Impact of innovativeness of the country on export performance: evidence from Asian countries

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Abstract: *This paper makes an attempt to find the relationship between innovation indicators and export performance of the country. We used patents, trademarks, industrial design, number of scientific journals, R&D expenditures as indicators of innovativeness of the country. As a sample we have constructed unbalanced panel data for 48 Asian countries with time series from 1997 to 2011. After OLS regression we found that only innovativeness indicator which positively associated with export performance is a number of registered industrial design in the country. The rest of innovativeness indicators did not show any significant relationship with export performance of the country.*
Keywords: *innovation, export, FDI, trademarks, patents, R&D*

I.   Introduction

In current competitive world the competitive advantage gained through developing new products and processes is crucial factor for success of firms. Innovative firms logically more competitive and should have productive performance and should have better opportunity to be successful in international markets. It is clear that innovation policy of the country is different than it is in particular firm, because of different tasks and goals, but still there are some similarities and bonds. As more firms of one country are successful in international markets as better trade performance of the country will be in the end. According to theories of Vernon [1] and Krugman [2] innovation is considered to be a driving force behind the international trade.

Today when privatization of scientific commons is increasing along with stronger intellectual property laws [3] make innovation more important than ever in enabling firms, industries or even countries to achieve positional advantages and better economic outcomes [4]. As a result, innovation performance determinants – the proportions of the economic returns to innovation – have attracted substantial research interest [5,6].

Our research has a goal to estimate the impact of innovation on export intensity of the country on example of Asian economies, where there are geographically close related different economies, with different opportunities. Countries of our sample belong to Asian region and are not divided by its current economic situation or conditions. This will give us results maximally close to factual situation.

Previous studies which investigated the impact of innovation on export performance of the firms have generally found positive and significant effect [7,8]. But most of researches were based either on firm level samples or on sectoral approach. These researches all used firms as samples and there are very few papers where countries have been used as a sample with the aim to analyze overall effect of country's innovation indicators on export performance. There were attempts to have analysis on the data based on European countries and on developed countries, but these results are not likely to be same regarding to other countries.

To fulfill this gap we have decided to make analyzes on country level and to find the effect of innovation on export performance on the basis of Asian countries.

The paper is structured as follows: the following section critically reviews the literature on innovation and its impact on export performance. After we present methodology used for analysis, description of data and interpretation of our empirical findings. The last section presents concluding remarks.

II.   Literature review

There is a growing literature that attempts to investigate the determinants of trade performance, either for one country, or for a group of countries, with the aim to assess the factors which influence trade performance of nations. Fagerberg [9] found the positive effect of technology on economic growth and international competitiveness at the aggregate economy level, by using a combination of R&D data and patent statistics. Soete [10], Dosi et al. [11], and Verspagen [12] found that technological activity (mainly measured by patents granted in the U.S.) had a positive impact on trade performance at the sectoral level.

Studies on trade performance where innovation is considered as an explanatory variable take place from two different theoretical traditions. The first approach is the Hecksher-Ohlin model of trade, in which relative factor profusion determines the pattern of trade. The second view considers differences in technology as an important motive in explaining trade performance. In the first view, early studies used the data on labor

productivity to explain countries' specialization. Other studies found that R&D intensity is positively related to export performance. Stern and Maskus [13] in their research based on US trade from 1960 to 1970 used a neo-endowment model. They included human capital and technology (measured by R&D expenditures) as factors of production, and found considerable evidence for the importance of technology in affecting trade performance.

In the second approach, the relationship between technology and international competitiveness based on the neo-technological trade theories of the 1960s. According to this approach differences in technology are the primary motive for differences among nations in terms of trade performance. So-called the `technology gap' approach shows the reason of international trade flows as a result of the inter-country differences in innovativeness. According to Posner [14] it is technological change in one country, and not in others that induces exports. Knowledge is a public good, so earlier or later it will flow to other developing economies. The conclusions of the `product cycle' model [1] are very similar to the technology gap model. Innovation in leader countries helps to produce new products which pass through different stages of maturity. Initially the innovator country is the only producer of the new. Once the new product reaches a particular phase, the production starts in other developing economies, where labor costs are lower. This leads to more diffusion of knowledge.

Most of studies, where subject is about factors impacting on trade performance in country level find strong evidence that domestic innovation is an important variable. Fagerberg [9] made a research with 15 OECD countries as object of his study for the period 1960 to 1983. He used R&D expenditures and external patents as the technological proxies. The analysis was conducted at the aggregate level and he finds that technological competitiveness and `the ability to deliver on time' were the most important determinants on international competitiveness and growth. Dosi et al. [11] studied the influence of technology gaps on OECD trade, using patents as technology measure. They also used different dependent variables for trade performance and found similar results as Fagerberg. The study [15] based on particular sectors showed little effect of technology on trade flows.

Amable et al. [48] found that change in bilateral export market shares among OECD countries was positively correlated on relative R&D as well as on number of patents. Wakelin [7] in his work made emphasis on innovation and examined the determinants of bilateral OECD trade. She used two innovation proxies. She finds that there is a positive relationship between relative innovation and bilateral trade performance. This analysis is undertaken at the country level and the results confirm that technology gaps partly determine trade, but not in all sectors.

The need for understanding what drives differences in innovation performance brought to three predominant theoretical explanations which revolve around the role of international trade [16,17,18,19], foreign direct investment (FDI) [20,21], and industrial research and development (R&D) [22,23,24,25]. As many studies indicate [e.g., 26,27] most previous research on innovation has focused on developed countries but a rapidly growing share of the world's total R&D is now undertaken in emerging economies [28]. To address this issue, we employ data for all countries in complex in Asian region, where there are developed and emerging economies are considered in combination.

An important problem in understanding the mechanisms underlying innovation is the difficulty of measuring the innovative activity [29,30]. Previous researches which studied the effects of international trade, FDI and R&D has employed broad measures of performance such as total sales, number of patents and productivity [31,32,4,24]. In our research we use not only number of patents, but also trademarks and industry designs, research and development expenditure (% of GDP), scientific and technical journal articles to fully represent the innovation performance of the country.

Many growth theorists claim [33,34,35] that international trade may facilitate technology creation and diffusion. Participation in export markets enables firms to explore new technologies and enhance organizational learning by analyzing the innovations of their foreign competitors [36]. Organizations that export their products may also enhance their innovation performance by accessing diverse knowledge, ideas and information about competing products and customer preferences [19]. Beside of it, they can benefit from exposure to more strong competition, which in turn may force them to enhance their innovation performance [37]. Overseas buyers may suggest ways to improve the manufacturing process, and share information about design specifications and production techniques [38], which can help firms to learn from exporting [5].

III. The Impact of innovation on export performance

Porter [39] says that firms, not nations, compete in international markets and that the basic unit of analysis for understanding competition is the "industry". So speaking about the effect of innovation on export in country-level, first we have to analyze the same effect on firm-level. International trade is driven by many factors but innovation is considered to be a driving force behind it in the process of firm development and its efforts to penetrate into the international markets. There are many factors impacting on international trade and innovation is one of the most important ones. Based on the models of Vernon [1] and Krugman [2] in the process of entering into the international markets innovation is considered as the driving force for firms.

Innovation is significant element of firms' strategic strength, so firms invest more on new product and process developments with the aim to penetrate into new markets and to be more competitive. According to Vernon [1] new products are introduced by firms to meet national needs and are first exported to similar countries, and by this way companies diminish risks and costs using other markets out of national boundaries.

Later Krugman [2] developed a model of international trade in which patterns of trade are determined by a continuing process of innovation and technology transfer. As Grossman and Helpman [5] predicted, in the economy global-models of innovation and growth, the increase of exports driven by innovation will in return increase investments of the firm in activities stimulating innovation, thereby raising the endogeneity issue between innovation and exports.

There are some researches which support the idea that innovation has a positive impact on export of the firm. The study done by Hirsch and Biaouji [40] tested the impact of R&D intensity on export performance on example of Israeli firms and found the positive effect of innovation on export. Beside of it in that research it has been proved that number of R&D employees is positively related with export growth.

Kumar and Siddharthan [41] found an interesting results where the relationship of firm size and export performance suggests an inverted U-shaped form meaning that firms export more when they start to grow, but after a certain point of growth the effect on exports starts to decline. This might imply that large enterprises act as oligopolist over the protected domestic market which generally makes them less prone to export than the other firms. In their study they measured innovation in form of R&D intensity.

Wakelin [7] in his study, where he used samples of UK firms analyzed the role of innovation in determining export behavior. The results of the Wakelin research suggest that innovating and non-innovating firms behave differently both in terms of probability of exporting and the level of exports, showing that the capacity to innovate changes the behavior of the firm. It says that small innovating firms are less likely to enter export markets than non-innovating firms, but large innovative firms are likely to export, and the more innovations they have had, the higher is the probability to enter export markets. Small innovative firms are more likely to stay in domestic markets due high cost of entering to foreign markets for small firms. Another indirect result of the study is that positive spill-over effects are significant for the increase of probability for first time exporters, but not for the increase of export propensity.

Sterlacchini [42] in his study uses other innovation inputs than R&D such as the ratio of expenditure on design engineering and trial production to sales, the innovative content of capital stock and the shares of costs for acquiring innovative capital goods on sales.

In general, the literature reviewed suggests a positive and significant effect of innovation indicators on export performance. Thus we propose the following hypothesis:

Hypothesis. Innovation indicators of the country are positively and significantly associated with export performance of the country.

IV. Data sampling and variables

The growth of Asian countries in last decade showed very interesting results, having shocking growth in macroeconomic indicators in the same time most of countries of the region still have a poverty issues. In our research we have chosen Asian countries as a sample for our study, because of diversity and complexity of financial-economic achievements of these countries. We believe that research on Asian countries can show more interesting results than in any another region. All the data for variables of regression model were taken from open sources, such as web-sites of World Bank and of WIPO. In constructing our sample there are some countries which are geographically counted in Europe, as well as in Asia, they are Russia, Turkey, Kazakhstan, Azerbaijan, Georgia, Israel and Armenia. From these disputed in topic of continental belonging countries we have included only Russia and Kazakhstan into our sample. The reason is that these two countries have much more effect on Asian economy than the rest and after analysis of bilateral trade relations of these countries with the rest of Asian countries we made our choice. From the selected 48 countries after the process of data availability check in the end we had 36 countries available to use in our regression analysis. Our models are constructed based on one dependent variable and 5 independent variables with the control of three variables. We use Gretl software for making OLS regression analysis with time-stacked unbalanced panel data.

Dependent variable

Export performance. Export performance is measured in logarithm of export of goods and services in current USD for country i in the year t. This indicator is chosen in order to have objective results, which reflect the "real-life" situation. Data has been obtained directly from World Bank web-site www.worldbank.org.

Independent variables

Patents. There are several ways to measure patents value. It can be measured in terms of quality and quantity. As we use panel data we have countries as our sample we have decided to use the number of patents as

one of measures for innovation performance. In some researches patents were used as an indicator of innovation performance. [31,32,4,24]. We collected data directly from the World Intellectual property organization (WIPO) web-site for each country in the sample.

Trademarks. Number of Trademark registration is not common measure for measuring the innovation performance, but still as count data trademarks can somehow represent innovativeness of the country and we assume that it can closely be related to export. In general there is one approach for definition of trademark from WIPO: "trademark is a distinctive sign which identifies certain goods or services as those produced or provided by a specific person or enterprise. Its origin dates back to ancient times, when craftsmen reproduced their signatures, or "marks" on their artistic or utilitarian products. Over the years these marks evolved into today's system of trademark registration and protection". We can add here that a trademark is a word, name, symbol, sound, or color that indicates the source and origin of goods and services, and distinguishes them from those manufactured, sold or provided by others. The term "service mark" is sometimes used to describe a trademark that represents services. Trademark rights are created by use in commerce, and registration is not required. Unlike patents and copyrights, trademarks can last forever, as long as they are being used in commerce. Also, unlike patents and copyrights, trademark rights are subject to both federal and state laws. Trademark data has been obtained from WIPO web-site directly for each country.

Industrial design. Next variable to measure is an industrial design, where we used the count number for country i for the year t. The Industrial Designers Society of America (IDSA) defines Industrial Design as: "Industrial design (ID) is the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer." [43]. According to WIPO [49] an industrial design is the ornamental or aesthetic aspect of an article. The design may consist of three-dimensional features, such as the shape or surface of an article, or of two-dimensional features, such as patterns, lines or color. In most countries, an industrial design must be registered in order to be protected under industrial design law. As a general rule, to register it, the design must be "new" or "original". Different countries have varying definitions of such terms, as well as variations in the registration process itself. Generally, "new" means that no identical or very similar design is known to have existed before. Once a design is registered, a registration certificate is issued. Following that, the term of protection lasts generally for five years, in most cases with the possibility of renewing it up to 15 years.
Research and development expenditure (per cent of GDP).

Research and development expenditure is the money spent on creative work undertaken on a systematic basis to increase the stock of knowledge and the use of this knowledge to devise new applications. Expenditure on Research and Development (R&D) refers to all expenditure on research performed at universities and at other institutions of tertiary education, regardless of whether the research is funded from general institutional funds or through separate grants or contracts from public or private sponsors. This includes all research institutes and experimental stations operating under the direct control of, or administered by, or associated with, higher education institutions [44]. We obtain this data also directly from World Bank global web-site and measure it as percent to GDP.

Scientific and technical journal articles. Number of scientific and technical journal articles is taken as a measure to represent innovation performance of the country. Establishing and publishing of new articles about research results and achievements in scientific and technical fields is a hard and long process, which we believe can be a suitable indicator to show the level of overall innovativeness of the country.
Control variables. For control we have decided to use three variables which can have effect on export performance of the country. They are economic size of country, measured in GDP constant 2005 USD, physical size of the country, measured by population of the country and foreign direct investments (FDI), measured in USD. In firm level the link between innovation and firm size has long been a debated issue in the innovation literature [45]. Most empirical studies regarding innovation performance include firm size as a control variable. In our analysis we use countries as our sample, so following the logic we will use the population of a country as a control variable for the country size effect [46].

Also we will use FDI as a control variable. There are some works which focus on impact of FDI on export performance of the country, for example, Prasanna [47] in his work related to impact of FDI on export performance on example of India concludes that FDI has significantly contributed to improve the export performance of India between 1991-92 and 2006-07.

V. Results

Descriptive statistics of all variables and correlation is given in Table 1.

		1	2	3	4	5	6	7	8	Mean	Median	Min	Max	S.D	C.V.
1	Export of goods	1								23.59	23.39	19.84	28.46	2.05	0.08
2	Patents	0.77	1							6.56	5.7	1.79	13.18	2.81	0.42
3	Trademarks	0.92	0.77	1						8.22	8.39	2.48	14.13	2.57	0.31
4	Industrial design	0.86	0.82	0.93	1					6.57	6.57	0	13.16	2.78	0.42
5	R&D	0.64	0.81	0.62	0.7	1				0.89	0.28	0.04	3.74	1.02	1.14
6	Journals	0.84	0.88	0.91	0.87	0.73	1			5.22	5.09	0	11.21	2.59	0.49
7	Economic size	0.91	0.76	0.95	0.88	0.56	0.89	1		4.67	4.54	0.23	9.2	1.87	0.4
8	Size of country	0.54	0.47	0.79	0.65	0.25	0.65	0.78	1	16.71	16.79	12.45	21.01	1.9	0.11
9	FDI	0.83	0.62	0.79	0.7	0.45	0.7	0.73	0.47	20.56	20.81	12.04	26.35	2.33	0.11

Table 1. Descriptive statistics and correlation

Most of data for variables was in form of factual numbers taken from the source and in order to give them equal statistical meaning we have converted all variables except R&D expenditure variable into logarithms. R&D expenditure was already given in percentage from overall expenses. We have generated and checked 7 models where we used 8 independent and one dependent variable. The data was in unbalanced panel form, where we had missing values. The lowest value for two variables was equal to zero, while the lowest mean was for R&D expenditures. Our panel data has 15 time series, with 9 variables. Descriptive statistical results show that standard deviation for all variables is not more than 3, which shows that the data's spread range is not high.

Table 2.ooled OLS models. Dependent variable: Export performance (all innovation indicators included)

	Model 1. Control only		Model 2. Patent		Model 3. Trademark		Model 4.Industrial design		Model 5. R&D		Model 6. Journals		Model 7. All variables	
	C	S.e.	C	S.e.	C	S.e.	C	S.e.	C	S.e.	C	S.e.	C	S.e.
constant	-3.58	1.45**	22.9	0.59***	21.82	0.49***	22.7	0.62***	22.8	0.56***	21.6	0.4**	23.37	1.09***
Patents			-0.03	0.015**							0.001	0.01	-0.11	0.02***
Trademarks					0.17	0.029							0.14	0.1
Industrial design							0.05	0.02***					0.09	0.04**
R&D									0.02	0.04			-0.05	0.08
Journals													0.01	0.05
Economic size	7.05	9.2***	1.26	0.04***	0.98	0.04***	1.13	0.04***	1.22	0.04***	1.14	0.03***	1.11	0.1***
Size of country	-1.42	7.12**	-0.59	0.03***	-0.51	0.02***	-0.56	0.03***	-0.62	0.03***	-0.45	0.01***	-0.68	0.05***
FDI	1.81	5.28***	0.24	0.01***	0.22	0.01***	0.24	0.02***	0.26	0.02***	0.2	0.01***	0.26	0.02***
R-squared	0.42		0.95		0.96		0.96		0.96		0.95		0.98	
Adjusted R-squared	0.41		0.95		0.96		0.95		0.96		0.95		0.97	
Log-likelihood	-13264.73		-172.2154		-177.07		-134.15		-88.01		-253.4		-28.7	
Akaike criterion	26537.46		354.48		364.15		278.31		186.02		516.8		75.41	
Hannan-Quinn	26544.04		361.88		371.81		285.43		192.52		524.78		85.81	
Schwarz criterion	26554.2		373.06		383.39		296.01		202.04		536.98		101.01	

***P<.01, **P<.05, *P<.10

Correlation coefficients show that all variables correlated with each other and that correlation level is high. The lowest correlation was between FDI and Size of country, while the highest correlation rate was between Industrial design and Trademarks. Although most of values in correlation matrix is high (close to 9), we could not find multicolinearity problem after checking it with variance inflation factor test. Main relationship correlation values, which is between 8 independent variables and dependent variable Size of country was the lowest and Trademarks had a highest level of correlation.

For regression models we used Ordinary least squares method to find the relationship between variables, we generated several regression results in order to see effect of variables on dependent variable simultaneously and separately.

First model was for control only in order to see the effect of variables which are not under our main study and to check previous researchers' assumptions. We got the result were R square was quite low, but all control variables appeared to be significant with low p-value, which coincides with previous studies. Other regression models were aimed to check the relationship of Export performance with each of variables separately. And last model was generated to show the effect of all variables on Export performance in the same time. We found that control variables were significant in all regression models, where Economic size of country and FDI had a positive effect on export quantity of the country, while size of the country had a negative effect in all regression models. Patents and Industrial design of the country were both associated with export performance, but we should mention that we found that patents has a negative effect on export of the country,

which we will try to explain in discussion part of this paper. Other variables which were supposed to represent innovativeness of the country, such as Trademarks, R&D expenditures and Scientific journals in the country were not associated with export performance of the country, as they all were statistically insignificant with high p-values.

Table 3. Model 8. Pooled OLS. Dependent variable: Export performance
(only with two innovation indicators)

	Coefficient	Std. Error
constant	24.93	0.67 ***
Patent	-0.12	0.01 ***
Industrial design	0.12	0.02 ***
Economic size	1.31	0.05 ***
Size of country	-0.7	0.03 ***
FDI	0.22	0.01 ***
R-squared	0.96	
Adjusted R-squared	0.96	
Log-likelihood	-102.89	
Akaike criterion	217.79	
Hannan-Quinn	226.2	
Schwarz criterion	238.67	

***P<.01, **P<.05, *P<.10

Despite the fact that R squares, as well as adjusted R squares show high values and close to 1, we can't accept those models which are in table 2. With the purpose to define best fit model we will run another regression without 3 used variables for innovation, such as trademarks, R&D expenditures and scientific journals in the country. You can see results of new regression model with only two independent and three control variables on table 3.Results of regression model from table 3 show that all variables are statistically significant and that model explains the relationship with 96% accuracy. Indicators such as Akaike criterion and Hannan-Quinn also show that this model is better compared with the one where we used all innovation related indicators, because values of model 8 are higher than values of model 7. Also we should pay attention that even in this model the negative sign of patent coefficient is present, this new finding needs the explanation.

VI. Discussion and conclusions

Hypothesis which we proposed in the beginning of this research was about positive association of innovation on export performance on country level, where we used Asian countries as a sample. Asian countries economies by its nature are heterogeneous and related results were in high interest and could have strong value. Despite of fact that there is a high correlation of innovation with export performance, we see from regression analyses that this relationship is week. There can be several explanations for that. First, is mainly because those variables which by logic had to represent innovativeness of the country were indirect. Most of these variables such as trademarks, R&D expenditures and amount of scientific journals in the country do not directly interact into the process of export of the country and not necessarily increase the innovation amount or overall innovativeness of the country. For example, high amount of scientific journals of the country not necessarily can increase the innovativeness, although still we can assume that it can increase the awareness of population about new findings and novelties, which somehow can effect on increase of innovativeness of the country. This kind of assumption based on indirect effect of some variables led us to include them as part of innovation indicators. Second, regulations and property rights protection systems in some Asian countries are not mature yet, which leads to fact that countries still will export different items, despite of fact whether there are many registered trademarks or not, and whether the expenses on R&D are increased.

Patents and industrial design amount in the country is indeed strongly associated with export performance of the country. But the relationship of patents is negative, which was not expected. This kind of results we can explain with the structure of export in Asian countries. Most of Asian countries are overpopulated and have cheap labor force, which helps to export goods and services without the use of innovative technologies developed by county itself. Recently, it became common to buy and use patents and inventions developed in other, mainly European and North American countries. The result is suitable only for Asian countries, because of differences between these countries, future researches can investigate each country separately, and where we believe there can be different results.

The only innovation indicator which had strong positive association with export performance was registered industrial design of the country. Industrial design can be applied to many items or products and can increase sails. In order to have competitive advantage and to be successful in the market companies pay enormous attention on design of the product. As we mentioned before, in Asian countries where patents are mainly bought by companies, design of the product remains as an essential focus of firms, because it can't be used by other companies, especially when companies operate in foreign markets. This leads to the increase of the amount of registered industrial designs hence positively associates with export of the country, because

competition in foreign markets is more fierce and buyers there, are more sensitive to forms and design of the product, which in the end gives us to conclude that if country has more registered industrial designs, it can increase the country's export.

As most of indicators of innovativeness of the country did not show statistical significance on the example of Asian countries, except industrial design variable, we reject our alternative hypothesis and conclude that more research should be done to find the positive association, which has been proposed based on previous studies and researchers logic.

During our research we had new findings such as the positive effect of industrial design on country's schexport performance. Also we found that countries with bigger population are not doing so well in export of goods. Beside of it we found that increase of FDI and GDP of the country can positively impact on export performance of the country, which does coincide with researches where other countries were used as a sample.

Results of this paper give us a field for future researches and leave even more questions, thus pushing us to investigate innovation related indicators' effect on export performance of the country. Future researches in their studies should measure innovation with other parameters; also there is a need to make research on other samples with more homogeneous nature. Besides of it dividing countries on developed and developing, or by other criteria, can give better explanatory results rather than sampling just by geographical criteria.

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