An Analysis of the Relationship Between Innovation and Economic Growth: The Case of Emerging Markets[1]

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ABSTRACT

Innovation is sweeping the globe at breakneck speed, and emerging markets are where tremendous growth and opportunity reside for the present and future. Although innovation is widely viewed as the key to economic growth, there is no consensus on what makes some industries and countries more "innovative" than others, or exactly how innovations fuel an economy. The purpose of this study is to check whether innovation is a key factor in the economic growth of emerging countries. The empirical analysis is performed on 13 emerging economies, using the time series annual data for the period of 1970-2014. Unit root, Engle and Granger co-integration, Vector Error Correction Model (VECM) and Vector Autoregressive (VAR) tests were used to check out the relationship between innovation and economic growth. The result of the analysis indicates that only 4 of the 13 countries' data confirms the hypothesis that innovation is the main factor of growth in the emerging economies.

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[1] This article is produced from a master thesis called " The Relationship Between Innovation And Economic Growth: The Case of BRICS and Turkey "

INTRODUCTION

The past decades have witnessed the emergence of a group of countries with rapid economic growth with China as leader. An emerging market economy describes a nation's economy that is progressing toward becoming more advanced, usually by means of rapid growth and industrialization. These countries experience an expanding role both in the world economy and on the political frontier. Emerging markets have lower per-capita incomes, higher unemployment, and lower levels of business or industrial activity relative to the United States; however, they also typically have much higher economic growth rates. The four largest emerging and developing economies by either nominal or PPP-adjusted GDP are the BRIC countries: Brazil, Russia, India and China. The next three largest markets are, Mexico, Indonesia and Turkey.

Economic growth depends on a variety of factors. Among them are human capital, increases in the stock of productive inputs, and technical change. Innovation bears most directly on technical change, and thus is a major determinant of economic growth. In a globalizing world in which rising population places growing pressure on the stock of natural resources, sustainable growth depends more than ever on how innovation can be nurtured. Innovation is what may be considered as knowledge capital, and it stands in distinction to traditional measures of capital, notably physical stocks.

New economic growth theories focus on technological change to explain the growth trends of economies. According to endogenous growth theories, pioneered by Romer (1986), the research and development sector creates technological innovation by using human capital and the stock of existing knowledge. It's then participated in the process of producing final goods by promoting permanent increases in the rate of output growth. These models are based on the assumption that endogenously determined innovation generates sustainable economic growth, given that there are constant returns to technological change in terms of human capital employed in the R&D sectors (IMF, 2004).

Data of 13 emerging countries for the period 1995-2014 will be used to investigate the postulation of R&D based endogenous growth models which says that innovation leads to permanent increases in per capita GDP. The purpose of this study is to check whether innovation is a key factor in the economic growth of emerging countries and what role could play the investments from developed countries on their growths. This paper is organized into three sections. The first section presents the theories of innovation and economic growth, the second section is devoted to a brief presentation of the economic situation of few emerging countries and macroeconomic indicators to be used. Finally, in the third section, empirical researches will be practiced about endogenous growth model by using econometric analysis.

1. The Concept of Emerging Country

The concept of "emerging country" comes from the world of finance. After the debt crisis in the early 1990s, the term "emerging markets" appeared to refer to the countries growing rapidly and presenting investment opportunities for rich countries. Mexico, Argentina, Indonesia, Turkey, for example, were included in this new category. Then it emerged that growth in these countries was sustainable, unlike that seen in previous decades, and it gradually changed the world economic geography. Finally, in early 2000, the bank Goldman Sachs has introduced the concept of BRIC to describe Brazil, Russia, India and China. In 2010, South Africa began its membership process in the BRIC group, which will finally be formalized in August. After being officially invited by the other members of the BRIC, South Africa officially joined the group on 24 December 2010. After the accession of South Africa, the group was renamed BRICS with the "S". (Graceffo, Antonio 2011:32). These five states differ from other emerging countries firstly by their economic and demographic weight, and also by their ability to influence international politics. These countries are both emerging economies and considerable political actors. Outside the BRICS, there is also the MINT, which is an acronym, referring to the economies of Mexico, Indonesia, Nigeria and Turkey but we will limit our study in the case of Turkey and BRICS countries.

1.1. Economic Situation of the BRICS Countries

In 2013, most of the BRICS countries were already the biggest economic powers in the world and should gain even more weight on the international scene in the decades to come. All BRICS countries represent 45% of the population of the planet, nearly a quarter of its wealth, and two thirds of its growth. Four of the five BRICS countries are among the top ten world economic powers (Brazil 7th, Russia 8th, India 10th, and China 2nd). South Africa, first power of the African continent, is ranked among the 30 largest economies in the world (29th place) (Centre for Economics and Business Research, 2015).

China is currently considered as the second world power (behind the US) and she became in 2011 the second largest economy in the world, dethroning Japan and becoming the first power of the Asian continent. In 2013 for the first time China has overtook the U.S. to become the world's largest trading country in goods. China's foreign trade rose 7.6%, China's exports rose to 2210 billion and imports increased 7.3% to 1.95 trillion, according to figures released in 2013 by customs. With a spectacular growth (the most important of the last decade) in the order of about 10% per year, China is the country that registered the highest economic growth of recent years. In 2010, China reached a record 9.5% growth (for comparison, economic growth in France was 2,1% in 2011) (World Bank, 2016). Rapid economic ascendance has brought on many challenges as well, including high inequality; rapid urbanization; challenges to environmental sustainability; and external imbalances. China also faces demographic pressures related to an aging population and the internal migration of labor. After 30 years of rapid economic growth, growth rate of China has been slowing down. China's GDP growth rate fell to around 7.7% in 2013, the lowest since the 1997 Asian financial crisis. Technological innovation, improvements in resource productivity, significant policy adjustments are required in order for China's growth to be sustainable.

Brazil is the fourth largest economy of the BRICS and the main economic power in South America. The liberalization of the Brazilian economy took place at the pace of liberalization of the global economy as evidenced by Brazil's accession to the World Trade Organization (WTO) and the rapid development of Brazilian multinationals in primary productions (agriculture, energy) but also in industrial production (aeronautics). The service sector is the largest component of GDP at 67.0 percent, followed by the industrial sector at 27.5 percent. Agriculture represents 5.5 percent of GDP (2011). Brazilian labor force is estimated at 100.77 million of which 10 percent is occupied in agriculture, 19 percent in the industry sector and 71 percent in the service sector. However, despite the increase of the middle class and significant poverty reduction, (several million poor Brazilians have joined the middle class between 2000 and 2010), Brazil is still marked by increased inequality between social groups and between regions. In terms of the economy growth, Brazil has registered an increase of 7.5% in 2010, representing a growth significantly higher than that of developed countries such as Germany, France, the United Kingdom and the United States. With India and China, Brazil is one of countries that experienced the highest rates of growth between 2007 and 2010. In 2011, after a growth rate of 7,6%, Brazil overtook the UK to become the 6th world economy (IMF, 2016). Brazil is now the seventh world power and has the world's seventh largest GDP, just ahead of Russia. Brazil is currently going through a deep recession. The country's growth rate has decelerated steadily since the beginning of this decade, from an average annual growth of 4.5% between 2006 and 2010 to 2.1% between 2011 and 2014. The GDP contracted by 3.8% in 2015. The economic crisis - coupled with the political crisis now facing the country - has contributed to undermining the confidence of consumers and investors

India is among the countries that have experienced high rates of economic growth in recent years. India ranks at the 3rd place among the countries that experienced the highest rate of growth in last years with a growth rate of about 9.3% in 2006, 9.8% in 2007 and up 10.3% in 2010. Over this period, no other country except China has outperformed India. However, since 2012, the Indian economy is experiencing a slowdown, due to the global economic crisis and the weakness of domestic demand. Growth reached its lowest level in a decade in Q2 2013 (4.4%). After several consecutive years of depreciation of the Indian currency (-11% of its value against the dollar over the year 2013), it has been relatively stable during the year 2014, thanks to the interventions of the central bank and greater confidence of investors against the currencies of other emerging countries. Beyond the current slowdown in its economy, India

remains an important market for large companies, and also benefits from investments of its diaspora: India's growth has thus recovered to 7.3% in 2014.[2] If this trend continues, India should become by twenty years one of the top four global economies.

The question of Russia as an emerging country has long been a source of controversy. Russia is indeed one of the most influential countries in the world and is one of five countries in the world to occupy a permanent seat on the United Nations Security Council. It is probably the most developed of the BRICS countries, with a literacy rate over 99% in 2010, more than China (95%), Brazil (90%), South Africa (88%) and India (77%)[3]. On this point, it is one of the most developed countries in the world, ahead of Germany, France, the United Kingdom or the United States. Economically, Russia has a moderate economic growth (3.4% in 2016), has the world's third largest currency reserves (after China and Japan) and is one of the least indebted countries (the Russian debt has a low rate of 10% of GDP, one of the best in the world). Economic growth in Russia remains nevertheless modest compared to 6% experienced by Brazil (almost double) and 10% in China and India. According to some analysts, the Russian presence in BRICS would be more geopolitical than economic aspects, given that the economy of Russia, despite a sizeable economic growth, has not had much in common with the dynamism that characterizes the rest of the group.

South Africa has 75% of the biggest African companies, has lower growth than 2% and a GDP of sixteen times lower than that of China. In the opinion of a large majority of specialists, experts or economists, South Africa appears to be the least influential BRICS countries. South Africa is indeed far behind the four economic giants Russia, India, China and Brazil in terms of GDP, development or to economic growth. With a GDP of $ 384 billion, South Africa's GDP is not even half that of India ($ 1,842 billion), Russia ($ 2,000 billion), Brazil (2253 $ billion) and appears to be very small compared with that of China ($ 8 227 billion). Considering the size of its economy (2.5% of total GDP of the BRICS) or of its population (52 million), South Africa appears tiny compared to other countries in the group. However, regionally, South Africa remains a leader in its entire continent. Today ranked second economic power (after Nigeria), South Africa until 2013 was the largest economy in Africa (J. Herbst, G. Mills 2015:1).

Turkey was in 2010 the first economic power in the Middle East ahead Iran and Saudi Arabia, the 7th economic power in Europe and the 15th largest economy. G20 member and the Customs Union, Turkey officially started its accession talks with the EU in October 2005. After significant growth until 2011 (9.2% in 2010 and 8.8% in 2011), Turkey is experiencing a sharp slowdown in its growth rate (2.9% in 2014). Turkey is an industrial country where agriculture plays an important role in the national wealth production. The added value of the industry represents 26.6% of GDP against 63.7% for services and 9.6% for agriculture[4]. The vitality of the Turkish economy is explained by:

➢ The presence of a large internal market (75 million de consumers): Private consumption is supported and its purchase power is growing. Turkey shows a Growth of of 7.8% compared to 1,4% in the United Kingdom.

➢ Significant investments: they represent a significant share of GDP in 2010 (20% against 17.3% in Germany).

➢ Turkey's business sector dynamism has underpinned strong and inclusive growth in the 2000s, even though well-being indicators suggest there remains ample room for improvement. Robust public finances and a resilient banking sector have supported economic performance. However, with low domestic saving and volatile external competitiveness, growth is highly dependent on domestic demand and foreign finance (OECD, 2014).

Turkey's rising prosperity has been shared. Between 2002 and 2012, the consumption of the bottom 40 percent increased at around the same rate as the national average. Over the same period, extreme poverty

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[2] *World Bank Data Set, World Development Indicators (WDI) Economic Growth. 2011*

[3] *OECD 2012 Data set, literacy rate*

[4] *World Bank data set, World Development Indicators (WDI). 2011*

fell from 13 to 4.5 percent and moderate poverty fell from 44 to 21 percent, while access to health, education, and municipal services vastly improved for the less well off. Since the global financial crisis, Turkey has created some 6.3 million jobs, although increases in the labour force, including through a rise in the participation of women, has kept unemployment at around 10 percent (Worldbank overview, 2016). The Turkish economy is a relatively open economy. Foreign trade accounted for 48% of GDP against 22% in Brazil and 88% in Germany.

1.2. Socio-Economic Indicators

It is important to observe the economic indicators that will be used in the econometric analysis. Our observations will be limited in the period of 1990-2014 for the BRICS countries and Turkey.Economic growth means an increase in real GDP. Firstly, and most commonly, growth is defined as an increase in the output that an economy produces over a period. The second meaning of economic growth is an increase in what an economy can produce if it is using all its scarce resources. An increase in an economy's productive potential can be shown by an outward shift in the economy's production possibility frontier. Economic growth is an important macro-economic objective because it enables increased living standards and helps create new jobs.

Figure 1: Economic Growth
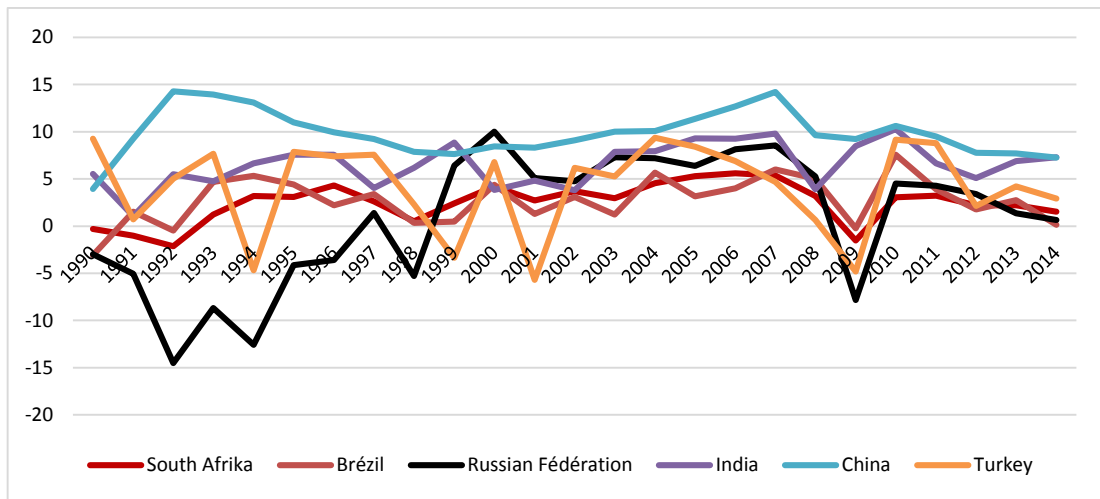
Source: World Bank data set (WDI).

This graph shows that Chinese growth curve clearly dominates the other countries until 2008 period of the financial crisis. Russia is the country that has been the most affected by this crisis, which has for that matter spared none of the other countries. From 2010, we observe a general decline of growth in these countries except India, which shows a slight recovery of its economy. We can also observe the crises of 1994, 1998 and 2000 experienced by Turkey.

Figure 2: Patent Application, Residents
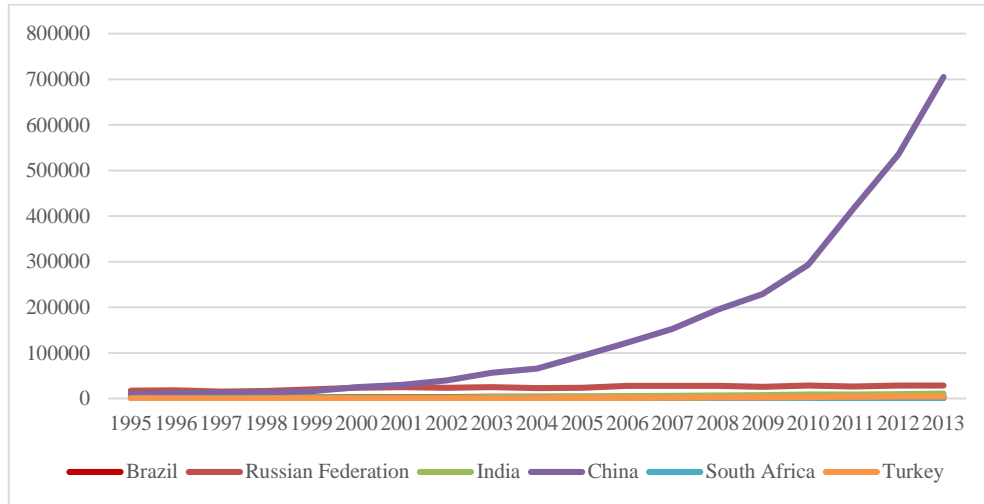
Source: World Bank 2016

The increase in last ten years have been the witnesses of an extraordinary increment in the number of patent in China, from 100,000 in the early 2000s to over 700,000 in 2013. China is by far the country that owns the most patents among the BRICS countries. The increasing number of patent has mainly been promoted by government's policy oriented on expenditures in research and development. China is followed by Russia whose number of patent in recent years remains below 100,000 per year. we can also see that the number of patent of Turkey and South Africa is less than 20,000 per year during these recent decades.

Figure 3: Foreign direct investment (% GDP)
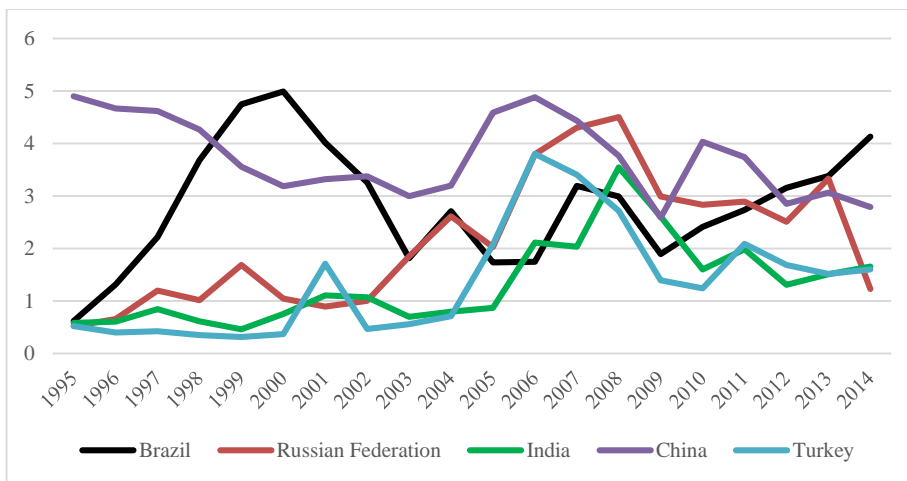
Source: World Bank 2016

Figure - 3 shows that foreign direct investments in China clearly dominates the foreign direct investments in the other emerging countries. China is in the midst of opening its markets to global investors while encouraging local investment abroad and she has become the world's largest FDI recipient, surpassing the United States. The country is also at the top of the 2015-2017 list of the economies most attractive to multinational companies. The absorption of FDI is part of the policy of opening China to the outside world. This graph also shows the extreme sensitivity of foreign direct investments in periods of financial crises.

Figure 4: Gross Fixed Capital Formation (% GDP)
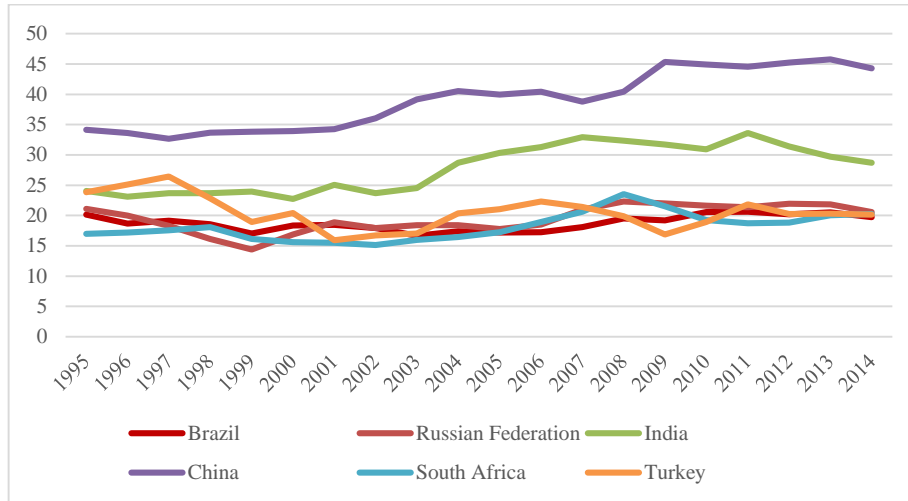
China is by far the country whose value of gross fixed capital formation is the highest followed by India. This gives us an idea of how much of the new added values in China's economy are invested rather than consumed. In the other BRICS countries, the value of the gross fixed capital formation is constantly lower than 25% of GDP.

2. Relationships Between Innovation and Economic Growth

Economic growth is the increase in the goods and services produced by an economy, typically a nation, over a given period of time. It is measured as percentage increase in real gross domestic product (GDP) which is gross domestic product (GDP) adjusted for inflation GDP is the market value of all final goods and services produced in an economy or nation. There are three main types of economic growth theories that have all attempted to explain the mechanisms of economic growth. The Classical, Neo-Classical, and Modern theories will each be described.

The empirical model will be built on the R&D based growth model of Romer. In terms of Romer's model of endogenous technical change, the research sector is specialised in the new ideas. New ideas and knowledge are generated in this sector by using human capital along with the existing stock of knowledge. In Romer's ideas, natural resources are less important than ideas. Japan has very few natural resources but it was open to new western technology and ideas. Japan imported machines from the USA during the Meiji era, dismantled them to understand how they worked and tried to manufacture better prototypes. Therefore, ideas are very important for economic growth. These ideas relate to enhance designs for the production of producer durable goods for final production.

According to the Romer model, new knowledge enters in the production process in three different ways. First, a new design is employed in the intermediate goods sector in order to produce a new intermediate input. Second, in the final sector, human capital, available producer durables and labour produce the final product. Third, a new design improves the stock of knowledge that increases the productivity of human capital used in the research sector. The Romer's model can be explained by the equation - 1

$$Y(H_r, L, X) = H_Y^\propto L^\beta \int_0^\infty X(i)^{1-\propto-\beta} di \qquad (1)$$

In this equation, x, H, L are producer durables, human capital and labour respectively. x is produced by a monopoly in the intermediate goods sector using η units of forgone consumption and the design of that durable bought from R&D sectors. The equation - 2 shows how the creation of new designs in R&D sector evolves.

$$\dot{A} = \delta H_A^\theta A \qquad (2)$$

A is knowledge stock, H_A is total human capital in R&D sector, and $\dot{A}$ the new designs (technological change). According to the Romer's model, sustainable economic growth is the fact that production of

innovation is linear in human capital used in the R&D sectors and knowledge stock (i.e, θ = 1). This has two repercussions: first, allocating more human capital to research leads to a higher rate of production of innovation; second, the productivity of an engineer working in the research sector depends on the total stocks of designs and knowledge. After the production of a new design, it enters into an economy in two different ways: a new design enables the production of a new intermediate good that can be employed to produce output; it also increases the stock of knowledge and the productivity of human capital in the R&D sector (IMF, 2004). The equation - 3 shows how the total capital evolves.

$$\dot{K} = Y(t) - C(t) \tag{3}$$

This accounting measure of K is related to durable goods that are actually employed in production by the rule because it takes η units of forgone consumption to produce one unit of any type of durable.

$$K = \eta \sum_{i=1}^{\infty} x_i = \eta \sum_{i=1}^{A} x_i$$

All available durable goods are supplied at the same level and can be denoted as x due to symmetry in the model. Since A determines the range of durable goods that can be created, and since η units of output are needed per unit of durable goods, it is possible to find for x from the equation that K = ηAx. Substituting x = K/ηA into the production function in equation (1) results in the final form of the production function in Romer's model

$$Y(H_Y, L, x) = (H_Y A)^\alpha (LA)^\beta (K)^{1-\alpha-\beta} \eta^{\alpha+\beta-1} \tag{4}$$

Increasing returns to scale occurs in both R&D and final output sectors because both sectors employ non-rival knowledge stock, A, as an input. A participates into the final good production process indirectly through knowledge spillovers and directly into the R&D sector. The most important conclusion in the Romer's model is that countries can achieve perpetual economic growth by investing in human capital and promoting R&D sectors.

There is a huge literature suggesting and demonstrating that innovation and scientific indicators make an important contribution to the growth at the firm, industry and national levels. Most of these studies have investigated the relationship between productivity, innovation, R&D and growth.

Innovation has been and continues to be an important topic of study for a number of different disciplines, including economics, business, engineering, science, and sociology. Despite the fact that innovation has been studied in a variety of disciplines, the term is often poorly understood and sometimes confused with related terms such as change, invention, design, and creativity. Most people can provide examples of innovative products such as the iPod or the PC, but few can clearly define the innovative aspects of these products. Among academics there is a difference of opinion about what the term innovation really means. Innovation is the process of making changes, large and small, radical and incremental, to products, processes, and services that results in the introduction of something new for the organization that adds value to customers and contributes to the knowledge store of the organization (O. Sullivan 2008: 4).

Most economists agree that technological change has a considerable impact on economic growth throughout the world. All over the world, companies are competing to improve their technologies so as to progress in their business, and to also progress the global economy. Researchers have come to the conclusion that technological change influence approximately 1/3 of economic growth (Jaffe, Newell and Stavins, 2001:9) That is why technological advancements and innovation are essential to the survival of an economy.

The category of Research and Development (R&D) spending is a strong indicator of economic growth through innovation in a company. There are four main methods to analyse growth through innovation, which are known as: research and development, human capital, learning by doing and public infrastructure. Some innovation developments and methods can't always be kept by the original company, due to imperfect patenting, technical spillovers, and movement of skilled laborers to other firms (G. Cameron 1996: 3).

Over the course of the last hundred years, there have been many products that have been underestimated in economist's minds, but turned out to be amazing inventions. Innovations such as the television and the mobile phone were incredibly underestimated by economists, but turned out to be huge technological advancements, which people loved. Taking risks in the product market is what needs to be done in order to turn a profit. The television for example was claimed, back in the 1930s, to be a "flop" once it was released (lange, 2007:6) Economists believed that American families would not have enough time for television, but would instead listen to the radio more often. They could not have been more wrong. The mobile phone, back in the 1990s was also highly underestimated as well because economists believed that individuals would be using their home phones more than a mobile phone. In today's world, some people cannot even go through their normal day without their mobile phone. The bottom line is that innovation and risk taking will inspire a large amount of economic growth.

4. Empirical Analysis

4.1. Purpose of the Study and Research Hypothesis

Nowadays there is a consensus that technological progress is the engine of economic growth, productivity gains and rising long-term living standards. Together, these elements lead us to wonder about the relationship between economy and innovation, with a view both theoretical and empirical. The purpose of this study is to show that innovation is a key factor in the economic growth of emerging markets and the role of investments from developed countries on their growths. The following hypotheses are developed to better achieve the set objectives.

> ➢ Innovation is one of the main reasons for the strong economic growth of emerging markets during last decades.
> ➢ Innovation have more impact on the economic growth of emerging markets than foreign direct investments.
> ➢ Gross fixed capital formation plays an important role in the emerging economies.

The mentioned and macroeconomic data used in Chapter 2 will allow us to make an empirical approach to the impact of innovation on emerging markets' economic growth with time series.

4.2. Description of Data and Methodology

Sample period uses annual time series data over the period from 1970 to 2014 of 13 emerging markets. The data consists of patent applications, research and development expenditure as a percentage of GDP, Gross domestic product per capita, percentage of population with secondary education, gross fixed capital formation as a percentage of GDP, foreign direct investment net inflows as a percentage of GDP. NBER Patent Citations Database is used to obtain the Patent data; the remaining macroeconomic variables are obtained from the World Bank.

The R&D based growth model of Romer will be used to build the empirical model. The analyses in this study are carried out in three phases. Unit root, Engle and Granger co-integration, Vector Error Correction (VECM) Model and vector autoregressive tests will be use to check out the relationship between innovation and economic growth.

4.3. Rankings of Countries by R&D, GDP, Patents and Investment

In this section some stylized facts about the main variables of the Romer's model will be presented, namely, growth, Foreign direct invest, R&D and patent applications. Table two and three present the rankings of the countries in terms of their average levels of investment, R&D, patent applications, and GDP.

Table 1: Rankings of Countries by R&D, GDP, Patents and Investment, 1995–2005

Rank	Foreign direct invest	Growth	Patents	R&D Expenditure
1	Hungry 6,531731	China 9,35	China 34083,45	Russian Federation 1,093968
2	Czech Republic 5,955808	India 6,52	Russian Federation 20953,55	Czech Republic 1,081497
3	China 3,879164	Malaysia 5,32	Brazil 3222,18	Brazil 0,994912
4	Malaysia 3,572587	Turkey 4,73	India 2638,455	China 0,918416
5	Poland 3,442116	Poland 4,44	Poland 2335,727	Hungary 0,808773
6	Thailand 3,35237	Thailand 3,6	Hungry 803,1818	South Africa 0,747264
7	Colombia 2,970024	Hungary 3,46	South Africa 732,5455	India 0,714772
8	Mexico 2,852604	South Africa 3.29	Czech Republic 592,9091	Poland 0,613874
9	Brazil 2,827132	Russian Federation 3,22	Thailand 548,4545	Turkey 0,491718
10	South Africa 1,51018	Czech Republic 3,17	Mexico 477,6364	Malaysia 0,467156
11	Russian Federation 1,32062	Colombia 2,6921	Turkey 379,2727	Mexico 0,344395
12	India 0,765436	Brazil 2,6915	Malaysia 288,2727	Thailand 0,221011
13	Turkey 0,718115	Mexico 2,54	Colombia 89,81818	Colombia 0,179433

Source: Different Sources of Mentioned Countries Official Web Sites

As seen from Table-1, Russian Federation, Brazil, China, Hungary, India and South Africa are in the highest rank, while Colombia, Thailand, Mexico and Turkey are in the lowest rank of patents and R&D expenditure. In addition, out of seven countries having both higher levels of Patents and R&D expenditure, four of them also have higher levels of growth and patent applications.

As seen from Table-2, out of seven countries having higher levels of patent applications, five of them also have higher levels of growth, which suggests a positive correlation among these variables. China, India, Colombia, Malaysia, Turkey and Poland are in the highest rank, while Hungary, Czech Republic, Mexico, South Africa and Russian Federation are in the lowest rank of growth. regarding the foreign direct investments Hungry, Colombia, Czech Republic and China are in the highest rank of countries having the highest level of foreign direct investments, while South Africa, India, Turkey, Mexico and Brazil are in the lowest rank of this variable.

Table 2: Rankings of Countries by R&D, GDP, Patents and Investment, 2006-2014

Rank	Foreign direct invest	Growth	Patents	R&D Expenditure
1	Hungry 13,679	China 10,16	China 331024,6	China 1,670551
2	Colombia 3,8928	India 7,53	Russian Federation 27672,75	Czech Republic 1,458871
3	Czech Republic 3,7925	Colombia 4,79	India 7948,125	Hungry 1,140006
4	China 3,6699	Malaysia 4,76	Brazil 4422,625	Russian Federation 1,120578
5	Malaysia 3,5521	Turkey 3,95	Poland 3208,125	Brazil 1,110171
6	Russian Federation 3,3940	Poland 3,93	Turkey 2943,625	Malaysia 0,94464
7	Poland 3.3765	Brazil 3,84	Thailand 1080,625	South Africa 0,815389
8	Thailand 3,064776	Thailand 3,73	Malaysia 984,125	India 0,811222
9	Brazil 2,688	Russian Federation 3,45	Mexico 903,73	Turkey 0,805806
10	Mexico 2,4455	South Africa 2,91	Czech Republic 795	Poland 0,702181
11	Turkey 2,2316	Mexico 2,41	South Africa 773,25	Mexico 0,423379
12	India 2,089093	Czech Republic 1,63	Hungry 686,5	Thailand 0,275323
13	South Africa 1,73028	Hungary 0,15	Colombia 163	Colombia 0,207578

4.4. Estimation of Production Function

This section is devoted to the analysis of the relationship between per capita GDP and innovation (technological change). Equation (14) in Section I, will be the basis of the regression analysis

$$Y(H_Y, L, x) = (H_Y A)^\alpha (LA)^\beta (K)^{1-\alpha-\beta} \eta^{\alpha+\beta-1} \qquad (15)$$

H, L, A and Y are human capital, labour, knowledge stock of economy and total output, respectively. K includes both new products and physical investment. Production function shows constant returns to scale in its inputs K, L and H. Increasing returns to scale arises because of the knowledge stock that enters the production function through new products and spillovers from R&D sectors. Deriving the above regression equation, the variables are normalized by labour series; composite investment, K, decomposed into physical investment and new products and the equation is log linearized. The above model can be rewritten in the following way.

$$y_t = \propto h_t + \gamma i_t + (1 - \propto - \gamma) x_t + \varepsilon_t \qquad (15')$$

yt, xt, and *it* are per labour output, new products and investment, respectively; h_t is the human capital as share of population. The new product, investment and human capital are measured by the stock of patent applications, gross fixed investment and the secondary school enrolments as share of the population, respectively. In addition to the variables in the equation above, R&D expenditure variables and foreign direct investment are included in the model as well (IMF, 2004). Data include 13 emerging markets for the period 1970–2014.

4.4.1. Unit Root Test

It is essential to carry out a unit root test before any estimation. This makes it possible to know whether the processes generated are stationary and, therefore, the obtained estimations are not spurious and have economic sense. Philips-Perron (PP) and the augmented Dickey-Fuller (ADF) are the most applied tests. In both, the null hypothesis assumes that series are generated by integrated processes whereas the alternative establishes the series are stationary. The difference between these two methods is in the way the serial correlation problem is dealt. Whereas ADF introduces additional lags as regressors of the variable that is susceptible to present a certain autocorrelation degree, PP makes a non-parametric correction of the t-test statistic, i.e., PP test uses Newey–West (1987) standard errors to account for serial correlation (Celia Melguizo Cháfer 2015). The Augmented Dickey-Fuller (ADF) has been chosen to check the stationarity of variables.

Table 3: Unit Root Test Result

	GDP	EDUC	FDI	GFCF	PATENT	RED	EXPR
Colombia	-4,611		-4,937	-5,717*	-6,021	-5.622*	-5,654
	(0,000)		(0,001)	(0,000)	(0,001)	(0,000)	(0.001)
Chili	-5,538	-6,559*	-4,716	-6,603*	-7,474*		-6,453*
	(0,000)	(0,000)	(0,002)	(0,000)	(0,000)	(0,045)	(0,000)
Morocco	-12,358	-4,727*	-4,234	-4,800*	-5,961*		-3,435
	(0,000)	(0,000)	(0,008)	(0,000)	(0,000)	(0,011)	(0,022)
Peru	-5,538	-6,559*	-4,716	-6,603*	-7,474*		-3,452
	(0,000)	(0,000)	(0,002)	(0,000)	(0,000)		(0,037)
Philippine	-3,522	-4,750*	-11,619*	-3,165	-6,775*	-4,895	
	(0,011)	(0,000)	(0,000)	(0,029)	(0,000)	(0,002)	
Brasilia	-5.355*	-4.112	-4.618*	-2.941	-7.017*	-4.202*	-4.752*
	(0.000)	(0.015)	(0.000)	(0.051)	(0,000)	(0.010)	(0.000)
Russian federation	-6.627*	-3.967*	-4.6154*	-2.615*	-3.535*	-4.623*	-10.25*
	(0,000)	(0.009)	(0.001)	(0,011)	(0,016)	(0,002)	(0,000)
India	-3.479*	-3.130*	-5.622*	-4.799*	-5.045*	-3.823*	-6.680*
	(0,017)	(0,005)	(0,000)	(0,001)	(0,002)	(0,015)	(0,000)
China	-3.849	-1.767*	-4.339*	-3.691	-6,026*	-5.117*	-4.964*
	(0,006)	(0,073)	(0,001)	(0,037)	(0,000)	(0,001)	(0,000)
South Africa	-5.176*	-3.153*	-4.359*	-3.400*	-3.848*	-2.929*	-5.445*
	(0,000)	(0,051)	(0,002)	(0,021)	(0,008)	(0.010)	(0,000)
Turkey	-5.484	-9.581*	-4.175*	-4.875*	-3.537*	-5.905*	-4.695*
	(0,000)	(0,000)	(0,003)	(0,000)	(0,018)	(0,000)	(0,001)
Poland	-3.712	-7.130	-5.018*	-5.671	-3.136*	-3.787*	-4.492
	(0,013)	(0,000)	(0,000)	(0,000)	(0,037)	(0,045)	(0,008)
Mexico	-5.360*	-3.204*	-3.372*	-5.136*	-3.940*	-4.168*	-4.065*
	(0,0004)	(0,035)	(0,022)	(0,000)	(0,006)	(0,006)	(0,004)

Note: *P values are in italics and brackets under*
*Show the first difference stationary and
** Show second difference stationary

Table - 3 exhibits the stationarity of variables at different form. According to the ADF test, the series are stationary at first difference in most countries. All variables are stationary at first difference in the case of Brazil, Mexico, India, South Africa and Russia. The stationary is found on the same differencing level of the variables of same country that fulfil the Engle granger requirement, in the others case VAR tests will be use to check out the relationship between innovation and economic growth.

4.4.2. Co-integration Test

The results of augmented Dickey-Fuller (ADF) test emphasize that the variables are integrated at same order, the next step is to check if a long run relationship exists between the variables of interest. The variables are co-integrated if the sequence of residuals from this regression is stationary. If these residuals are non-stationary, it's said that there is no cointegration or no long run equilibrium relationship between the growth gap and patent gap.

Table-4: Engle and Granger cointegration Result

	P-Value of Null Hypothesis (None*)	Decision
Brasilia	0.017	cointegrated
Russian Federation	0,000	Cointegrated
Indıa	0,000	Cointegrated
South Africa	0,000	Cointegrated
Mexico	0,000	Cointegrated

Table - 4 summarizes the results of Co-integration analysis between the variables. Engle and Granger result identifies the existence of long run association, error term of equations are stationary at level, which reflects the evidence of Co-integration. Thus, the presence of Co-integration vector shows the existence of a long run equilibrium association between the variables. Therefore, our annual data (1970-2014) supports the proposition that there exist long run relationship among variables in case of Russia, South Africa, India, Mexico and Brazil.

4.4.3. Error Correction Model

The cointegrating regression only take into account the long-run property of the model, and does not evaluate the short-run dynamics explicitly. Evidently, a good time series modelling should set out both long-run equilibrium and the short-run dynamics simultaneously. For this purpose, an error correction model (ECM) will be developed.

Tablo-5: Error correction model results (long run)

	Coefficient	Prob.	R-squared
Braz	-0.677430	0,0004	0,68
Russ	-0,45398	0,0487	0,74
Ind	-1,852	0,0010	0,83
ZAF	-0,0135	0,9357	0,32
Mex	-0,099332	0,4028	0,38

Table-5 summarizes the results of VECM analysis between dependant and independent variables. In the case of Brazil, Russia and India the coefficients are negative and significant, it means that there is a long run causality between the independent variables and dependent variable. Coefficients are not significant in the case of Mexico and South Africa which means that there is no long run causality between the independent variables and dependent variable (GDP).

Table-6 exhibits the results of short run causality between dependant and independent variables. The results show that in the short run, gross fixed capital formation (GFCF) cause GDP in Russia and South Africa. It can be seen that there is a short run causality running from foreign direct investment (FDI) to GDP only in India. In the short run the patents cause GDP in Russia and India. In all countries expenditure in research and development doesn't cause GDP in short run.

Table-6: Error correction model results (short run)

Null Hypothesis	BRAZ	RUSS	IND	ZAF	MEX
GFCF does not Cause GDP	0.6002	0,0054	0.4847	0.0054	0,6209
FDI does not Cause GDP	0.6774	0,5514	0.0363	0.3564	0,5184
PATENT does not Cause GDP	0.4672	0,0447	0.0016	0.1325	0,9268
RED does not Cause GDP	0,6791	0,8216	0,2224	0,6574	0,9487
RED does not Cause Pat	0,6759	0,5209	0,3525	0,7787	0,3965

Note: The values in the table are the "P-values" of Wald tests

4.4.4. Vector Autoregressive Models

The VAR model is especially use to describe the dynamic behaviour of financial, economic time series and for forecasting. VAR allows to determine the linear inter dependencies among multiple time series.

Table-7: Vector Autoregressive analysis (Wald Test)

Null Hypothesis	Colom	Chile	Moroc	Peru	Philip	Turk	Plnd	Chine
PATENT does not Cause GDP	1,5643 (0,4574)	0,13023 (0,9370)	0,387045 (0,8241)	1,6808 0,4315	4,1868 (0,1233)	1,3774 (0,5022)	45,0301 (0,0000)	12,1692 (0,0013)
FDI does not Cause GDP	2,3924 (0,3023)	0,6968 (0,7058)	0,4456 (0,8003)	3,6476 (0,1614)	1,0839 (0,5816)	4,6211 (0,0992)	2,9994 (0,2232)	1,6289 (0,4429)
GFCF does not Cause GDP	0,80868 (0,6674)	4,1719 (0,1242)	5,5156 (0,0504)	3,3117 (0,1909)	11,8111 (0,0027)	0,4528 (0,7974)	26,7560 (0,0000)	10,4784 (0,0053)
EDUC does not Cause GDP	1,5024 (0,4718)	0,6082 (0,7378)	4,726667 (0,0941)	0,2763 (0,8710)	2,8579 (0,2396)	0,6458 (0,7240)	3,41060 (0,1817)	3,8314 (0,1472)

Note: P values are in brackets under, Chi-square values are in italics

Table-7 exhibits the results of VAR analysis between dependant and independent variables. We can reject null hypothesis only if the P value is less than 5%. The results show that gross fixed capital formation (GFCF) cause GDP in the case of China, Poland, Philippines and Morocco. We can also notice that in all countries foreign direct investment doesn't cause GDP. Patent cause GDP only in the case of China and Poland.

4.5. Estimation Results

Annual data support the proposition that there exist long run relationship among variables in case of Russia, South Africa, India, Mexico and Brazil; there is a long run causality from independent variables to GDP only in the case of Brazil, Russia and India.

Table 6 and 7 show that there is a causality relationship from patent to GDP only ın the case of Russia, India, Poland and china. Except the case of India, the estimation results show that foreign direct investment doesn't cause GDP in all countries. According to these results we can say the foreign direct investments doesn't cause growth in the emerging economies.

These results also show that gross fixed capital formation plays an important role in the growth of emerging economies. There is a causal relationship from gross fixed capital formation (GFCF) to GDP

in the case of china, Poland, Philippines, Morocco, South Africa and Russia which are half the countries surveyed.

CONCLUSION

Innovation continues to affect the world at an unbroken pace and therefore emerging markets are the places where tremendous growth and opportunity reside for the present and future. Although technological innovation is widely viewed as the key to economic growth, there is no consensus on what makes some industries and countries more "innovative" than others, or exactly how innovation develop an economy.

Most people can provide examples of innovative products such as the iPod or PC, but few can clearly define the innovative aspects of these products. Among academics there is a difference of opinion about what "innovation" really means. Innovation is the process of making large and small or radical and incremental changes on products, processes, and services that results in the introduction of something new for the organization that adds value to customers and contributes to the knowledge store of the organization.

The purpose of this study was to check whether innovation is a key factor in the economic growth of emerging markets and what role could play the investments from developed countries on their growths. Our empirical analysis was performed on 13 emerging economies over the period from 1970 to 2014. The analysis was built on Romer's Model of Technological Change (1990). Unit root, Engle and Granger co-integration, Vector Error Correction (VECM) Model and Vector Autoregressive Model was used to check out the relationship between innovation and economic growth.

The result of the performed analysis indicates that only 4 of the 13 countries surveyed confirms the hypothesis that innovation is the engine of growth in the emerging economies. Russia, India, China and Poland are the only countries where the patent has a considerable effect on economic growth. These countries represent approximately 30% of Emerging economies, so we can say that innovation is not the engine of growth in the emerging economies but remains anyway an important factor in the development process of emerging markets.

The foreign direct investments have less effect on the growth of emerging economies than innovations. The results obtained shows that foreign direct investment has a relatively small effect in the emerging economies. These results also show that gross fixed capital formation plays an important role in the growth of these economies. There is a positive and considerable effect of gross fixed capital formation (GFCF) on the growth in China, Poland, Philippines, Morocco, South Africa and Russia which are half the countries surveyed.

The level of innovation in a country can affect economic growth but Strong economic growth cannot be achieved only at a high level of innovation. Strong economic growth has many components and innovation is only one of them. Due to the positive impact on economic growth, innovation should be given importance. Development of education, increase of research and development expenditures, promotion of science are factors that can increase the rate of innovation of a country. For this reason, governments should encourage innovation and ensure that this innovation has a real impact on growth and economic development. In emerging economies, public and private investment have more impact on economic growth than foreign direct investment. Because a significant portion of foreign capital comes to purchase existing facilities and companies (privatizations or private sector sales) rather than new investments. Therefore, it does not create new production capacity and does not contribute to growth. Governments must invest in appropriate economic sectors and encourage entrepreneurs through subsidies. By intervening on interest rates, taxes and customs tariffs governments can act on activities of the entrepreneurs and thus trigger the innovation.

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