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The Relationship between Labor Market Efficiency and Innovation

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Abstract: This paper aims at investigating the interaction between the two sets of "Labor market efficiency" and "Innovation" as the two basic pillars of national competitiveness in order to provide information for improving national competitiveness in countries which are transiting from stage II to stage III of development. The research method is descriptive-correlation methodology. The statistical population was 138 countries whose Global Competitiveness Index (GCI) data were included in GCI 2016-2017 report. Also, this research employed Canonical Correlation Analysis (CCA) to investigate interaction between two sets of "Labor market efficiency" and "Innovation". the findings shown that there is a significant and positive relationship between the set of "Labor market efficiency" and that of "Innovation".
Keywords: Global Competitiveness, Labor market efficiency, Innovation, Canonical Correlation Analysis

1. Introduction

In globalization age, the economic competition among countries and economic enterprises has increased globally. The concept of competitiveness has been applied by Michael Porter at a wide extend of competitiveness of enterprise and industry to national and global competitiveness [14].

The rapid progress of globalization has alarmed nation states worldwide to develop stable macroeconomic policies in order to enhance the competitiveness of domestic markets. The State has an important role to play in this process. This also means greater efforts to reform education and science, to promote advanced technologies and to strengthen the private sector [7]. Economic management agenda in many economies around the world is transition from efficiency-driven economy to innovation-driven. To this end, their economic policy making should benefit valid orientation and indicators for this transition. Utilizing comparative approach and benchmarking from successful economic experiences around the world can help the policy makers and business leaders manage economy and achieve a higher level of prosperity. In this regard, improving the national competitiveness is a key factor [20].

The concept of competitiveness has attracted abundant attentions of both scholars and governors during the past decade to the extent that World Economic Forum (WEF) has developed GCI to measure competitiveness of countries around the world [20]. The purpose of WEF of issuing the annual GCI

reports is to provide benchmarking tools for business leaders and policymakers to identify obstacles to improved competitiveness, thus stimulating discussion on the best strategies and policies to overcome them [24].

However, before adopting the GCI as a benchmark or spending any resources and efforts to improve national competitiveness, policymakers must determine their country priorities for improving national competitiveness. This research seeks to investigate interactions between pillars of "Labor market efficiency" and "Innovation" in GCI in order to provide information for countries which are transiting from stage II of development to stage III to improve their national competitiveness in an efficient way.

2. Literature Review

2.1. Competitiveness

According [3] in today's perspectives, competitiveness has become a fundamental force in economics like gravity in physics. Competitiveness is a concept, which tries to explain why some countries develop faster than others. Also, it connects the macro- and micro-economic views of social-economic development [11]. [17] identified competitiveness at three levels: firm, industry and national. In the context, [18] believed that "the only meaningful definition of competitiveness at the national level is national productivity". Furthermore, [5] point out that "improving productivity is the only way of baking a bigger cake – most other changes simply give us different sized slices".

Also, It may have significant consequences for the long-term competitiveness of the firms because adapting to one relationship may boost the competencies and attractiveness of a particular supplier/customer [8]. From a macro policy perspective, the primary goal of competitiveness is the well being of the citizens of a country, be it through individual income, standard of living, human development, or social justice [11].

Since 1979, annual Global Competitiveness Reports of World Economic Forum (WEF) have examined the many factors enabling national economies to achieve sustained economic growth and long-term prosperity. In these reports competitiveness has been defined as the set of institutions, policies, and factors that determine the level of productivity of a country [14]; Also, since 2005, the WEF has developed the Global Competitiveness Index (GCI). As a highly comprehensive index, GCI captures the microeconomic and macroeconomic foundations of national competitiveness. According to GCI reports, "a nation's level of competitiveness reflects the extent to which it is able to provide rising prosperity to its citizens" [24].

The GCI captures the open-ended dimension of competitiveness by providing a weighted average of many different components, each of which reflects one aspect of the complex concept of competitiveness [24]. The GCI contains 12 pillars which are classified as following Table 1.

Table 1. GCI pillars in three main sub-indexes [24]

main sub-indexes	Pillars of GCI
Basic requirements	1. Institutions
	2. Infrastructure
	3. Macroeconomic stability
	4. Health and primary education
Efficiency enhancers	5. Higher education and training
	6. Goods market efficiency
	7. Labor market efficiency
	8. Financial market Development
	9. Technological readiness
	10. Market size
Innovation and sophistication factors	11. Business sophistication
	12. Innovation

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2.2. Labor Market Efficiency (LME)

The efficiency and flexibility of the labor market are critical for ensuring that workers are allocated to their most efficient use in the economy and provided with incentives to give their best effort in their jobs. Labor markets must therefore have the flexibility to shift workers from one economic activity to another rapidly and at low cost, and to allow for wage fluctuations without much social disruption. The importance of the latter has been dramatically highlighted by the recent events in Arab countries, where high youth unemployment sparked social unrest in Tunisia that spread across the region. Efficient labor markets must also ensure a clear relationship between worker incentives and their efforts to promote meritocracy at the workplace, and they must provide equity in the business environment between women and men. Taken together these factors have a positive effect on worker performance and the attractiveness of the country for talent, two aspects that are growing more important as talent shortages loom on the horizon. The "Labor Market Efficiency" sub-indexes are:

1. Cooperation in labor-employer relations;
2. Flexibility of wage determination;
3. Effect of taxation on incentives to work
4. Hiring and firing practices
5. Redundancy costs, weeks of salary;
6. Pay and productivity;
7. Reliance on professional management;
8. Country capacity to retain talent
9. Country capacity to attract talent
10. Women in labor force, ratio to men [24].

2.3. Innovation

Although substantial gains can be obtained by improving other 11 pillars, all these pillars eventually seem to run into diminishing returns. In the long run, standards of living can be enhanced only by technological innovation. Innovation is particularly important for economies as they approach the frontiers of knowledge and the possibility of integrating and adapting exogenous technologies tends to disappear. Designing and developing cutting-edge products and processes to maintain a competitive edge requires an environment that is conducive to innovative activity, supported by both the public and the private sectors. In particular, it means sufficient investment in research and development (R&D), especially by the private sector; the presence of high quality scientific research institutions; extensive collaboration in research between universities and industry; and the protection of intellectual property. The "Innovation" sub-indexes are:

INN1. Capacity for innovation;
INN2. Quality of Scientific research institutions;
INN3. Company spending on Research and Development (R&D);
INN4. University-industry collaboration in R&D;
INN5. Government Procurement of advanced tech products;
INN6. Availability of Scientists and engineers;
INN7. PCT patents, applications/million pop [24].

2.4. Canonical Correlation Analysis (CCA)

CCA is a multivariables statistical approach for measuring linear relationship between different groups of variables. This approach can play an important role in exploratory mean when multi attribute variables have some relations to an analytical category [6]. CCA is obtaining linear composition of predicting variables that has the most correlation with linear combination of criteria variables. These combinations are shown as follow [13]:

$$W = a1x1 + a2x2 + \ldots + apxp \quad (1)$$

$$V = b1y1 + b2y2 + \ldots + bqyq \quad (2)$$

The number of dependent variables (ten) or the number of independent variables (seven), whichever is smaller, determines the maximum number of canonical functions. Thus, the analysis is based upon the derivation of four canonical functions [12]. Table 2 is showing some researches in CCA field.

Table 2. Some previous research which applied CCA for investigating GCI's Pillars

author(s)	summery
(Bazargan, 2017)	A CCA model for Business sophistication & Innovation
(M. R. Mehregan, 2016)	A DEMATEL-CCA model for 12 pillars
(M. J. Mehregan, 2014)	A CCA model for Macroeconomic Environment and Financial Market Development
(Rohollah Ghasemi, 2013)	A CCA model for Infrastructure & Technological readiness
(S. M. Razavi R. G., 2012)	A CCA model for Business sophistication and innovation
(A. Rastegar, 2012)	A CCA model for Technological readiness and Labor market efficiency
(Saeed Safari, 2012:b)	A CCA model for Higher education and training and Technological readiness
(Jafarnejad R. G., 2012)	A CCA model for macroeconomic environment and technological readiness
(S. M. Razavi R. G., 2011)	A CCA model for Technological readiness and Innovation
(Jafarnejad R. G., 2011)	A CCA model for Financial Market Development and Technological readiness

3. Proposed Model

This Proposed model is composed of two kinds of variables: "Labor market efficiency" and "Innovation" as in the following figure.

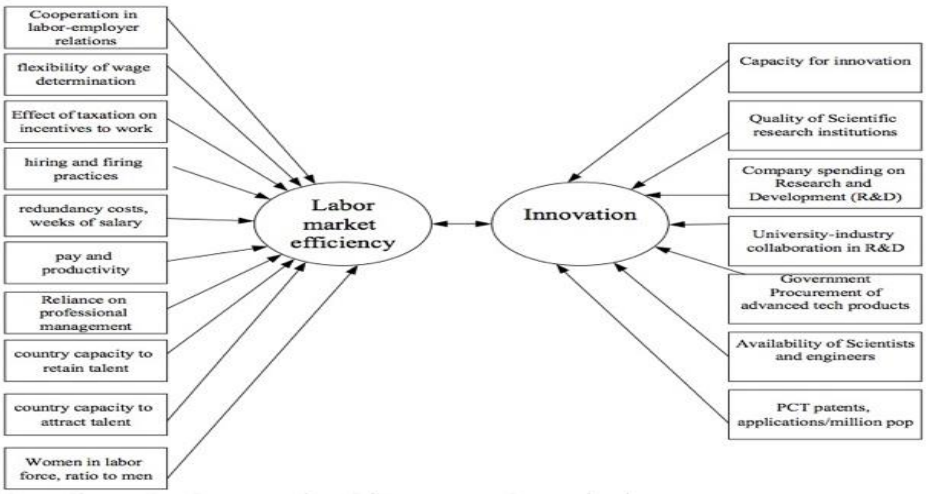

Figure 1. Research proposed model

According to the above-mentioned figure research question is: Is there any meaningful relationship between "Labor market efficiency" and "Innovation"?

And Research Sub questions are:

1. Is there any correlation between "Labor market efficiency" sub-index and "Innovation" sub-index?
2. In the set of "Labor market efficiency", which pillar has the most and which one has the least impact on creating a meaningful relationship between "Labor market efficiency" and "Innovation"?
3. In the set of "Innovation", which pillar has the most and which one has the least impact on creating a meaningful relationship between "Labor market efficiency" and "Innovation"?

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4. Research Methodology

4.1. Research Method

Research method used for this study is descriptive-correlation. Secondary analysis method was also used for analyzing secondary data source. First, we studied literature of Competitiveness, GCI, "Labor market efficiency", "Innovation" and CCA. Then, we used the GCI report data in 2016-2017 for doing our secondary analysis. The Statistical population in this study was 138 countries whose data was included in GCI report in 2016-2017. Finally, we utilized Canonical Correlation Analysis (CCA) by Statistica 13 software; thereafter, analysis output was obtained.

4.2. Information gathering tools

According to [25] it would be appropriate to use data collected by other people or agencies to address the relevant research questions. Such data is called secondary data resource. So, we utilized the data published by World Economic Forum (GCI report in 2016-2017) as our secondary data resource.

5. Results and Discussion

Using Statistica 13 software, we investigated correlation between two sets of "Labor market efficiency" and "Innovation" by using CCA. For answering the first sub question, based on table 3, we can see a meaningful positive correlation among some sub-indexes in significance level of 0.05 between "Labor market efficiency" sub-indexes and "Innovation" sub-indexes.

Table 3. Correlation coefficient between "Labor market efficiency" and "Innovation"

indexes	INN1	INN2	INN3	INN4	INN5	INN6	INN7
LME1	**0.559**	**0.557**	**0.566**	**0.651**	**0.644**	**0.585**	**0.671**
LME2	-0.157	0.026	0.128	-0.063	-0.072	-0.070	-0.005
LME3	-0.005	0.170	**0.504**	0.200	0.173	0.071	0.174
LME4	0.164	0.373	0.561	0.402	0.362	0.277	0.342
LME5	-0.202	-0.226	-0.088	-0.243	-0.203	-0.275	-0.233
LME6	**0.525**	**0.707**	**0.681**	**0.757**	**0.780**	**0.740**	**0.793**
LME7	**0.679**	**0.687**	**0.548**	**0.812**	**0.836**	**0.826**	**0.859**
LME8	**0.562**	**0.634**	**0.705**	**0.785**	**0.757**	**0.676**	**0.712**
LME9	0.411	**0.551**	**0.724**	**0.708**	**0.681**	**0.603**	**0.653**
LME10	0.265	-0.033	-0.016	0.197	0.222	0.229	0.225

"Reliance on professional management" and "PCT patents, applications/million pop" have the strongest correlation. With regard to table 3, we can obtain some valuable findings. For example, in "Labor market efficiency" sub-indexes, "Cooperation in labor-employer relations", "pay and productivity", "Reliance on professional management", "country capacity to retain talent" and "country capacity to attract talent" have the most correlation with Innovations' indexes.

Table 4. Statistical tests: Chi-square Tests with Successive Roots Removed

roots	Canonical R	Canonical R^2	Chi-sqr	df	P	Lambda Prime
0	**.9139**	**0.8353**	395.3	70	**0.00**	**0.041**
1	.7089	0.5025	171.6	54	**0.00**	0.250
2	.4878	0.2380	85.06	40	**0.00**	0.503
3	.4172	0.1740	51.35	28	**0.00**	0.660
4	.4045	0.1636	27.64	18	0.06	0.800
5	.19606	0.0384	5.47	10	0.85	0.956
6	.0704	0.0049	0.61	4	0.96	0.995

Usual Canonical Correlation Analysis meaningful level for interpretation is 0.05. As it's shown in table 4, P-value is used for this research; first, second and third canonical variables are statistically meaningful. In addition, other statistical tests like "Lambda Prime" and "Chi-square" are proofing our results. Based on table 4 we considered first canonical variable and ignored interpretation of 2nd, 3rd and 4th variables because of their weak canonical cross loading and redundancy index. For answering research question, we focus on table 4. Relationship importance between **"**Labor market efficiency**"** and "Innovation" is determined by canonical correlation (R_c) and Eigen value (R_c^2).

Based on table 4, first variable R_c is 91.39% and R_c^2 is 83.53%. Because R_c cannot directly prepare the shared variation, we utilize redundancy index. Redundancy index for R_c^2 is in multiple regression analysis.

Table 5. Canonical loading for meaningful canonical variables in Labor market efficiency & Innovation

Labor market efficiency	Root 1 (canonical loading)	Root 2 (canonical loading)
Cooperation in labor-employer relations	**0.7567**	-0.1334
Flexibility of wage determination	-0.0213	-0.3297
Effect of taxation on incentives to work	0.2332	-0.7221
hiring and firing practices	0.4366	-0.6094
redundancy costs, weeks of salary	-0.2709	-0.1492
pay and productivity	**0.8935**	-0.2219
Reliance on professional management	**0.9472**	0.1492
Country capacity to retain talent	**0.8532**	-0.3099
Country capacity to attract talent	**0.7799**	-0.4538
Women in labor force, ratio to men	0.2197	0.4246
Extracted variance (%)	39.72%	15.95%
Redundancy index (%)	33.17%	8.01%
Innovation	Root 1	Root 2
Capacity for innovation	**0.9672**	0.1001
Quality of Scientific research institutions	**0.9389**	0.1905
Company spending on R&D	**0.9654**	0.0256
University-industry collaboration in R&D	**0.9558**	-0.0377
Government Procurement of advanced tech products	**0.7088**	-0.6533
Availability of Scientists and engineers	**0.8194**	-0.0922
PCT patents, applications/million pop	**0.7468**	0.3741
Extracted variance (%)	77.06%	6.43%
Redundancy index (%)	8.91%	4.47%

For answering 2nd and 3rd sub-questions, we used canonical loading for evaluating the importance of every criterion in meaningful canonical variable. In general, the researcher faces the choice of interpretation of the functions using canonical weights (standardized coefficients), canonical loadings (structure correlations). Given a choice, it is suggested that cross loadings are superior to loadings, which are in turn superior to weights [4].

According to table 5, all variables in Innovation sets have a high canonical loading in creating a canonical variable in its set, also almost variables in "Labor market efficiency" sets have a high canonical loading in creating a canonical variable in its set.

So, they are very effective in creating a meaningful relationship between "Labor market efficiency" and "Innovation". Based on table 5, In "Labor market efficiency" sub-indexes, "Reliance on professional management", "Pay and productivity", "Country capacity to retain talent" & "Country capacity to attract talent" have the highest effect and "Flexibility of wage determination" has the lowest effect in creating this relationship. Furthermore, in the "Innovation" sub-indexes, "Capacity for innovation", "Company spending on R&D", "University-industry collaboration in R&D", and "Quality of Scientific research

institutions" have the highest effect and "Government Procurement of advanced tech products" has the lowest effect in creating this relationship.

Also, for CCA validity, we used sensitivity analysis on independent variables. For this validation, we eliminate one of "Labor market efficiency" sub-indexes every time and utilize CCA. Outputs depicted no impression change in construct coefficient of variables. So, we assured that data were valid.

6. Conclusions

This research intended to investigate the relationship between "Labor market efficiency" and "Innovation" by using CCA for GCI 2016-2017 data. First, we studied literature of Competitiveness, GCI, "Labor market efficiency", "Innovation", and CCA. Then, we used the Global Competitiveness report data in 2016-2017 to do our secondary analysis. The population in this study was 138 countries whose data was included in GCI report in 2016-2017. Eventually, we utilized Canonical Correlation Analysis (CCA) through Statistica 13 software then analysis output was obtained.

According to research findings, there is a meaningful relationship between "Labor market efficiency" index and "Innovation" index and "Labor market efficiency" index have a positive effect on "Innovation" index. In "Labor market efficiency" index, "Reliance on professional management", "Pay and productivity", "Country capacity to retain talent" & "Country capacity to attract talent", also in "Innovation" sub-indexes, "Capacity for innovation", "Company spending on R&D", "University-industry collaboration in R&D", and "Quality of Scientific research institutions" have the most impact on creating a meaningful relationship.

Being familiar with national competitiveness indexes provides a suitable ability for different industry agents to analyze their country environment with regional countries and even world countries. Generally, the findings of this research increased our knowledge about the relationship between indexes of "technology readiness" and "innovation".

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