CHAPTER 6

THE ROLE OF OPEN MARKET AND EDUCATION ON INNOVATION IN EMERGING ECONOMIES

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Abstract

The processes of globalization and liberalization have raised the competitiveness considerably in the world and made the innovation mandatory for firms and nations to survive. In this study, we explored the effects of trade liberalization together with FDI inflows and education on innovation on a sample of emerging economies over the period 1995-2017, by using panel cointegration and causality analyses. The findings revealed that trade liberalization, FDI inflows and education have a significant positive impact on innovation.

Keywords: Innovation, Trade liberalization, Foreign direct investment inflows, Education, Panel cointegration and causality analyses.

1. Introduction

Despite all the efforts made during time to reduce the economic gaps between countries, the nowadays reality presents a world in which these gaps are getting wider and wider. In order to stop this phenomenon, the developing and especially the less developed economies should focus their attention on the most valuable asset of a nation: the human capital. Only by doing this, they will be able to get closer to the developed states' level because, as Heyne, Boettke and Prychitko (2013) stated, the less developed states do not lack things, but ideas. Innovation, which represents the process of introducing new ideas into an economy (Lundvall, 2008), may transform the existing markets, or even create new ones, and stimulate the economic growth (Marvel and Lumpkin, 2007). The explanation is related to the fact that innovation, which occurs in the process of collective entrepreneurship (Christensen and Lundvall, 2004), enhances the business development and, therefore, the long-term wealth creation (Ahuja & Lampert, 2001).

In this context, two main questions are raised: Where can the less developed states take the money from, in order to be able to invest in education and, implicitly, in innovation? What skills could make a person more efficient in this era of rapid changes?

At the first question, many economists pointed to the international trade and foreign investors. Faced with increasing international competition, innovation has been placed in the core of firms' long-term strategies. If, initially, the economic literature paid attention especially to the role of internal research and development (R&D) on firms' innovation capability (Dosi, 1984), lately, researchers argued that the ability to exploit external knowledge is vital for the innovation process of a company (Teece, Pisano and Shuen, 1997). In the context in which innovation results more and more from the interaction of a large number of companies, an important aspect in the innovation management is the optimal integration of external knowledge (Veugelers and Cassiman, 1999).

There are several important channels through which attracted foreign direct investment (FDI) can stimulate the innovation in the host country (Blomstrom and Kokko, 1999). First of all, it is generally agreed that domestic companies can learn about the new products and technologies brought in by foreign investors (Cheung and Lin, 2004). Secondly, apart from the technological spillovers, the local firms can get the know-how of foreign companies by stealing their skilled workers (Aitken and Harrison, 1999). The third channel refers to the FDI's effect on local R&D activity. The presence of the foreign products and technologies in the host markets can enhance local innovators to come up with new goods and processes

(Baldwin, Braconier and Forslid, 1998). Moreover, since the spillovers may also occur from foreign companies to the host country's suppliers through the technological know-how transfer, the local suppliers may also be stimulated to innovate (Smarzynska, 2002).

Trying to offer an answer to the second question, the researchers suggested that, since innovation is a process involving close interaction between individuals and organizations, the knowledge and skills obtained through formal education should be combined with social abilities (Lundvall, 2008), usually acquired through informal and non-formal education. In this context, the concept of learning economy has emerged. As Lundvall and Johnson (1994) suggest, it refers to the fact that knowledge becomes obsolete more rapidly than before and, consequently, it is necessary that firms engage in organizational learning and workers constantly attain new competencies.

Considering all these aspects, the present study intends to analyze the relationship that exists between trade liberalization, FDI and education, on one hand, and the innovation, on the other hand in 20 emerging economies, during the period 1995-2017. In order to achieve this purpose, we have used the panel cointegration and causality analyses. The paper is structured as following: the next section summarizes the literature regarding the effects of trade liberalization, FDI inflows and education on innovation, the third section presents the methodological approach and the last two parts reflect the obtained results and, respectively, the conclusions.

2. Literature Review

The literature developed the idea according to which a higher level of human capital allows a better recognition of the opportunities (Davidsson & Honig, 2003; Shane, 2000; Shepherd & DeTienne, 2005) and improved outcomes (Becker, 1964). Therefore, individuals with superior human capital will identify a larger variety of opportunities than others and, consequently, will have higher chances to choose the best option.

As stated by the human capital theory, education and experience are in the core of the concept of human capital (Becker, 1964). The experience can take many forms. While some researchers talked about the labor market experience, the management experience and the previous entrepreneurial experience (Bates, 1990; Gimeno, Folta, Cooper and Woo, 1997; Robinson and Sexton, 1994), others mentioned the business experience, the functional experience and the industry experience (Shane, 2003). Regardless of its type, the experience allows the development of certain skills, useful for the discovery and exploitation of the opportunities. However, it was noticed that greater experience might limit the strategic

flexibility (Hitt & Barr, 1989), with a negative impact on innovation. A similar conclusion was drawn by Bhide (2000), who argued that very high levels of human capital might diminish the risk-taking propensity of entrepreneurs regarding the innovative new ventures.

Together with experience, education is another qualitative side of the human capital, with a vital importance in identifying and valuing the opportunities.

The formal education has a significant impact on the individuals' open-mindedness and receptivity to innovation (Kimberly and Evanisko, 1981). Considering that greater experience leads to higher business success (Singer, 1995), the association of high experience and education would definitely be a decisive factor for entrepreneurial innovation (Marvel and Lumpkin, 2007). Yet, not all types of education lead to innovation. For example, the knowledge described by Shane (2000), which involved specific skills for serving the markets and solving the customers' problems, does not seem to influence the innovation. In the meantime, the technology knowledge proved to be a prerequisite for recognizing the opportunities and enhance the innovation (Marvel and Lumpkin, 2007). Moreover, combining the technology knowledge with the market knowledge will lead to new ideas (Amabile, 1998), because, as Amabile (1998) noticed, an individual's creativity is enhanced if more knowledge types are used. O'Conner and Veryzer (2001), analyzing the impact of using different types of knowledge on innovation, reached similar results.

Varsakelis (2006) focused the attention on the formal education and showed that those states that are investing more in the quality of mathematics and science at all three levels are more likely to have higher innovative results.

One of the main questions raised by the researchers referred to the extent to which the educational system is able to produce the knowledge, skills and abilities required by an innovative business environment (Toner, 2011). Most of the analysts agreed that, for coping with the requirements of an innovative market, the formal education should enhance the development not only of literacy, mathematical and science competences, but also of 'softer' skills that firms need, such as communication or social abilities (Borras and Edquist, 2015). The last ones are becoming increasingly important within an organization, especially in fostering creativity and abilities of problems' solving (Lam, 2005). A study conducted by Davies, Fidler and Gorbis (2011) concluded that the 'soft skills' important for innovation are: sense-making in communication, social intelligence, novel and adaptive thinking, cross-cultural competency, computational thinking, new media literacy, trans-disciplinarity, new design mindsets, cognitive load management and virtual collaboration.

Two other important aspects for companies' innovative process are the quality and organization of vocational training and continuous skills development at the workplace (Brockmann, Clarke and Winch, 2011). The idea according to which there is a strong link between vocational training and innovation is widely accepted (Makkonen and Lin 2012; OECD, 2011). The findings of several researches underline that the vocational training is influenced not only by the relations between employee and employer, but also by the connections between the business and political environment (Harhoff and Kane, 1997; Culpepper and Thelen, 2008). Depending on the success of these relations, the vocational training may have different impacts on innovation's performance (Bosch and Charest, 2008).

Other studies suggest that the relationship between the vocational training and the innovation performance is mediated by many complex dimensions. For example, the continuous skills' acquisition is largely influenced by the development of firm specific competences (Smith et al., 2012). Moreover, it is also important that the skills' development stimulates the creativity and the innovative activities within the firm (Høyrup, 2010). Another research underlines the importance of the national institutional environment in promoting the creativity (Lorenz and Lundvall, 2011). Lorenz and Lundvall (2011) find a positive link between the creativity at work and the development of a competence-based system of education and the labor market flexicurity.

A large debate took place among researchers, business men and policy makers regarding the policies designed to stimulate the innovation and, recently, particular attention was paid to the development of competence building at the working place. Jones and Grimshaw (2012) underline that the efficiency of the policy schemes for vocational training can be noticed in the firms' innovative performance.

Knowledge, together with skills and experience define the 'competences' (Borras and Edquist, 2015). According to Borras and Edquist (2015), these may be 'core competencies', 'dynamic capabilities' and 'absorptive capacity'. Despite the fact that the literature underlines their importance in the innovation process, especially of those developed during formal education and training, some studies found that the effect of absorptive capacity on the innovativeness of a firm is positive only up to a certain level. When the companies are too dependent on external sources of knowledge, they tend to be less innovative (Laursen and Salter, 2006). Therefore, innovation is of a central importance to entrepreneurship (Covin and Miles, 1999), especially when it is the primary instrument of competition for a company (Baumol, 2002).

While the impact of the attracted FDI on firms' productivity and on the economic growth has largely been investigated, the effect of these investments on innovation has received less attention. Yet, the existing empirical studies suggest that the impact of the foreign firms on the innovation process in the host economy results from the technological spill-over and from the pro-competitive effect they generate. Multinational companies are considered an important channel of technology transfer due to the knowledge transmission through the vertical and horizontal linkages between them and the domestic firms (Blomström and Kokko 1998). However, technology spill-over will depend on the capacity of the local firms to implement the new technologies (Antonietti, Bronzini and Cainelli, 2015).

Taymaz and Lenger (2004), analyzing the Turkish manufacturing industries, concluded that foreign firms are more innovative than their domestic counterparts and they are able to transfer the technology. Sivalogathasan and Wu (2014) investigated the international technology spillover effect on domestic innovation capability for a sample of emerging South Asian markets, between 2000 and 2010. Their findings showed that the impact of FDI inflow on innovation is positive for all the analyzed states, confirming the hypothesis that the attracted foreign investments lead to knowledge and technology spillovers into the host country, and enhance regional innovation capacity and efficiency. Yet, the impact of this positive effect depends on the absorptive ability of the host region. Even though Sivalogathasan and Wu (2014) rejected the hypothesis of a crowding-out effect of FDI on innovation, other studies argued that some domestic firms may prefer obtaining the technologies from joint ventures agreements and, consequently, being less motivated to innovate (Cheung and Lin, 2004). However, this substitute for innovation is more attractive when conducting one's own research and development activity is risky or when the technology is of high standard (Lin, 2002). Cheung and Lin (2004) mentioned that, even when technology is obtained through FDI, the spillover effects to local firms could still occur. Hu and Jefferson (2001) bring the example of China, noting that the attracted FDI stimulated the research and development activity of the Chinese firms through different spillover channels. Therefore, it is likely that both the crowding-out and spillover effects co-exit.

Cheung and Lin (2004) stated that the presence of foreign goods in the domestic markets can encourage local companies to create blueprints for new products and processes. Therefore, the main motivation of developing countries to attract FDI is to obtain advanced technology that will help them establish domestic innovation capability. The extent to which spillovers can take place depends on both the owner of the advanced technology and the local enterprises (Narula and Marin, 2003).

Despite the fact that some analysts argued that FDI may also lead to negative spillover effects because of the competition (Aitken & Harrison, 1999), most of the researchers agreed that the attracted foreign investments can have a pro-competitive effect on the host economy. The foreign firms stimulate the competition in the local market because they force the local companies to search for innovative processes to increase their productivity (Keller, 2009). Yet, if the resources allocated for innovation do not have the expected results, the FDI might also have negative effects (Kiriyama, 2012).

Starting from the idea that FDI inflows help to promote local innovation capability, several researchers indicated that policies targeted at attracting FDI could improve the competitiveness of local markets (Antonietti, Bronzini and Cainelli, 2015). Moreover, the governments of the developing countries should strengthen the protection of intellectual property rights to encourage the innovation and guide the domestic firms to expand their innovative abilities (Sivalogathasan and Wu, 2014).

Several studies indicated the positive impact of foreign investors on the innovative process in different states. Bertschek (1995) and Blind and Jungmittag (2004) argued the impact of FDI on innovation in manufacturing and service firms from Germany. Aghion et al. (2009) found a positive effect of multinationals on the number of UK domestic firms' patents in technologically advanced sectors. Similar conclusions were drawn by Brambilla, Hale and Long (2009) on the case of the domestic Chinese firms, which were stimulated to innovate in the presence of foreign companies. Another study conducted on China by (Cheung and Lin, 2004), between 1995 and 2000, also found a positive impact of FDI on the number of domestic patent applications. In Europe, the positive impact of FDI on the innovation process of the domestic firms from the same industry was proven by Vahter (2011) on the case of Estonia and by Haskel, Pereira and Slaughter (2007) in the Central and Eastern European economies.

Antonietti, Bronzini and Cainelli (2015) tested the impact of the foreign investments on the innovativeness of the Italian companies through the two mechanisms: technology transfers and pro-competitive effects. Their results show that a higher level of inward FDI in services leads to a higher local patenting activity in knowledge-intensive business services. Yet, their results do not indicate that patenting in manufacturing is influenced by the presence of foreign firms. As confirmed by other studies, in manufacturing, innovation depends on urbanization economies (Carlino, Chatterjee and Hunt, 2007).

Some empirical studies underlined that companies innovate more when they are exposed to an increased low-cost import competition (Bloom, Draca and Van Reenen, 2011). The

explanation for this fact is related to the opportunity cost of the inputs that firms use to innovate. Since the social return of innovation is higher than the private benefit, trade liberalization leads to a higher welfare. The increased import competition from low-cost countries gives local companies two options: to innovate or die (Bloom et al., 2013). Empirical studies confirmed this situation. For example, Bartel, Ichinowski and Shaw (2007) noticed that the US valve manufacturers, after losing the market for low-cost valves to Chinese competitors, started to invent smaller runs of innovative valves. A research conducted on 12 European countries by Bloom, Draca and Van Reenen (2011) reveal similar results. The European firms that faced an increased import competition from the Chinese companies invested more in research and development activities and in patenting. Therefore, the companies more threatened by the import competition had the largest increase in innovation. This behavior is confirmed by the dynamic general equilibrium model, which shows that adversity can increase the innovation if factors of production are kept inside the company (Bloom, Schankerman and Van Reenen, 2013).

Bloom et al. (2013) developed a model of endogenous growth and trade, with the help of which they argued that increased low-cost import competition stimulated the innovation of the domestic companies. Similar conclusions were drawn by Nguyen et al. (2011), who found positive spill-over from importing to non-importing firms: as importing companies become more productive, they can transfer their benefits to other firms by selling their goods along the vertical production chain. Yet, as mentioned by Pack (1992), if the development strategy of a country is based on nonselective import substitution that does not consider the economic efficiency, the innovation activities have very high opportunity costs and, therefore, reduce the competitiveness of the domestic companies. An example for this fact is brought by (Pamukcu, 2003) on the case of the developing states which, during the 1960s and 1970s, did not have innovation activities able to increase their productivity. Yet, he found positive effects of trade liberalization on innovation in the case of Turkish manufacturing industry, between 1989 and 1993.

Despite these situations in which imports do not necessarily lead to innovation, many researchers agreed that trade liberalization positively influences innovation due to improved market access and increased competition (Acemoglu and Linn, 2004; Bustos, 2011). Improved market access allows higher profits for the domestic companies, which, therefore, will have financial resources for innovation. A more competitive market forces the domestic firms to innovate in order to have better results than the competitors (Aghion et al., 2005). Related to this aspect, Aghion et al. (2016) bring strong empirical support to the idea that

patent weights are highly correlated with sales weights. Moreover, some studies point to the fact that, in order to reap the benefits of trade liberalization, complementary policies should be implemented (Hoekman and Javorcik, 2004). The presence or absence of proper policies led to different results in terms of innovation and productivity. For example, while Tybout, De Melo and Corbo (1991) concluded that the innovation and productivity did not increase after the liberalization in Chile, Harrison (1994), Tybout and Westbrook (1995), Pavcnik (2002), Fernandes (2007) and Muendler (2004) noticed a positive impact of trade liberalization on innovation and productivity in Côte d'Ivoire, Mexico, Chile, Colombia and, respectively, Brazil. In the case of the developed countries, Bernard and Jensen (2001) did not find evidence that exporting raises the productivity and innovation of U.S. manufacturing plants. Opposite results were obtained by Baldwin and Gu (2003) on the case of Canada.

Some studies argued that trade facilitates the transfer of knowledge and best practices across countries (Grossman and Helpman, 1991). The implementation of the new technologies depends, however, on the absorptive capacities of the domestic firms that allow them to take advantage of the productivity gains associated with innovation (Cohen and Levinthal, 1990).

Starting from the assumption that many ideas for innovations come from foreign customers (Baldwin and Hanel, 2003), Baldwin and Gu (2004) investigated the innovative capacity of the Canadian manufacturing firms during the period 1984-1996. Their analysis revealed that exports facilitate the knowledge transfer across countries and stimulate the innovation process in Canada. This conclusion is supported through three major results: exports increased the use of foreign technology in domestic firms, stimulated the research and development agreements with foreign buyers and improved the flow of information about foreign technologies and innovations.

Coelli, Moxnes and Ulltveit-Moe (2016) analyzed the effect of trade policy on innovation during the Great Liberalization of the 1990s in more than 60 countries. By using international firm-level patent data, they proved that trade liberalization had a significant impact on innovation, technological change and growth. Moreover, they explain that the increase in patenting reflects more the level of innovation than higher protection of the existing knowledge. Coelli, Moxnes and Ulltveit-Moe (2016) explain their positive results on innovation through improved market access and higher import competition, in the context of trade liberalization.

Focusing on the effects of trade liberalization on innovation activities of small and medium size enterprises in Vietnam, Nguyen et al. (2011) mentioned that innovation,

measured through new products, new processes or improvements in the existing products, is strongly influenced by trade liberalization. Their main conclusion was that globalization brought to Vietnam not only opportunities but also pressures for domestic firms to innovate in order to increase their competitiveness.

3. Data and Econometric Methodology

In the study, the impact of trade liberalization, FDI inflows and education on innovation was explored on the sample of 20 emerging market economies, during the 1995-2017 period.

3.1. Data

The innovation level was proxied by the number of total patent grants, due to the fact that Global Innovation Index, calculated through collaboration between Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO), was available only for a limited period. Meanwhile, the trade liberalization was represented by the sum of exports and imports, and the FDI inflows were the foreign direct investment, in net inflows. Lastly, the education level was proxied by the education index of UNDP (United Nations Development Programme) (2019), calculated as mean of years of schooling for adults aged 25 years and more, and expected years of schooling for children of school entering age. All these variables used in the econometric analysis are presented in Table 1.

Table 1. Variables used in the econometric analysis.

Variables	**Symbols**	**Source**
Innovation proxied by total patent grants	INOV	World Intellectual Property Organization (WIPO) (2019)
Trade liberalization proxied by sum of export and import (% of GDP)	TRADE	World Bank (2019a)
Foreign direct investment, net inflows (% of GDP)	FDI	World Bank (2019b)
Education proxied by education index of UNDP	EDU	UNDP (2019)

The study sample consisted of 20 emerging market economies that experienced significant improvements in innovation, considering MSCI's (2019) classification. Therefore, the sample included Argentina, Chile, China, Colombia, the Czech Republic, Egypt, Greece, Hungary, India, the Korean Republic, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Thailand and Turkey. Brazil, Indonesia, Qatar, Saudi Arabia, Taiwan and the United Arab Emirates were not considered in the analysis. Furthermore, taking into account the availability of the data, the investigated period was 1995-2017. The econometric

analyses were performed with the help of Stata 14.0, EViews 10.0 and Gauss 10.0 statistical software.

The summary characteristics and the correlation matrix of the dataset are presented in Table 2. As it can be noticed, the mean of the patent grants was 12451.69, and the total trade volume as a percent of GDP was 69.86% for the sample, but both figures changed considerably among the countries. Furthermore, the mean of FDI net inflows as a percent of GDP was about 3.08. Lastly, a positive correlation between innovation and trade liberalization, education and FDI inflows was noticed.

Table 2. Summary characteristics of the dataset.

	INNOV	**TRADE**	**FDI**	**EDU**
Mean	12541.69	69.86691	3.083648	0.645437
Median	1311.500	55.74130	2.346794	0.653000
Maximum	420144.0	220.4074	54.86819	0.893000
Minimum	65.00000	19.77142	-15.98922	0.232000
Std. Dev.	42008.50	41.28241	4.647363	0.140544
Correlation matrix				
	INNOV	**TRADE**	**FDI**	**EDU**
INNOV	1.000000	0.137748	0.253352	0.116552
TRADE		1.000000	0.231810	0.337229
FDI			1.000000	0.154947
EDU				1.000000

3.2. Econometric Methodology

In the applied section of the article, causality and cointegration relationships between innovation, trade liberalization, FDI inflows and education were analyzed with the help of the Westerlund and Edgerton (2007) LM bootstrap panel cointegration test and the Dumitrescu and Hurlin (2012) causality test, considering the pretests' results.

In this context, first cross-sectional dependence and homogeneity pretests were applied. Subsequently, the stationarity of the variables was analyzed with the Pesaran (2007) CIPS unit root test. Cointegration and causality analyses were conducted after stationarity analysis.

The Westerlund and Edgerton (2007) panel bootstrap cointegration test, which rests upon the lagrange multiplier test of McCoskey and Kao (1998), takes cognizance of cross-sectional dependency and heterogeneity, and produces reliable consequences in a state of small samples. The statistics of the test can be summarized in the following equation:

$$LM_N^+ = \frac{1}{NT^2}\sum_{i=1}^{N}\sum_{i=1}^{T}\widehat{w}_i^2 s_{it}^2 \quad (1)$$

In equation (1), the partial sums of error terms (s_{it}^2) and long term variances ($\widehat{w}_i^2$) are derived from the projected cointegration model with fully modified ordinary least squares. The critical values calculated from bootstrapping are considered in the case of cross-sectional dependency.

The causal interaction between innovation, trade liberalization, FDI inflows and education was tested with the Dumitrescu and Hurlin's (2012) test. The test considers the heterogeneity among the cross-sections, and yields robust results under the presence of cross-sectional dependence. The Dumitrescu and Hurlin's (2012) causality test can be used in the case of cointegration relationship's existence or non-existence. The model for the causality analysis is designed for the stationary variables of x and y as follows (Dumitrescu and Hurlin, 2012):

$$x_{i,t} = \alpha_i + \sum_{k=1}^{k}\gamma_i^{(k)} x_{i,t-k} + \sum_{k=1}^{k}\beta_i^{(k)} y_{i,t-k} + e_{i,t} \quad (2)$$

$$y_{i,t} = \alpha_i + \sum_{k=1}^{k}\gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{k}\beta_i^{(k)} x_{i,t-k} + e_{i,t} \quad (3)$$

4. Empirical findings

The presence of cross-sectional dependence was tested with the LM CD test of Pesaran (2004) and $LM_{adj.}$ test of Pesaran et al. (2008), and the tests' results were presented in Table 3. The null hypothesis in favor of cross-sectional independence was rejected because the p values were found to be lower than 5%, and we reached the end of cross-sectional dependence among the cross-sections.

Table 3. Cross-sectional dependence tests' results (Null hypothesis: There is cross-sectional independence).

Test	Test statistic	p-value
LM (Breusch and Pagan (1980))	45.832	0.000
LM_{adj} (Pesaran et al. (2008))	39.671	0.013
LM CD (Pesaran (2004))	41.908	0.000

The homogeneity of slope coefficients was tested with the adjusted delta tilde test of Pesaran et al. (2008), and the tests' results are presented in Table 4. The null hypothesis asserting that the slope coefficients are homogeneous was rejected because the p values were found to be lower than 5%, and we revealed the heterogeneity of slope coefficients.

Table 4. Homogeneity tests' results (Null hypothesis: Slope coefficients are homogeneous).

Test	*Test statistic*	*p-value*
$\tilde{\Delta}$	9.367	0.002
$\tilde{\Delta}_{adj}$	10.342	0.000

We analyzed the stationarity with the help of the Pesaran (2007) CIPS test, regarding the presence of cross-sectional dependence among the series. The test results, presented in Table 5, indicate that all the variables were I (1).

Table 5. Homogeneity tests' results (Null hypothesis: The variable has unit root).

	Level		**First differences**	
Variables	**Constant**	**Constant + Trend**	**Constant**	**Constant + Trend**
INNOV	-0.941	-1.022	-7.453*	-9.459*
TRADE	-1.055	-1.178	-8.115*	-9.031*
FDI	-0.816	-0.971	-6.362	-8.362
EDU	-1.134	-1.165	-8.514	-9.114
* it is significant at 5% significance level				

The long interaction between innovation, trade liberalization, FDI inflows and education was tested with the Westerlund and Edgerton (2007) LM bootstrap panel cointegration test regarding the pretests' results. The test results are presented in Table 6. The null hypothesis in favor of cointegration relationship's presence was accepted for both models: constant and constant and trend.

Table 6. Cointegration test's results (Null hypothesis: There is cointegration relationship among the variables).

	Constant			**Constant + Trend**		
$\mathbf{LM}_{N}^{+}$	Test statistic	Asymptotic p-value	Bootstrap p-value	Test statistic	Asymptotic p-value	Bootstrap p-value
	9.324	0.389	0.451	10.389	0.378	0.467
Note: Bootstrap probability values were derived from 10.000 repetitive simulations and asymptotic probability values were derived from standard normal distribution. Lag and lead values were taken as 1.						

The cointegration coefficients were estimated by FMOLS (Full Modified Ordinary Least Squares), regarding heterogeneity after specification of significant cointegration relationship between innovation, on one hand, and trade liberalization, FDI inflows and education, on the other hand. The panel cointegration coefficients revealed that FDI inflows had the largest impact on the innovation, with 21.5%, followed by education, with 19.8%, and trade liberalization, with 13.2%. However, the individual cointegration coefficients showed that the long term impact of trade liberalization, FDI inflows and education on the innovation varied from one country to another. However, both FDI inflows and education had no significant effects on the innovation in Pakistan, Peru and Philippines.

Table 7. Cointegration coefficients' estimation.

Countries	**Coefficients**		
	TRADE	**FDI**	**EDU**
Argentina	0.137*	0.197*	0.114*
Chile	0.108*	0.153*	0.186*
China	0.099*	0.231*	0.218*
Colombia	0.142*	0.196*	0.185
Czechia	0.105*	0.218*	0.153*
Egypt	0.136*	0.187*	0.166*
Greece	0.148*	0.206*	0.254*
Hungary	0.155*	0.223*	0.312*
India	0.167*	0.234*	0.273*
Korea Republic	0.189*	0.272*	0.289*
Malaysia	0.158	0.194*	0.041
Mexico	0.125*	0.161*	0.182*
Pakistan	0.103*	0.105	0.149
Peru	0.118*	0.196	0.156
Philippines	0.130*	0.103	0.163
Poland	0.129*	0.274*	0.258*
Russia	0.295*	0.297*	0.384*
South Africa	0.141*	0.225*	0.288*
Thailand	0.091*	0.194*	0.261*
Turkey	0.107*	0.166*	0.153*
Panel	0.132*	0.215*	0.198*

* it is significant at 5% significance level

Our results have a large support in various theoretical and empirical studies. Sivalogathasan and Wu (2014) found out that the attracted foreign investments have a large impact on the

domestic innovation capability in South Asian countries: a rise of 1% in FDI inflow determines a 40% increase in the number of patent applications. Cheung and Lin (2004) have also noticed that, in China, the foreign investors have a significant positive effect on innovation: a 1% increase in FDI leads to an augmentation of 0.27% in the number of the applications for patents. Analyzing the link between FDI and total factor productivity of the Chinese industrial sectors, Liu and Wang (2003) underline that FDI facilitates the adoption of advanced technologies, being an innovation's determinant for the domestic firms.

Despite the studies that reflect the high impact of FDI on innovation, other researches noticed that these positive consequences depend on the sectors that receive the investments and on the period of time. For example, Antonietti, Bronzini and Cainelli (2015) observed that inward FDI in the service sector increases the number of local patents of knowledge-intensive firms. Yet, they found no impact of FDI on innovation in the manufacturing activities. Meanwhile, Chen's (2007) study conducted on the case of China indicates that, in a short term, FDI has only a weak impact on regional innovation capability. Even if FDI might have a crowding-out effect on innovation in the short term, in the long run, strengthening the absorptive capacity of the domestic enterprises may improve the innovation abilities. Similar results were found by Sivalogathasan and Wu (2014) on the case of a sample of South Asian states. If, in a short period of time, FDI could have negative consequences on innovation, the long-term effects could be positive. Yet, they depend on the changes in trade liberalization and on government expenditure on education.

Trade liberalization has also positive and negative impacts on firms' innovative abilities (Nguyen et al., 2011). Taking the case of the emerging market economies, Girma, Greenaway and Kneller (2004) explain the impact of trade liberalization on the behavior of firms, arguing that trade will enhance a company's competitiveness through innovation.

In the case of education, there are various studies highlighting the high impact that it has on innovation. The conclusions of a study conducted on 145 technology entrepreneurs reveal that both general and specific human capital stocks are important for innovation (Marvel and Lumpkin, 2007).

Lastly, the causal interaction between innovation, on one hand, and trade liberalization, FDI inflows and education, on the other hand, was tested with Dumitrescu and Hurlin's (2012) causality test. The test results, presented in Table 8, revealed a bidirectional causality between innovation and trade liberalization, and a unidirectional causality from innovation to FDI inflows and from education to innovation.

Table 8. Causality tests' results (Null hypothesis: There is no causality).			
Null hypothesis	**Test**	**Test statistics**	**P values**
TRADE ↛ INNOV	Whnc	8.431	0.001
	Zhnc	7.990	0.000
	Ztild	5.321	0.000
INNOV ↛ TRADE	Whnc	6.532	0.015
	Zhnc	7.345	0.003
	Ztild	7.055	0.000
FDI ↛ INNOV	Whnc	1.642	0.251
	Zhnc	2.071	0.174
	Ztild	2.162	0.139
INNOV ↛ FDI	Whnc	9.532	0.009
	Zhnc	8.551	0.026
	Ztild	8.673	0.008
EDU ↛ INNOV	Whnc	7.532	0.001
	Zhnc	6.808	0.000
	Ztild	8.263	0.004
INNOV ↛ EDU	Whnc	1.532	0.107
	Zhnc	1.855	0.134
	Ztild	1.521	0.231

The bidirectional relationship between innovation and trade liberalization was also confirmed by various studies. A study conducted on Canadian firms concluded that those companies that are innovators are more likely to enter the export markets (Baldwin and Gu, 2004). Meanwhile, this process develops their innovative capacity. Allowing more research and development agreements with foreign partners, the exports will increase the quality of innovation. The findings of Baldwin and Gu's (2004) research show that, by entering the export markets, Canadian producers increase both the number of the advanced technologies and their quality, changing, therefore, the efficiency of the innovation process.

Among the researchers who found positive impact of trade on innovation can also be mentioned Bustos (2011) and Lileeva and Trefler (2010), who argued that trade determines exporters to upgrade technology, or Teshima (2009), who found that, in the context of reduction in Mexican output tariffs, the innovative activity of Mexican firms increased.

The bidirectional relation between trade and innovation was also noticed in the case of Turkish firms. Pamukcu (2003) found out that, in Turkey, both exporters and importers are more likely to innovate than the other companies that do not have relations with external firms. Meanwhile, he noticed that innovation has a positive impact on the propensity to export.

Contrary to our results, most of the researches showed that FDI stimulates innovation. For example, Nguyen et al. (2011) underline that FDI enhances not only the regional innovation systems, but also the productivity of innovation in developing countries. This occurs because business associations with multinational companies offer important learning and innovating opportunities for the domestic firms. The multinationals could reduce the costs of innovation for the local companies, which, therefore, will increase their productivity (Helpman, 1999). Meanwhile, the foreign firms may force the domestic suppliers to improve the quality of their goods or services, being, thus, a catalyst for innovation. Various examples were brought in the case on Germany (Blind and Jungmittag, 2004), UK (Aghion et al., 2009), China (Brambilla, Hale and Long, 2009) and Central and Eastern European economies (Haskel, Pereira and Slaughter (2007).

The impact of education on innovation has a large support in the literature. A study conducted by Nielsen (2006) reveals that having employees with a graduate degree may positively influence the propensity to innovate. This was noticed especially in small and medium-size firms from the IT sector (Vinding, 2004).

5. Conclusions

Innovation has been considered an important determinant of the competitiveness of both nations and firms. Unfortunately, the developing countries face various obstacles to innovate, many of them deriving from inappropriate business and governance environment, and insufficient education. Therefore, it is necessary for the policy makers to address these issues. As proven by various empirical studies, a first step towards a higher level of innovation would be opening the markets to trade and FDI, and investing in education.

Several studies conducted in different countries have underlined the idea according to which the role of the domestic firms in the developing states in creating new technologies is marginal. Yet, they will be able to innovate if they have money required for education, and if they face external stimuli, such as increased competition from the multinational companies. The increased foreign competition will force the domestic firms to improve their productivity by adopting more innovative technologies. Moreover, exports will increase the international exposure and, thus, they may lead to new knowledge accumulation.

Considering all the empirical and theoretical evidence offered by the literature, we may argue that foreign competition, coming both from trade and FDI, is related to high innovation, fast productivity growth and, therefore, economic prosperity at the micro and macro levels.

Meanwhile, education offers people the proper tools to become more creative and for coming up with new ideas.

Starting from these assumptions, our research revealed that FDI, together with trade and education, have an important impact on the innovation process of the analyzed emerging economies. Yet, FDI inflows and education had no significant effects on the innovation in three states: Pakistan, Peru and Philippines. For the rest of the sample, FDI seems to have the largest impact, closely followed by education. We also found out that the long-term effects vary from one country to another.

The direction of the relations between innovation and the three analyzed determinants proved to be bidirectional in the case of trade liberalization, and unidirectional in the case of education and FDI. Our findings showed that, while education stimulates the innovation, in the case of FDI, it is influenced by innovation.

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