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## DETERMINANTS OF INNOVATIONS AND COMPETITIVENESS IN THE EUROPEAN UNION

*This paper evaluates determinants and sources of innovation and competitiveness in the European Union. Our central hypothesis is that there are two main sources of competitiveness represented by the cost competitiveness and innovation (value added) competitiveness, with the latter being more important for the EU than the former. Unfortunately, econometric model was not sufficient enough to distinct the importance of innovations and more data are necessary to make clear conclusions. Nevertheless, some suggestions about the sources of innovation and the desired supports are presented and discussed.*
Keywords: innovations, competitiveness, value added, investment, product, European Union.

**Introduction.** At the beginning of the 21$^{st}$ century, European Union belongs to the wealthiest and therefore most expansive and attractive business destinations in the world. It has its beneficiaries that are represented by the high wages enables very high living standards. On the other hand, there are also costs represented by the very expensive production in connection with lowering transaction costs motivates enterprises to resettle their production facilities to cheaper countries. One of the most important questions of current economic policy is dealing with this issue. Developed countries have to compete for investment with cheaper developing economics from out of Europe [18; 13]. The question is whether they want to compete via prices (i. e. wages) or if there is a possibility to compete via value added on the product – innovations [1; 3].

Our paper attempts to evaluate the sources of the EU competitiveness. Specifically, it tackles the questions: Is more important to be price-competitive? Or, it asks, is the road to success paved by emphasizing value added. Our paper attempts to provide answers for those questions in relation with GDP growth – measure of "success" of modern economies.

This paper is organized as follows: in the first part we provide a short literature review – namely how is GDP growth connected with competitiveness, how competitiveness is defined and how it can be measured. Based on those acknowledgements, we state our hypothesis about

the contribution of two "pillars" of competitiveness – the innovations and general economic conditions. In the third part, we conduct an econometric test of this hypothesis, and finally in the Conclusions we discuss the outcomes and limitations of our study.

**Literature review: investments and innovation.** The first question to be answered is why to study determinants of investments? The link between GDP growth and international investment inflow is explored in detail – the higher the foreign direct investment (FDI), the higher prosperity, see e.g. [7; 16]. According to Borensztein, Gregorio, & Lee [5] the purpose of FDI is transferring technology. They agree with Solow [20], that the main contributor to long term growth are technologies. Similarly Barrell & Pain [2] finds, that "investments are likely to be an important channel for the diffusion of ideas and technologies". The empirical work by Hansen & Rand [10] finds long term influence of FDI on GDP. Deeper insight in their data revealed, that the influence is transferred via knowledge transfers and adoption of new technology.

Not all of the authors are that optimistic about beneficiary of FDI. For example, Carkovic & Levine [6] used modern statistic techniques and found that "FDI does not exert a robust, independent influence on growth". It does not deny the contribution of technology – but technology is implanted to GDP growth via different channels. On the golden middle way there is a work from Haskel, Pereira, & Slaughter [11] they admit some contribution of FDI on growth, but it is not that big as government incentive – therefore FDIs in the end could contribute negatively.

Another question is how to achieve higher competitiveness. First, we have to know what does competitiveness means. There is a lot of different definitions of competitiveness. Every discussion has to start at the company level. So what makes the firm competitive? "According to prevailing thinking, labour costs, interest rates, exchange rates, and economies of scale are the most potent dominant of competetiveness" [17, p. 74]. But this approach has weaknesses – we can name so called Kaldor paradox – "the observation that countries with high increases in relative unit labour costs (i.e. low price competitiveness) often had fast rises in their export shares" [8; 12]. On the other hand there is another (more modern) approach. This approach emphasises "soft" attributes of competitiveness – innovations. "competitiveness depends on the capacity of its industry to innovate and upgrade" [17, p. 74]. Those are two extremes and the truth is always somewhere in middle. Also Fagerberg, [5, p. 356] argues, that competitiveness is "ability to compete in technology, the ability to compete in price and the ability to compete in capacity".

On macro level we can use much more general concept of competitiveness, used by OECD. "Competitiveness is a measure of a country's advantage or disadvantage in selling its products in international markets" [15]. For purpose of this study we define competitiveness as an ability to attract foreign investments and therefore contribute to GDP growth.

The last question needed answer is how to measure competitiveness. The first widely used measure of competitiveness was Relative unit labour cost – "unit labour cost converted to international currency and divided by average labour cost of trading partners" [4; 9; 19]. But this concept is very limiting – the only source of competitiveness is labour costs, which is naturally very simplified view.

That's why many institutions came with their own measure of competitiveness. Most complex measure is provided by World Economic Forum – Global Competitiveness Index. Global Competitiveness Index is based on three different pillars – Basic requirements, efficiency enhancer and innovation and sophistication factors.

A slightly different view provides Heritage Foundation. Their Index of Economic Freedom

is not primarily focused on measuring competitiveness, but according to authors there is very close connection between the two [14].

World Bank looks at administrative barriers as obstacles to competitiveness. That is why they compute Doing Business Index, which try to transfer administrative barriers on enterprising in numbers. Strong correlation between Doing Business and Global Competitiveness Index is shown in World Bank [21]. They insist, that "enterprises are key drivers of competition, growth and job creation, particularly in developing economies" [21, p. 24] and if there are limited in their development, it will harm an economy. There are also two pillars in Doing Business Index - Complexity and cost of regulatory processes and Strength of legal institutions.

Last measures of competitiveness have been proposed by Erste Group Bank in 2012 and 2013. They provide the two "opposite" views at competitiveness – the innovation vs. cost competitiveness. The first one was Ceska sporitelna Business Index. The simple index is composed from 5 cost, 1 infrastructure and 1 macroeconomic variable. From the point of neoclassical economics it tries to find simple measure of competitiveness. The second one is Este Innovation Barometer, focused on technological view of competitiveness. The authors focused on capability of innovations of companies. Those two indices are the central data for analysis.  There is a list of included variables in both indices (Table 1).

*Table 1 –* **List of variables by the indices** (Ceska Sporitelna and Erste Bank (2012))

| Česká spořitelna Business Index | Erste Investment Barometer |
|---|---|
| Expected GDP growth. | RnD expenditures. |
| Highway density. | Registered patents. |
| Electricity prices. | Technical fields graduates. |
| Average Interest rate. | Quotable documents. |
| Labor Cost. | Venture Cap expenditures. |
| Cost of Starting Business. | Broadband connection. |
| Average Effective Tax Rate | Public education expenditures. |
| | High-tech exports. |
| | E-Government |

**The aim of this study** is to find, which source of competitiveness is more important in European Union nowadays.

Using econometric modelling, we will estimate a relationship between FDI and exogenous variables which will answer our central question: "Are innovations more important in terms of competitiveness more important than neoclassical view in Europe of 21st century?"

In accordance with the neoclassical view, we employ price indicators and general indicators of economic performance such as GDP. For economists it is much more common to work with those statistics than with data about innovations.

What should economic policy aim to make local enterprises more competitive? The aim is to show, that many firms are willing to payer substantially higher prices of production, if this production is innovative and high value added. Or else there is no trade-off between competitiveness and costs in the country. Country with higher costs just has to be able to offer higher quality. Else it cannot succeed on international markets. We differentiate between two approaches: General economic conditions approach and innovation approach. General economic conditions approach emphasizes ordinary economic variables – such as price indicators, GDP growth or infrastructure. Innovation approach is trying to measure "softer"

aspects of competition – science, willing to innovate and to create high value added products.

**Basic materials**

**Data and methodology.** We will use data used for two of previously mentioned indices: Erste Innovation Barometer and Ceska sporitelna Business Index. In Table 2 there is a very brief description of those data. The data are summarized into two main groups. The first group describes variables in general economic conditions approach. The second group includes innovations variables.

*Table 2* – **Brief description of variables** (authors' own results)

| Approach | Variable | Info and units | FDI Corr |
|---|---|---|---|
| Innovation approach | Expected GDP growth | Average growth for next 5 years estimated by IMF; % y-o-y | 0.1 |
| | Highway density | Eurostat; km/km2 | 0.42 |
| | Electricity prices | Price for medium enterprises, Eurostat; EUR/kWh | -0.06 |
| | Average Interest Rate | Loans to non-financial enterprises, ECB; % p. a. | 0.16 |
| | Labour Cost | Business sector labor cost, Eurostat ; EUR | -0.27 |
| | Cost of Starting Business | Cost of founding average LLC, World DataBank; EUR | 0.01 |
| | Average Effective Tax Rate | Part of year profit paid on corporate tax, European Commission; % of profits | -0.11 |
| General economic conditions approach | RnD expenditures | R&D expenditures/GDP ratio, Eurostat | 0.04 |
| | Registered patents | Registered patents, EPO | 0.4 |
| | Technical fields graduates | Graduates of technical fields per 1 000 person 20-29 year old | -0.39 |
| | Quotable documents | Number of quotable publications per 1 000 person | 0.05 |
| | Venture Cap expenditures | Venture capital investments to GDP ratio | -0.07 |
| | Broadband connection | Share of households connected to broadband internet | 0.18 |
| | Public education expenditures | Public education expenditures to GDP ratio | -0.37 |
| | High-tech exports | Share of High tech exports on sum of exports | 0.45 |
| | E-Government | Share of persons communicating electronically | 0.3 |

Because of strong correlation within groups and very serious suspicion on multicolinearity in model we transformed data to two indices. One is used for general economic approach, second for innovation approach. The goal of the transformation is to measure competitiveness by two different ways and avoid multicolinearity of the model. See the first step of transformation in equation 1 – describes ordinary standardization to normal distribution of each variable in groups from Table 2. Resulting Index is just an average of standardized deviations from mean:

$$I = \frac{\sum_{1}^{k} \frac{x_i - x_{avg}}{x_{stdev}}}{k}, \tag{1}$$

where $I$ – the resulting index; $x_i$ – total number of observations; $x_{avg}$ – number of average observations, $x_{stdev}$ – the number of standard deviations, and $k$ – the number of cases.

In second step, data are then transformed to be interpreted on the scale 0-100, where 0 are worst values and 100 best – see equation 2. First holds for maximizing variables, such as GDP growth or number of quotable documents. The latter holds for minimizing such as all price indicators:

$$I_{final} = 25 \cdot I + 50 \;\; or \;\; I_{final} = -25 \cdot I + 50, \tag{2}$$

The data for 2012 are summarized in following maps (Figure 1).

General economic conditions approach

Innovation approach
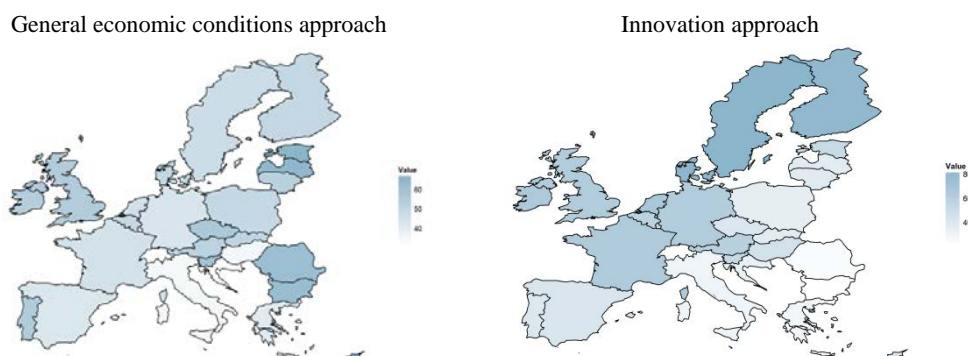


**Note:** The darker colour, the higher value

*Figure 1* – **Mapping the approaches: general economic conditions and innovation**
(authors' own results)

There is a clear trend visible from maps. Both approaches yield totally different results. In general economic condition approach the winner is Eastern Europe with low prices and high growth prospects. On the other hand, Innovation approach yields much better results for western and especially northern Europe. The data are available for all 28 countries for 2009-2012. If values were missing for just one year, we used the average of both enveloping years. If there was missing value from 2009 or 2012, we adjusted available value for average trend of the variable in all other countries. Therefore we have panel data for 4 years and 28 countries and we are interested in individual effect for those countries. Therefore we have 112 observations. We will estimate for pooling OLS, fixed effects and random effects model and by testing models and data decide which is best to use.

**Results and discussions.** Although the results of all models are very similar, we run a few tests to validate results (Table 3). All models have similar problems. There is a little suspicion for heteroskedasticity – according to Breusch-pagan test, we can refuse null hypothesis of homoscedasticity on 10% confidence level. According to Shapiro-Wilk test on residuals of the model, the residuals are from being normally distributed in all three cases – standard errors are not computed properly. Finally, Breusch-Godfrey tests confirm the presence of strong autocorrelation.

*Table 3* – **Pooling, Fixed and Random Effects Models Summary** (authors' own results)

| | Pooling | | Fixed Effects | | | | Random Effects | |
|---|---|---|---|---|---|---|---|---|
| | | | Individual | | Time | | | |
| (Intercept) | -5.3672 | 0.0721 | | | | | -5,1645 | 0,014 |
| | (2.9552) | | | | | | (2.0671) | * |
| CSBI | 0.0585 | 0.457 | 0.0552 | 0.0658 | 0.443 | 0.022 | 0,0555 | 0,0748 |
| | (0.0748) | | (0.0297) | . | (0.189) | * | (0.0309) | , |
| EIB | 0.036 | 0.0049 | 0.0349 | 0.0289 | 0.390 | 0.089 | 0,035 | 0,0348 |
| | (0.0125) | ** | (0.0157) | * | (0.227) | . | (0.0164) | * |
| R-squared | 0.0333 | | 0.0658 | | 0.1046 | | 0.0601 | |
| Adj. R-squared | 0.0324 | | 0.0623 | | 0.0766 | | 0.0585 | |
| F statistics | 1.8775 on 2 df | | 3.7733 on 2 df | | 4.79 on 2 df | | 3.48474 on 2 df | |
| F (p-value) | 0.1579 | | 0.0271 | | 0.0107 | | 0.0341 | |
| B-P (p-value) | | | | | | | | |
| B-G (p-value) | 8.274e-10 *** | | 1.2e-09 *** | | 1.2e-09 *** | | 1.2e-09 *** | |
| S-W (p-value) | 9.457e-07 *** | | 5.465e-06 *** | | 1.1e-05 *** | | 2.305e-07 *** | |

**Note:** by each variable, there is coefficient, with standard errors in brackets and p-value; for pooling OLS we used panel corrected standard errors.

The * symbols signify the significance levels: * $0.05 < p < 0.10$; ** $0.01 < p < 0.05$; *** $p < 0.01$

Data inputs coming to models are pretty weak – only 4 years panel in very turbulent time (at least from the point of GDP growth). This is reflected in very low R-squared – in all three cases it is lower than 8 %. Competitiveness does not seem to be very efficient in explaining GDP growth variations. It is not really a problem – we are interested in explaining GDP growth levels, not fluctuations.

Our empirical study does not prove our hypothesis of greater importance of innovation in international competitiveness. The weakness of data does not allow us to conclude in very strong relationships. According to coefficients it even seems than general economic conditions approach is more important in economic growth – by better position on the scale 0 – 100 by 1 point it increases GDP growth by 0.45 percentage point. A 1 point increase in innovation scale brings "only" 0.3 percentage growth. Both effects are huge and highly improbable – it is distorted with the current turbulent development on GDP growth.

Overall, it seems that standard errors are quite solid and p-value allows quite strong conclusions. As it has been mentioned previously, both data and models have very serious problems, such as abnormal residuals or autocorrelation which optically improves standard errors to such extent that it would be better not to interpret at all.

**Conclusions and directions of feather researches.** Our study was not successful in a sense of answering the question about importance of different aspects of competiveness in the EU. Weak dataset does not allow making strong conclusions. Collecting more data will be necessary for precise conclusions and further research. If there was a longer panel – for at least 10 years – available to the authors, it is very possible, that results would be better and would enable us to come to more solid conclusions. Nevertheless, it becomes apparent that general economic conditions approach that entitles the development of ordinary economic variables, such as price indicators, GDP growth or infrastructure, might have larger impact on competitiveness in the EU that the support of science, willingness to innovate and creation of

higher value-added products. These results might be regarded by the EU institutions willing to support innovations and economic growth within the European Union.

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**Чинники інноваційності та конкурентоспроможності в Європейському Союзі**

*Ця стаття оцінює детермінанти і джерела інновацій та конкурентоспроможності в Європейському Союзі. Головною гіпотезою є існування двох основних джерел конкурентоспроможності, представлених ціновою конкурентоспроможністю та інноваційною (додана вартість) конкурентоспроможністю, яка для ЄС є важливішою. На жаль, використання економетричної моделі було недостатньо ефективним для визначення важливості інновацій, тому для формування чітких висновків необхідно більше даних. Тим не менше, деякі пропозиції щодо джерел інновацій та бажаної підтримки представлені та обговорені в статті.*

Ключові слова: інновації, конкурентоспроможність, додана вартість, інвестиції, товар, Європейський Союз.

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**Факторы, определяющие конкурентоспособность и инновации в Европейском Союзе**

*Эта статья оценивает детерминанты и источники инноваций и конкурентоспособности в Европейском Союзе. Наша главная гипотеза заключается в том, что есть два основных источника конкурентоспособности, представленные ценовой конкурентоспособностью и инновационной (добавленная стоимость) конкурентоспособностью, причем последняя более важна для ЕС. К сожалению, эконометрической модели оказалось не достаточно, чтобы подчеркнуть важность инновацийю Поэтому для того, чтобы сделать четкие выводы, необходимо больше данных. Тем не менее, некоторые предложения об источниках инноваций и желаемой поддержке представлены и обсуждены в статье.*

Ключевые слова: инновации, конкурентоспособность, добавленная стоимость, инвестиции, товар, Европейский Союз.