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FDI as a Source of Patent Activity in V4

Abstract
The foreign direct investment (FDI) have played an irreplaceable role during the transformation processes in Visegrad Four (V4) countries contributing to successful transition from central planned to market-based economy system, bringing new technologies, capital sources, know-how in many areas leading to higher productivity and above average economic growth, and they contributed to increasing competitiveness. The current challenges these economies face are twofold - first, it is a need for a strategic shift from the growth and competitiveness fuelled very much by the low cost labour force to a qualitatively new model based on creative and knowledge based aspects; second, it is an overall economic downturn, which affects smaller and open economies very significantly, since they are still dependant on external sources of growth like foreign demand. Generally, in the current fragile economic situation around the globe the innovative approach is seen as a chance for recovery bringing new effective solutions for companies, households and even states, more over it can also contribute to tackle global challenges. Despite the general tendency of research outcomes towards more complex and sophisticated composite indexes measuring competitiveness and innovations, the paper is focused on examining and testing of selected input and output indicators, namely FDI and their influence on the dynamics of patent indicators, namely total FDI inward stocks to the region and number of patent applications. The paper particularly analysis the relation of FDI inward stocks coming to the V4 region from the 15 most innovative countries according to the Global Innovation Index 2012 and the number of patent applications during the years 200-2010.

Key Words
foreign direct investment, competitiveness, Innovation, patent, Visegrad Four, Czech Republic

JEL Classification: O31, F21, P3

Introduction

In the theoretical literature on innovations, a number of studies have examined how FDI is accompanied by interregional spillovers of knowledge from the more to the less advanced country. Such studies include those Walz [31], Cheung [4], Calliano and Carpano [2]. Sourafel and Holger [26] conducted by using conditional quantile regression the evidence for a u-shaped relationship between productivity growth and FDI interacted with absorptive capacity. Timothy [27] found that FDI in neighbouring states has just as strong an impact on patent rates and that knowledge can spill across state borders. Using survey studies and econometric studies Benacek et al. [1] concluded that the presence of foreign firms has increased productivity levels in Central Europe,
but only to a limited degree. Within a semi-endogenous growth model Neuhaus’s book [20] illustrates the impact of FDI on economic growth for every stage of development of a country with special attention to the countries of Central and Eastern Europe.

Several researchers have examined performance of foreign-invested firms in the Czech Republic. Kinoshita [16] examines the effects of R&D (innovation and development of absorptive or learning capacity) and technology spillovers from FDI on a firm’s productivity growth. The study of Hamplová and Provazníková [12] analyzed the most frequent motives why FDI enter the Czech Republic and Hlaváček [13] cautions against the concentration of the direct foreign investments that are more dependent on the economic cycle. Despite the large body of research examining the determinants and impacts of FDI, there is a lack of knowledge with respect to the linkage between the origin of FDI and its absorption. There is robust evidence that economic growth; productivity and development are significantly induced by innovations, which significantly contribute to competitiveness. [21, 22]. And in the current very fragile economic situation around the globe the innovative approach is seen as a chance for recovery bringing new effective solutions for companies, households and even states, more over it can also contribute to tackle global challenges (e.g. developing green technologies).

Competitiveness can be described as an ability of a long-term growth [17]. The World Economic Forum (WEF) defines the term as “the set of institutions, policies, and factors that determine the level of productivity of a country” [24]. According to Porter, innovations speed up process of productivity growth and productivity is essential for achieving a competitive advantage. [23] According to OECD1, there are innovations of products, processes, marketing and organisational methods2, which is an enhancement of TPP3 concept into service sector, which reflects a growing share of investments in knowledge-based capital as well as the role of knowledge flows. Innovations are seen as a substantial improvement or they can be new in relation to a company, to the market or completely new (to the world), and they are rather a continuous process than only a result aiming at increasing productivity and performance. Although innovations are not limited to any sector, measurement in public sector is still in the progress. [21, 22]

In both cases, at national or European level, there is a common long term goal interconnecting almost all fields of economic and related policies and it is – increasing standard of living of citizens in a sustainable manner. At the European level a main strategic document is Europe 2020, which is a 10-year strategy for smart4, sustainable and inclusive growth, where research and innovation is among 5 key targets5 with a goal: 3 % of the EU’s GDP to be allocated in R&D to catch up the best [7]. The strategy

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2 In business process; workplace; external relations.
3 Technological product and process innovations in manufacturing were complemented by non-technical ones.
4 It includes following areas: education; research/innovations; digital society.
5 The others are: employment; education; social inclusion and poverty reduction; climate and energy.
expects the goals to be reflected in national targets and introduces 7 flagship initiatives providing further framework for coordinated efforts. One of them is Innovation Union with more than 30 action points aiming at increasing science performance, improving conditions for innovations and introduction of Innovation Partnership for effective cooperation between private and commercial sector; while shifting the focus to solutions of important societal challenges (e.g. climate, energy etc.) [8]. In case of the Czech Republic, the strategic framework is composed of Strategy\(^2\) of International Competitiveness for period 2012 – 2020 (SIC) and National Innovation Strategy as a part of SIC and was issued as a separate document related to the Innovation Union, which is Europe 2020 Initiative, and of the National policy of research, development and innovations for years 2009 – 2015\(^3\). The goal set by SIC is to be among the 20 most competitive economies measured by GCI by the year 2020 [30]. The basic means is a shift from a growth model based on cheap labour force to economy driven by entrepreneurship and innovation and based on quality institutions, infrastructure and effective usage of labour force potential [30]. FDI will still play an important role, but the stress will be shifted to entrepreneurship and knowledge. [30, 17, 18]

1. Measuring Innovations and Competitiveness

In times of austerity and increasing competition, innovations become inevitable for businesses and for states as well. Thus, it is important also to assess results and effectiveness of funds allocated and policies designed and implemented including a direct comparison with others in terms of success and dynamics [21, 22]

Among the key sources of methodology and data on science, research and innovation belongs the OECD with its ongoing process of more than 50 years of development of measuring tools, closely cooperating with Eurostat. Additional important sources on competitiveness including aspects of R&D and innovations are World Bank, World Economic Forum and International Institute for Management Development (IMD), OECD in its document Measuring Innovation: A New Perspective, which accompanies the OECD Innovation Strategy\(^3\), uses traditional indicators complemented by newly developed, but points at significant gaps and inadequacies in several areas, which need to be addressed in the future. [21, 22]

The Innovation Union Scoreboard (IUS) represents a measuring tool\(^4\) of the EU for comparison of innovation performance within EU 27 and 17 non-member countries [9]. The IUS is accompanied by Regional Innovation Scoreboard [10] and Regional Innovation Monitor, which provides information on innovation policy in all EU regions.

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1 It is based on the Framework for the Strategy of Competitiveness and Analysis of Competitiveness.

2 It relates to other interdepartmental conceptions focused on R&D and innovations, sectoral conceptions of applied R&D, and special studies [28].

3 The strategy provides a practical guidance for governments to prepare and implement national innovation strategies and policies.

4 It is based on previous European Innovation Scoreboard [9].
The fifth edition of the Global Innovation Index (GII) Report is as a result of cooperation of the INSEAD and the World Intellectual Property Organization (WIPO) with research support of the Joint Research Centre (JRC) and covers 141 countries and 84 indicators. [6] Among the most important comparison instruments incorporating innovation agenda into the core of even more complex evaluation of competitiveness is the well-known WEF’s Global Competitiveness Index (GCI) covering 144 countries [24].

Except from GCI, the WEF prepares also the Europe 2020 Competitiveness Report, which is a biannual study (published in 2012 for the first time) covering EU27 + 6 accession and candidate states, where as all V4 countries belong to the 3rd tier group (out of 4) according their competitive performance. [32] The IMD World Competitiveness Yearbook (WCY) is published since 1989 and its last edition from 2012 compares 59 countries and takes into account 329 indicators classified in 4 groups: Economic Performance (78 criteria); Government Efficiency (70 criteria); Business Efficiency (67 criteria); Infrastructure (114 criteria). [14] Worth to mention are the World Bank’s Knowledge Index composed of Education, Innovation and ICT Indexes, and the broader Knowledge Economy Index including also Economic and Institution Regime Index and European Regional Competitiveness Index – based on GCI, but it is adjusted. [33]

2. Methodology

The geographical range of the article covers V4 region, namely the Czech Republic, Slovakia, Poland, Hungary, which belong to the new EU member countries, sharing a communist area history, and facing similar problems as a result of transition from central planned to market based economies and catching up processes. As a previous preview of the most important studies has shown they are also comparable in terms of competitive performance and related challenges.

Despite the general tendency of research outcomes towards more complex and sophisticated composite indexes, the paper is focused on examining and testing of selected input and output indicators, namely Foreign Direct Investment and their influence on the dynamics of patent indicators. Patent statistics belongs to traditional tools of measuring Science and Technology (S&T) together with R&D expenditures. Although often used for measuring output of research, it faces certain limitations (e.g. it does not cover all inventions, differences in economic or technological value of patents). On the other hand indicators of Foreign Direct Investment are often included among framework conditions related to macroeconomic environment and its prospects or among those indicators allowing and contributing to higher competitiveness. So, on one side they reflect overall attractiveness of country or particular location and simultaneously they contribute to this attractiveness by their presence and also by participating in knowledge diffusions.

In both cases, the paper will use as a main source of data Eurostat statistics in order to maintain mutual compatibility. The period will cover years 2000 – 2010. The time series face ordinary limits related to availability of data, e.g. FDI statistics as of 29.03.2013.
includes the year 2011, but patent applications only 2010, or not available data\(^1\) for certain year.

Since another common feature of V4 countries is the level of openness of economies and importance of foreign direct investment on employment, productivity, export performance and economic growth, the paper will examine a positive correlation between FDI inward stocks and number of patent applications in V4 region in total (hypothesis A). Considering studies of OECD indicating that the globalisation processes lead to internationalisation also in area of R\&D and innovations, the article will focus on testing a positive correlation between FDI inward stocks originated from the 15 most innovative countries (TOP15) and number of patent applications in V4 region (hypothesis B). The list of most competitive countries is based on GII 2012 and contains: Switzerland; Sweden; Singapore, Finland, United Kingdom, Netherlands, Denmark, Hong Kong (China), Ireland, United States, Luxembourg, Canada, New Zealand, Norway; Germany. FDI inward stocks are in millions EUR as a total sum coming to V4 region from all over the world or from TOP15. The number of patents is measured by patent applications to the EPO by priority year at the national level as a total sum in V4 region. The correlation of indicators will be tested using linear regression and correlation analysis methods.

### 3. Analysis of FDI inward stocks and patent applications

In general, the amount of total FDI inward stocks increased by 462 % in V4 region in 2000 – 2010 with higher dynamics during 2004 – 2007 connected with joining the EU, when 55 % of absolute change during the period and the highest annual relative change (24.3 % in 2004) occurred. The country with the highest relative change was Slovakia, where FDI inward stocks increased by 675.3 % (2000 - 2010) and Poland had the biggest share on total FDI inward stocks within observed period (41.2 %) with a slight increase during the recent years. The dynamics of FDI inward stocks originated from TOP15 is similar, but slightly slower (+43.5 %; 2000 – 2010) with the highest rates again during the accession period (2004 – 2007)\(^2\), when 53.5 %\(^2\) of absolute change within 2000 – 2010 happened. The share of Poland on total FDI inward stocks from TOP15 is 40.7 %. The TOP15 represent 60 % of all FDI inward stock in 2000 – 2010, with the highest percentage (but decreasing trend) in the Czech Republic (70.9 %).

What regards patents, the dynamics of the whole V4 region was in comparison to FDI inward stocks slower, the number of patent applications rose by 235 % (2000 – 2010), with the highest growth in Poland (+610 %) and the lowest in Hungary (+67 %). Slovakia had the lowest\(^4\) percentage (6 %), the remaining share of 94 % was almost

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\(^1\) E.g. for FDI stocks from Luxembourg coming to the Czech Republic in year 2000.

\(^2\) But e.g. in Slovakia + 31.8 %; 2003; y/y.

\(^3\) The number is influenced by missing data for years 2000-2002 for Hungary.

\(^4\) In case of measuring patent applications per million inhabitants, Poland with the highest share of 31.9 % would drop to the last place with 10.4 % behind Slovakia with 13.5 %.
equally divided among the others. In this case, the activity is shifted to the last 4 years (2007 – 2010), when 55 % of overall absolute change in number of patent applications for the whole period of 2000 – 2010 occurred. The highest relative annual growth rates were in 2002 (+35 %) and in 2006 (+24 %).

Fig. 1 Patent applications and total FDI inward stocks in V4
(aggregate; 2000 – 2010)

\[ y = 0.002x + 78,253 \]
\[ R^2 = 0.949 \]

Source: own calculations and processing based on [11]

Applying the correlation and regression analysis on total FDI inward stocks and number of patent applications in V4 confirmed the hypothesis A that there is a positive correlation between these two indicators when measured as aggregate for the whole V4 region (Fig. 1) with correlation coefficient (R) of 0.97416 and coefficient of determination (R²) of 0.949. For comparison reasons, the Fig. 2 shows the difference in correlation when measured using all individual values for each country.

Fig. 2 Patent applications and total FDI inward stocks in V4
(individual values; 2000 – 2010)

\[ y = 0.002x + 13,289 \]
\[ R^2 = 0.7799 \]

Source: own calculations and processing based on [11]

Although, it is still high: R = 0.8831 and R² = 0.77991, it is noticeable lower. A closer look at each country separately would show that the Czech Republic proved the strongest correlation (R = 0.9788 and R² = 0.9581), on the contrary Slovakia albeit had a positive
correlation as well, it was significantly lower: $R = 0.77844$ and $R^2 = 0.60597$. The average of values for V4 countries were $R = 0.91352$ and $R^2 = 0.84097$.

Further analysis of FDI inward stocks originated from the 15 most innovative economies pointed at the fact that there exists even stronger correlation: $R = 0.97424$ and $R^2 = 0.94914$ (when measured as aggregate) or $R = 0.9191$ and $R^2 = 0.84474$ (when measured using individual values for each V4 country), while the average of values of each V4 country were $R = 0.91966$ and $R^2 = 0.8496$. Although, Slovakia again registered lower values, the correlation was stronger.

![Graph: Patent applications and TOP15 FDI inward stocks in V4 (individual values; 2000 – 2010)](source)

**Conclusions**

Foreign direct investment played a central role during the transformation period in 1990’s, participated in privatisation, allowed fast and relatively successful transition to market-based economy, contributed to dramatic structural changes laying foundations of rapid economic growth, which is necessary for catching up leading European economies, and they significantly helped in preparing domestic economies for extensive and intensive European competition within the internal market after the entry of Visegrad countries to EU in 2004.

V4 countries still have space for improvements. As GCR shows, the Czech Republic and Slovakia are in the group of 35 innovation-driven economies, while Poland and Hungary are in the group of 21 economies in the transition to that group from efficiency-driven stage. According to the GII, Poland and Slovakia (ranking 44 and 40) are behind the Hungary (31) and the Czech Republic (27), in respect to Innovation Output Index Poland lags behind even more (50).

Thus, nowadays, a shift to a growth model based on knowledge creation is inevitable for Visegrad countries, due to possible diminishing effect of previous FDI waves profiting from low labour costs advantages and due to increased competition pressure resulting
from stagnation or slow growth in EU. Companies, regions and state face very urgent question – how to increase competitiveness? The answer in many cases involves improving business environment and stimulation of innovation activity.

The paper confirmed that in case of Visegrad countries there is a strong correlation between total FDI inward stocks and number of patent applications to the EPO (by priority year at the national level) when measured as aggregate for the whole V4 region. The positive correlation showed up also when all individual values for each country were used, although Slovakia registered a bit weaker relation. A closer look at FDI stocks from 15 most innovative countries in relation to patent applications revealed even stronger correlation.

The extent of the article does not provide enough room for detailed analyses or a broader geographical context (e.g. comparison within EU12). Further possible options for analysis lie also in modifications of indicators, e.g. using PCT patent applications, relate applications to inhabitants, labour force; to Business enterprise sector's R&D expenditure (BERD) or total R&D expenditure (GERD); including trademark registrations or take into consideration other aspects of R&D and innovation activities. A structural approach – analysis of target activities for FDI and R&D and innovation outcomes (based on NACE) may bring interesting results as well.

References


