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Opportunities to Catch Up Advanced Countries by Investing in Technologies

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ABSTRACT

Growing internationalization constitutes an opportunity to catch up by investigating in technology. Recently a significant amount of papers analysed phenomenon of technological catch up at domestic-foreign company‘s level. However, the need for empirical studies at country’s level is relevant as well. The main aim of the paper is to evaluate the relation among investment in technology, technological progress and macro-economic indicators and in this way to estimate opportunities of investing in technology to catch up advanced countries at macro level. We applied theoretical framework of neoclassical growth theory to explore relation between investment in technology, technological progress and macro-economic indicators in different countries. The approach used in the paper is quantitative. Research results show that regardless income level, countries can increase economic growth rates and catch up higher income countries by making appropriate decisions of investment, changing the structure of investment in technologies by funding sources and spheres. Research contributes to the scientific literature of technological progress and country‘s economic growth by providing empirical evidence of 44 countries.

INTRODUCTION

Investment in technology is a part of country’s investment policy. Governments make investment decisions regarding country’s economic and social situation, political directions and society expectations. In general, investment in technology is a source to create technological progress due to developed or adapted technological processes, products or knowledge. Technological progress is recognized as an important factor for long-term economic growth. Therefore, we use the neoclassical growth theory (Solow, 1957, 1994).

Many authors discussed and analysed different broad areas of technological progress importance in relation to country‘s economic growth: influence to economic growth rates by using strategies of technological transfer and creation of technologies (Armstrong and Taylor, 2000; McArthur and Sachs, 2002; Colino et al., 2014); how economic growth and technological progress is related to the intelligence of people in the country (Burhan et al., 2014, 2015); tendencies of various macro-economic indicators and investment in technology (Banioniene and Valanciene, 2014); foreign direct investments as an important factor of economic growth (Hlavacek and Bal-Domanska, 2016; Prochniak, 2011; Newman et al., 2015; Iamsiraroj, 2016); technological transfer of multinational companies to their subsidiaries (Buckley and Nashai, 2014; Wang et al., 2014; Giuliani et al., 2016). However, we observe lack of aggregate (macro) empirical studies demonstrating how investment in technologies can ensure country‘s economic growth and increase country's opportunities to catch up leaders. To fill the gap, this paper seeks to answer the following research question: *what are opportunities to catch up advanced countries by investing in technology*?

The main aim of the paper is to evaluate the relation among investment in technology, technological progress and macro-economic indicators and in this way to estimate opportunities of investing in technology to catch up advanced countries at macro level. Research contributes to the scientific literature of technological progress and country‘s economic growth by providing empirical evidence of 44 countries.

This paper is organized as follows. Literature review of technology transfer and neoclassical growth theory are presented in the first part of the paper. Second part presents the methodology used while the third part presents results of this empirical study. Discussion and Conclusions are drawn based on the identification of the future insights in the last parts of this paper. Research limitations are provided.

1. THEORETICAL BACKGROUND

Since 1980, technological innovation has been analysed as a key stimulus of growth by using the economic growth theory (Solow, 1994; Banioniene, Valanciene 2014). Lucas (1988), Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1992), Sachs and McArthur (2002), Adak (2015) analyse the importance of the technological innovation for economic growth. Wang et al. (2014) research result confirm that catch-up is positively related to technological gap and technological capability. Giuliani et al (2016) argue that cross-border inventions between European Union and some non European Union countries represent an opportunity for emerging country firms to accumulate technological capabilities, access frontier knowledge, and appropriate the property rights of co-inventions.

Moreover, according to Armstronf and Tayolor (2000) small economies have the opportunity to select to invest in technology creation or to use created technological progress which is available due to technology transfer between borders. The role played by transfer of technologies and technological knowledge is evident (Colino et al, 2014; Giuliani et al, 2016) because of investment decisions made by international corporations and information technologies.

Armostrong and Taylor (2000) findings showed that the bigger is the gap of technologies between two countries, the faster is technological progress in the lagging country. Besides, technologically dependent countries benefit to a larger extent than technology leaders from their relative technological backwardness by adopting technological advances from abroad (Colino et al., 2014). Also, for open economies it is economically beneficial to gain technological knowledge by transfer. Although innovative and technologically smart countries can gain technological progress only by investment in technology creation and new technological knowledge. Rapid transfer of technological knowledge between countries means that significant macro-economic disparities should not exist. Armstrong and Taylor (2000) indicated two reasons explaining differences of economic growth rates in medium term. Firstly, countries with lower income per capita have a lot to catch up and receive significant benefits from the existing technological knowledge, because of the efficiency of investment in technology. During the catch-up phase, these economies grow faster than the economies that extensively used technological knowledge before (Armstrong, Taylor, 2000).

The growth rate is faster in the economy, which try to catch up by using existing technological knowledge. Secondly, the decision to invest in technology creation or to buy existing technological knowledge depends on the country's policy. The differences occur due to political and institutional approach to the accumulation of capital and different economic and social conditions.

Moreover, some countries become the innovation leaders and the creators of technological knowledge. The leading countries use existing innovations for the creation of new products and manufacturing processes. In emerging countries, economic growth depends on the ability to use technological gap for the growth. Foreign direct investments (FDI) often comes with new technologies and innovations (Newman et al., 2015; Prochniak, 2011; Hlavacek and Bal-Domanska, 2016). FDI are potentially an important source of economic growth as they may help host country domestic industries catch up with the international technology frontier (Newman et al., 2015).

The study of Barrell and Pain (1997) showed that more technologically advanced small countries tend to invest in foreign countries. They argued that foreign direct investment is the source of new technologies and is the way to transfer knowledge between countries. In addition, country's economic and fiscal policy has an impact on the time of investment.

Barro and Sala-i-Martin (1997) constructed *„a model that combines elements of endogenous growth with the convergence implications of the neoclassical growth model"*. They found that, growth rate is driven by discoveries in the technologically leading economies in the long run. Later in the 2004, Barro and Sala-i-Martin analysed the economic growth of regions in USA and Europe in 1880-2000. The study found the weak convergence of income per capita among countries. In addition, investment in technology and the level of technological progress was growing rapidly, so the changes of country's macro-economic growth due to technological progress created in surrounding countries.

Moreover, McArthur and Sachs (2002) presented the study of economic growth factors in Asia. The researchers argued that East Asia is the most successful installer of technological innovation from developing countries. However, East Asia needs to become a technology creator in order to reduce the gap with the leading countries.

Lately, Burhan et al. (2014) analysed how economic growth and technological progress is related to the intelligence of people in the country. The analysis of over 60 countries shows that the intellectual class has a great impact on economic growth. Also, Burhan et al. (2014) found that the impact of the intellectual class on technological progress is exceptionally more significant than even the number of professional researchers engaged in R&D activities. This study highlights the importance of labour force ability to create and adopt technological knowledge.

The tendencies of macro-economic indicators and investment in technology were analysed by Banioniene and Valanciene (2014). Research results confirm that linear correlation between variables is strong in 27 countries out of 44 countries sampling. The linear correlation is weaker than strong in remaining countries due to growth of investment in technology despite the effect of macro-economic fluctuations. Also migration of labour force has the impact on weak or negative linear relation between labour force and investment in technology in East European countries, Sweden and Denmark. Iamsiraroj (2016) empirical research suggest that labour force, trade openness and economic freedom stimulate income growth further by increasing FDI.

To conclude, countries may use the created technological knowledge for technological progress without contribution to the development of technologies. Technological knowledge is spreading because of foreign direct investment and information technologies (Newman et al., 2015; Iamsiraroj, 2016). Thus, the technology transfer between countries takes place, but the process is slow on the basis of empirical research.

In order to evaluate the relation between investment in technology and macro-economic indicators to catch-up advanced countries, we use theoretical assumptions derived of technology transfer model from neoclassical theory:

- New technological ideas spread quickly even between countries (in open economies).
- Social-political infrastructure is supportive to technology transfer.
- Countries invest in technologies efficiently – create and/or buy created technological ideas.
- The growth rate is higher in the country seeking to catch up from existing technological knowledge.

Based on scientific literature review four research hypotheses are formulated:

- The strength of relation between technological progress and macro-economic indicators of a country depends on the level of income.
- High income countries invest in technology creation more than low income countries, whereas low income countries invest in created technologies.
- Technological progress created from high technologies and economic growth is strongly related in countries which invest in high technology creation.
- Lower income countries can catch up higher income countries due to technology transfer and by investing in created technologies.

2. METHOD

The applied research methodology implies comparative and systematic analysis and statistical method (correlation) in order to evaluate the relation between investment in technology, technological progress and macro-economic indicators. The linear relation between the pairs of selected variables is evaluated by measuring linear correlation coefficients using Microsoft Excel. The value of correlation coefficient is in the range [-1; 1] and could be classified as follows in the Table 1.

Table 1. The scale of values of correlation coefficient

Very strong	*Strong*	*Medium*	*Weak*	*Very weak*	*No connection*	*Very weak*	*Weak*	*Medium*	*Strong*	*Very strong*
−1	(−1; -0,7]	(−0,7; -0,5]	(−0,5; -0,2]	(−0,2;0)	0	(0;0,2)	[0,2; 0,5)	[0,5; 0,7)	[0,7; 1)	1

Source: made by authors

If correlation coefficient is equal to 1, there is very strong linear relation between variables. When correlation coefficient is equal to -1, the linear relation between variables is very strong but inversely proportional. If correlation coefficient is equal to 0, there is no linear relation between analysed variables. When the correlation coefficient is + 0.7 and over, and from -0.7 and up – l, the relation between analysed variables is considered strong. Comparison method is used for analysis of correlation results after the estimation of variables' pairs. According the correlation results, the analysis of correlation of each country variables' pair is done. Also, correlation results of different countries and groups of countries are analysed using comparison method. On the basis of analysis results, conclusions are constructed.

Selected variables are defined by indicators. The indicators were selected on the basis of literature review (Romer, 1990; Solow, 1994; Armstrong, Taylor, 2000; McArthur and Sachs, 2002). All indicators are represented in Table 2.

Table 2. Variables, indicators and sources of data

Variable	*Indicator*	*Source*
Economic change	GDP per capita (current US dollars, $)	The World Bank
Capital	Gross capital (current US dollars, $)	The World Bank
Labour	Number of labour force	The World Bank
Technological progress (creation of new ideas)	Number of patent applications Number of trademarks Number of high-technology patent applications	World Intellectual Property Organization, The World Bank. EUROSTAT
Investment in technology	R&D expenditure (current US dollars, $)	The World Bank, UNESCO Statistics Institute, EUROSTAT
Investment in technology by spheres (US dollars, $)	Acquisition of machinery, equipment and other capital goods; Intramural (in-house) R&D; Acquisition of (extramural) R&D; Acquisition of other external knowledge.	EUROSTAT UNESCO Statistics Institute.
Investment in technology by sources of funds (US dollars, $)	Government sector; Business enterprise sector; Higher education sector; Private non-profit sector; Funds from abroad.	The Organisation for Economic Co-operation and Development (OECD), EUROSTAT, The Network for Science and Technology Indicators –Ibero-American and Inter-American (RICYT).

Source: made by authors

The statistical data was used from 1990 to 2010 years for empirical study. The United States dollar was selected as currency unit for analysis. The period of the research and the countries were selected according to availability of statistical information, the welfare level, economic growth data. Countries and the period of the research was selected respectively the study of Banioniene & Valanciene (2014), so that the results of the studies could be comparable.

Selected countries are classified into four groups according to level of income and investment in technology: high-income countries, higher-middle income countries, lower-middle income countries and low-income countries (Table 3).

Table 3. Selected countries by the level of development

Level of development	*Selected countries*
High income	Austria, Ireland , Denmark, Estonia, France, Finland, Germany, Italia, Israel, Japan, Poland, Singapore, Spain, Sweden, Switzerland, United Kingdom, United States of America
Higher-middle income	Argentina, Brazil, Bulgaria, Chile, China, Latvia, Lithuania, Malaysia, Mexico, South Africa, Romania, Russian Federation, Turkey
Lower-middle income	Armenia, Egypt, Georgia, India, Indonesia, Moldavia, Mongolia, Ukraine
Low income	Burkina Faso, Kirgizia, Madagascar, Mozambique, Tadzhikistan, Uganda

Source: made by authors

3. RESEARCH RESULTS

The main scope of the research is to evaluate the relation among investment in technology, technological progress and macro-economic indicators in different countries.

According to the scientific literature, technology transfer model explains and evaluates country's technological progress and gap of technological knowledge. Moreover, new technological knowledge (the creation of new ideas) influences economic growth and shows technological progress of a country. Therefore, the relationship between creation of new ideas and macro-economic indicators should be analysed as well as the relationship between investment in technologies and creation of new ideas. Referring to neoclassical growth model and technology transfer model, macro-economic indicators are capital and labour.

Because of a large data sample, estimated strength of correlation value is ranked according to Table 1. Ranked results of correlation are presented in Annex 2. By using comparative approach method the correlation results are analysed in each country, in different groups of countries and between countries. The strength of the relation between pairs of these variables is analysed: GDP per capita and R&D, capital and R&D, labour force and R&D, GDP per capita and patents, GDP per capita and trademarks, GDP per capita and HT patents, R&D and patents, R&D and trademarks, R&D and HT patents. Then, the comparative analysis of investment in technology by spheres and by sources of funds is done in different countries, groups of countries and between countries.

After empirical data analysis the hypotheses are being tested.

H1. The strength of relation between technological progress and macro-economic indicators of a country depends on the level of income. The hypothesis is confirmed partially.

The primary analysis showed that no obvious features could be found between groups of countries classified by the level of income. Then the relation between three indicators for technological progress measurement (patents, trademarks and HT patents) and macro-economic indicators was estimated. The results indicate that lower-middle-income countries have moderate or strong linear correlation between GDP per capita and trademarks. Meanwhile, in high-income European countries, the linear correlation between GDP per capita and the patents is weak, very weak or negative.

H2. High income countries invest in technology creation more than low income countries, whereas low income countries invest in created technologies. The hypothesis is confirmed.

The results of the analysis showed that economically developed and financially strong countries tend to invest in technologies more than countries from low-income and lower-middle income group. For example, investment in internal and external R&D expenditure is higher in high income countries.

In addition, the correlation between the creation of new ideas and macro-economic indicators allows to state that economically weaker countries behave very differently - one is investing in high-technology creation, others are creating trademarks. However, the assessment of structure of investment in technology by spheres shows that economically less developed countries tend to concentrate their investments in created technologies, especially in the economic growth phase.

H3. Technological progress created from high technologies and economic growth is strongly related in countries which invest in high technology creation. The hypothesis is confirmed partially.

The linear correlation between HT patents and macro-economic growth indicators was strong or medium in all countries which invest in high technology creation (where correlation of investment in technology and HT patents was strong). In addition, all of these countries had the strong correlation between GDP per capita and investment in technology.

H4. Lower income countries can catch up higher income countries due to technology transfer and by investing in created technologies. The hypothesis is confirmed.

The data analysis indicated that regardless group of income, economic change of countries strongly correlates to investment in technology (R&D) and all spheres of creation of new ideas. So, lower income countries can catch up higher income countries by making appropriate decisions of investment, changing the structure of investment in technologies by sources and by spheres.

Countries with lower-middle income and low income per capita have a lot to catch up, but get substantial benefits using created technological ideas developed by other countries, because the efficient use of new technological ideas. During the catch-up phase, countries with lower income per capita with grow faster than the countries which use, create and develop new technologies intensively. However, organizational changes together with investment in technology decisions can ensure the success of catch up in developing countries.

4. DISCUSSION

The discussion consists of three parts: economic growth and creation of new ideas; analysis of the structure of investment in technology; analysis of investment in technology by funding sources. At last research limitations are provided.

4.1 Creation of new ideas and economic growth

After the analysis of correlation results, it was noticed that distribution of countries by level of income is not appropriate. The results were similar and comparable only in the low income countries. Meanwhile, no obvious features could be found between groups of countries classified by the level of income in the rest of groups. Therefore, countries have been grouped according to the correlation results, the strength of correlation.

The analysis of correlation among creation of new ideas, macro-economic indicators and investment in technology allowed to evaluate trends of indicators and differences of countries in terms of the choice to invest in technology creation and/or in created technologies.

Technology leaders (Japan, USA and Germany) have growing investment in technology which is independent on changing economic conditions and created technological progress in the past. Moreover, economically developed and financially stable countries invest more in technology creation than in created technologies. The economically weaker countries behave differently – some are investing in high-technology creation development, others are creating trademarks. However, China, India, Israel are an example of strong correlation between investment in technology, creation of new ideas (patents and trademarks) and macro-economic indicators regardless the income group. In addition, the amount of GDP per capita raised several times in these countries during analysed period. The results implicate that a country can significantly improve economic indicators, successfully grow and catch up developed countries by purposefully investing in technology.

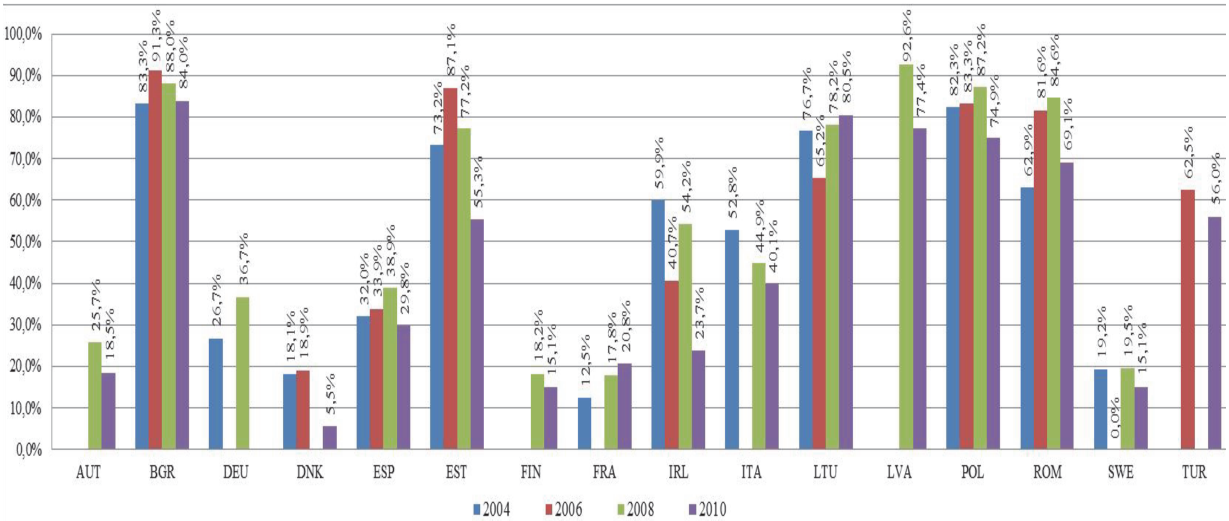
The research shows that countries with lower-middle and low income per capita have a lot to catch up. Also, these countries can get substantial benefits using created ideas from abroad. During the catch-up phase, countries with lower income per capita growth faster than countries which tend to invest in technology creation.

4.2 Structure of investment in technology

Structural analysis of investment in technology is important for evaluation of investment efficiency and differences between countries' decisions to invest in technology creation or to buy created technologies.

Due to the lack of statistical data on investment in technology by spheres this analysis included only 16 countries out of 44 countries. The analysed countries represented groups of high income and higher-middle income countries. The statistical data was used from Eurostat survey of European Union entities with more than 10 employees. The survey has been carried out since 2002, but data on the structure of investment in technology was started collecting since 2004 biannually. The percentages and percentage changes are used for structural analysis of investment in technology from 2004 to 2010, in order to find the essential similarities and differences between selected countries.

Figure 1. Part of investment in technologies on investment in machinery, equipment and other capital goods



Source: arranged according to the set of Science and Technology reports by Eurostat, 2013

Research results show that investment in machinery, equipment and other capital goods is more sensitive to economic changes in economically weaker countries (Figure 1). Also, investment in machinery, equipment and other capital goods is over 75 percent of all investment in technology in these countries. Macro-economic changes have a weaker impact on investment in machinery, equipment and other capital goods as well as structural changes of investment in technology in financially stable and economically developed countries.

Moreover, economically developed and financially stable countries concentrate investment in technology on intramural and extramural R&D, i. e. invest in technology creation. Less stable and less economically developed countries concentrate their investment in technology on acquisition of created technologies, especially then economy is growing.

4.3 Investment in technology by funding sources

The analysis of investment in technology by funding sources is performed to identify trends and differences of main sources of investment in technology in selected countries and groups of countries. The analysed 29 out of 44 countries belong to high income and higher-middle income groups. The low income and lower-middle income groups of countries were not included because of the lack of statistical data.

Research results indicated that in some countries the structure of investment by sources is steady with light changes during the entire period. Founding by business and government sectors were changing in the range of 10 percent points in Austria, Switzerland, Germany, Great Britain, Italy, Sweden, Japan, Singapore, Spain, Chile and Argentina. Investment funded by business sector was almost steady in Brazil (54,1% in 2000, 52,7% in 2010) and France (43,5% in 1990, 52,5% in 2000, 53,5% in 2010), while investment funded by government was almost steady in Poland (66,5% in 2000, 60,9% in 2010) and South Africa (36,4% in 2000, 44,4% in 2010).

To sum up, the part of investment from government and business sectors is about 75 percent of total investment in technology in most of countries. Investment in technology funded by business sector is the highest in economically strong, high income countries-technology creators, such as Japan, Switzerland and Germany. As an emerging economy, China has the changing structure of funding sources (decreasing part of government from 33,4% in 2000 to 24,0% in 2010 and increasing part of business sector from 57,6% in 2000 to 71,7% in 2010), and already has reached the similar structure of investment by sources as in high income countries in 2010. The USA (as the major creator of technologies) has almost steady structure of investment in technology by sources. However, it was noticed that the decreasing part of investment from business sector (54,6% in 1990, 69,4% in 2000, 61,0% in 2010) is compensated by increasing part of investment from government sector (41,6% in 1990, 25,8% in 2000, 32,5% in 2010) during the analysis period.

Israel, Turkey and Bulgaria have conspicuous changes in structure of investment in technology by sources of funds. For example Israel has increasing part of investment in technology from foreign funds (6,5% in 1990, 22,2% in 2000, 42.8% in 2010) and decreasing parts of investment from government (36,9% in 1990, 23,9% in 2000, 14,8% in 2010), higher education (7,1% in 1990, 2,0% in 2000, 1,8% in 2010) and non-profit sectors (6,0% in 1990, 0,7% in 2000, 1,6% in 2010). The part of foreign funds is the largest and the part of government sector is lowest in Israel comparing with all selected countries. In Turkey, the part of investment from government sector decreased (71,4% in 1990, 50,6% in 2000, 30,8% in 2010) to the level of high income countries, whereas the part of investment in technology from business and higher education sectors increased during the analysis period. In addition, in 2010 the part of investment in technology from higher education sector was ahead of all countries in Turkey (19,6%). During the analysed period Bulgaria had strongly fluctuating investment in technology from government sector (33,1% in 1990, 69,2% in 2000, 43,2% in 2010) due to a strong decline of investment from business sector (66,9% in 1990, 24,4% in 2000, 16,7% in 2010) and the sharp rise of investment from foreign funds (5,3% in 2000, 39,6% in 2010).

Thus, the high income countries and countries-technology-creators have consistent structure of investment in technology by source of funds. Higher-middle income countries try to change the structure of investment in technology by encouraging investment from business sector and attracting foreign funding.

CONCLUSIONS

Research results indicate that technology leaders, such as Japan, the USA and Germany, are increasingly investing in technology creation and investment decisions are independent on the economic fluctuations in the country or the technological progress created in the past. In these countries, investment in technology is mainly funded by business sector.

Economically developed and financially stable countries invest more in technology creation than in technology adoption and created technologies, e.g. the main part of investment in technology is spent on internal and external R&D. The economically weaker countries behave in different ways – some are investing in high-technology creation, others are creating trademarks. However, the assessment of investment in technology's structure shows that economically less developed countries concentrate their investment in created technologies by acquisition of technological transfer.

The part of investment from government and business sectors is about 75 percent of total investment in technology in most of countries. Moreover, high income countries and countries-technology-creators have consistent structure of investment in technology by funding sources. Higher-middle income countries try to change the structure of investment in technology by encouraging investment from business sector and attracting foreign funding.

The examples of China, India, Israel show that, regardless the income, countries can improve economic growth indicators and catch up higher income countries by making appropriate decisions of investment, changing the structure of investment in technologies by funding sources and spheres.

Countries with lower-middle income and low income have a big gap, but get substantial benefits using created technological ideas developed by other countries, because of the efficient use of new ideas. During the catch-up phase, countries with lower income grow faster than countries which use, create and develop new technologies intensively. However, organizational changes, intelligence of people and government support are essential for successful growth.

Although the research has reached its aim, there were some unavoidable limitations.

Firstly, the selection of countries was made by using the World Bank's Database. Countries were divided into groups by the level of income. There was limited selection of lower-middle income and low income countries due to the lack of statistical information in the used database. Therefore, countries from lower-middle income and low income groups were selected if at least the data about investment in technology indicators and macro-economic indicators was available. In addition, the analysis of investment in technology by spheres and by sources of funds could not be made in lower-middle income and low income countries due to the lack of statistical data.

Secondly, we were constraint in selecting indicators for technological progress evaluation (patents and high technology patents), as there were no other proper statistical indicators in the databases. For example, the price of patents is very high, so not all countries could invest in patenting of new ideas. Because of this reason, patent indicators selected for the analysis may be smaller than actual technological progress created and applied in a country. This problem is stronger for the lower-middle income and low income countries.

The investment in technologies and high technologies is long lasting process. Therefore, the created technological progress per year should be compared with country's investments made during several years in order to create technological progress of particular year. In addition, new ideas are not always used for GDP creation. However, the analysis of selected countries was carried out without evaluating the time factor influence on creation of technological progress (patents, trademarks and HT patents) and adjustment for GDP creation.

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Annex 1. Ranked results of correlation

Country code	*GDP per catipa/ R&D*	*Capital / R&D*	*Labour force/ R&D*	*GDP per catipa/ patents*	*GDP per catipa/ trademarks*	*GDP per catipa/ HT patents*	*R&D/ patents*	*R&D/ trademarks*	*R&D/ HT patents*	*Data sample*
ARG	weak**	weak**	strong**	strong*	weak neg.*	n	very weak*	medium*	n	1996-2006* 1996-2010**
ARM	strong*	strong*	strong neg.*	weak*	strong*	n	weak*	strong*	n	1997-2009*
AUT	strong	strong	strong	weak	very weak	medium	weak	weak	strong	
BFA	strong*	strong*	strong*	medium neg.*	strong*	n	medium neg.*	strong*	n	1996-2009*
BGR	strong	medium	strong	strong neg.	medium	medium	strong neg.	very weak	weak	
BRA	strong*	strong*	strong*	medium	medium	medium	medium*	strong*	medium*	1996-2010*
CHE	strong*	strong*	strong*	medium neg.	medium	weak	strong neg.*	strong*	weak*	1992, 1996, 2000, 2004, 2008 data
CHL	very weak neg.*	strong*	strong*	weak	strong	n	strong neg.*	strong*	n	2007-2010*
CHN	strong	strong	strong	strong	strong	strong	strong	strong	strong	
DEU	strong	strong	strong	medium	weak	very weak	strong	medium	medium	
DNK	strong	strong	medium	very weak neg.	medium neg.	weak	very weak	medium neg.	medium	
EGY	strong*	strong*	strong*	strong	weak*	n	medium*	very weak*	n	1996-2009*
ESP	strong	strong	strong	strong	medium neg.	strong	strong	medium neg.	strong	
EST	strong**	strong**	strong**	medium neg.*	very weak*	strong	strong neg.**	weak neg.**	strong**	1994-2010* 1998-2010**
FIN	strong	strong	strong	medium neg.	weak neg.	weak	strong neg.	very weak	medium	
FRA	strong	strong	strong	very weak	very weak	medium	weak	very weak	strong	
GBR	strong	strong	strong	weak neg.	very weak	weak	weak neg.	very weak	weak	
GEO	medium neg.*	medium *	weak*	medium neg.	medium	n	weak *	weak neg.*	n	1996-2005*
IDN	n	n	n	strong	strong	n	n	n	n	
IND	strong*	strong*	strong*	strong*	strong*	strong	strong *	strong*	strong*	1996-2007*
IRL	strong	strong	strong	weak neg.	weak neg.	strong	medium neg.	medium neg.	strong	
ISR	strong	strong	strong	strong	strong	medium	strong	strong	strong	
ITA	strong	strong	strong	medium*	medium	weak	medium*	medium*	medium	1996-2010*
JPN	weak	medium	weak	weak neg.	very weak neg.	very weak neg.	weak	medium neg.	medium	
KGZ	strong*	strong*	strong*	very weak neg.*	weak	n	very weak *	strong*	n	1997-2009*
LTU	strong*	strong*	strong neg.*	weak neg.	very weak	strong	medium neg.*	very weak*	strong*	1994-2010*
LVA	strong*	strong*	very weak*	weak neg.*	weak neg.*	strong	weak neg.*	weak neg.*	strong*	1993-2010*
MDA	strong*	strong*	strong neg.*	weak	medium	n	weak neg.*	medium*	n	2003-2009*
MDG	medium *	medium *	medium *	medium	strong	n	weak neg.*	medium*	n	1997-2009*
MEX	strong*	strong*	strong*	strong	strong	weak	strong *	strong*	very weak*	1993-2009**

MYS	strong*	strong*	strong*	weak	strong	medium	medium neg.*	medium*	strong*	1996-2006*
MNG	strong*	strong*	strong*	very weak	medium neg.	n	weak neg.*	medium neg.*	n	1997-2009*
MOZ	n	n	n	strong*	medium neg.*	n	n	n	n	1998-2010*
POL	strong	strong	weak	weak neg.	medium	strong	weak neg.	weak	strong	
ROM	strong	strong	weak neg.	medium neg.	strong	strong	medium neg.	medium	strong	
RUS	strong	medium	medium	weak	medium	very weak	very weak	medium	weak	
SGP	strong*	strong*	strong*	strong**	weak neg.**	medium	strong **	weak neg.**	medium*	1994-2010* 1998-2010**
SWE	strong*	strong*	medium *	strong neg.	very weak	medium	medium neg.*	weak*	strong*	Data from 1992 every two years to 2003*
TJK	strong*	strong*	strong*	weak neg.	very weak	n	medium neg.*	strong*	n	2001-2009*
TUR	strong	strong	strong	weak	strong	strong	medium	strong	strong	
UGA	strong*	strong*	strong*	n	n	n	n	n	n	2002-2009*
UKR	strong*	strong*	weak neg.*	very weak neg.	strong	n	very weak neg.*	strong*	n	1997-2009*
USA	strong	strong	strong	strong	strong	medium	medium neg.	very weak	weak	
ZAF	strong*	strong*	strong*	strong*	strong	very weak	strong *	strong*	weak*	2001-2009*

n – no data is available
Source: made by authors