

SUBMISSÃO ÀS SESSÕES DE COMUNICAÇÕES

ÁREA 7. Trabalho, Indústria e Tecnologia

SUBÁREA 7.2. Economia industrial, serviços, tecnologia e inovações

TECHNOLOGICAL FORECASTING: A LOOK AT BRAZILIAN PATENTS

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ABSTRACT

Innovation is directly linked to economic growth. The quantity of patents filings within a country is commonly regarded as an economic indicator. Patents are the key to protecting and registering intellectual property, and thus serve as a manner of analyzing and interpreting economic growth of a country. Global patent filings remained stable until the 1970s, when the USA, Japan and the Republic of Korea experienced marked growth through the 1980s. More recently, jumps in intellectual property have been seen in emerging markets such as Brazil, China and India; By quantitatively analyzing the rhythm of Brazilian patent production within a worldwide scope through demonstrative data, correlation analysis and regression models, the objective of this article is to gain a greater understanding of the country's ability to generate and capture intellectual property. As patents are a relevant economic indicator, this type of analysis can help in demonstrating Brazil's future economic growth.

Keywords: patents, economic growth, Brazil, intellectual property

1 INTRODUCTION

Innovation is directly linked to technological and scientific progress, as well as productivity and economic growth (BRONZINI; PISELLI, 2009; ANG, 2011; BASAK, 2011). The quantity of patents filings within a country is commonly regarded as an economic indicator (PÉREZ, BENGGOA; FERNANDES, 2011), as it is a form of documenting innovation and inventive activity for new ideas and products to be put on the market. Thus, patents serve as a manner by which to gauge economic activity and pioneering industrial undertakings leading into coming years.

In recent decades, patent filings have nearly tripled in markets spread around the world. Around 600,000 patents were filed in 1975. Global patent filings remained stable until the 1970s, when the United States of America, Japan and the Republic of Korea experienced marked growth through the 1980s. The number of patent filings nearly reached 1,800,000 in 2008. More recently, jumps in intellectual property have been seen in emerging markets such as Brazil, China and India; moreover, total global patent filings have reacted resiliently in spite of economic crisis (WIPO,

2011). Figure 1 shows the total number of patent filings from 1985 to 2010, according to the WIPO database.

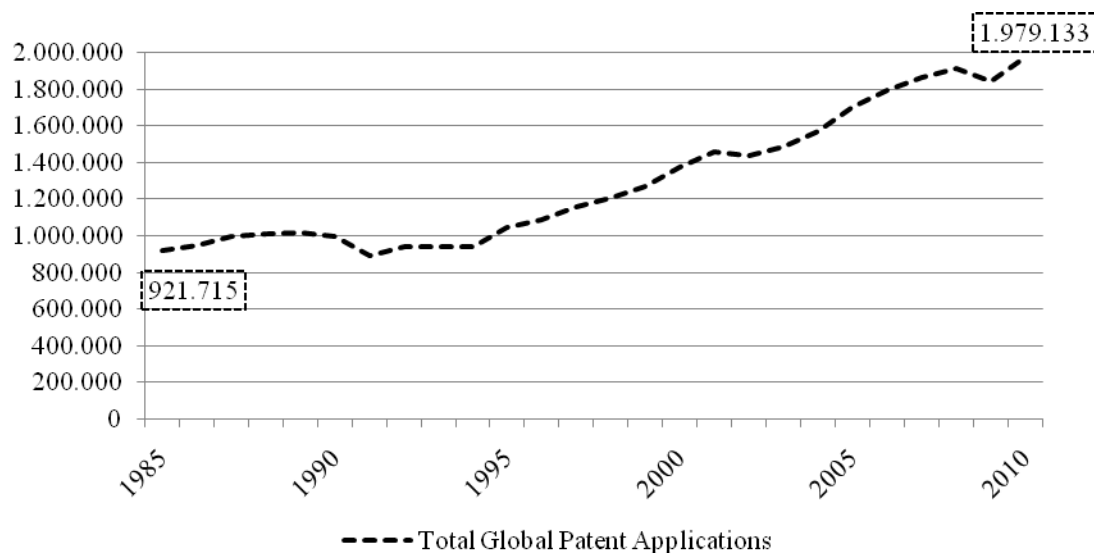


FIGURE 1: Total global patent applications
Source: Search Direct

This growth in developing economies may be characterized by a number of explanations, three of them being presented in the 2011 WIPO Intellectual Property Indicators Report: Technological progress leading to increased prosperity; Shifting patent strategies being employed by international firms; Efforts to protect technology in international markets.

While there is ample information on the current state of global intellectual property, this article aims to take a more in depth look at Brazil's patent history and its recent growth within the global IP context by means of statistical analysis.

2 STATE OF INTELLECTUAL PROPERTY IN BRAZIL, OTHER BRIC COUNTRIES THROUGH DEMONSTRATIVE DATA

Hartmann, Pyka and Hanusch (2010) and Herman and Avran (2011) states that, in order to better understand the impact of patents as an economic indicator for a country or region, it is important to take into consideration also those filed by non-residents within the country or region of interest. The objective of this article is to gain a greater understanding of the country's ability to generate intellectual property. Based on comparisons with the other BRIC and G7 countries (Japan, the United States of America, the United Kingdom, Germany, France, Italy and Canada), it is possible to evaluate if Brazil has kept pace with the rest of the world in the intellectual property race while also generating a global portrait of patent production (COE, HELPMAN, HOFFMAISTER, 2009)

As an initial attempt to describe Brazilian as well as global IP tendencies, Figure 3 exhibits demonstrative data of the total number of first patent filings in the Russian Federation (RF), India (IN) and Brazil (BR) from 2000 to 2010 (WIPO, 2011). It should be noted that, at the time of writing this paper, there was no report for India's 2010 patent filing figures. It can be seen that India overtook Brazil in total first patent filings in 2005.

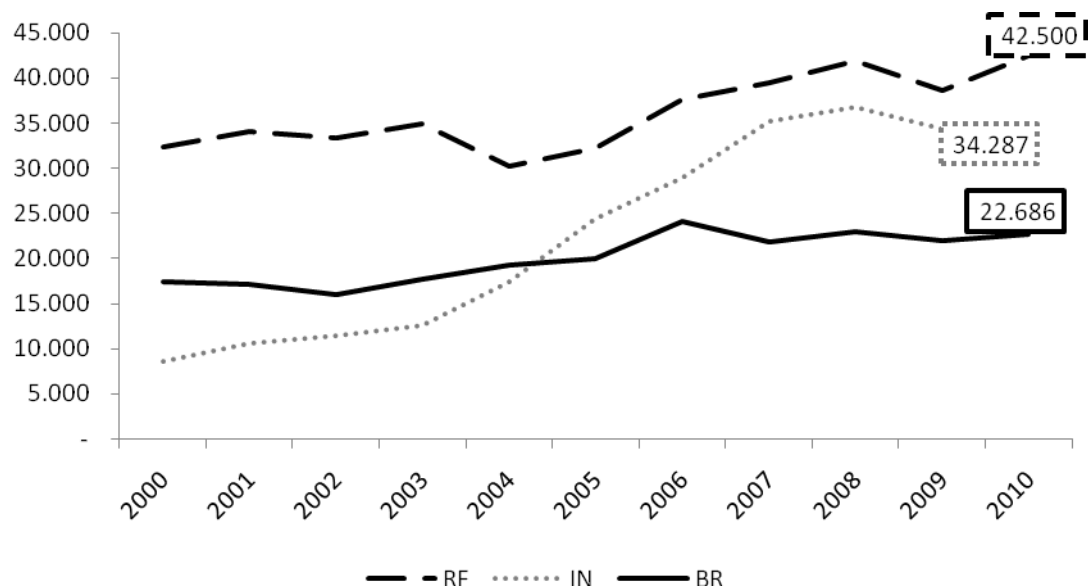


FIGURE 2: Total first patent filings, the Russian Federation (RF), India (IN) and Brazil (BR)
Source: Search Direct

The growth seen in these emerging economies has been overshadowed by the exponential expansion of patent filings in the People's Republic of China (CN). Using the same data, but including China in the count as well, it is possible to see the growth by the BRICs has been spurred by China's patent boom.

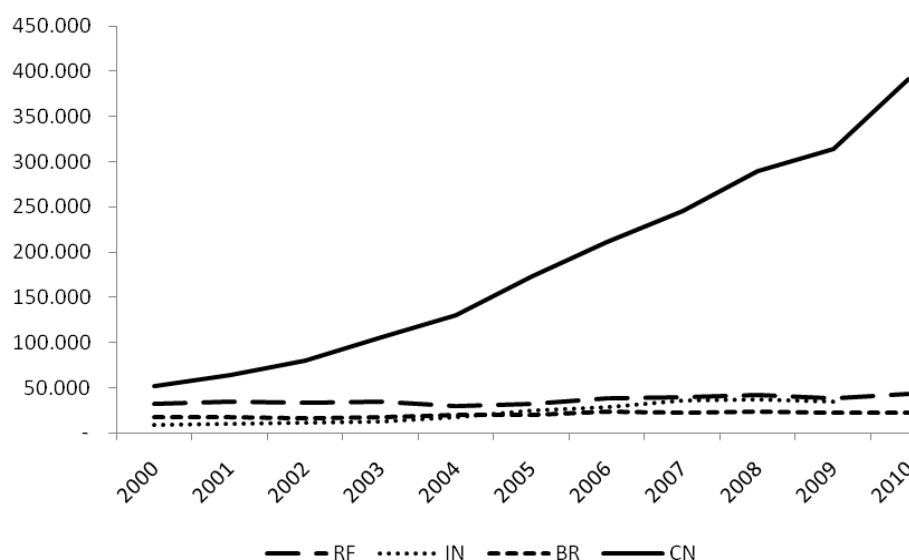


FIGURE 3: Total first patent filings, the Russian Federation (RF), India (IN), Brazil (BR) and the People's Republic of China (CN)
Source: Search Direct

Although the IP growth in China has dwarfed the other BRIC countries, this is not to say that Brazil, India and the Russian Federation have not witnessed substantial growth, as witnessed in Figure 3. Thus, in order to gain a greater understanding of these tendencies in first patent filings, standardization and correlation were adopted for the second and third steps of this statistical analysis.

3 METHODOLOGY

3.1 Standardized Analysis

In order to generate an understanding of the clip of first patent filing trends in Brazil and other BRIC and G7 countries, data obtained from WIPO regarding resident and non-resident filings, from 2000 – 2009, were utilized to elaborate an initial, standardized graph to show global tendencies. Due to the dramatic absolute differences in filings in offices such as Brazil and India (21,944 and 34,287 total filings, respectively, in 2009) and China (391,177 total filings in 2009), the data were standardized in order to better characterize and visualize their tendencies.

Data are comprised of the sum of total resident and non-resident patent filings for the five main areas of knowledge under which WIPO classifies patents (Electrical, Instrumentation, Chemical, Mechanical and Others). Individual country sums were then added up in their respective G7 and RIC groups, thus generating a year-by-year look at the agglomerated sum of first patent filings for the economic blocks. As Brazil is the focal point of this article, it was considered separately.

Standardization of these data is justified by Montgomery and Runger (2003), who state that standardization is an attractive option for statistical analysis when there is a great variance existent in normally distributed data sets and ratio comparisons are indeed meaningful. As the data came from WIPO, which registers all patent and IP information worldwide, all population parameters are known and thus, standardization may be applied. Standardized data simply show the variation of the dataset in relation to the data's mean, thus generating a proportional interpretation of the data's tendency and shifts (OOSTERBEEK; PRAAG; IJSSELSTEIN, 2010).

In order to achieve standardized data, first the mean and standard deviation of the dataset are calculated. Then, the mean is subtracted from each datum. The difference between the datum and the mean is then divided by the standard deviation to generate a standardized score (SECK, 2011).

As evidenced in Figure 3, the ratio of patents historically produced in Brazil has, at the least, accompanied global tendencies. Recalling the tendencies seen in Figure 2, it can be seen that the

RIC countries are largely driven by the IP growth in China. This upswing in IP trends can be seen in Figure 3. Moreover, intellectual property production in G7 countries, considered to be developed economies, has remained steady since 2005 and even fallen off in recent years.

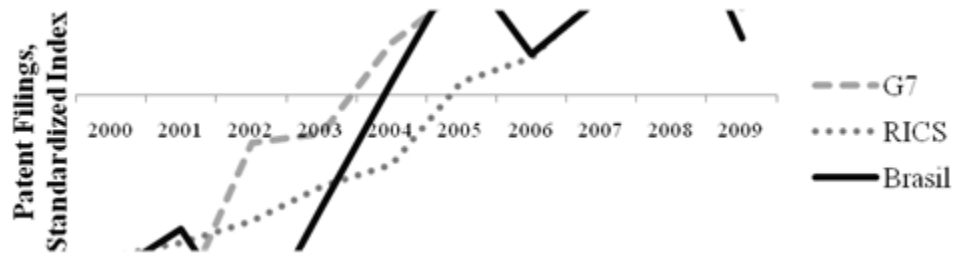


FIGURE 3: First Patent Filings from 2000 – 2009, Normalized: G7, Brazil and RIC
Source: Search Direct

Taking a closer look at Brazil, at first glance it appears that the South American country has kept up with the pace of patent filings generated by the two economic blocks under consideration in this paper: BRICs and G7. While G7's patent filings have proportionally remained stagnant over the last half decade, the RIC countries – largely spurred by an exponential boom in patent filings in China – have experienced a period of dramatic growth. Brazil has at times maintained the clip of global innovation (2002 – 2008), at least on a standardized, proportional scale; however, this rate fell off in 2009.

3.2 Correlation Analysis

However, Figure 3 in the previous section only serves as a preliminary visual representation of IP tendencies. In order to generate a deeper understanding of the pace of Brazilian IP and innovation, it is necessary to carry out more detailed statistical analysis. Aside from descriptive data, the Pearson r coefficient measures the linear association between a response variable Y (in this case, Brazil) and an independent variable X (in this case, G7 and RIC) (Montgomery and Runger, 2003). That is, by using this simple statistical test, it is possible to shed some light on the degree and nature of the correlation between two variables of interest. By understanding the positive or negative correlation of the behavior of a response variable in relation to an independent variable, it may be possible to better understand Brazil's past IP tendencies based on observations of the patterns exhibited by G7 and other BRIC countries.

Correlation is a standardized scale which varies between -1 and 1. When a value is close to -1, this indicates a negative correlation and that the variables are inversely proportional. The opposite is also true; values close to 1 indicate a positive correlation and that the variables are

directly proportional. Values closer to 0 indicate weak or inexistent correlation (Montgomery and Runger, 2003).

The P-Value demonstrates the lowest significance level which leads to the rejection of the null hypothesis, H_0 , with the data available (Montgomery and Runger, 2003). Through analysis of the P-Value, it is possible to state if the findings are insignificant or not, thus implicating that there is some level of statistical significance (Montgomery and Runger, 2003). The P-value is attained using a Student t test. The hypotheses are given below:

$$\begin{aligned} H_0: r &= 0 \\ H_1: r &\neq 0 \end{aligned} \quad (1)$$

Where the significance level $\alpha = 0.05$. Thus, if the P-Value is greater than the significance level, the null hypothesis, H_0 , may be accepted, demonstrating that the correlation is equal to zero; that is, the correlation is statistically insignificant. If the P-Value is less than the significance level, the null hypothesis can be rejected and the alternative hypothesis, H_1 , accepted, implicating that the correlation is not equal to zero and, as such, implicating statistically significance.

Through the first analysis carried out, it can be seen in Table 1 that there is strong positive correlation between Brazil and both the G7 (+0.797) and RIC (+0.802) countries in terms of number of first patent filings among all knowledge areas between 2000-2009. In other words, as both economic blocks have increased in first patent filings, proportionally similar numbers were registered in Brazilian patent offices as well. That is, in terms of first patent filings throughout all areas of knowledge, Brazil is keeping up with the global IP production pace.

TABLE 1: Correlation between Brazil and G7 and other BRIC countries

	Total – Brazil
Total – G7	0.797
P-Value	0.006
Total – RIC	0.802
P-Value	0.005

Source: Search Direct

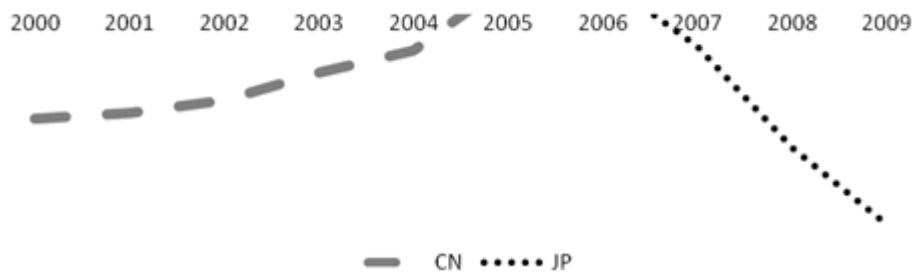
As an illustrative example of negative correlation, it can be seen that, in the knowledge area “Others” – which includes patents related to Civil Engineering, Toys and Furniture – China and Japan have exhibited a strong negative correlation (-0.870), and a P-Value (0.001) which indicates that, over the last decade, this correlation has been statistically significant.

TABLE 2: Correlation between China and Japan, “Other” Patents, 2000 – 2009

	Japan
Patents Area 5 – China	-0.870
<i>P-Value</i>	0.001

Source: Search Direct

A standardized graph can be seen below in Figure 4. Due to large absolute value differences between first patent filings in Japan and China, the data were standardized. While in 2009, Japan produced 26,949 first filings in the knowledge area “Others” and China produced 12,641 first filings, these values, when standardized, reflect the proportional fall off in Japan and growth in China since 2000, when Japan produced 31,939 patent filings in the area, and China just 1,375. In other words, while Japan’s participation in the “Other” patents category has dropped off, China has experienced a substantial boom.

FIGURE 4 – First Patent Filings, China and Japan, Knowledge Area 5. Source: WIPO, 2011.
Source: Search Direct

3.3 Regression Analysis

Regression analysis is a statistical technique used to model and investigate the relation between two or more variables (Montgomery and Runger, 2003). In this case, historical data regarding the number of patent filings registered in other BRIC and G7 countries were used. In light of the fact that there is a strong positive correlation between Brazil and the G7 and other BRIC countries, it is possible to develop a linear regression model which serves the purpose of describing Brazil’s past patent filing behavior in reference to the behavior of the two economic blocks being considered in this text. For this article, two regression models were developed: First Patent Filings, Brazil (Y) = Patent Filings, G7 Countries (X); First Patent Filings, Brazil (Y) = Patent Filings, other BRIC Countries (X).

In both cases, the models presented R^2 -adjusted values which showed themselves to be suitable in describing the experimental response (Brazil). That is, by evaluating the behavior of the

two economic groups’ numbers of first patent filings, it is possible to understand a significant amount of variance in Brazil’s IP production.

For the first model, Brazil was considered as the response variable and the independent variable the total number of first patent filings among the G7 members. Through analysis of the graph and equation below, it can be seen that a suitable linear regression model can be elaborated based on historical data. With a fitted R value of 59%, it can be said that nearly 60% of Brazilian first patent filings can be explained by first patent filings registered in G7 countries. As the P-Value exhibited was 0.006, being less than the 0.05 significance level (α), it can also be said that the model adequately describes the phenomenon adequately to the fitted R value.

$$BR(X) = 759.1 + 0.003956G7(Y)$$
(1)

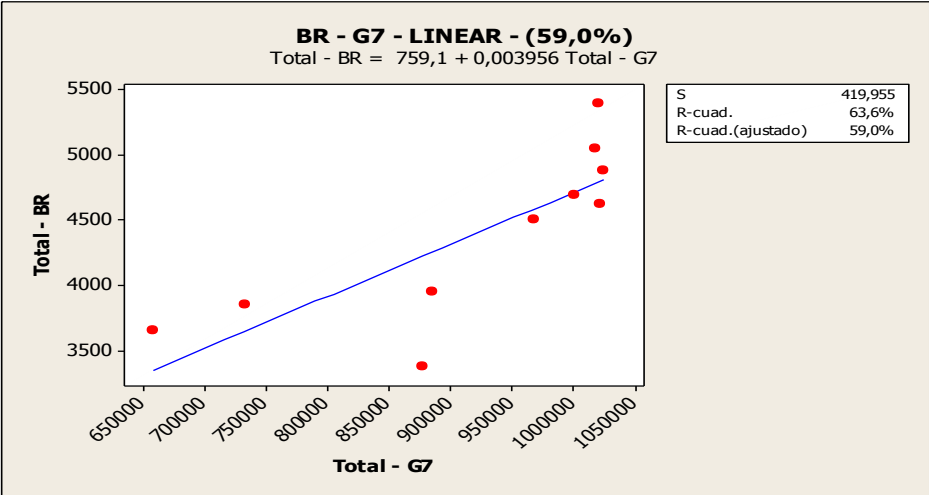


FIGURE 5 – Linear Regression Model with Total First Patent Filings in Brazil (Y) as the experimental response variable and Total First Patent Filings in G7 countries
Source: Search Direct

For the second model, Brazil was considered as the response variable (Y) and the independent variable the total number of first patent filings among the other BRIC members. Through analysis of the graph and equation below, it can be seen that a suitable linear regression model can be elaborated based on historical data. With a fitted R value of 59.8%, it can be said that nearly 60% of Brazilian first patent filings can be explained by first patent filings registered in other BRIC countries. As the P-Value exhibited was 0.005, being less than the 0.05 significance level (α), it can also be said that the model describes the phenomenon adequately to the fitted R value.

$$BR(Y) = 3605 + 0.007699BRIC(X)$$

(2)

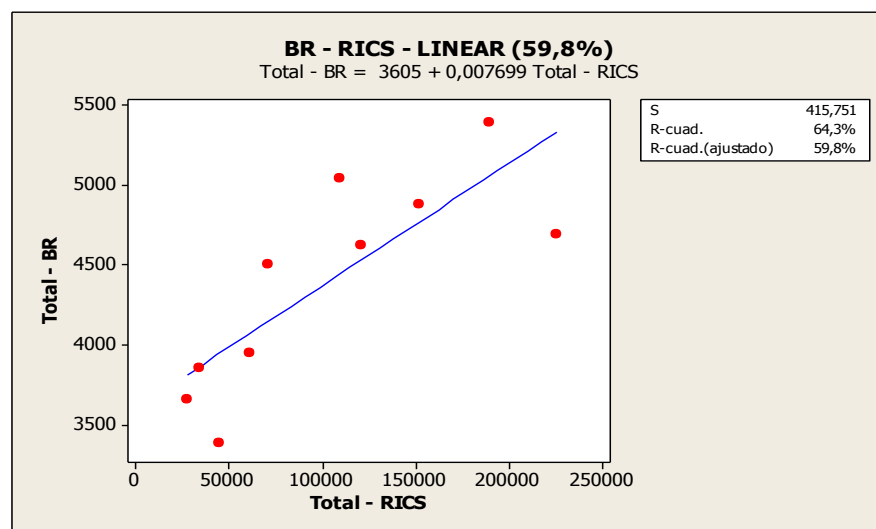


FIGURE 6 – Linear Regression Model with Total First Patent Filings in Brazil (Y) as the experimental response variable and Total First Patent Filings in other BRIC countries
 Source: Search Direct

As shown in Figures 5 and 6, it is possible to explain at least the greatest portion of IP production in Brazil based on an analysis of the constituent nations of the BRIC and G7 economic blocks, considered emerging and developed countries. This statistical congruency implicates that Brazil, regardless of the proportion of resident-to-non-resident patent generation, is keeping up with global innovative efforts.

4 CONCLUSION

As patents are a relevant economic indicator implicating innovative endeavors and subsequent industrialization, this type of analysis can help shed light on new technological life being produced by, or injected into, a regional economy. Brazil served as an example of this application as well as a point of discussion to compare emerging and developed economies.

This could be useful in generating global and regional forecasts for IP developments and their consequential economic developments in their respective countries, regions and economic blocks.

It has been said that the recent growth in global IP activity can be explained by a number of factors, those being: technological progress, shifting patent strategies from international firms and efforts to protect technology in international markets (WIPO, 2011). For the case of Brazil, it does seem that recently heightened IP activity may be due the efforts of international firms in changing their patent strategies and defending their innovative undertakings.

This can be understood by taking into considering a final statistic. While overall patent applications in Brazil have increased over the last ten years, according to WIPO's 2011 Intellectual

Property Indicators, this growth has been entirely due to non-residential applications. That is, although intellectual property registered in Brazilian patent offices has indeed increased, these contributions are coming principally from foreign firms rather than resident patent filings, which actually dropped. As proof of this, 88.1% of patent applications in Brazil in 2010 were filed by non-residents.

In conclusion, this article has shown that historical patent data for independent variables, in this case data from G7 and other BRIC countries, may be used to explain IP developments in a variable of interest, in this case the Brazilian economy. Not only can a general idea be generated by analyzing standardized and correlation data, one may also generate more specific valid linear models which can explain past behavior using regression models.

Recommendations for future studies include the analysis of other countries in both emerging economies, such as other BRIC countries, as well as investigation of specific areas of knowledge among different countries. Another possibility would be the evaluation of the use of non-linear regression models to evaluate historic IP production, along with the use of historical data in order to generate forecasts of future IP activity. In order to do generate more precise models with a greater level of resolution, it is recommended that researchers evaluate data based on a monthly IP production rate.

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