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IMPACT OF THE CONSUMPTION OF DRINKING WATER IN THE ECONOMIC GROWTH OF THE BRAZILIAN STATES FROM 1994 TO 2018

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ABSTRACT

The objective of this study was to identify how water drinking consumption impacted the economic growth of the Brazilian State from 1994 to 2018. To develop this study has used the methodology called dynamic panel was proposed by Arellano and Bover (1995). Beyond this, was used as a theoretical model to help us to discussthe results of the Dose-Response Method. The GDP was used as an explained variable for Brazilian states. The variables of interest were the water drinking consumption (human, industry, and agriculture). The variables of control were Cattle Herd, Total Production of Temporary and Permanent Crops, and Population. We obtained, as a result, that water drinking consumption (human, industry, and agriculture) influence the economic growth of the Brazilian states during the studied period. This scenario shows the importance of water to the economy, and how it can be crucial to the survival of humanity.

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INTRODUCTION

Environmental concern never was a priority to society, according to explain Wakim et al. (2012), who in function this low compromise of the man with the environment became necessary due to the disordered exploration of natural resources, search for new alternative sources of fuels, preserve the freshwater rivers and, mainly, mitigate the effects of the climatic change, because this is affecting of the way direct and indirectly all the Planet. Several attempts to circumvent the environmental problems arising from the unsustainable exploration of natural resources were realized by world leaders. The first alerts about these environmental questions were formalized in the Report of the First Minister of Norway Gro Harlen Brundtland, called Our Future Common, in 1980. Was this Report who emerged the first discussions about Sustainability and its effects on the planet. After this first moment, other discussions started to win the spotlight in society, reinforcing the initial discussions proposed in the Brundtland Report. For example, we can cite the United Nations Conference on Environment and Development in Rio de Janeiro city in 1992. This Conference search to discuss environmental degradation and how it affects the continuity of the planet.

In this context, environmental discussions insert water resources because these are essential to human survival. Because he promotes social development and the economy of a country beyond the quality of life to society. According to Hawken, Lovins, and Lovins (1999), as further globalization advances, and as the percapitaavailability of water, agricultural soil, and food reduce, the possibilities of regional barriers increase due to this environmental imbalance. However, the water availability in the world, mainly destined for human consumption, is infinitely smaller than saltwater. Therefore, the greater the technological advance and the countries' economic growth, the more significant environmental degradation. Consequently, the natural resources will be degraded if they do nothave changes in consumption. Before this scenario, the National Water Agency (ANA, 2019) explains that around 97.5% of the global water is salted and inappropriate for human consumption or other consumptive uses, irrigation, aquaculture, and animal consumption. The 2.5% remaining of the world's wateris considered sweet. Of the total, 69% are indifficult access areas, like the glaciers, 30% in underground areas (aquifers), and just 1% in lakes and rivers. However, the exploration or mainly the contamination/degradation of this natural resource couldbe compromisedwhole the economic and social systems. Once, this environmental issue is highly relevant to human beings. After the considerations made before, this paper had as its objective, to identify how drinking water consumption impacted the economic growth of the Brazilian states from 1994 to 2018.

Theoretical Framework

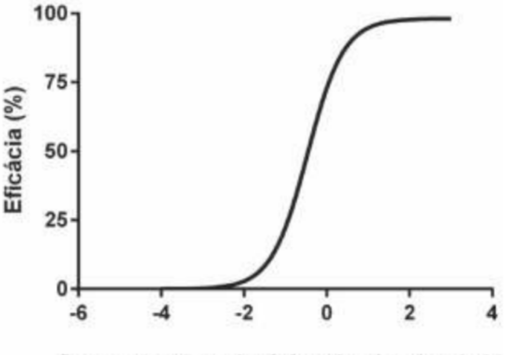
Dose-Response Theory: To identify a possible theory that promotes sustentation to discussions about the impacts on the economic growth of Brazilian states from the variation in hydric available and or from water drinking consumption was opted by using the method called Marginal Productivity (MP) or Dose-Response. This methodology is widely used in environmental research, where one needs to verify the results obtained in a specific product from the variation (quantities and qualities) of the specific input that be linked directly to him. It is important to highlight that in the Brazilian literature or international literature existent, dose-response is commonly used to analyze the impacts on the environmental resources, where these are inputs to the production process. Or in the health area, its used to measure of the effects on human health from the levels of environmental pollution. In this sense, when it pretends to use the Dose-Response Method, we need to have to imagine that the environmental inputs, like air, water, or land, should be considered as inputs in the production process of goods or services. Adapting the context explained by Brower et al. (2017), the function of dose-response of the*f*connects the quantities of inputs used in the "production" (dose – x) with the probability of the results due to this input (response – *f(x)*). In other words, the product is in the function of the quantity of the inputs used in the process. The authors related that if $x = 0 \rightarrow f(x) = 0$; if the quantity inserted as input in the processes was elevated, the product should increase. In this connection, Faucheux and Noël (1997, p. 274) affirm that "any change in environmental conditions will translate into the company's production costs, in the prices, and product quantity". That is, considering the hydric resource as an important input to the growth economic, her variation, be positive or negative, will impact the result of the GDP. Seroa da Motta (2006) explain that the dose-response or marginal productivity is a function which the product is reflex of a combination of the economic factors, social and environmental ($P = f(Y, R)$). Assuming that the impact of the drinking water consumption over the GDP is given from the variations of the variable of hydric available x, this way relative risk over the GDP from the x variable is shown by equation (1) adapted from de Calthrop e Maddion (1996).

$$RR(x) = \frac{E(Y|x)}{E(Y|0)} \quad (1)$$

The relative risk of any variation in the level of the x is equal to the expected impact on GDP (Y). The authors explain that not only a variable is responsible for the variations in the GDP. However, the variation in the GDP will not necessarily be due to the oscillation of the availability/drinking water consumption in the economy. Still, other variables will also be responsible for the relative variation over Y. Altshuler (1981) explains that the function of dose-response is dichotomic as a function of the distribution *P(d)*, in that *d* is a quantitative generic dose, that is, total dose, rate of dose, daily dose, or concentration, however, *d* signify rate of dose.In turn, the response function is due to the combined effect of the induced response with the background response, and this relationship needs to be well specified. Nordberg and Strangert (1978) explain that the dose-response methodology is a relationship between the level/volume of the dose entered with the proportion of the expected response. Esperancini (2001) explains that the dose-response method is usually used to assess/measure the impacts on the environment due to air pollution and health issues when seeking to identify the effect on mortality in human beings, as well as resulting from the levels of environmental pollution. Pearson (1992) associates the use of the method with agronomic issues, that is, the relationship is based on problems arising from the erosion process that occurs in the soil. For each variation in the level of erosion (dose), this will imply different levels of production in the crops. The author explains that the loss of land is in the function of any factors like the level of rains that promote erosion (R), soil erosion itself (K), terrain slope (SL), crop factor (C), and conservation practices (P). Therefore, it presents a function of erosion as a function of these variables as being: $SoilLoss = f(R, K, SL, C, P)$. Another study using the dose-response theory was realized by Wakim et al. (2012), which authors searched to measure the impact on the profit of the irrigated rice production in the microregion of the Formoso do Araguaia, state of Tocantins, Brazil, from the scenario simulation due to the positive and negative variation from hydric available in the region. They concluded that exists an oscillation in the quantitative and in the quality of the hydric resource, the irrigated rice production would be affected and consequently the profitably of the rice producers of the region.

Esperancini (2001) conducts research relating several studies where they sought to use the dose-response method and analyzed each one of them in terms of the method used as well as the variables used in the model. In turn, Fryges (2006) studied a Dose-Response function, using the GPS method, the relationship between a company's sales propensity with the growth rate, the latter being a proxy for the firm's performance. The author confirmed the existence of an inverted U between the exportation intensity before the treatment of the firm's performance. He commented that a factor that may have brought some difficulty in estimating the dose-response function was the sample size, which can be considered undersized for the estimation. Therefore, in the health area, the Dose-Response method is widely used to measure the effects of the level of the specific drugs over specific sicks to verify the drug's capacity to control/mitigate the results provided by diseases in patients organisms. In this regard, Viecili et al. (2008) studied the effect of the exercise practice in hypertensive people. Thus, they studied around 90 people in many age groups that practiced some physical exercise. The authors noted that the research dose-response curve can be steeply decreasing rather than flattening

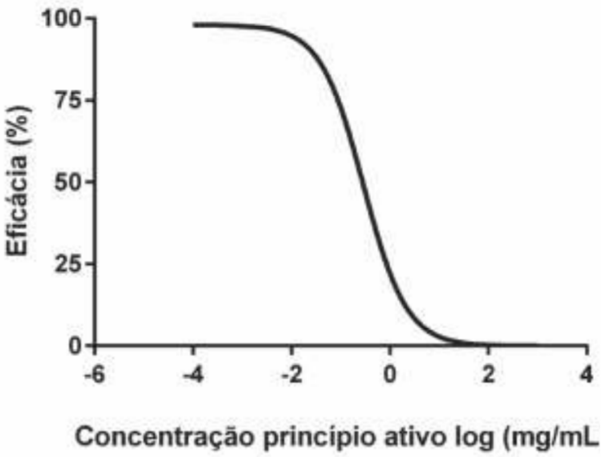
The authors Minho, Gaspar, and Domingues (2016) developed a study where researchelaboratesa practical guide to determinates of the dose-response in bioassays with plant extracts. They comment that in toxicology studies in humans and/or animals, an average lethal dose can be a way to obtain an understanding of how lethal a particular chemical compound can be. In addition, one may be trying to measure the effectiveness of a particular drug in controlling a specific disease. It can be stated that a dose-response graph will normally have on its X-axis the concentration of the element that is being tested. On the other hand, on the Y-axis is the response of this element, whether in the human body, in animals, or in crops. Any type of response can be obtained depending on the dosage applied and the substance used. Minho, Gaspar, and Domingues (2016) exemplify this statement, stating that the use of an element and/or its amount in an individual, can cause changes in heart rate among other possible responses. They explain that the dose-response curve can take up two formats. The first is the stimulation DR curve, and the second is the inhibition DR curve. Figure 1 shows the DR Curve of Stimulation.



Source: Minho, Gaspar, and Domingues (2016)

Figure 1. Dose-Response Curve of Stimulation

In Figure 1, the authors suggest that as you increase the quantity/quality of the tested input, it will present a higher percentage of effectiveness in its proposed use. In this case, the example described by Minho, Gaspar, and Domingues (2016) is that increasing the concentration of a substance, will cause the death of larvae. Figure 2, in turn, describes the Dose-Response Inhibition Curve. Referring to Figure 1 to the proposal of this research, we have that as we seek to increase the use of inputs, whether economic and/or environmental, in this specific case, water consumption, we intend to increase the final product, i.e., the gross domestic product.



Source: Minho, Gaspar, and Domingues (2016)

Figure 2. Inhibition Dose-Response Curve

In the case of Figure 2, the goal is to verify how the increase in the concentration of a certain compound causes a decrease in the event being tested. Minho, Gaspar, and Domingues (2016) explain that the higher the concentration of the inhibitor element, the greater its effectiveness in controlling the event may be. Gadagkar and Call (2015) report that typical dose-response model studies produce a sigmoid curve, such as those plotted in Figures 1 and 2, and explain that the dose-response function curve can be obtained from a four-parameter nonlinear logistic equation from a nonlinear logistic regression, as described by equation (2).

$$\hat{Y} = \alpha + \frac{(\beta-\alpha)}{\left[1+(\frac{Y}{X})^{\delta}\right]} \quad (2)$$

where $\hat{Y}$is the dose-response expected; α is the minimum response when the dose is equal to zero; β is the stabilizing response for an infinite dose; γ is the dose at which 50% of the subjects are expected to show the desired response; $\delta$is the slope at the steepest part of the dose-response curve, also called the slope of the Hill equation.

METHODOLOGY

To answer the research problem, this paper used the Dynamic Panel methodology proposed by Arellano and Bover (1995). In the Panel Data model, according to Gujarati and Porter (2011) and Greene (2012), the same unit of analysis is studied over time. In addition, the authors explain that this technique allows for less collinearity between variables, greater variability, more degrees of freedom, and efficiency in estimators. Beyond this characteristic mentioned by Gujarati and Porter (2011) and Greene (2012), the methodology allows verifying the temporal dependency of the explained variable. Therefore, it makes it possible to assess whether current events have a link to events that have already occurred in the past. A condition to be considered in this method is the possibility of the existence of the endogeneity between one or more explained variables and the dependent variable. Therefore, the methodology proposed could control this issue. Arellano and Bover (1995) explain that an essential characteristic of this methodology is the strict endogeneity of some conditioned explained variables to the individual effects do not observed. In practice, this type of model allows the use of past, present, and future variables, considered as strictly exogenous, as instruments (ARELLANO; BOVER, 1995). Therefore, considering exposed, the model to be estimated in this research was expressed in equation (3).

$$Y_{it} = \gamma Y_{it-1} + \beta X_{it} + \alpha_i + \nu_t + \varepsilon_{it} \quad (2)$$

$i = 1, \ldots, 27$ states
$t = 1994, \ldots, 2018$

where Y_{it} represents the GDP of the Brazilian states in the period from 1994 to 2018; $Y_{it-1}$is the dependent variable lagged in one period; X_{it} is the vector of economic variables; γ and β are the parameters to be estimated; α_i is the unobserved specific effect of each state; $\nu_t$is the specific effect in time that does not vary across states; and ε_{it} is the random error. The description of the variables used in the present study is presented below. The set of explanatory variables $X_{it}$was composed of the following variables in logarithm: Human Drinking Water Consumption; Industry Drinking Water Consumption; Agriculture Drinking Water Consumption; Cattle Herd; Total Production of Temporary and Permanent Crops, and Population. The variable Human Consumption of Drinking Water is expected to have a negative sign, because it reduces the availability of water, and therefore the other uses of water can be compromised due to the scarcity of this resource. And because of this situation, the economic growth of the states may be harmed. As for the variables Drinking Water Consumption in Industry, Drinking Water Consumption in Agriculture, Cattle Herd and Total Production of Temporary and Permanent Crops, it is expected that the coefficient of these variables will be positive, indicating that as the productive sector uses water resources, the economy tends to leverage. And finally, the variable Population is expected to have a positive coefficient sign, indicating that the population increase contributes to economic growth through the consumption of goods and services offered by the productive sectors of the economy.

RESULTS AND DISCUSSIONS

Initially, in the results, we will present the descriptive statistics of the variables that composed the econometric model of dynamic panel data of Arellano and Bover (1995). Table 1 presents the results of the descriptive statistics. Initially, it is important to highlight that the GDP variable was deflated by the IGP-DI of the Getúlio Vargas Foundation. With this procedure it is possible to make an analysis of the monetary value considering the inflation of the period studied. Therefore, the monetary value is corrected to maintain its real monetary value.In the Gross Domestic Product analysis, the values in Table 1 refer to 24 years of analysis. Therefore, it is possible to note through the table that the average value of the GDP of the Brazilian states in the period studied (1994 to 2018) was around R$ 257 trillion. The GDP is a variable that reflects the level of wealth of a city, state, or country. From it, it is possible to verify to what extent public agents can invest in the various social and economic areas of public administration to try to meet all social demands. On the other hand, human consumption of drinking water in Brazilian states in the period from 1994 to 2018 totaled an average of 5 million m^3. Agriculture, on the other hand, consumed an average of 2.6 million m^3 in the same period and industry, used about 3.5 million $m^3$of water from 1994 to 2018.

Agricultural production and cattle raising together consumed an average of 9.4 million m^3 of water, with agricultural production taking about 2.3 million and animal watering about 7.1 million m^3. All these types of drinking water consumption are characterized as consumptive water use because they decrease the water availability in society's main water supply sources. As water is consumed, and do not exist regularity in the rainfall cycles, springs and rivers tend to decrease their levels, which can cause periods of water stress, such as the one recently experienced in the country. Starting for the econometric analysis of the model proposed in this paper, with reference to the central objective of identifying how drinking water consumption impacted the economic growth of Brazilian states between 1994 and 2018, we used the dynamic panel data model proposed by Arellano and Bover (1995) (TABLE 2).

Initially, it should be noted that the Sargan Test was performed to identify whether the instruments used in the modeling were valid. Therefore, considering that the null hypothesis of the thesis (H_0) is that the instruments are valid and considering the test result and that it was not significant, it can be said that the null hypothesis was accepted, ratifying that the instruments used in the estimation are valid. In turn, the Arellano and Bond 1st and 2nd order autocorrelation tests were also performed. In this regard, considering the result for the 1st order, the p-value was significant at 1% significance level, suggesting that exists evidence of 1st order autocorrelation in the estimation. In the 2nd order autocorrelation test, however, it was found that this was not significant. Therefore, it can be stated that the Null Hypothesis (H_0) of the test was accepted, indicating that no exist autocorrelation problems. The tests performed were necessary to identify whether the estimated model presented the minimum desirable characteristics to that the estimated betas could be considered the best linear unbiased estimators.c Analyzing the results found in Table 2, the log variable of the GDP lagged in one period shows that the formation of the GDP it has dependent on a period. Therefore, if exist a 1% increase in the gross domestic product of the previous period, this will cause an increase in the current GDP of about 0.66%, keeping the other variables constant. This finding shows the dynamic profile of the states analyzed, which justifies the use of the dynamic panel. The variable human consumption of drinking water presented statistical significance at the 1% level, and its coefficient was negative, indicating that if exists 1% increase in human consumption of drinking water, the economic growth of the states will tend to be decreased by about 15.5%. Considering that human consumption of water is considered consumptive use of water, i.e., it reduces the availability of water in rivers and lakes, our main sources of water supply, as human consumption increases, the availability of water for industry, agriculture, and livestock will decrease.

This scenario can be seen in Table 1, where it is possible to see that the average human consumption of water, during the period studied, averaged 5.0 million m^3 of water. In this case, this volume may be computing the actual use, that is, what is consumed by humans and, also, the volume of water resource that is lost in terms of leaks or other events that cause the resource to be lost. In turn, the variables of water consumption, potable in Industry and Agriculture, were both significant at the 1% level of significance showing that these contribute to the economic growth of the Brazilian states over the period studied (1994 to 2018). In the specific case of water use in industry, the log variable shows that if there is a 1% increase in this consumption, the GDP of the Brazilian states will tend to increase by around 0.67%. And in the case of agriculture, a 1% increase in this consumption will increase the gross domestic product by about 0.64%. Both results are in line with what was expected, showing that water consumption in these two segments contributes significantly to the economic growth of the states. The marginal productivity or dose-response theory helps explain these results, because considering that water is the basic input for several productive activities, if exist an increase in its consumption, the economic result tends to be in the same proportion, as evinced by Minho, Gaspar, and Domingues (2016). Following the same logic presented so far in the analyses, the variables in the logarithm of Cattle Herd and Total Production of Agriculture, the latter being composed of the total production of temporary and permanent crops, both were also significant at the level of 1% significance, indicating that with a 1% increase in cattle production and in the total production of agriculture, the gross domestic product of the Brazilian states would be increased by 3.29% and 0.68%, respectively. Making a comparison of the statement of Seroa da Mota (2006), one can say that the GDP of the states, which is considered the product in the production function of this study, it reflects a combination of economic, social, and environmental factors, therefore, the increase in these two economic variables, it was expected that there would be a positive reflection on the state GDP. Associating, also, the arguments of Minho, Gaspar and Domingues (2016) to this study, as the productive inputs are increased, in this case the production of temporary and permanent crops, in addition to cattle production in the states, the GDP will receive a return, which in this specific case was positive, increasing the economic result.

Final Considerations

Considering the central objective of this research, which was to identify how drinking water consumption variables, whether for human consumption, agriculture, and/or industry, affected the economic growth of Brazilian states, it was found that these are highly important for the increase in GDP, except for human consumption, because it reduces water availability, without directly promoting economic growth. In turn, the other variables have shown the capacity to promote economic growth, even though they are considered consumptive uses, they have shown great potential for increasing the gross domestic product of the states. Therefore, it can be said that water consumption has great potential to contribute to economic growth, however, society must apply more sustainable means in order not to deplete this natural resource, which has its availability compromised when long periods of drought occur. Therefore, it becomes vitally important that the public manager adopts more sustainable measures to use this input/resource without damaging its availability. As a limitation of this study, we can point out the lack of studies correlated to the theme, in which the impact of drinking water consumption on economic growth was effectively analyzed, besides the inexistence of a specific theoretical model capable of helping in the discussions to better explain the results.As a suggestion for future studies, we suggest the insertion of other economic and/or social variables in the modeling to verify their impact on economic growth, along with the variables of water availability.

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REFERENCES

National Water Agency (ANA). Situação das Águas no Mundo. Brasília, DF. Disponível em: https://www.ana.gov.br/panorama-das-aguas/agua-nomundo. Acesso em: 21 out. 2019.

Altshuler, B. Modeling of dose-response relationships. Environmental Health Perspectives. v. 42, p. 23-27, 1981.

Arellano, M.; Bover, O. Another look at the instrumental variable estimation of error-components models. Journal of Econometrics, v. 68, n. 1, p. 29-51, 1995.

Calthrop, E.; Maddison, D. The dose-response function approach to modelling the health effects of air pollution. Energy Policy. v. 24, n. 7, p. 599-607. 1996.

Esperancini, M.S.T. Métodos de valoração e a função dose-resposta: dificuldades e viabilidade de aplicação em estudos de poluição do ar. Holos Environment. v. 1, n. 1, p. 1-17. 2001.

Faucheux, S.; Noël, J. F. Economia dos recursos naturais e do meio ambiente. Portugal: Instituto Piaget, 1997.

Fryges, H. The export-growth relationship: estimating a dose-response function. Center for European Economic Research. 2006.

Gadagkar, S.R.; Call, G.B. Computacional tools for fitting the Hill equation do dose-response curves. Journal of Pharmacological and Toxicological Methods. n. 71, p. 68-76, 2015.

Greene, W.H. Econometrics Analysis. 7. ed. New Jersey: Pearson, 2012.

Gujarati, D.N.; Porter, D.C. Econometria Básica. 5. ed. Porto Alegre, 2011.

Hawken, P.; Lovins, A.; Lovins, L. H. Capitalismo Natural: criando a próxima Revolução Industrial. Tradução de Luiz A. de Araújo e Maria Luiza Felizardo. São Paulo: Editora Cultrix, 1999.

Minho, A.P.; Gaspar, E.B.; Domingues, R. Guia Prático para determinação da curva dose-resposta e concentração letal em bioensaios com extratos vegetais. Comunicado Técnico 93. EMBRAPA, 2016.

Nordberg, G.F.; Stramgert, P. Fundamental aspects of dose-response relationships and their extrapolation for noncarcinogenic effects of metals. Environmental Health Perspectives. v. 22, p. 97-102, 1978.

Seroa da Motta, Ronaldo. Economia ambiental. Rio de Janeiro, RJ: Ed. da FGV, 2006.

Viecili, P.R.N. et al. Curva dose-resposta do exercício de hipertensos: análise do número de sessões para efeito hipertenso. Arquivos Brasileiros de Cardiologia. v. 92, n. 5, 2009. http://dx.doi.org/10.1590/S0066-782X2009000500010.

Wakim, V. R.; Vergara, F. E.; Magalhães, E. A. Uso do método dose resposta na mensuração de impactos na lucratividade de produção de arroz irrigado na microrregião de Formoso do Araguaia no Estado do Tocantins. Revista em Agronegócios e Meio Ambiente. v. 5, p. 103-133. 2012

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