International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:14, No:11, 2020

The Importance of Patenting and Technology Exports as Indicators of Economic Development

Hugo Rodríguez

***Abstract*—**The patenting of inventions is the result of an organized effort to achieve technological improvement and its consequent positive impact on the population's standard of living. Technology exports, either of high-tech goods or of Information and Communication Technology (ICT) services, represent the level of acceptance that world markets have of that technology acquired or developed by a country, either in public or private settings. A quantitative measure of the above variables is expected to have a positive and relevant impact on the level of economic development of the countries, measured on this first occasion through their level of Gross Domestic Product (GDP). And in that sense, it not only explains the performance of an economy but the difference between nations. We present an econometric model where we seek to explain the difference between the GDP levels of 178 countries through their different performance in the outputs of the technological production process. We take the variables of Patenting, ICT Exports and High Technology Exports as results of the innovation process. This model achieves an explanatory power for four annual cuts (2000, 2005, 2010 and 2015) equivalent to an adjusted r2 of 0.91, 0.87, 0.91 and 0.96, respectively.

***Keywords*—**Development, exports, patents, technology.

I. Introduction

PATENTS are considered as indirect measures of technological innovation [15]. Although there are other more direct measures such as the number of new product ideas [16] and the percentage of ideas with marketing potential [15], these other indicator options are not objective or measurable in a standard or comparable way over the years, countries and industries [13].

At the beginning of the 90's, 541,404 patents had already been applied for globally, and by 2018 that figure was 2,294,847 patents. The strategic and competitive importance that research and development has both at the market and at the state level is evident. Simultaneously with the rest of the world, China exhibits an exponential growth by increasing its patent production from 5,832 to 1,393,815 for the same years [17].

Being the items of technological and pharmaceutical companies that contribute the most patents to the account and therefore, those who lead the technological development of the countries are additionally the companies that generate the most increases in exports. From this connection, it is essential to incorporate the exports of these technology companies into the study, whether in the category of High Technology Goods or in the Export of ICT Services.

Hugo Rodríguez works at the Fulgor Foundation of the Province of Córdoba, Argentina (e-mail: lic.hugorodriguez.ft@gmail.com).

Technological exports must be incorporated as part of the output of the innovation process that in a previous period has patents as its protagonist. Additionally, technological innovation causes a positive impact at the level of comparative advantages at the level of international trade. For this reason, technological innovation must also reflect an increase in exports of goods and services that use the same innovation. Specifically, exports of high technology and ICT services [2]. Obviously, in those countries where patent property rights are more consolidated, companies have more incentives to invest and it turns out that the benefits through international trade are consequently more important [8].

The final impact of technological innovation, either from its early stages, such as invention patents, as well as to its final stages, such as the increase in technological exports through increased competitive advantages, will generate an increase in GDP volume and therefore the standard of living of the population. This reason, for example, justifies indirect promotion policies (subsidies) or direct ones (national research institutes dedicated to technology transfer).

We understand that the combination of patents with measures of exports of ICT services and high-tech goods come very close to the concept of innovation process interpreted as invention plus export [1]. This idea includes the implementation of significant news or improvements in products, processes or services and the commercialization of innovation [11].

In this work, we are going to explore the quantitative, specifically econometric relationship of the three variables linked to technological innovation with the GDP. The objective is mainly to explain the differences among nations and not the year-on-year performance for each country. In this way, we consider that the promotion of innovation has to occupy a strategic space in the planning of public policies, especially in developing countries.

II. Review of Related Studies

The Ricardian model of comparative advantages, under the assumption of equal productivity of the labor factor, predicts the specialization of the national economy in the production of those goods for which there is greater relative abundance. As in the improved version proposed in the Heckscher-Ohlin model where specialization, although not complete (due to the assumption of decreasing marginal factor returns), will occur in the sector where the provision of the most technologically intensive factor is most abundant [18]. In any of these schemes and under the assumption of keeping the factor endowment of national economies constant, an increase in the technology given by innovation will produce an increase in the production possibilities frontier, increasing the possibility of domestic consumption as well as the possibility of exporting the surplus. Along these lines, technological innovation must be explicitly seen as an increase in export capacity by generating greater factor productivity. In this research, the differential impacts in the ICT services export sector and in the export of high-tech goods can be analyzed. Additionally, in the academic field [19] technological innovation can be visualized in publications and patents. Being more precise in the conception of innovation that we use referring to the invention plus exploitation of the invention [1], we must concentrate mainly on patenting since it shows more transfer to the industrial area than the set of academic publications of papers in general.

The generation of patents is a scientific and industrial activity that has the potential to generate large positive externalities in the national economy. The fact of publishing a patent gives credibility to the research group to obtain financing when starting companies that use these technologies. Already incorporated companies that manage to be at the technological forefront of their field not only increase their productivity by innovating; rather, they create new products, services and generate at the company level the productive capacity that they transfer to suppliers, customers and the same employees who can start an independent company with their new skills. Thus, it is consistent to include a direct estimate of patenting in the GDP since we would be visualizing a proxy measure of the externality that it generates throughout the economy. The combination of exports of high technology goods, ICT services and patenting thus results in diverse manifestations of the innovation process. And innovation generates economic development, although depending on the specialization that each country it presents in the production of goods and services, that impact will be different, and then we will study those characteristics.

We will follow the proposal by Dziallasa and Blinda [1] when studying innovation as a process. Insofar as they define it as “invention plus exploitation” used by Dewangan and Godse [11] and others. This definition includes the implementation of significant novelties or improvements in products, processes or services [14] and the commercialization of the innovation.

Unlike Cooper and Kleinschmidt [16], we will not use some direct indicators such as the number of new product ideas and the percentage of ideas with commercialization potential as proposed by Dewangan and Godse [11], since globally for the countries that we analyze are not measurable in a standard way and are comparable throughout the years, countries and industries (as recommended by Andrew et al. [5] and Edison et al. [12]).

Akis [4] points out that both Research and Development activities and Patenting have become fundamental factors in the power of competitiveness. It defines competitiveness as the rivalry between economic units to achieve the same and scarce objective. In macroeconomic terms, it understands the power of competitiveness as the export volume of a country. We agreed with this concept, which is why this variable was used in this article, although not the expense in research and development, which we take as an input in the innovation process. Several authors [5] [6] consider innovation as a central research topic both from the point of view of public policies aimed at promoting economic development and from the point of view of private companies in terms of gaining competitive advantages. Thus, Andrew et al. [5] postulate that a group of countries led by China, India, Brazil (RDEs Rapid Growth Economies) are generating a new world order in terms of innovation. In their 2010 Boston Consulting Group report, they point out that 84% of their companies consider innovation important or extremely important. For their part, Artz et al. [6] mention that due to increasing levels of competition and decreasing product life cycles, it has become essential to maintain levels of competitive advantage.

Although we do not use Belenzon's proposal here [7], we consider it very interesting for future extensions when proposing a relationship between the market value of a firm and the citations it receives for patents, when studying the problem of rapid obsolescence of new discoveries. Opposite to Cavdar [9], who is interested in including a wide set of indicators as proxies to measure technological development, including spending on research and development, high-tech exports, long-term unemployment, patent application, health spending, Gini per capita, percentage of women employed in non-agricultural jobs, and sales volume, in this work only the ones which are linked indisputably to the innovation process and at the same time are parsimonious are taken into consideration.

Unlike Chen [2] who is one of the main authors who only uses patenting as a proxy variable for innovation, we incorporate a vision of market acceptance by adding exports of technological goods and services. Thus, an econometric model will show us to what extent each component contributes more to national economic development.

Dang [10] develops an investigation comparing patenting in China with data from an industry survey and confirms that patenting statistics are good estimators of technological development in China.

Unlike Frietsch's work [3] where the link between patenting and the value of exports is studied, we consider both as outputs of the innovation process and do not take into account the causality of one variable over the other, but rather of both on economic development.

III. Theoretical Framework

We have developed a causal model where we make Relative Economic Development (DER) depend on the country's innovative performance (PIT).

$$DER = f(PIT) \tag{1}$$

$$GDP_{i,t=x} = \beta_0 + \beta_1 * PAT_{i,t=x} + \beta_2 * ESTIC_{i,t=x} + \beta_3 * EAT_{i,t=x} \tag{2}$$

where the null hypothesis is:

$$\beta_0 = \beta_1 = \beta_2 = \beta_3 = 0 \quad (3)$$

TABLE I
VARIABLES, PARAMETERS AND MEANINGS

DENOMINATION	MEANING
GDP	Gross Domestic Product
PAT	Patenting
EAT	Export of high technology
ESTIC	Export of ICT Services
$\boldsymbol{\beta}$	Impact parameter
$\boldsymbol{\hat{\beta}}$	Parameter estimator
I	Country
$\boldsymbol{\sigma^2}$	Standard Deviation DS
$\boldsymbol{\widehat{\sigma^2}}$	DS estimator
$\boldsymbol{\varepsilon}$	error
t = x	Year x

In this model, the different link between the variables associated with technological innovation and the dispersion in economic development is studied for the same annual cut.

IV. Research Approach

We will use an econometric model to estimate the parameters through an OLS (Ordinary Least Squares) regression of the following model.

$$GDP_{i,t=x} = \hat{\beta}_0 + \hat{\beta}_1 * PAT_{i,t=x} + \hat{\beta}_2 * ESTIC_{i,t=x} + \hat{\beta}_3 * EAT_{i,t=x} + \varepsilon_{i,t=x} \quad (3)$$

Being $\hat{\beta}$ the statical estimators of the true population parameters β. The variables GDP, PAT, ESTIC and EAT are taken from The World Bank [20] for 178 available countries and in the annual periods 2000, 2005, 2010 and 2015.

We process all the data without transforming the variables and we use Python.

V. Expected Outcome

Our theory states that the different levels of technological innovation in the different countries of the world sufficiently explain the dispersion observed between their economic development. Based on the model proposed in (1) and prepared for the estimation in (3), we expect the value of the estimators $\hat{\beta}$ corresponding to each of the explanatory variables (PAT, EAT and ESTIC) to be positive and significantly (statistically speaking) different from zero. In other words, our theoretical framework suggests that the three proxy variables of technological innovation should positively impact the development of countries. We hope that this relationship occurs in the four annual cuts that we study.

A priori we have not conjectured that any estimator of the impact parameters is greater than another.

VI. Finding and Discussion

In Table II we present the results of the estimates made for 178 countries.

The value obtained from the impact estimators (betas 1 to 3) results in the expected sign, that is, all positive. It is also important that in none of the 4 annual cuts do they change sign.

TABLE II
SUMMARY OF REGRESSIONS BY OLS

Variable	MEANING		Variable	MEANING
GDP	Y		ESTIC	X 2
PAT	X1		EAT	X 3
Año	2000	2005	2010	2015
$\widehat{\beta_0}$	-3.162e+10	4.723e+09	6.745e+10	4.454e+10
$\widehat{\sigma^2}_0$	1.69e+10	2.53e+10	2.58e+10	2.06e+10
p>|t|	0.063	0.852	0.009	0.032
$\widehat{\beta_1}$	4.528e+07	5.777e+07	5.402e+07	5.37e+07
$\widehat{\sigma^2}_1$	2.94e+06	2.38e+06	1.69e+06	1.12e+06
p>|t|	0.000	0.000	0.000	0.000
$\widehat{\beta_2}$	66.6470	65.2081	20.3341	18.2942
$\widehat{\sigma^2}_2$	21.292	9.642	5.070	3.370
p>|t|	0.002	0.000	0.000	0.000
$\widehat{\beta_3}$	13.6627	0.2480	4.5158	6.1896
$\widehat{\sigma^2}_3$	1.626	1.505	0.889	0.581
p>|t|	0.000	0.869	0.000	0.000
r^2	0.912	0.877	0.914	0.964
$Adj.r^2$	0.91	0.876	0.913	0.964

All the estimators of the variables (not the constant) are statistically significant, even at 1%, except for the estimator of High Technology Exports for the year 2005 alone.

The level of adjustment of the model in general is very good, presenting $\boldsymbol{Adj.r^2}$ that even go up to 0.964 for the year 2015.

The combination of statistical significance of the estimators, the positive sign of the estimators and the high values produced by the adjustment measurement of the model suggests that it is correct to indicate that technological innovation has a decisive impact on the disparity in the economic development of nations.

VII. Conclusion

The configuration of a model that seeks to explain the different levels of economic development (measured by the proxy variable GDP) through approximate technological innovation by the use of the application of patents and technological exports (whether of high-tech goods such as of ICT services) is plausible. When contrasted with the data available for 178 countries in four annual cuts (2000, 2005, 2010 and 2015), all the estimators of relevant impact parameters turned out to have the expected (positive) signs, being generally statistically significant and showing overall a very good fit level.

The potential implications of this line of research are very powerful in the field of public policy. Since achieving a situation of less inequality in the development of nations would be strongly related to promoting greater access to the possibilities of technological innovation.

Possible Extensions

This work has possible extensions referring to carrying out similar analyses disaggregated by industrial sectors, even at the individual company level.

ACKNOWLEDGMENT

To the Fulgor Foundation board of directors for their permanent financial and motivational support.

REFERENCES

[1] M. Dziallasa K. Blinda, Innovation indicators throughout the innovation process: An extensive literature analysis Technovation 2019 (3-29).
[2] W. C. Chen, The Extensive and Intensive Margins of Exports: The Role of Innovation, The World Economy (2013).
[3] R. Frietsch, P. Neuh¨ausler,, T. Jung B. VanLooy, Patent indicators for macroeconomic growth — the value of patents estimated by export volume, 2014 Elsevier.
[4] Akis, E. Innovation and competitive power. Procedia, Social. Behav. Sci. 195, 1311–1320 2015.
[5] Andrew, J.P., Manget, J., Michael, D.C., Taylor, A., Zablit, H.,. Innovation 2010: a Return to Prominence - And the Emergence of a New World Order, . The Boston Consulting Group, pp. 1–29. 2010.
[6] Artz, K. W., P. M. Norman, D. E. Hatfield, and L. B. Cardinal. A longitudinal study of the impact of RD, patents, and product innovation on firm performance, The Journal of Product Innovation Management 27(5), 725–40, 2010.
[7] Belenzon, Cumulative innovation and market value: evidence from patent citations. , Econ.J.122,265–285. 2012.
[8] Briggs, K. Patents, technology adaptation, and exports to developing countries, GlobEconJ12, 1–20. 2012.
[9] Cavdar, S.C., Aydin, A.D. An empirical analysis about technological development and innovation indicators (World Conference on Technology, Innovation and Entrepreneurship) , Procedia - Social and Behavioral Sciences 195. pp. 1486–1495. 2015.
[10] Dang, J., Motohashi, K. . Patent statistics: a good indicator for innovation in China? Patent subsidy program impacts on patent quality. , China Econ. Rev. 35, 137–155. 2015.
[11] Dewangan, V., Godse, M. . Towards a holistic enterprise innovation performance measurement system. , Technovation 34 (9), 536–545. 2014.
[12] Edison, H., bin Ali, N., Torkar, R. . Towards innovation measurement in the software industry. , J. Syst. Softw. 86, 1390–1407. 2013.
[13] Ernst, H., Conley, G., Omland, N. . How to create commercial value from patents: the role of patent management. , RD Manag. 46 (S2), 677–690. 2016.
[14] OECD . Directorate for Science, Technology and Industry, Economic Analysis and Statistics Division, https://www.oecd.org/sti/ind/48350231.pdf 2011.
[15] Flor, Maria Camison, Cesar, Oltra, Maria J. - 2004/01/01. El Efecto de la Estrategia de Innovación Tecnológica y de la Estrategia Exportadora en el Desempeño Internacional de la Empresa VL - 20 Cuadernos de economía y dirección de la empresa, ISSN 1138-5758, Nº 20, 2004, pags. 151-174 –
[16] Cooper R.G. and Kleinschmidt. New product success factors: A comparison of “skills” versus successes and failures. R&D Management 20(1)_ 1-7 (1990)
[17] https://data.worldbank.org/
[18] Bajo Rubio, Oscar (1991). Antoni Bosch, ed. Teorías del comercio internacional.
[19] H. j . Watsilla and Narasimha R. Vajijhala. Knowledge Management in Acadamic: A perspective of academic research contribution to economic development of a Nation. International Journal of Economics and Management Engineering. Vol. 14 N 3. 2020
[20] www.data.worldbank.org . The World Bank. 2020.

Hugo Rodríguez Born in Argentina in 1987. He has a Bachelor of Economics (Universidad Nacional de Córdoba 2012) and is a Candidate for a Doctorate in Politics and Government (Universidad Católica de Córdoba).

Hugo is currently working as a researcher at the Fulgor Foundation in Córdoba Argentina. Previously, he was a Research Assistant at the Institute of Economics and Finance of the National University of Córdoba. His fields of interest include Economic Development, Entrepreneurship, Military Spending, and Geopolitics.