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Knowledge-Based Economy as a Foundation for the Economic Development of Countries

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Abstract. *This paper highlights the relationship between knowledge and economic development. The study considers nine countries grouped in three different development models: 1) the Asian model includes Japan, the Republic of Korea, and Singapore; 2) the Anglo-Saxon model includes the United Kingdom, the United States, and Canada and 3) the European model includes Germany, France, and the Netherlands. The data was sourced from the Global Competitiveness Report of the World Economic Forum, the PISA reports, the Academic Ranking of World Universities (ARWU) and the Global Innovation Index of the World Bank. The Asian group ranked highest for innovation as shown through the application of patents; they also obtained the highest scores in the PISA test. The Anglo-Saxon group stood out by having a good institutionalized knowledge system. From the European group, Germany is recognized by its innovation capabilities and the Netherlands by the quality of its higher education.*

Keywords: *knowledge-based economy, economic development, competitiveness, innovation, higher education.*

Introduction

In this research paper, we analyze the relationship between knowledge and the economy of nine countries classified into three different models of economic development. The models are taken from Gregory and Stuart (2014), who point out the existence of four different models of development in the capitalist system:

1. The Anglo-Saxon: The United States, The United Kingdom, Switzerland, New Zealand, Canada and Ireland
2. The Northern Europe: Germany, Norway, Sweden, The Netherlands, France, Finland, Denmark, Belgium, and Austria
3. The Southern Europe: Spain, Portugal, Italy, and Greece
4. The Asian: Korea, Malaysia, China and Singapore.

The Anglo-Saxon model has its historical origins in Great Britain and is based on the ideas of Smith (1776/2008), and the fundamental concepts of classical liberalism that apply for both, individuals and the nations; where the factors of production are fully allocated by the market forces and there is non-interventionism.

The European model is based on ideas developed in Germany and France in the nineteenth century; these countries have less confidence in the invisible hand and allow a greater state intervention in economic affairs. It is mainly based on the Friedrich List doctrine where the state plays a central role in coordinating and promoting industrialization through the development of a "productive power" in the society. These countries pay special attention to the coordination of the different productive sectors and the protection of infant industries (Selwyn, 2014). The state widely intervenes in economic activity; therefore, it gives greater attention to the "common good," that in some ways is opposed to individual rights. In fact, during the first decade of the 21st century, the expenditure of the European governments was between 40% and 50% of the Gross Domestic Product (GDP), which reflects the high interventionism of the state in the economies.

The Asian model is focused on the accumulation of capital, very often with the help of the state. The goal is to reduce the economic gap and achieve a convergence with the high-developed countries in the less time possible. The countries of this group came from a recent industrialization process compared to the other models. They started their economic takeoff process via imitation, through the formation of human capital and industrialization policies to become innovator countries. In their first stage of growth, they showed a low level of income per capita and a wide rural population, so the main tasks in this first phase were the creation of human capital and the promotion of conditions to switch the labor force from the primary to the industrial sector.

From the beginning, the Asian model was based on five factors (Gregory & Stuart, 2014):

1. A fast demographic transition.
2. Macroeconomic reforms that created favorable conditions for investment.
3. Universal education and high investment in human capital.
4. An economy open to international trade.
5. Promotion of direct foreign investment.

Another consideration is the approach of Baumol, Litan, and Schramm (2007), who stated the existence of four categories of capitalism:

1. Capitalism led by the state, where the government directs the actions of the market, often through the establishment and control of state owned corporations.
2. Oligarchic capitalism, where the power and the wealth belong to a small group that is controlled by the state.
3. Corporate capitalism, where large firms carry out the most significant economic activities.
4. Entrepreneurial capitalism, where the small innovative companies and policies that promote innovation play the most important roles.

It is difficult to classify each model in one of the aforementioned categories, but we can make an approximation. The Anglo-Saxon model can be considered to be corporate capitalism with entrepreneurial vision. The European model is state oriented and promotes social innovation. Finally, the Asian model is ruled by the state; they foster an industrialization process focused on innovation and domestic savings.

All of the capitalistic outlooks and models introduce the knowledge variable and the different theoretical approaches and policies that promote development through the adoption of strategies that suit a knowledge-based economy. For example, the Organization for Economic Cooperation and Development (OECD) when developing its project TEP (Technology Economy Programme) recognized knowledge as the core of economic development and stated four main elements that a country should have in order to stand out as a knowledge-based economy (Ásgeirsdóttir, 2006):

1. Good overall economic performance.
2. Promote innovation, new technologies, the formation of human capital and entrepreneurship.
3. Considers globalization in the productive process and the application of knowledge.
4. The emergence and development of new institutions to promote a knowledge-based economy.

The objective of this work is to determine the importance of knowledge in the three models of economic development: Anglo-Saxon, Northern European and Asian. We describe the models and analyze the role that knowledge plays in their economic structure. The data is sourced from four reports that show the performance of the countries considered as knowledge-based economies. These reports are:

1. The Competitiveness Index developed by the World Economic Forum (WEF) since 2005.
2. The results of the test applied by the Programme for International Student Assessment (PISA) developed by the OECD since 2000.
3. The Academic Ranking World Universities (ARWU).
4. The Knowledge Economy Index (KEI) developed by the World Bank.

The first premise of our study is that the countries being studied consider knowledge to be the main factor for their development, although this could be used and assimilated in different ways in each of the models. A second premise is that recently industrialized countries give a greater priority to knowledge in the policies that promote economic development.

The content of this research paper is divided into three sections: First, a theoretical framework that highlights the importance of knowledge and its impact on countries development. Second, Methods and data, which includes an analysis of the main concepts regarding knowledge and innovation. The data includes the rankings in general competitiveness, higher education and innovation published by the World Economic Forum, the number of world class universities that every country has among the best 500 universities in the list of the ARWU, the countries performance

in the PISA test, and the positions that each of the nine countries has in the Knowledge Economy Index (KEI) 2000-2012. Third, a brief analysis of the results, authors considerations and the conclusions.

Theoretical framework

The term “knowledge-based economy” implies radical changes in the stages of production, distribution and consumption within the economy that follows a growth model based on the increase of intangible capital and the expansion of activities highly based on knowledge. In this economy, the investment is mainly directed at the production and the dissemination of knowledge and the promotion of institutions responsible for sustaining and improving human capital (Hadad, 2017; Leovaridis & Popescu, 2015).

Presently, there is a consensus that knowledge is a factor of great economic value and essential for development, therefore the governments try to move toward economic models based on this factor. For that, they require the implementation of policies that promote innovation, industries based on research and development, science, education and training (Rooney, Hearn & Ninan, 2005). A form of entrepreneurial capitalism requires significant incentives to promote innovation (Baumol et al., 2007).

There have been many studies that present a direct correlation between knowledge and economic growth. McMahon (2008) reviews such models and analyzes those proposed by Solow (1957), Lucas (1988), Romer (1990), Mankiw, Romer, and Weil (1992), and Kim and Lau (1996). These growth models have been the foundation of many other studies that link the variables of a knowledge-based economy with economic growth.

Industrial economies use knowledge to add value to the natural resources involved in the production processes. This factor generates value through new ideas and develops innovations as a means to achieve growth. This implies the implementation of new activities related to the production, acquisition, diffusion, and application of knowledge in the productive processes, therefore there is an emergence of companies, institutions, and societies that promote and carry out such activities (Lopez-Leyva, Castillo-Arce, Ledesma-Torres & Rios-Flores, 2014).

At the end of the 1980's, a new model in the organization of research and development activities was developed, and new products with a higher content of knowledge emerged in the market. This new model has the following characteristics:

1. Decentralization of large corporations to smaller enterprises; small and medium enterprises have a greater participation in innovations.
2. Universities started designing diverse components for products.
3. Emergence of alliances between large corporations and small enterprises focused on research.

4. Transformation of the industrial structure with the emergence of capital-venture companies (Augier & Teece, 2007).

This new paradigm where knowledge has a greater participation in the productive activities is known as a knowledge-based economy, although some authors call it "new economy". In 2002, Grant described six characteristics of the "new economy" based on knowledge:

1. In terms of productive factors, knowledge is comparable to what land was in the preindustrial economy and capital in the industrial age.
2. It is an economy based on intangibles rather than on tangibles.
3. Networking.
4. An economy based on digital technologies.
5. An increase of virtual businesses.
6. The "new economy" experiences accelerated changes. The leap from innovation to diffusion is very short.

Slaughter and Rhoades (2004) point out that the "new economy" considers knowledge as a material resource that can be acquired through legal resources and marketed as any product or service. Cohendet and Joly (2002) observe three facts regarding the production of knowledge:

1. An increase of codified knowledge in productive processes.
2. Research plays a new role in organizations, public and private companies.
3. The transformation of the incentive mechanisms for the producers of knowledge.

The works of Foray (2006) are in the same direction.

In the new economy, there is more competition between firms and countries where knowledge is a strategic resource for decision making; in this regard, Bratianu and Bolisani (2015) successfully integrate the processes of knowledge management and strategic management to create the concept of "knowledge strategy" which is referred to the creation of value through the use of knowledge as a strategic resource in decision making.

An essential aspect of this new paradigm is the participation of universities in the production and application of knowledge. This phenomenon has been widely studied and received different interpretations. For example, Etzkowitz, Industry, and Healey (1998) and Bratianu (2013) consider it as a second academic revolution centered on the "triple helix" model, where universities are linked to companies. Slaughter and Leslie (1997) establish the concept of "academic capitalism"; on the other hand, Gibbons et al. (1994) refer to "mode 2 of knowledge production."

As knowledge has become a factor of production, it has been necessary to have tools to measure it, thus a series of indicators have been designed to measure inputs and results. Other indicators measure the participation of the different agents: schools, colleges, universities and private companies (particularly the number of investments they make in knowledge.) Some other indicators measure the participation of the different levels of government.

In the global context, multiple international agencies have been developing benchmarks, standards and indicators to measure different knowledge-related activities. We use some of these measurement instruments in this research (Gault, 2006).

Methods and data

First, we consider three countries for each of the three models mentioned above:

1. Asian model: Japan, the Republic of Korea and Singapore.
2. Anglo-Saxon model: the United States, the United Kingdom, and Canada.
3. Northern European model: Germany, France, and the Netherlands.

We use the competitiveness studies developed by the WEF when analyzing the performance of each model. The WEF says that competitiveness is built on twelve pillars, from which we only considered two for having a greater impact on knowledge-based economies. Pillar number 5 which is referred to higher education and training, and pillar number 12 that evaluates innovation. The rest of the pillars are institutions, infrastructure, macroeconomic environment, health and primary education, goods market efficiency, labor market efficiency, financial market development, technological readiness, market size, and business sophistication. Table 1 shows a ranking of the nine countries considering the concepts of global competitiveness, higher education, and innovation.

In 2016, the WEF evaluated 138 countries and classified them according to their levels of competitiveness; three main stages and two of transition:

1. Stage one: low competitiveness
2. Stage of transition: low-medium competitiveness
3. Stage two: medium competitiveness
4. Stage of transition: medium-high competitiveness
5. Stage three: High competitiveness

In this case, the nine countries are classified in stage three, which means they are highly competitive.

Table 1. Global Competitiveness, Higher Education and Innovation Rankings (2007-2016) (World Economic Forum, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016)

Country	Years and Category	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Avg.
Japan	Competitiveness	8	9	8	6	9	10	9	6	6	8	8
	Higher Education	22	23	23	20	19	21	21	21	21	23	21
	Innovation	4	4	4	4	4	5	5	4	5	8	5

Republic of Korea	Competitiveness	11	12	19	22	24	19	25	26	26	26	21
	Higher Education	6	12	16	15	17	17	19	23	23	25	17
	Innovation	8	9	11	12	14	16	17	17	19	20	14
Singapore	Competitiveness	7	5	3	3	2	2	2	1	2	2	3
	Higher Education	16	8	5	5	4	2	2	2	1	1	5
	Innovation	11	11	8	9	8	8	9	9	9	9	9
United States	Competitiveness	1	1	2	4	5	7	5	3	3	3	3
	Higher Education	5	5	7	9	13	8	7	7	6	8	7
	Innovation	1	1	1	1	5	6	7	5	4	4	3
United Kingdom	Competitiveness	9	12	13	12	10	8	10	9	10	7	10
	Higher Education	15	18	18	18	16	16	17	19	18	20	17
	Innovation	14	15	15	14	13	10	12	12	12	13	13
Canada	Competitiveness	13	10	9	10	12	14	14	15	13	15	12
	Higher Education	13	9	9	8	12	15	16	18	19	19	14
	Innovation	12	13	12	11	11	22	21	22	22	24	17
Germany	Competitiveness	5	7	7	5	6	6	4	5	4	5	5
	Higher Education	20	21	22	19	7	5	3	16	17	16	15
	Innovation	7	8	7	8	7	7	4	6	6	5	6
France	Competitiveness	18	16	16	15	18	21	23	23	22	21	19
	Higher Education	18	16	15	17	20	27	24	28	25	21	21
	Innovation	17	16	18	19	17	17	19	19	18	17	18
The Netherlands	Competitiveness	10	8	10	8	7	5	8	10	5	4	7
	Higher Education	10	11	10	10	8	6	6	3	3	3	7
	Innovation	13	12	13	13	12	9	7	8	8	7	10

From the Asian group, Singapore is the best-ranked country in global competitiveness; they were in 7th place in 2007 and moved up to first place in 2014. For 2015 and 2016 they were in 2nd place. For 2007-2016 they are in third place. They also performed well in higher education, going from 16th place in 2007,

to first place in 2015 and 2016. There is a high correlation (coefficient=0.96) between higher education and competitiveness. In comparison, they didn't do as well in the innovation index; being ranked in 9th place for the period 2007-2016.

Regarding the indicator, for global competitiveness, Japan had stood out with an 8th place rank in 2016, and 5th place in innovation, although there is not a strong correlation between these two variables. With respect to higher education, they're in 21st place.

For the 2007-2016, the Republic of Korea has been losing competitiveness in the three areas. They are placed 21st in global competitiveness and 17th for higher education. Even worse, if we take into account the last year of our study, that is 2016, the country was ranked 26th and 25th respectively. The loss of competitiveness in higher education has happened despite the fact that the country has the best indicator of education coverage in the international context.

From the Anglo-Saxon model, the most competitive country is the United States. It is globally ranked in 3rd place for the period 2007-2016, although in 2007 and 2008 it was in first place. Its best variable is innovation, which is also in 3rd place. Innovation has a higher correlation to global competitiveness than the other variables.

The United Kingdom holds 10th place in competitiveness for the period. From 2015 to 20016 it went from a 10th to a 7th place. In higher education, it's in 17th place on average, although just for the year of 2016 it was in 20th place, which means a loss of competitiveness. Regarding innovation, it is placed in 13th, showing a steady performance in the previous years of the period.

Canada has lost competitiveness in the three indicators. For example, regarding global competitiveness, the country was ranked in 9th place in 2009, but it went down to 15th place by 2016. In higher education, it went from place 9th to 19th from 2009 to 2016. And, in the category of innovation, it went from place 12th to 24th in the same period.

From the European model, Germany is the most competitive country in 5th place. Its most significant variable is innovation in 6th place, although they are placed in 15th concerning higher education. France's numbers have shown a steady behavior and all of them are around the 20th place; the indicators have a high correlation among them. On average, the global competitiveness of the Netherlands is placed in 7th and has a positive trend. Its best performance is in higher education, ranking in 3rd place for three consecutive years (2014-2016).

The nine countries are among the most competitive in the world; they are in stage three with other 28 countries according to the WEF. Singapore and the United States have the highest rankings (3rd place in global competitiveness for the period of 2007-2016), while the Republic of Korea is in the bottom of the group in 20th place.

Table 2. Number of World Class Universities that every country has among the best 500 universities of the Academic Ranking World Universities (ARWU)

Countries	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Group 1										
Japan	33	31	31	25	23	21	20	19	18	16
Rep. of Korea	8	8	9	10	11	10	11	10	12	11
Singapore	2	2	2	2	2	2	2	2	2	2
Total	43	41	42	37	36	33	33	31	32	29
Group 2										
United States	166	159	152	154	151	150	149	146	146	137
United Kingdom	42	42	40	38	37	38	37	38	37	37
Canada	22	21	22	23	22	22	23	21	20	19
Total	230	222	214	215	210	210	209	205	203	193
Group 3										
Germany	41	40	40	39	39	37	38	39	39	38
France	23	23	23	22	21	20	20	21	22	22
The Netherlands	12	12	12	12	13	13	12	13	12	12
Total	76	75	75	73	73	70	70	73	73	72

The Shanghai Jiao Tong University first published the Academic Ranking of World Universities in 2003. More than 1200 universities are ranked by ARWU every year, but only the best 500 are published. ARWU uses six objective indicators to rank world universities:

1. Number of alumni winning Nobel Prizes and Fields Medals.
2. Number of professors winning Nobel Prizes and Fields Medals.
3. Number of highly cited researchers selected by Thomson Reuters.
4. Number of articles published in journals of Nature and Science.

5. Number of articles indexed in Science Citation Index - Expanded and Social Sciences Citation Index.
6. The per capita academic performance of a university.

From the Asian group, Singapore only has had only 2 universities listed since 2007. The Republic of Korea shows a slight increasing number of universities listed in the ranking (8 in 2007, 11 in 2016). But, Japan has shown a decrease in the number of universities; in 2007 there were 33 universities in the list, while in 2016 the number went down to 16.

The Anglo-Saxon group has the most universities on the list (193 in 2016); although, their participation is declining. The number of American institutions considered world-class universities went from 166 to 137 between 2007 and 2016.

The European group has shown more stability (76 in 2007, 72 in 2016). The only country that showed a slight decrease was Germany.

In 2007, 69.8% of the world-class universities were from these nine countries. For 2016, this percentage went down to 58.8%, explained by the increasing participation of China that went from having 25 universities in 2007 up to 54 in 2016. These percentages show the high concentration of the production of knowledge.

Table 3. PISA scores for 2012 and 2015 (OECD, 2013, 2016)

Subjects		Mathematics		Reading		Science		Mean	
Years		2012	2015	2012	2015	2012	2015	2012	2015
Asian group	Japan	536	532	538	516	547	538	540	527
	Korea Rep.	554	524	536	517	538	516	543	519
	Singapore	573	564	542	535	551	556	555	554
	Mean	554	540	539	523	545	537	546	533
Anglo-Saxon group	United States	481	470	498	497	497	496	492	488
	United Kingdom	494	492	499	498	514	509	502	500
	Canada	518	516	523	527	525	528	522	524
	Mean	498	497	507	507	512	511	505	505
European	Germany	514	506	508	509	524	509	515	508
	France	495	493	505	499	499	495	500	496

group	The Netherlands	523	512	511	503	522	509	518	508
	Mean	511	504	508	504	515	504	511	504

PISA evaluations facilitated by the OECD started in 2000. Since then, the survey is applied every three years to assess the performance of fifteen-year-old students in three disciplinary fields: mathematics, reading comprehension, and science. In 2012, the test was focused on assessing mathematics skills and it was administered in 64 countries. In 2015, the test was focused on science and it was administered in 70 countries. Table 3 shows the scores obtained by the nine countries.

In 2012, Singapore received the highest scores in all three subjects; the country obtained 573 points in mathematics, and it was placed in 2nd out of 64 countries (only surpassed by Shanghai, China with 613 points); in reading and science they ranked 3rd place with 542 and 551 points respectively.

The United States obtained the lowest scores in all three subjects (481 points in math, 498 in reading, and 497 in science). It should be noted that the United States was the only country that performed under the OECD score average in the subject of mathematics, which is 494.

On average, the Asian group was in first place with 546 points, the European group in second with 511, and the Anglo-Saxon group in third with 505 points.

By 2015, Singapore achieved the highest scores in all three subjects, 564 points in math, 535 in reading and 556 in science. The Asian group obtained the highest scores in the three subjects, 540 points in mathematics, 523 in reading and 537 in science. On average, the Asian group was in first place with 533 points, the Anglo-Saxon in second with 505 points and the European in third with 504. The changes in the ranking were the result of Canada's higher scores, and slightly worse performance of the countries from the European group.

Table 4. Knowledge Economy Index (2000-2012)

	Countries	2000	2012	Change
Asian group	Japan	17	22	-5
	Republic of Korea	24	29	-5
	Singapore	20	23	-3
Anglo-Saxon group	United States	4	12	-8
	United Kingdom	12	14	-2
	Canada	10	7	3

European group	Germany	15	8	7
	France	21	24	-3
	The Netherlands	2	4	-2

The KEI measures the capacity of a country to generate, adopt and disseminate technology. In 2012, the World Bank assessed 146 countries. The index is built upon 109 indicators that are classified in 4 pillars:

1. Economic and Institutional Regime
2. Education
3. Innovation
4. Information and Communication Infrastructure.

Table 4 shows a comparison of the rankings of the nine countries for 2000 and 2012. The ranking goes from 1 to 146 (from the most to the less competitive). The table shows that the Netherlands is the most competitive from the group of nine, although considering all the countries it ranked in 4th place and also has lost 2 places since 2000. The Republic of Korea has the lowest KEI of the group; globally, it is in 29th place and has gone down 5 places since 2000. The United States has the worst performance of the group; from being in 4th place in 2000, it fell to 12th place in 2012.

Analysis and discussion

We first present our conclusions about the Asian group, then the Anglo-Saxon group and finally the European group.

The Asian group

The countries of this group advocate for policies that promote the formation of human capital, where two tendencies can be observed: Japan promotes innovation and training, while Singapore aims for policies that improve higher education and research; precisely, one of the five policies that support this model is called "Education for all."

From the WEF report, Japan's scores are steady considering the three variables (global competitiveness, innovation and higher education), although its highest rank is in the area of innovation (4th place). The most important indicators within the higher education variable are continuing education and job training. For innovation, the most significant indicators are patent applications by the industry, the quality of scientific research institutions and the availability of scientists and engineers. Korea's ranks for the three variables have declined. Its greatest loss is in higher education, since in 2007 it was in 6th place and by 2015 it was in 16th. Even so, their higher education policies aimed to increase coverage. In regards to innovation, their concern is the patent applications. On the other hand, Singapore has moved up in the rankings; its most significant improvement is in higher

education, since in 2007 it was placed in 16th and by 2015 it moved up to the first place, which was also held in 2016. Singapore's global competitiveness acquired high significance, the country has moved from place 7th in 2007 to first place in 2014 and second place in 2015 and 2016. The country has been focused on improving the quality of its universities and has become number one in teaching mathematics and science; they also thrive on the use of new technologies and Internet access in the universities.

The results from the PISA 2016 report validate Singapore's education good performance; this country ranks in first place in the three subjects: 564 in mathematics, 535 in reading comprehension and 556 in science. This group had the best scores in PISA 2015; it was 29 points ahead of the European group, and 28 points ahead from the Anglo-Saxon group. Their strength and the best scores are in the subject of mathematics. These results are consistent with the index developed by Hanushek and Woessmann (2015), that aimed to measure the skills acquired by 15-year-old students; such index was built for 77 countries from 1964 to 2003; the Asian group scored 5,326 points, followed by the European group with 5,037 points and the Anglo-Saxon group with 4,963 points. The country that scored the highest number was the Republic of Korea with 5,338 points, while the United States was at last with a score of 4,903 points.

Moreover, the Asian model world-class universities listed on ARWU are related to the industry sector, compared to other universities from the other two groups (Lopez-Leyva, 2013). Regarding the KEI, the three countries of the Asian group lost places during the period of 2000-2012. Japan and Korea lost 5 places each, while Singapore lost 3.

Analyzing the type of education institutions, we found that in Japan, the higher education institutions are mostly private, 542 out of 709 universities (76.55%). Just considering colleges and training schools, from a total of 3,443 institutions, 3,228 were private, that is almost 94% (Yonezawa, 2006). Since most of the universities ranked in the ARWU are public, a decreasing investment in these institutions has been reflected in a decreasing number of universities in the ARWU rankings (Altbach, 2016).

Regarding innovation, the Ministry of International Commerce and Industry of Japan fostered an industrialization process that has been intensive in the use of capital and technology, for that it was necessary to implement innovation processes (Vietor, 2007).

Korea's higher education system is mostly private (75%), although this sector received public funds they are not significant. Students of private universities pay about 80% of their total expenses, while students of public universities pay about 50%. It is also important to note that Korea is number one in education coverage. The education system has seven different types of institutions, although the most important are the universities and the junior colleges (Park, 2006). Higher education is conceived in two sectors: Institutions that are mainly oriented to teaching which are under the authority of the Ministry of Education and secondly,

institutions that are oriented to researching which are under the authority of the Ministry of Science and Technology. Regarding innovation, Korea implemented policies that facilitate the learning of technology and thus strengthen their international competitiveness. In 1986, the country made some changes to their regulations, switching from policies that privileged strategic sectors to policies that support innovation through the promotion of R&D activities. Besides, the country has always tried to disseminate instead of just imitating the technology that has been acquired through imports (Kim, 1997).

Singapore's education system is more oriented to research; its two public universities are listed on the Academic Ranking World Universities. The National University of Singapore is in 113th place and the Nanyang Technological University is in 161st place. This country has become, in a short period of time, an economy of innovation. It also had a growth rate that surpassed 8% annually from 1960 to 2000. This growth has been supported by a service sector that is technology oriented and the strength of their national innovation system, which protects copyrights the creation and trade of knowledge (Wong, 2007).

The Anglo-Saxon group

The countries of this group are consolidated economies that had an early industrialization process. England is considered the cradle of the industrial revolution with a history that goes back to the "glorious" revolution of 1688. In the case of the United States, the process of industrialization began after its independence in 1776.

First, the United States is known for its strength in innovation. It was globally ranked in 2nd place in innovation capacity, thanks to the availability of scientists and engineers, their investment in R&D companies and the collaboration between universities and the industry. Regarding higher education and training, it was ranked in seventh place. Their coverage in higher education is good and the management processes within the universities are excellent. Some of their strengths are the institutionalization of research and the promotion of the so called third mission (communities engagement). However, the country has lost competitiveness, from being ranked in first place in 2007; it fell to seventh place in 2012, but recovered in 2014 when it was ranked in third place.

The United Kingdom is in 10th place in global competitiveness, 17th in higher education and 13th in innovation. A good management and their capacity to do local research recognize the universities of this country. Their Research Centers are known for their quality and the close collaboration between the university and the industry.

Canada is in 12th place regarding global competitiveness, in 13th for higher education, and 16th in innovation. Its universities are recognized for their quality and the availability of research support services. One of the factors that positively impact innovation is the availability of scientists and engineers.

The results of the 2012 PISA test showed that the Anglo-Saxon group obtained the lowest scores compared to the other two groups of countries; 505 points in average, 498 in mathematics, 507 in reading, and 512 in science. It should be noted that there is a significant gap of 56 points between this group and the Asian group. The United States average score is the lowest of the group with 492 points, while Canada obtained the highest score with 522. By 2015, this group surpassed the average score of the European group by one point, but only because the scores obtained by the latter decreased. Also, Canada showed an improvement in the global average score.

Regarding the KEI, the United States lost 8 places from 2000 to 2012, with the worst performance of the group; the United Kingdom lost 2 places, while Canada gained three places.

The higher education system in the United States is very diverse; there are community colleges that offer 2 year programs, which approximately 53% are public, 35% are private and 12% are non-profit. There is a system of public universities with four-year careers (25% of the total); there are private universities with important research groups; and there are also a number of private institutions that offer certifications and short careers with specializations. Universities, both public and private, are closely linked to knowledge production activities through research (Eckel & King, 2006).

The education system in Canada is provincial, since the provinces provide the funds for the higher education institutions. In 2006, there were 190 public universities and 300 community colleges. There are also private colleges (Jones, 2006).

The United Kingdom education system consists of 14 universities, plus seven higher education institutions of another type in Scotland. Wales has 13 institutions, while England in 2006 had 131 institutions, of which 77 were universities, 14 general colleges and 40 specialized colleges (Shattock, 2006).

In 2016, this group had 193 universities listed on the ARWU rankings, which represents 38.6% of the total world-class universities. Lopez-Leyva (2013) states that universities in North America are teaching oriented, and they have better institutional and infrastructure conditions.

European group

Germany is the most competitive country of this group; according to the WEF rankings in global competitiveness, the country is in 5th place. They also showed good numbers in innovation scores, being placed in 6th. However, in terms of higher education, they are in 14th place and their performance got worse in 2015 when they were in 17th place. Germany is recognized for its policies that aim to improve the quality of the higher education system, research services and the formation of training-job groups. The country is also recognized for its innovation capacity, the investment that enterprises do in research and development and the application of patents.

Netherlands is in place 8th in global competitiveness, 7th in higher education and 11th in innovation. Although lower presently, their innovation ranks improved to 8th place in 2014 and 2015. This country is recognized for the quality of its universities, higher education coverage, and their local capacity to do research. Regarding innovation, they stand out for the quality of their research institutes and the collaboration between universities and the productive sector.

In 2012, according to the PISA report, this group of countries was in 2nd place with a score of 511 points in average; 511 points in mathematics, 508 in reading and, 515 in science. Germany was in first place in math and science, while the Netherlands was in first place in reading. In 2015, this group fell to 3rd place with 504 points in average. The three countries obtained lower scores, although the worst performance was seen in science.

This group has 72 world-class universities, 14.4% of the total. The report shows that their authors are highly cited and their academic production has an impact in the world (Lopez-Leyva, 2013).

Regarding the KEI, Germany has shown improvement, from being in 15th place in 2000, it moved up to place 8th in 2012. Meanwhile, France lost three places and the Netherlands lost two; although, the latter is in 4th place globally, which is the best place among the nine countries. The German education system is considered the foundation for the emergence of research universities. They promoted what we know as the first academic revolution in the universities, by considering research a substantial activity in higher education institutions. The German universities have been involved in research activities since the second half of the 21st century. Their education system is based on the Humboldtian philosophy introduced in the University of Berlin in 1810. Its main success was the revolution in the chemistry field with the discovery of ammonia. Their education system is highly controlled by the state. More than half of their universities are focused on applied sciences, about 27% are universities in general fields and the rest are tech schools and others aim to form teachers (Kehm, 2006).

The higher education system in France is also essentially public, since 80% of the students are enrolled in public universities, while about 50% of the big *ecoles* are also public. That means that 90% of the students in the country are enrolled in a public university (Musselin, 2006).

Finally, we briefly describe the higher education system of The Netherlands, which in 2015 had 16 public universities from which, nine offered all the disciplines, three offered engineering careers, one more offers agriculture, and another one life sciences, the University of the Nation and an online university.

Germany has 12 institutions in the world-class universities and also has 50 institutions dedicated to professional training, whose main objective is to give professional training to people for work (De Weert, 2006).

This research helps to understand the importance of knowledge in three different models of development followed by the most successful countries in the global economy. These countries have designed and implemented strategies that could be used in developing countries. We are not suggesting they should implement the same policies, but they could observe the behavior and performance of developed countries and define their own strategies considering their regional and local conditions.

Conclusions

The nine countries highly participate in activities related to the knowledge economy; their great performance in some of the indicators reflects and supports such statement. The state plays a central role, fostering strategies toward the strengthen of knowledge-based economies, through the promotion of quality in higher education and the implementation of policies for innovation. A good example is Japan that went from being an imitator of technology, to successfully becoming an innovative economy.

The greatest concern of the countries participating in the knowledge economy has led to a growing interest to measure the components of this factor and their impact in development. Such measurements are relatively new; some started to be developed in the 21st century. For example, the World Economic Forum (WEF) introduced the Global Competitiveness Index in 2005, the PISA test was introduced in 2000, and the KEI became popular in the same year. Other mechanisms of assessment are the university rankings, which, even though it might be an old practice, they have only started being widely used since 2000. The high interest in measuring knowledge reflects the importance of this factor and its impact on economic development.

The nine countries are in stage three of development, that means they are part of the most competitive nations according to the WEF, but they use knowledge differently and even though there is a tendency to design development models that group countries together, internally the countries show differences regarding the application of this factor. For example, considering the Asian model, Japan has put more emphasis on innovation based on learning from companies and technological institutions that train for work. They are also recognized for their effectiveness in the application of patents. On the other hand, Singapore promotes knowledge through scientific research, hence the development of research universities that has led to the creation of "biopolis." Such concern has led the countries of this group to establish agreements and promote a good relationship between the universities and the industry. Moreover, this group is in first place in the matter of skills acquired in school (Hanushek & Woessmann, 2015).

For the countries of the Anglo-Saxon group, the influence of codified knowledge in the industry was very little, the reason why the universities had to make a great transformation to respond to the requirements of the industry. The United States, although slightly has lost competitiveness, its strength lies in innovation through

large firms; regarding education, the country has lost competitiveness, according to the PISA test and the KEI. It should be noted that all three countries have great strength in the institutionalization of research and excellent infrastructure for teaching in their universities.

From the European group, Germany has improved its competitiveness through innovation. Meanwhile, The Netherlands has considerably improved in higher education. This group of countries has had a great performance in what is called the second industrial revolution, especially in the chemical industry. Their higher education institutions are strong in research, a fact that can be verified by the global influence that their researchers have through their publications.

Deeper and more detailed research on this matter should include an analysis of the competitiveness indicators for each of the twelve pillars. For this study, the component of higher education includes eight indicators and innovation includes seven. Likewise, a wider study of the PISA test components, a revision of the indicators of the university rankings and the KEI index should be done.

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