	0	0	0	0	0
FRANCE	0	0	0	0	0
GERMANY	0	0	0	0	0
GREECE	1	1	1	1	1
HONG KONG	1	1	1	1	1
HUNGARY	1	1	1	1	1
INDIA	1	1	1	1	1
INDONESIA	1	1	1	1	1
IRELAND	0	0	0	0	0
ISRAEL	0	0	0	0	0
ITALY	0	0	0	0	0
JAPAN	0	0	0	0	0
KOREA	1	1	1	1	1
MALAYSIA	1	1	1	1	1
MEXICO	1	1	1	1	1
NETHERLAN	0	0	0	0	0
NEW ZEALAND	0	0	0	0	0
NORWAY	0	0	0	0	0
PHILIPPIN	1	1	1	1	1
POLAND	1	1	1	1	1
PORTUGAL	1	1	1	1	1
RUSSIA	1	1	1	1	1
SINGAPORE	0	1	0	0	0
SOUTH AFR ICA	1	1	1	1	1
SPAIN	1	1	1	1	1
SWEDEN	0	0	0	0	0
SWITZERLAND	0	0	0	0	0
TAIWAN	1	1	1	0	0
THAILAND	1	1	1	1	1
TURKEY	1	1	1	1	1
UNITED KING.	0	0	0	0	0
USA	0	0	0	0	0
VENEZUELA	1	1	1	1	1

Correlation coefficients between CTSP Indexes (upper triangle); significance levels (lower triangle)

	CTSP93	STSP94	CTSP95	CTSP96	CRSP97
CTSP93	-----	.956	1.000	.956	.956
CTSP94	.000	-----	.956	.915	.915
CTSP95	.000	.000	-----	.956	.956
CTSP96	.000	.000	.000	-----	1.000
CTSP97	.000	.000	.000	.000	-----

5. INDEXES OF NIS

Table 3 Factors – Indexes identified in the study

	1993		1994		1995		1996		1997	
					INPUT P					
Out	PUR		PUR		PUR		PUR		PUR	
KMO	.769		.749		.797		.818		.829	
PVE	67.6		66.0		72.5		74.4		73.4	
	EDUTP	.925	EDUT	.938	EDUT	.933	EDUT	.928	EDUT	.933
	EDUP	.912	EDU	.897	EDU	.899	EDU	.874	EDU	.911
	GERDP	.717	GERD		GERD		GERD		GERD	.752
	EM	.								
PVE	15.7		15.3		15.2		12.9		14.9	
	BRDP	.925	BRD	.892	BRD	.934	BRD	.930	BRD	.945
			EM		EM		EM		EM	
					OUTPUT P					
KMO	.748		.741		.736		.727		.726	
PVE	65.3		66.8		65.8		63.9		64.0	
	PUBP	.912	PUB	.915	PUB	.918	PUB	.925	PUB	.926
	CITP	.899	CIT	.899	CIT	.899	CIT	.902	CIT	.902
	PATEP	.788	PATE	.752	PATE	.762	PATE	.841	PATE	.840
PVE	20.3		19.7		20.2		22.8		22.8	
	PATRP	.975	PATR	.970	PATR	.972	PATR	.896	PATR	.985
					MODERATORS P					
KMO	.758		.785		.756		.778		.779	
PVE	64.5		64.9		64.7		63.7		64.1	
	CTSP	.955	CTSP	.945	CTSP	.916	CTSP	.899	CTSP	.898
	PPP	-.867	IDV	-.874	IDV	-.865	PDI	.866	PDI	.868
	PDI	.848	PDI	.864	PDI	.857	IDV	-.849	PPP	-.859
	IDV	-.827	PPP	-.831	PPP	-.848	PPP	-.834	IDV	-.844
PVE	18.3		18.5		18.3		18.3		18.3	
	UAV	.910	UAV	.987	UAV	.983	UAV	.977	UAV	.982

Table 3[3] identifies factors (Indexes) of NTS. It can be observed, that consistently, the following factors can be identified:

Inputs:
- purchases of technology from abroad (PUR);
- public investment in human development / research (EDU, EDUT, GERD);
- commercial orientation of research project (private sector involvement) (BRD, EM)

Outputs:
- quality of outputs (PUB, CIT, PATE);
- short term R&D results (PATR)

Moderators:
- culture impact on technology development (IDV, PDI, PPP, CT);
- acceptance of uncertainties associated with technological change (UAV).

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[3] Only factors for weighting scheme by population (‘P’) are presented here for illustrative purposes. Results for ‘g’ factors provide similar results in terms of explanation of observed patterns.

Albeit differences in values of loadings, the percentage-of-variance-explained, and the KMO, factor analyses results show similarities that justify us to accept them as “stable” Indexes of NTS. It also permits to select a leading element from which factor to represent this factor in further studies – for example, EDU or GERD may serve as the representation of factor called “public investment in human development / research”. Such an observation has two practical implications. First, it gives flexibility in selection of “indicators of factors” – an item convenient in situation when certain data is not available. Second, it permits the use of “raw data” in situations, where due to constraints imposed on statistical tests standardized data cannot be used (e.g., DEA where all data must be positive).

6. CONCLUSIONS. FUTURE EXTENTIONS OF THE STUDY

The focus in the current study has been on examination of stability of NTS. The importance and the impact of contextual variables (e.g., existing level of technology development/adoption capability, culture characteristics, size of the country) have been taken into account. Results unquestionably show a high degree of stability of solutions adopted in NTS. These observations have several implications for further research.

The existence of two clusters suggests the need to follow different technology policies subject to the of existing conditions. The assessment of the fit of a technological solution to local conditions and the efficiency of its implementation is complex. One encounters a relativism of objectives and paradigms. The abundant literature on the subject typically concentrates on the operations of multinational companies and a "free-market" perspective to the problem. Yet, concepts appropriate in the surroundings of industrialized countries may not necessarily be considered as such in developing countries. The economic criteria do not unconditionally resolve the dilemma, especially when emotional elements originating from political or culture preferences are in place. Each case has to be examined on its individual merits, making a uniform evaluation procedure quite difficult to develop. Such an attempt, however, should not be ignored.

The high degree of collinearity among elements of NTS points out to the need to use Structural Equation Modeling technique when examining the impact of elements of NTS upon outputs and the impact of NTS upon economy – for example productivity and competitiveness levels.

Further analysis of the model and the Indexes will allow determining the underlying reasons for technological performance. This opens the possibility to continue discussion on patterns of Input-Output relationships and to determine the character of this function (linear or not, with a declining or increasing pattern) in the function of the type of the country.

Next, one of the more onerous tasks in the modeling of NTS is the measurement of their efficiency and the potential changes in such efficiency over time. The stability of NTS (in terms of clusters, variables important to the explanation of NTS, cluster membership, etc.) validates the basics of the model. On the other side, however, it poses questions regarding appropriateness of the approach in terms of measuring the efficiency of NTS and measuring the changing impact of NTS upon productivity and competitiveness. The first dilemma can be handled with the use of Data Envelopment Analysis: a non-parametric technique, which is distribution free and produces an index of efficiency via a linear programming formulation that links the inputs and the outputs of each NTS. DEA will be used to determine specific reasons for performance/relative-technological-competitive-position of each individual country. The second dilemma, however, remains unresolved and further study is needed in order to outline means to cope with it.

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