

Effect of Public Higher Education Institutions on Local Economic Growth

Leilyanne Viana Nogueira*
CIPP S/A
(leilyviana@hotmail.com)

Felipe de Sousa Bastos†
DTE/CAEN/UFC
(felipebastos@caen.ufc.br)

Abstract

The paper focuses on the effects that the human capital produced by Higher Education Institutions (HEI) promote on the local economic growth. The empirical framework comprises two steps: (1) estimating efficiency indexes for each HEI, through a stochastic frontier approach and a simulated marginal maximum likelihood estimator developed by Belotti and Ilardi (2017); and (2) estimating a dynamic panel model in order to provide the effects of human capital on local economic growth. The data sample consists of a panel of 37 public higher education institutions located in 22 municipalities in the Northeast of Brazil and a panel of 166 private institutions located in 53 municipalities in the Northeast of Brazil, both for the period over 2009-2015. There is evidence of a positive correlation between the efficiency of public HEIs and local economic growth.

Keywords: Higher Education Institutions; Human Capital; Economic Growth.

Resumo

O foco central deste artigo é investigar os efeitos do capital humano gerado pelas Instituições de Ensino Superior (IES) sobre o crescimento econômico em nível municipal. A abordagem empírica consiste em duas etapas: (1) estimar índices de eficiência para as IES, a partir da abordagem de fronteira de produção estocástica e por meio do estimador de máxima verossimilhança marginal simulada seguindo Belotti e Ilardi (2017); e (2) utilizar os índices na estimação de um modelo de crescimento na forma de painel dinâmico, a fim de se obter os efeitos investigados. A base de dados é composta por um painel de 37 instituições públicas de ensino superior localizadas em 22 municípios do Nordeste do Brasil e um painel de 166 instituições privadas localizadas em 53 municípios do Nordeste do Brasil, ambos no período de 2009 a 2015. Encontra-se evidência de correlação positiva entre a eficiência das IES públicas e o crescimento econômico local.

Palavras-chave: Instituições de Ensino Superior; Capital Humano; Desenvolvimento Institucional; Crescimento Econômico.

JEL: C23, O15, O43.

1. Introduction

Macroeconomic research should primarily focus on studying the determinants of long-term economic growth and analyzing policies that impact per capita income and long-term social well-being (SALA-I-MARTIN, 2000). One such determinant highlighted in the endogenous growth literature is human capital, which contributes to economic growth by enhancing individual productivity and fostering knowledge spillovers (BARRO; SALA-I-MARTIN, 2004).

The levels of human capital in a region can be raised through the performance of universities in teaching activities, ensuring the training of a skilled workforce, or in research

* Commercial Logistic Development Analyst at Development Company of the Industrial and Port Complex of Pecém (CIPP S/A), São Gonçalo do Amarante, Brazil.

† Professor at Department of Economic Theory (DTE/UFC) and Research at Center for the Improvement of Economists of the Northeast (CAEN/UFC), Fortaleza, Brazil.

activities, which facilitate the attraction of innovative companies to the region, increase demand for skilled workers, and stimulate innovation in established local businesses (ABEL; DEITZ, 2011).

In addition to influencing the demand and supply of human capital, universities generate knowledge and promote technological innovation. Therefore, these institutions have the potential to foster economic development (GOLDSTEIN et al., 1995, cited in DRUCKER; GOLDSTEIN, 2007) and per capita GDP in the region where they are located (BARRA; ZOTTI, 2016).

In Brazilian legislation, the importance of universities is evident in the National Education Plans (BRASIL, 2001 and 2014), which are based on the recognition that no country can be developed without a strong higher education system. Thus, they consider strategic objectives: expanding higher education offerings while ensuring the quality of education and implementing an expansion policy that minimizes regional disparities and enables access to undergraduate education in more remote areas.

In the last two decades, Brazil has implemented a series of policies to achieve these objectives, including the establishment of the Student Financing Fund for Higher Education (FIES) (BRASIL, 2001), the University for All Program (PROUNI) (BRASIL, 2005), the Support Program for Restructuring and Expansion Plans of Federal Universities (REUNI) (BRASIL, 2007), and the creation of Federal Institutes of Education, Science, and Technology (BRASIL, 2008).

Because of these policies, there has been a significant expansion of universities, colleges, and federal institutes of technological education in the Northeast of Brazil. Between 2001 and 2016, there was an increase of 269 Higher Education Institutions (HEIs) in the Northeast, corresponding to a growth of 127% and an addition of 544 thousand places in on-site undergraduate courses¹. During the same period, considering all Brazilian regions, the growth in the number of HEIs was 73%.

Given this pronounced strengthening of higher education in the Northeast and the high demand in this region for development policies, and considering the importance of universities in producing human capital and its impact on economic growth, it is relevant to investigate whether HEIs in the Northeast contribute to the economic growth of the municipalities where they are located.

Following the study by Barra and Zotti (2016) and exploring a panel of 37 public higher education institutions located in 22 municipalities in the Northeast and a panel of 166 private institutions located in 53 municipalities in the Northeast from 2009 to 2015, this article aims to investigate, based on theoretical premises, whether the human capital formed by HEIs in the Northeast positively affects the per capita GDP of the municipalities where these educational institutions are located.

Considering that the effects of human capital on the economic growth of a region may depend on social capacities, individuals' rights and capabilities, socioeconomic, and institutional factors (ABRAMOVITZ, 1986; SEM, 1983), an institutional quality index was added as a control variable in the local economic growth regression.

To achieve this objective, efficiency indices are estimated for each HEI using the stochastic production frontier approach and the simulated marginal maximum likelihood estimator of Belotti and Ilardi (2017). Additionally, for the control variable of municipal institutional quality, indices based on information about local government, popular participation, degree of social development, and local market structure are calculated. Subsequently, a dynamic panel model is estimated using the Arellano-Bond GMM estimator (1991).

¹ Data from the INEP/MEC Higher Education Census.

The authors found other studies in the Brazilian literature² that calculate efficiency indices for universities, although using a different technique (Data Envelopment Analysis – DEA). However, they do not assess the relationship between the efficiency of higher education institutions and the local growth. There are also studies, such as Caldarelli et al. (2015), that investigate the contribution of HEIs to economic development but in a simplistic way by inserting only a dummy indicating the existence of a HEI in the region.

It is also important to highlight that most studies in the Brazilian literature use the average level of education of the economically active population as a proxy for human capital, which is only justified in the absence of more appropriate alternatives. This article innovates and differs from others by estimating human capital from efficiency indices of universities, focusing on the quality dimension of education rather than quantity.

This article also contributes by proposing an institutional quality index for municipalities, used as a control variable in the estimated growth regression, attempting to capture characteristics of the local society that define its political, social, and economic interactions based on North's (1991) concept of institutions.

In addition to this introduction, the article is organized into four more sections. The first provides a brief literature review on the importance of higher education institutions and the relationship between human capital, institutions, and economic growth. Following that, the empirical approach, the data used, and the discussion of results are described. In the last section, the final considerations are presented.

2. Theoretical Framework

2.1. The Role of Higher Education Institutions

The globalization of higher education and increased competition for resources have increasingly interconnected university goals with regional development purposes (GOLDSTEIN; GLASER, 2012).

In this context, Brazilian higher education, in its dimensions of teaching, research, and extension, aims to educate individuals to work in various professional sectors and contribute to societal development, develop science and technology, provide specialized services to the community, disseminate produced knowledge, etc. (BRASIL, 1996).

Considering the relevance of these purposes, the literature has investigated the impacts of university activities on economic growth. According to Drucker and Goldstein (2007), there are four types of research in this area: impact studies of a single university, surveys, studies of knowledge production functions, and cross-sectional and quasi-experimental designs. Generally, the analyses suggest that university activities, including teaching and basic research, have positive effects on regional economic progress.

The potential of universities to promote economic development stems from their activities of knowledge production, human capital formation, technological innovation, investment in capital, and influence on the regional environment (GOLDSTEIN et al., 1995, cited in DRUCKER; GOLDSTEIN, 2007).

Abel and Deitz (2011) also emphasize that universities can increase the supply and demand for human capital. Despite this, a study of the metropolitan areas of New York and New Jersey revealed only a small positive relationship between the human capital produced by HEIs and the local stock of human capital, indicating that the retention of graduates in the regions where they studied depends on the local demand for skilled labor.

In this sense, Abel and Deitz (2012) confirm that research activities contribute to raising local levels of human capital; however, the migration of graduates is significant for the geographical distribution of human capital.

² Façanha and Marinho (2001) and Costa et al. (2015), for example.

Evaluating the impacts of creating a new university in a coastal region of France, Mille (2004) found a retention rate of graduates below 50%, reduced dissemination of human capital due to jobs in the region requiring low levels of qualification and low direct cooperation between the university and local companies.

In the review by Astebro and Bazzazian (2010), evidence shows that commercialization cultures can be created locally in university departments or programs of study. This strategy can stimulate the development of many student start-ups, contributing to economic growth.

Barra and Zotti (2016), in turn, calculate efficiency indices for 72 Italian universities over a period of nine academic years and then estimate, using system-GMM, the relationship between human capital and local economic growth. The estimated models indicate that human capital produced by HEIs has a positive impact on local per capita GDP. Furthermore, the closer an area is to an efficient university, the greater the effect of university efficiency on the economic development of that area.

Exploring a sample of Brazilian municipalities between 2000 and 2010, Rocha et al. (2017) found that the variation in the proportion of people with higher education is positively related to changes in average wages, occupation rates, and per capita income. Moreover, while the growth of graduates from private HEIs is more associated with the increase in the occupation rate, the increase in the number of graduates from public institutions is more strongly correlated with the growth of average wages and per capita income.

2.2. The Importance of Human Capital for Economic Growth

Human capital, a set of knowledge, skills, abilities, and other characteristics acquired by individuals that contribute to production, is essential for economic growth and even for the efficient use of physical capital (GOODE, 1959).

This type of capital can be increased through direct spending on education, health, and internal migration to explore better job opportunities; opportunity costs of mature students attending school and workers training on the job; and leisure time used to acquire more knowledge (SCHULTZ, 1961).

The importance of human capital for economic growth was highlighted in early endogenous growth models, which relaxed the constraint of diminishing returns for an extended measure of capital, composed of physical and human capital. This allowed explaining long-term per capita income growth without assuming exogenous technological progress (BARRO; SALA-I-MARTIN, 2004).

From the discussion of Arrow's (1962) learning by doing, Romer (1986) focuses on knowledge spillovers from firms, which positively affect production possibilities in the economy and ensure increasing marginal productivity. In Lucas's (1988) model, human capital, which raises productivity, is accumulated so that a constant level of effort results in a constant growth rate of this type of capital. In this model, human capital can be acquired through work or through learning by doing.

On the other hand, Olson (1996) differentiates by considering two types of human capital: "personal culture", related to skills and work propensity, which is marketable and ensures higher incomes for the individual; and "civic culture", referring to knowledge about the effects of different public policies, which is not marketable. According to the author, this latter type of human capital determines individuals' choices in the electoral process, which can lead to better public policies and increased societal income.

It is important to note, however, that almost all components of human capital, except for education, are difficult to quantify. Therefore, most studies investigating the relationship between human capital and growth limit themselves to examining the impact of formal education on growth (ALI et al., 2016; LEE; LEE, 2016).

Barro (2013), for example, studies the importance of human capital for economic growth by investigating the impacts of two dimensions of education: quantity, measured by years of study, and quality, evaluated by countries' scores in international exams in science, mathematics, and reading. The main result indicates that, controlling for quality, the quantity of education is positively related to growth; however, the effect of quality is quantitatively more significant.

Using data from U.S. metropolitan areas from the 1970s to 2000, Berry and Glaeser (2005) find a strong correlation between the growth of the graduated population and the initial proportion of the population with high levels of education. Furthermore, they confirm a close relationship between education and income in metropolitan areas.

In the study by Fraga and Bacha (2013), the estimated models, through dif-GMM by Arellano and Bond (1991) and sys-GMM by Blundell and Bond (1998), suggest that the increase in the average education of the economically active population positively impacts the per capita GDP growth rate of Brazilian states. In turn, exploring a panel of 286 municipalities in the state of Paraná in 1991 and 2000, Nakabashi and Felipe (2007) also estimate a positive effect of human capital on the per capita GDP growth rate per worker.

It is important to emphasize, however, that studies at the micro and macro levels differ regarding the effect of education on economic growth. Exploring data from Indian states from 1961 to 2001, Schündeln and Playforth (2014) explain these divergences by considering that more educated individuals obtain public jobs with high individual rewards and low social returns, as they work in unproductive roles or exert negative externalities on the productivity of the private sector.

Schündeln and Playforth's (2014) analysis indicates that educational expansion is not statistically significant in the growth regression when government participation in the economy is not considered. On the other hand, controlling for the effects of government size, there is evidence that increased education promotes growth. However, the effect of education expansion decreases as government size increases.

2.3. The Importance of Institutions for Economic Growth and for the Human Capital-Economic Growth Relationship

In addition to human capital, social capacity - persistent characteristics of society such as technical competence and the quality of institutions - is a fundamental element to explain countries' productivity levels. Thus, the contribution of human capital to growth may depend on these social capacities (ABRAMOVITZ, 1986).

According to Sen (1983), growth is only a means to development, which consists of a process of expanding people's rights and capabilities. Thus, in addition to economic factors, political arrangements that affect people's ability to demand goods must be analyzed. From this perspective, the development of human capital and its impact on productivity depends on individuals' rights and capabilities.

For North (1991), institutions consist of a set of constraints defined by society that determine social, economic, and political interactions. These constraints can be formal rules or informal conventions, customs, and codes of conduct.

To investigate the importance of institutions, Olson (1996) evaluates "natural experiments", such as the cases of Korea and Germany. After division, these countries were administered from significantly different institutions, determining very distinct economic growth and development. For the author, differences in economic policies and institutions determine differences in per capita income between countries.

Similarly, Acemoglu et al. (2000) demonstrate that about 3/4 of the differences in per capita income between countries are explained by differences in their institutions. The study is based on the theoretical argument that the mortality rates faced by colonizers determined the

viability of settlements in the colonies, which influenced the type of colonization, exploitation, or settlement. These different colonization policies shaped different institutions that persisted after the colonies' independence.

Evaluating the Italian experience, Putnam (2006) notes that good institutional performance and socioeconomic progress are strongly related to "civic community", characterized by citizens participating in discussions of collective interest, balanced political relations, social relations based on trust and collaboration. Moreover, the "civic community" has historical roots, and civic traditions are persistent.

Rodrik (2000) also emphasizes that the adequacy of institutional arrangements depends on each people's history. Thus, although international models are useful, the institutional development process requires knowledge about local needs and capabilities, which can be aggregated by participatory political institutions (democracy).

Considering these discussions, Ali et al. (2016) try to identify the socioeconomic and institutional factors that explain the strength of the relationship between human capital and growth. Since a solid economic, social, and institutional environment is necessary for the human capital stock to be efficiently used, the study introduces explanatory variables related to Economic Opportunities and the Quality of Legal Institutions and Property Rights into traditional growth models.

In Ali et al.'s (2016) study, the human capital variable at the level becomes significant when variables related to social capacities are included in growth models. Furthermore, greater economic opportunities (freedom of trade and regulation) increase the effect of human capital on growth.

The structural VAR model estimated by Góes (2016) indicates that exogenous shocks to institutional quality, measured by a World Economic Freedom Index, have a positive effect on per capita GDP; there are diminishing returns to institutional improvements; and per capita GDP affects institutions contemporaneously.

Using World Bank and IMF indicators on Governance and Business Environment, Tiryaki (2008) finds that greater institutional development reduces the risk of infrastructure investment, stimulating private sector participation. Exploring the same indicators, Bittencourt et al. (2016) confirm a positive relationship between institutional quality and foreign direct investment (FDI) inflows and a negative relationship between FDI inflow and the institutional distance between the recipient and sender countries of the investment.

Regarding the long-term determinants of municipal institutions, Naritomi et al. (2012) demonstrate that municipalities directly affected by the Sugar Cane Cycle are characterized by a higher concentration of economic-political power. On the other hand, municipalities involved in Gold mining activities currently have worse governance practices and less access to justice.

In a cross-section analysis, Pereira et al. (2011) find evidence that the quality of institutions explains differences in per capita income among Brazilian municipalities. Ribeiro et al. (2017), in turn, construct proxies for institutions in municipalities, considering characteristics of legislation and planning instruments, resources for management, education, and health. The results indicate a positive association only between Resources for Management and the Firjan Municipal Development Index. For a panel of Brazilian states, Arraes et al. (2004) find a positive correlation between the civic participation index in state elections and per capita GDP.

3. Methodological Aspects

3.1 Empirical Exercise

The empirical strategy used in this article follows the proposal of Barra and Zotti (2016), which consists of estimating the relationship between human capital and local economic growth

using efficiency indices of higher education institutions, calculated through the stochastic frontier approach.

3.1.1. Growth Model

To assess the importance of efficiency indices of higher education institutions on local economic growth, the following dynamic panel model is estimated using the Arellano-Bond GMM estimator (1991):

$$\begin{aligned} \ln GDP_{pc_{ijt}} = & \alpha \ln GDP_{pc_{ij,t-1}} + \beta_1 \ln DH_{ijt} + \beta_2 \ln LIS_{ijt} + \beta_3 \ln QFT_{ijt} \\ & + \beta_4 \ln PESQ_{ijt} + \beta_5 \ln IQI_{ijt} + \mu_{ij} + \tau_t + \varepsilon_{ijt} \end{aligned} \quad (1)^3$$

Where i refers to higher education institutions (HEIs), the panel's units of analysis, j refers to the municipality where the HEI is located, t refers to the year, μ_{ij} is the unobserved specific effect of municipality j , τ represents annual dummies. The dependent variable, $\ln GDP_{pc}$, is the natural logarithm of the per capita Gross Domestic Product (GDP)⁴ of the municipality where the HEI is located. The explanatory variables⁵ are: The first lag of per capita GDP, Estimated efficiency indices of higher education institutions, $IEHEI_1$ and $IEHEI_2$, which qualitatively measure the level of human capital development (DH). Alternatively, we use a quantitative proxy for human capital development, represented by the number of graduates weighted by the General Course Index of the HEI, GRAD. The other control variables are: An indicator of the local industry structure, LIS , measured by the ratio of the sum of jobs in the service and industry sectors to the total population, A proxy for the quality of the local labor market, QLM, represented by the ratio of jobs held by college-educated workers to the total stock of jobs, The ratio of the sum of doctoral or master's degree-holding teachers and undergraduate students involved in research activities to the sum of teachers and enrolled students, capturing the effect of HEIs on local growth through knowledge production or innovation, SEARCH, and an index of institutional quality of the municipality, IQI, constructed as discussed in the next subsection.

As Abel and Deitz (2011) caution, the direction of causality between per capita GDP and human capital may be opposite to that established in Equation (1) because more productive regions possibly attract individuals with higher qualifications. In this case, the higher level of economic activity in a region would induce an increase in human capital levels. Additionally, the literature also points to a bidirectional relationship between institutional quality and economic growth.

To account for the endogeneity of human capital and institutional development, the parameters of Equation (1) will be estimated using the two-stage GMM estimator by Arellano and Bond (1991), with the Windmeijer (2005) corrected standard errors. Lagged levels of the dependent variable and endogenous variables are used to construct GMM-type instruments. Moreover, the first differences of strictly exogenous variables are used as standard instruments. To check the validity of the moment conditions of the two-stage GMM estimator, the Arellano-Bond test for first or second-order autocorrelation in first-differenced errors is applied.

3.1.2. Institutional Quality Index

For the estimation of Equation (1), two institutional quality indices will be used. Aligned with the concept of institutions (NORTH, 1991), the variables composing the indices are related

³ The specification of Equation (1) basically followed Barra and Zotti (2016), whose dynamic panel model was based on a similar approach applied in a context of studying the relationship between growth and finance, developed by Hasan, Koetter and Wedow (2009) and by Destefanis, Barra and Lavadera (2014). In this article, we differentiate the specification by inserting the proposed institutional quality index.

⁴ Values in 2015 reais.

⁵ On a logarithmic scale.

to the characteristics of the local society that define its political, social, and economic interactions. The first index is a weighted average of information about local government, popular participation, the degree of social development, and the structure of the local market, as outlined in Figure 1 and discussed below. The second index will be addressed in Equation (3) later.

In terms of local government, the following characteristics are considered. Local Government Participation, measured by the ratio of the number of jobs in the public administration to the total number of jobs, denoted as *Eadp*. Influence of Political and Economic Groups, represented by the percentage of non-effective statutory jobs out of the total statutory jobs, denoted as *Servne*. Municipal Transparency Indicator (*Itransp*)⁶, calculated as the arithmetic average of three variables: the age of the Municipal Education Council, the age of the Municipal Health Council⁷, and the age of the municipal regulation of the Access to Information Act (LAI)⁸.

The institutional quality indicators explored in the studies by Tiryaki (2008) and Góes (2016) consider characteristics related to government efficiency and the size of the public sector, respectively. In this context, the indicator constructed in this study attempts to capture the negative influence of government size on local institutions through the representation of the public administration in the labor market.

Building on Schündeln and Playforth (2014), the indicator's construction takes into account that a higher participation of the public administration in the labor market tends to increase the probability of public employees performing unproductive functions or exerting negative externalities on the private sector, thereby deteriorating political and economic institutions.

Conditioned on the available data for municipalities, the percentage of non-effective statutory jobs out of the total statutory jobs was used to assess the influence of political and economic groups on public administration. The institutional quality indicator assumes that a higher relative quantity of appointed positions may facilitate involvement in corrupt activities and actions benefiting personal or group interests, to the detriment of social benefit.

In this line, the theoretical decision-making model developed by Bugarin and Meneguín (2016) predicts that career managers take fewer risks in their activities, avoiding decision-making that may be questioned and result in the loss of public office. The authors empirically find that the higher the percentage of career civil servants in leadership and advisory positions, the fewer irregularities are found.

The transparency indicator aims to capture the willingness of municipal governments to provide information to citizens or encourage collaboration and participation of society in municipal education and health policies. Thus, it was considered that older municipal councils or LAI regulations reveal a greater willingness of the local government to transparent policies. This is because municipalities that have created councils and information access systems for a longer time have allowed their populations to participate more promptly in the control and supervision of municipal policies⁹.

⁶ To keep *Itransp* within a range of 0 to 1, the municipal transparency index is calculated relative to the highest transparency index found in the sample (municipality of Caruaru-PE in 2015).

⁷ Municipal education and health councils are collegiate bodies made up of representatives from government departments, universities and civil society organizations, responsible for controlling and monitoring the implementation of education and health policies, among other objectives.

⁸ Law No. 12,527/2011 regulates access to information provided for in the Federal Constitution and amends previous laws on access and disclosure of documents and information from public bodies. This law established that it would be up to States and Municipalities, in their own legislation, to define specific rules regarding the creation of information services for citizens.

⁹ The Comptroller General of the Union (CGU) uses the Transparent Brazil Scale (EBT) to measure public transparency in Brazilian states and municipalities. The EBT assesses the degree of compliance with provisions of

Considering that the performance of institutions is closely related to the nature of the "civic community" discussed by Putnam (2006), in the dimension of population participation, an attempt was made to capture: Popular Involvement in Collective Issues, Fulfillment of Civic Duty, and Degree of Population Organization.

An important societal issue of interest is the prevention and control of arboviruses, such as dengue. The Ministry of Health and state and municipal health departments carry out various public actions to combat the mosquito that transmits this disease. However, they consider the conscious and permanent action of the population as the most relevant. This is because the predominant breeding grounds for the mosquito in Brazil are water storage containers for human consumption (water tanks, drums, filters, pots), followed by domestic deposits (furniture, fixed and natural) and garbage. Similarly, in the Northeast region, water storage containers for human consumption prevail (BRASIL, 2019).

In this sense, the correlation between this societal issue, dengue prevention and control, and the need for conscious population action was considered to measure popular interest in collective causes based on the incidence of dengue in the municipality, denoted as Inc dengue^{10,11}.

Moreover, it is essential to highlight that increased citizen participation in the electoral process tends to reveal the demands of the community and local needs. According to Rodrik (2000), knowledge of these needs is fundamental for the development of better institutions. Thus, the fulfillment of civic obligations was measured based on the voter turnout rate, denoted as Tturnout, i.e., the ratio of the number of voters who participated in elections to the number of eligible voters¹².

Considering that social relationships built on collaboration and trust among individuals characterize the "civic community" and strengthen institutions (PUTNAM, 2006), the ability of the population to organize was measured by the participation of cooperatives, religious organizations, and autonomous social service organizations in the total establishments of the municipality, denoted as Coopigress.

To comprehend the foundation of rights and capabilities of individuals (SEN, 1983), which influences social relations, the indicator of institutional development also encompasses a dimension related to the social development of the municipality where the Higher Education Institution (HEI) is located. For this dimension, the average of three variables indicating the effectiveness of protection for youth and the safety of residents in the municipality was considered. These variables are the rate of live births to mothers aged 15 to 19, Txnvm15a19; the rate of violent deaths among individuals aged 15 to 24, Txov15a24; and the rate of violent deaths, Txov.

Concerning the local market structure, an attempt was made to capture the level of entrepreneurship in the municipality using annual rates of new business creation, Txnewbusiness, as presented in the Central Companies Registry of IBGE. Additionally, the degree of openness of the local economy, Open¹³, was considered, measured by the ratio of the sum of exports and imports to the municipal GDP.

the Access to Information Law, focusing on the assessment of passive transparency and the LAI Regulation. This indicator is perhaps more appropriate for measuring municipal transparency. Despite this, it was not possible to use it, because the CGU evaluations were only carried out in 2015 and 2016.

¹⁰ Incidence = (cases/population) x 100,000.

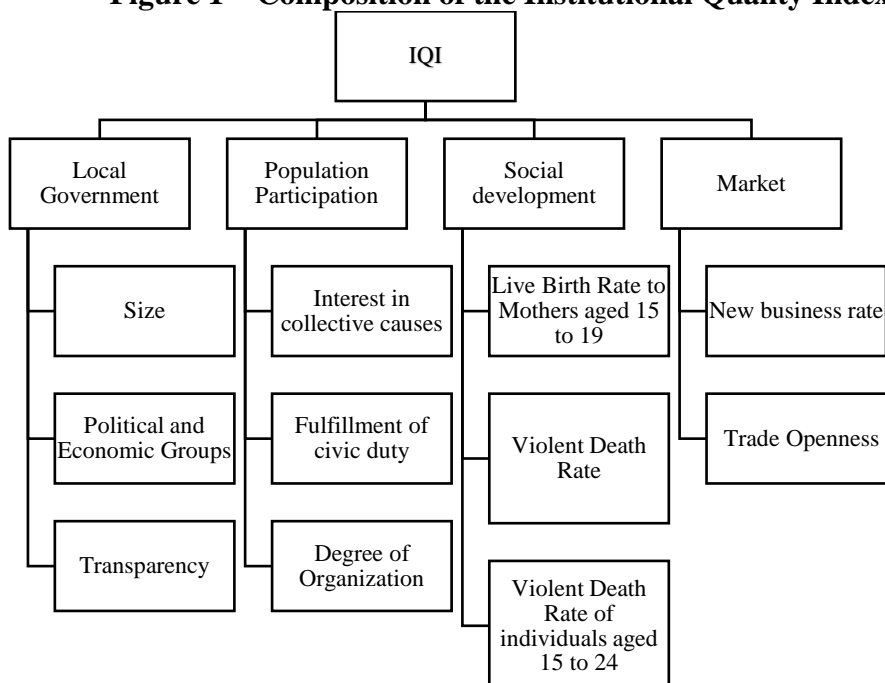
¹¹ To maintain Inc dengue within a range of 0 to 1, the relative incidence of dengue was calculated, taking as a reference the highest indicator found in the sample (municipality of Monteiro-PB in 2015).

¹² For years in which there was no election, the average turnout rate of the four elections immediately preceding the year considered was calculated.

¹³ In order to maintain the openness indicator in a range of 0 to 1, in order to make it compatible with the limits of other variables and avoid the influence of openness on the institutional quality index, the degree of openness

The selection of these market variables was based on the availability of municipal-level data that aligned with indicators used in empirical studies. In the literature, for instance, indicators of institutional quality for countries consider components related to the ease of doing business (TIRYAKI, 2008) and freedom in international trade (GÓES, 2016).

Figure 1 – Composition of the Institutional Quality Index



Source: Prepared by the authors.

In summary, the institutional quality indicator was calculated as follows:

$$\begin{aligned}
 IQI_1 = & \left\{ \left(\frac{1}{4} \right) * \left[\left(-\frac{1}{3} \right) * (Eadp) + \left(-\frac{1}{3} \right) * (Servne) + \left(\frac{1}{3} \right) * (Itransp) \right] \right\} + \\
 & \left\{ \left(\frac{1}{4} \right) * \left[\left(-\frac{1}{3} \right) * (Incdengue) + \left(\frac{1}{3} \right) * (Txcomparecimento) + \left(\frac{1}{3} \right) * (Coopigress) \right] \right\} + \\
 & \left\{ \left(\frac{1}{4} \right) * \left[\left(-\frac{1}{3} \right) * (Txnvm15a19) + \left(-\frac{1}{3} \right) * (Txov15a24) + \left(-\frac{1}{3} \right) * (Txov) \right] \right\} + \\
 & \left\{ \left(\frac{1}{4} \right) * \left[\left(\frac{1}{2} \right) * (Txnewbusiness) + \left(\frac{1}{2} \right) * (Open) \right] \right\}
 \end{aligned} \tag{2}^{14}$$

As an alternative indicator of the institutional quality of municipalities, a more synthetic index was considered, calculated according to the following equation:

$$\begin{aligned}
 IQI_2 = & \left\{ \left(\frac{1}{3} \right) * \left[\left(-\frac{1}{2} \right) * (Eadp) + \left(\frac{1}{2} \right) * (Itransp) \right] \right\} + \\
 & \left\{ \left(\frac{1}{3} \right) * \left[\left(-\frac{1}{2} \right) * (Incdengue) + \left(\frac{1}{2} \right) * (Txcomparecimento) \right] \right\} + \\
 & \left\{ \left(\frac{1}{3} \right) * \left[\left(\frac{1}{2} \right) * (Txnewbusiness) + \left(\frac{1}{2} \right) * (Open) \right] \right\}
 \end{aligned} \tag{3}^{15}$$

relative to the highest indicator found was used in the sample (municipality of São Francisco do Conde-BA in 2012).

¹⁴ $-0,50 \leq IQI_1 \leq 0,50$.

¹⁵ $-0,33 \leq IQI_2 \leq 0,67$.

3.1.3. Universities Efficiency

To calculate the efficiency indices for each university, a first-difference transformation is initially applied to the stochastic production frontier model to eliminate fixed effects. Subsequently, the model parameters are estimated using the simulated maximum likelihood estimator by Belotti and Ilardi (2017).

Consider the following stochastic production frontier model with fixed effects:

$$y_{it} = \alpha_i + \mathbf{x}_{it}\boldsymbol{\beta} + v_{it} - u_{it} \quad (4)$$

Here, y_{it} is the logarithm of the product of higher education institution i , $\ln GRAD$, represented by the number of graduates weighted by the General Course Index (IGC) of the institution¹⁶, as defined in Equation (5):

$$y_{it} = \ln Grad_{it} = \ln\{[1 * Alunocae_{it} + 0,75 * (Alunoc_{it} - Alunocae_{it})] * IGC_{it}\} \quad (5)$$

Where $Alunocae_{it}$ indicates the number of graduating students who participated in some type of extracurricular activity (non-mandatory internship, university extension activities, teaching, and research), $Alunoc_{it}$ is the total number of graduating students, and IGC_{it} represents the General Index of Evaluated Courses of the Higher Education Institution, calculated annually by INEP¹⁷. In the composition of the variable $\ln GRAD$, graduating students who participated in extracurricular activities are given a weight of 1, greater than the weighting of 0.75 assigned to students who did not engage in these activities. This is because engaging in extracurricular activities potentially allows for a more comprehensive and higher-quality education for undergraduates.

In Equation (4), \mathbf{x}_{it} is a vector of inputs for university i , consisting of the logarithm of the number of students enrolled in the institution, $\ln STUDm$, and the logarithm of the number of faculty members at the institution, weighted by education level, $\ln PROFge$, or by employment status, $\ln PROFrt$, and by the General Course Index of the institution, as per Equation (6) and Equation (7).

$$\ln Profge_{it} = \ln\{[(1 * Profdout_{it}) + (0,75 * Profmestre_{it}) + (0,5 * Profesp_{it}) + (0,25 * Profgrad_{it})] * IGC_{it}\} \quad (6)$$

Where $Profdout_{it}$ indicates the number of faculty members with a doctorate, $Profmestre_{it}$ is the number of faculty members with a master's degree, $Profesp_{it}$ is the number of faculty members with a specialist degree, and $Profgrad_{it}$ is the number of faculty members with an undergraduate degree.

$$\ln Profrt_{it} = \ln\{[(1 * Proftide_{it}) + (0,75 * Proftinde_{it}) + (0,5 * Proftp_{it}) + (0,25 * Profh_{it})] * IGC_{it}\} \quad (7)$$

Where $Proftide_{it}$ indicates the number of faculty members with a "Full-time with exclusive dedication" work regime, $Proftinde_{it}$ is the number of faculty members with a "Full-time without exclusive dedication" work regime, $Proftp_{it}$ is the number of faculty members with a "Part-time" work regime, and $Profh_{it}$ is the number of faculty members with an "Hourly" work regime. The efficiency indices of universities generated by using the variable $\ln PROFge$ in the input vector \mathbf{x}_{it} will be referred to as IEHEI₁. Alternatively, when the variable $\ln PROFrt$ is included in the vector \mathbf{x}_{it} , the efficiency indices will be designated as IEHEI₂. The efficiency indices range within [0,1], with values closer to unity indicating higher relative efficiency of the university.

¹⁶ Initially, it was intended to weight graduates based on the academic performance rates of graduating students, however, INEP reported that it does not have such data.

¹⁷ This index is calculated based on: (1) the average of the Preliminary Concepts of the Courses weighted by the number of enrollments in the corresponding undergraduate courses; and (2) the average grade of postgraduate programs weighted by the number of enrollments in the corresponding stricto sensu postgraduate courses (Normative Ordinance n° 12/2008 - MEC).

In Equation (4), β is a vector of unknown parameters¹⁸; α_i is the individual fixed effect, v_{it} is the stochastic error term for university i , assumed to follow $v_{it} \sim N(0, \sigma_v^2)$ and independent of u_{it} , u_{it} measures the inefficiency term for university i , assumed to have heteroscedasticity¹⁹ and quasi-normal distribution with $\sigma_u = g(z_i \delta)$, where $g(\cdot)$ is a known positive monotonic function, δ is a parameter vector, and z_i is a vector of exogenous variables explaining the specific inefficiency of university i .

In this article, the vector z_i comprises the following variables: Organization, an indicator variable for the academic organization of the institution²⁰, equal to 1 for College, 2 for University Center or Federal Institute of Education, Science and Technology, and 3 for University; Capital, a dummy variable equal to 1 if the institution is located in the capital, and 0 otherwise; Medicine, a dummy variable equal to 1 if the institution has a medical school, and 0 otherwise²¹.

To avoid estimator inconsistency issues, Belotti and Ilardi (2017) adopt a first-difference transformation strategy that eliminates fixed effects²². Thus, the model in Equation (4) takes on the form of Equation (8).

$$\Delta \mathbf{y}_i = \Delta \mathbf{X}_i \beta + \Delta \mathbf{v}_i - \Delta \mathbf{u}_i \quad (8)$$

where, $\Delta \mathbf{y}_i = (\Delta y_{i2}, \dots, \Delta y_{iT})'$ with $\Delta y_{it} = y_{it} - y_{it-1}$ and $\Delta \mathbf{X}_i$ is a $(T - 1) \times 2$ matrix of covariates with the t -th row represented by $\Delta x_{it} = (\Delta x_{it1}, \Delta x_{it2})$, for all $t = 2, \dots, T$. Assuming normality, $\Delta \mathbf{v}_i$ follows $\Delta \mathbf{v}_i \sim iid N_{T-1}(\mathbf{0}, \Psi)$. In turn, the multivariate distribution of $\Delta \mathbf{u}_i$ is generally unknown. Nevertheless, the marginal likelihood contribution can be defined.

Belotti and Ilardi (2017) propose estimating the model in Equation (8) through the simulated maximum likelihood approach. For this, they treat the marginal likelihood function as an expectation with respect to the random vector $\Delta \mathbf{u}_i$. Additionally, it is assumed: (1) the distribution of \mathbf{u}_i belongs to a family of single-parameter distributions with support defined on R^+ and scalar parameter σ ; (2) the distribution of \mathbf{u}_i exhibits a scale property, such that $\mathbf{u}_i = \sigma \tilde{\mathbf{u}}_i$, where $\tilde{\mathbf{u}}_i$ does not depend on the unknown parameter σ . The authors demonstrate that, under regularity conditions ensuring the large-sample properties of the simulated maximum likelihood estimator (SMLE) by Chen et al. (2014), the simulated maximum likelihood simulated estimator (SMLE) is consistent and asymptotically equivalent to the SMLE when $n \rightarrow \infty$ and $G \rightarrow \infty$ com $\sqrt{n}/G \rightarrow 0$, where G is the number of random draws from the multivariate distribution of $\Delta \tilde{\mathbf{u}}$. Furthermore, the authors suggest using Halton sequences (1960) for efficient random draws. Through Monte Carlo experiments, Belotti and Ilardi (2017) also demonstrate that the SMLE has good finite-sample properties, especially in small samples.

¹⁸The model will be estimated by specifying a Cobb-Douglas production function with homogeneity of degree 1 (HG1) in the inputs. To test the robustness of the results, the parameters will also be estimated without imposing HG1 on the inputs.

¹⁹ The heteroscedasticity assumption of the inefficiency term is tested using a likelihood ratio test.

²⁰ In Brazil, HEIs are classified according to their academic organization as colleges, university centers or universities (Decree n° 5,773/2006). Universities are multidisciplinary institutions of higher-level professional training, research, extension and mastery and development of knowledge, in accordance with the Law of Guidelines and Bases of National Education (Law n° 9,394/1996).

²¹ The variable Medicine was inserted into the vector z_i to control the fact that HEIs with medical faculties can be more efficient than other educational institutions. Institutions with a medical school are expected to present higher quality than others, because they undergo a rigorous evaluation process. Some of the requirements for authorization of a medical course include: availability of a Teaching Hospital; existence of a qualified Teaching Center, with experience and full dedication; IGC equal to or greater than three; concept of a course equal to or greater than four (MEC, 2013).

²²Greene (2012) highlights that maximizing the likelihood function for the stochastic frontier model, considering fixed effects as parameters to be estimated, can produce inconsistent estimates of variance, especially in short panels.

The inefficiency term estimate is obtained from the Jondrow et al. (1982) approximation $E(u/\varepsilon)$, where $\varepsilon = v - u$. The corresponding efficiency term is given by $\exp[-E(u/\varepsilon)]$.

4. Data Base

The data related to Higher Education Institutions (HEIs) were extracted from the Higher Education Census (CES)²³ and official evaluations of higher education courses produced by the National Institute for Educational Studies and Research Anísio Teixeira (INEP). Municipality information was collected from the databases of the Brazilian Institute of Geography and Statistics (IBGE); the Annual List of Social Information (RAIS) from the Ministry of Labor and Employment; the Transparency and Comptroller General of the Union portal; websites of Northeastern municipalities; databases from the Ministry of Health; the Superior Electoral Court; and the Foreign Trade Secretariat of the Ministry of Development, Industry, Commerce and Services.

This article employs two panels of higher education institutions: one consisting of 37 public institutions located in 22 municipalities²⁴ in the Northeast and another composed of 166 private institutions located in 53 municipalities²⁵ in the Northeast, both spanning from 2009 to 2015.

In 2009, there were 448 higher education institutions in the Northeast, according to the Higher Education Census. However, not all institutions could be used due to incomplete data for the period from 2009 to 2015. Additionally, six institutions were identified as outliers and thus excluded from the sample. The BACON algorithm (Blocked Adaptive Computationally Efficient Outlier Nominators), proposed by Billor et al. (2000), was used to identify multivariate outliers.

Moreover, in the first year of the sample (2009), it was necessary to select institutions with a non-zero number of graduates since this variable is used as the output of the institution in the stochastic production frontier model, which has a logarithmic form. Institutions meeting this criterion in 2009 are included in the sample for the period from 2009 to 2015.

Therefore, in 2009, the institutions in the sample had been operating for at least four or five years, meaning that these institutions had already graduated at least one class of students. This allows for investigating the effect of the teaching activities of these institutions on local growth, the objective of this study. Due to this criterion, institutions created from 2009 to 2015 could not be included in the data sample.

Regarding the choice of the analyzed period, it is noteworthy that information on teachers per course and the municipality where the course is offered was only available from 2009 onwards. This availability of data on teachers by municipality and the criterion of filtering institutions with a non-zero number of graduates in 2009 limited the sample size.

²³ The Higher Education Census is a nationwide survey, carried out annually by INEP's Directorate of Educational Statistics in all Higher Education Institutions (HEIs), public and private, in Brazil (INEP, Jan/2016).

²⁴ Maceió-AL; Feira de Santana-BA; Ilhéus-BA; Salvador-BA; Vitória da Conquista-BA; Fortaleza-CE; Sobral-CE; São Luís-MA; Campina Grande-PB; João Pessoa-PB; Arcoverde-PE; Belém de São Francisco-PE; Belo Jardim-PE; Cabo de Santo Agostinho-PE; Goiana-PE; Palmares-PE; Petrolina-PE; Recife-PE; Teresina-PI; Mossoró-RN; Natal-RN; São Cristóvão-SE.

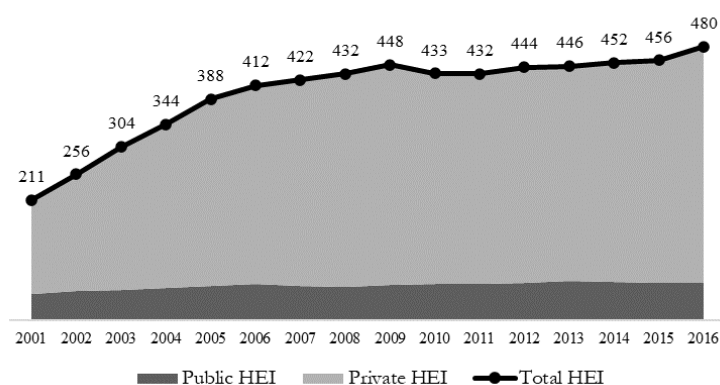
²⁵ Arapiraca-AL; Maceió-AL; Alagoinhas-BA; Barreiras-BA; Cruz das Almas-BA; Eunápolis-BA; Feira de Santana-BA; Ilhéus-BA; Itabuna-BA; Itamaraju-BA; Jequié-BA; Lauro de Freitas-BA; Paripiranga-BA; Paulo Afonso-BA; Ribeira do Pombal-BA; Salvador-BA; Santa Maria da Vitória-BA; Santo Antônio de Jesus-BA; Teixeira de Freitas-BA; Valença-BA; Vitória da Conquista-BA; Aracati-CE; Fortaleza-CE; Juazeiro do Norte-CE; Quixadá-CE; Caxias-MA; Chapadinha-MA; Imperatriz-MA; Pedreiras-MA; São Luís-MA; Cabedelo-PB; Cajazeiras-PB; Campina Grande-PB; João Pessoa-PB; Carpina-PE; Caruaru-PE; Escada-PE; Floresta-PE; Jaboatão dos Guararapes-PE; Olinda-PE; Recife-PE; Santa Cruz do Capibaribe-PE; Vitória de Santo Antão-PE; Água Branca-PI; Floriano-PI; Parnaíba-PI; Teresina-PI; Açu-RN; Caicó-RN; Mossoró-RN; Natal-RN; Aracaju-SE; Lagarto-SE.

5. Results

5.1 Descriptive Analysis

According to the Higher Education Census of 2016, 20% of Brazilian higher education institutions are in the Northeast Region. From 2001 to 2016, the number of higher education institutions in the Northeast more than doubled (Graph 1). This growth was primarily driven by the increase in the quantity of private institutions. In 2001, for each public institution, there were approximately four private institutions in the Northeast. However, by 2016, this ratio changed to six private institutions for every public institution.

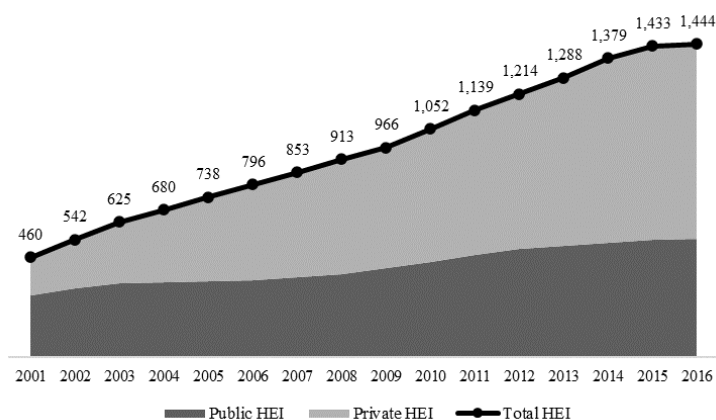
Graph 1 – Number of Higher Education Institutions in the Northeast, by Administrative Category, 2001 to 2016



Source: Prepared by the authors, based on data from the Higher Education Census/INEP.

The recent growth of higher education in the Northeast can also be observed through the evolution of enrollments in face-to-face undergraduate programs. Graph 2 illustrates that these enrollments tripled between 2001 and 2016. The upward trajectory indicates an increase of 984 thousand enrollments, of which 73% correspond to enrollments in private institutions.

Graph 2 – Enrollments in Face-to-Face Undergraduate Courses in the Northeast, by Administrative Category, 2001 to 2016



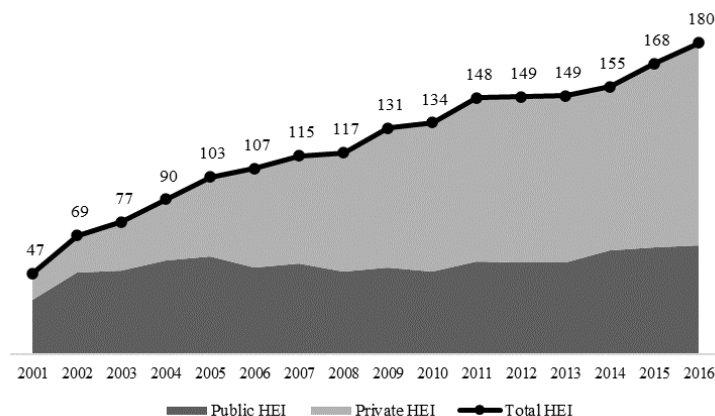
Source: Prepared by the authors, based on data from the Higher Education Census/INEP.

Note: Values in thousands.

Consistent with the increase in enrollments, Graph 3 reveals that the number of graduates from face-to-face undergraduate programs in the Northeast almost quadrupled between 2001 and 2016. Furthermore, it is observed that the graduation rate in private

institutions surpassed that in public institutions from 2006 onward. The ratio between the number of graduates from private and public institutions varied from 0.5 in 2001 to 1.9 in 2016.

Graph 3 – Number of Graduates from Face-to-Face Undergraduate Courses in the Northeast, by Administrative Category, 2001 to 2016



Source: Prepared by the authors, based on data from the Higher Education Census/INEP.

Note: Values in thousands.

In this article, efficiency indices of HEIs and growth models are estimated from two panels: one composed of 37 public institutions, and another formed by 166 private institutions, for the period from 2009 to 2015. The set of public HEIs contains 22 universities, 8 federal institutes, and 7 colleges located in 22 Northeastern municipalities. In this group, twenty institutions are in capitals, and seventeen offer medicine courses.

Regarding academic organization, private institutions differ significantly from public ones. In the sample of 166 private institutions, there are only three universities and two university centers; all other institutions are colleges. Additionally, the private institutions in the sample are distributed across 53 municipalities in the Northeast, with 99 of them located in capitals and only seven offering medicine courses.

Descriptive statistics presented in Table 1 reveal that, on average, the sample of public HEIs consists of larger institutions than private ones, in terms of the number of enrolled students, graduates, and faculty. The average General Course Index of public HEIs is also higher than that of private HEIs. Furthermore, the efficiency indices estimated through the stochastic frontier model indicate that, on average, public institutions are more efficient in human capital formation than private HEIs.

Regarding the characteristics of the areas where educational institutions are located, municipalities with higher per capita GDP are observed in the set of public HEIs. On the other hand, there is greater heterogeneity in the local industry structure, the quality of the workforce, and the institutional quality index among the municipalities in the sample of private HEIs. It is also noteworthy that municipalities with better institutional quality reached 22% of the maximum value of IQI_1 or 45% of the upper limit of IQI_2 .

Table 1 – Descriptive Statistics

Public HEIs					Private HEIs			
Variable	mean	s.d	min	max	mean	s.d.	min	max
Stochastic Frontier Model								
GRAD	1,738	1,971	14	8,069	605	1,045	6	11,230
PROF _{ge}	1,331	1,482	13	6,550	180	242	4	2,549
PROF _{rt}	1,441	1,570	6	6,469	124	166	4	1,654
STUD _m	7,359	7,313	424	31,517	2,441	3,431	57	29,161
IGC	2.41	0.53	0.72	3.20	2.19	0.46	0.82	3.68
Economic Growth Model								
GDP _{pc}	21,035.17	6,689.65	7,005.70	49,198.05	20,740.49	6,145.59	6,285.01	43,741.14
IEHEI ₁	0.70	0.21	0.09	0.95	0.57	0.19	0.04	1.00
IEHEI ₂	0.71	0.19	0.10	0.95	0.57	0.19	0.04	1.00
LIS	0.18	0.08	0.04	0.35	0.20	0.10	0.03	0.58
QLM	0.18	0.05	0.07	0.30	0.18	0.06	0.02	0.44
SEARCH	0.11	0.12	0.01	0.97	0.07	0.17	0.00	0.99
IQI ₁	0.06	0.02	-0.01	0.11	0.06	0.03	-0.04	0.11
IQI ₂	0.19	0.04	0.10	0.28	0.19	0.04	0.06	0.30

Source: Prepared by the authors.

Note: Sample of Public HEIs: Period 2009 to 2015; Number of HEIs: 37; Number of municipalities = 22; Number of observations = 259; IEHEI₁ was estimated using a Cobb-Douglas stochastic production function with the imposition of HG1. The relaxation of the HG1 assumption produces IEHEI₁' , where $\text{corr}(\text{IEHEI}_1, \text{IEHEI}_1') = 0.9771$. Similarly, $\text{corr}(\text{IEHEI}_2, \text{IEHEI}_2') = 0.9993$. Sample of Private HEIs: Period 2009 to 2015; Number of HEIs = 166; Number of municipalities = 53; Number of observations = 1,162; IEHEI₁ was estimated using a Cobb-Douglas stochastic production function with the imposition of HG1. The relaxation of the HG1 assumption produces IEHEI₁' , where $\text{corr}(\text{IEHEI}_1, \text{IEHEI}_1') = 0.9979$. Similarly, $\text{corr}(\text{IEHEI}_2, \text{IEHEI}_2') = 0.9979$.

5.2. Results

The growth models estimated using the two-stage generalized method of moments are presented in Table 2. The application of the Arellano-Bond test indicates the absence of second-order serial correlation in first-difference errors.

As expected, the coefficient of lagged per capita GDP is significant and positive in all specifications. Except for model (6), the efficiency indices or the number of graduates weighted by the quality of courses from public higher education institutions (HEIs) are significant and positively correlated with municipal per capita GDP. Like Barra and Zotti (2016), this study finds evidence of a positive association between the teaching activities of public universities and the economic growth of the municipalities where they are located.

On the other hand, the measure of graduates or the efficiency indices of private institutions did not show a significant effect. It is possible that the characteristics of private HEIs determine an insufficient level of efficiency in producing human capital to generate effects on local growth. This is because private institutions are generally colleges with lower enrollment and course quality compared to public HEIs. Another possibility is that the effects of graduate migration are stronger in the sample of private HEIs, which contains 3.2 times the number of municipalities in the sample of public HEIs, excluding capitals. Thus, there may be low local retention of graduates from private HEIs in inland municipalities, where opportunities for professional development are more limited.

In this regard, Mille (2004) and Abel and Deitz (2011) emphasize the need for a local labor market that absorbs the workforce trained by higher education institutions. In the absence of this market, graduate migration may hinder the increase of local human capital stock and its positive effects on local per capita income growth. Furthermore, there must be a reasonable alignment between the teaching activities of HEIs and local human resource needs to ensure that locally trained graduates can explore and develop the economic potential of the municipalities where its institutions are established.

Additionally, in the models estimated from the sample of public HEIs, there is a significant and positive effect of technology and workforce quality on local economic growth. As expected, this result suggests that increased knowledge incorporation into the production process and higher workforce qualifications raise productivity levels and, consequently, economic growth.

For the sample of private HEIs, however, the coefficients of the technology proxy and workforce quality, in general, are not significant. Moreover, when significant, workforce quality did not show the expected sign. As this sample has a greater variety of municipalities, many of which have a less developed industrial structure, there may be the employment of graduates in services that require lower qualification or in unproductive activities in the public sector. This negatively impacts growth potential. In this regard, Mille (2004) clarifies that the lack of local demand for qualified labor results in underutilization of human resources produced by higher education institutions. Schündeln and Playforth (2014) further highlight that the misallocation of graduates to unproductive government functions reduces the positive effects of education on economic growth.

Overall, there is no evidence that the research activities of public HEIs positively influence the level of per capita income. This result may reflect a gap between the research conducted at public universities and the demands of local productive sectors, partly explained by the bureaucracy inherent in the processes of agreements and partnerships between public institutions and the private sector. For Albuquerque (2003), this low interaction between knowledge-producing institutions and the productive system characterizes the incomplete and immature Brazilian innovation system. Suzigan and Albuquerque (2011) discuss the origins of this limited relationship based on the country's late industrialization and university creation process.

In models (7) to (9), there is some indication of a significant and positive relationship between the number of teachers and students engaged in research activities at private HEIs and local economic growth. However, the significance of the SEARCH variable coefficient is not predominant in the six models estimated from the private HEIs panel. Thus, the results do not allow us to conclude that private HEIs positively influence municipal per capita GDP through their research activities.

In models (1)-(6) and (10)-(12), the importance of institutions for local development is also observed. The significant and positive effect of institutional quality indices suggests that local government probity, popular participation, social development, and market structures are crucial factors for local economic growth. This result aligns with the works of Olson (1996), Acemoglu et al. (2000), and Rodrik (2000), which explain differences in per capita income among countries based on differences in institutional development.

Even though the institutional structures of Brazilian municipalities have been shaped by exploitation cultures (NARITOMI et al., 2012), and institutional development is determined by historical and persistent factors (RODRIK, 2000; PUTNAM, 2006), it is possible to develop institutions appropriate to regional peculiarities through participatory political structures (RODRIK, 2000).

Considering the possibility of shaping local institutions and the positive effect of institutions on per capita income, it is crucial to note that municipal socioeconomic progress depends on the exercise of democratic practices and civic participation and awareness.

In summary, this study found evidence of a positive correlation between the efficiency of public educational institutions and the economic growth of the municipalities where these institutions are located. Additionally, it was observed that institutional performance positively influences local economic growth.

Table 1: Estimated Models from equation (1).

<i>lnGDPpc</i>	<i>Public HEIs</i>						<i>Private HEIs</i>					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>lnGDPpc</i> _{t-1}	0.7764* (0.2259)	0.7462* (0.2815)	0.7382* (0.2131)	0.8726* (0.2596)	0.8748* (0.2560)	0.8065* (0.3410)	0.7378* (0.1063)	0.7319* (0.1036)	0.7296* (0.1084)	0.5741* (0.0875)	0.5754* (0.0859)	0.5864* (0.0874)
<i>lnIEHEI</i> ₁	0.0823* (0.0305)			0.0602* (0.0359)			-0.0086 (0.0180)			0.0014 (0.0196)		
<i>lnIEHEI</i> ₂		0.0885* (0.0344)			0.0704* (0.0341)			-0.0085 (0.0184)			0.0025 (0.0196)	
<i>lnGRAD</i>			0.0705* (0.0308)			0.0402 (0.0368)			-0.0105 (0.0147)			0.0034 (0.0142)
<i>lnLIS</i>	0.1795* (0.0575)	0.1804* (0.0765)	0.1283* (0.0555)	0.1814* (0.0807)	0.1797* (0.0859)	0.1419* (0.0592)	0.0984 (0.0822)	0.0992 (0.0824)	0.1095 (0.0802)	0.1460* (0.0587)	0.1438* (0.0575)	0.1402* (0.0566)
<i>lnQLM</i>	0.0388* (0.0212)	0.0348 (0.0232)	0.0388* (0.0230)	0.0581* (0.0280)	0.0583* (0.0297)	0.0422* (0.0219)	-0.0408* (0.0152)	-0.0410* (0.0155)	-0.0388* (0.0160)	-0.0182 (0.0174)	-0.0185 (0.0178)	-0.0152 (0.0162)
<i>lnSEARCH</i>	0.0176 (0.0121)	0.0209 (0.0148)	0.0214* (0.0144)	0.0144 (0.0147)	0.0171 (0.0152)	0.0062 (0.0114)	0.0111* (0.0052)	0.0111* (0.0051)	0.0111* (0.0052)	0.0054 (0.0068)	0.0053 (0.0068)	0.0059 (0.0067)
<i>lnIQI</i> ₁	0.0575* (0.0281)	0.0646* (0.0335)	0.0671* (0.0354)				0.0203 (0.0237)	0.0207 (0.0237)	0.0211 (0.0238)			
<i>lnIQI</i> ₂				0.2107* (0.1170)	0.1835* (0.0830)	0.2492* (0.1296)				0.3478* (0.0798)	0.3466* (0.0799)	0.3327* (0.0787)
Number of observations	185	185	185	185	185	185	808	808	808	827	827	827
Number of groups	37	37	37	37	37	37	166	166	166	166	166	166
Autocorrelation test (1st and 2nd order p-value)	0.0892 0.9482	0.1911 0.9937	0.0779 0.4685	0.1079 0.7944	0.1192 0.7152	0.2213 0.6751	0.0014 0.7002	0.0014 0.7007	0.0014 0.7511	0.0046 0.7674	0.0045 0.7467	0.0040 0.7086

Note: * Significance at a maximum of 10%; 53 instruments were used; Robust standard errors in parentheses, adjusted for clustering in groups; Omitted time dummies; Arellano-Bond autocorrelation test – H_0 : There is no autocorrelation between the first differences of errors.

6. Final Considerations

This article investigates the effects of higher education institutions' teaching activities on local economic growth. The empirical exercise undertaken consists of: (1) estimating efficiency indices for HEIs using the stochastic production frontier approach and the simulated maximum likelihood estimator by Belotti and Iardi (2017); and (2) estimating a dynamic panel growth model using the Arellano-Bond GMM estimator (1991).

The results indicate a positive correlation between the efficiency of public HEIs and the economic growth of the municipalities where these institutions are located. As discussed in Barra and Zotti (2016), the possible transmission mechanism for this positive effect occurs through the teaching activities of HEIs, which promote the increase of the local human capital stock. On the other hand, no significant effect was found for the teaching activities of private institutions, possibly because these institutions still need to advance further in the quality of graduate education.

Additionally, the estimated models reveal a positive correlation between institutional performance and local economic growth. Thus, ensuring the probity of local government, promoting popular participation, social development, and strengthening market structures should be understood as essential means for local economic development.

The evidence found in this study points in two directions: (1) education authorities, such as the Ministry of Higher Education/MEC, should focus on ensuring the quality of higher education. In addition to existing evaluation instruments, it would be interesting to require graduates to pass qualification exams administered by the MEC, not the universities, as a prerequisite for obtaining a graduate degree; (2) the direct forms of popular participation provided for in the Constitution, such as plebiscite, referendum, and popular initiative, should be more exercised by society to enable the development of appropriate local institutional arrangements.

It is important to note, however, that this article has the limitation of not using other strategies to complement the evidence of the results obtained from the dynamic panel methodology. Thus, a follow-up study could estimate the medium-term impact of the entry of a HEI into the municipality, comparing municipalities with higher education institutions to similar municipalities that do not have such institutions.

References

- ABEL, Jaison R.; DEITZ, Richard. 2011. "The Role of Colleges and Universities in Building Local Human Capital." *Current Issues in Economics and Finance* 17, no. 6: 1-7.
- _____. 2012. "Do Colleges and Universities Increase their Region's Human Capital?" *Journal of Economic Geography* 12, no. 3 (Maio): 667-691.
- ABRAMOVITZ, Moses. 1986. "Catching Up, Forging Ahead, and Falling Behind." *The Journal of Economic History* 46, no. 2 (Junho): 385-406.
- ALBUQUERQUE, Eduardo. M. 2003. "Immature systems of innovation: introductory notes about a comparison between South Africa, India, Mexico and Brazil based on science and technology statistics." In *Globelics Conference: Innovation Systems and Development Strategies for the Third Millennium*, 1, Rio de Janeiro: Globelics.
- ACEMOGLU, Daron *et al.* 2000. "The Colonial Origins of Comparative Development: an Empirical Investigation." *NBER Working Paper*, no. 7771 (Junho): 1-43.
- ALI, Muhammad *et al.* 2016. "Human Capital, Social Capabilities and Economic Growth." *Jena Economic Research Papers*, no. 13 (Junho): 1-25.
- ARELLANO, M.; BOND, S. 1991. "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations." *Review of Economic Studies* 58, no. 2 (Abril): 277-297.

- ARRAES, Ronaldo A. *et al.* 2004. “Efeitos do Capital Social e do Capital Político no Desenvolvimento Econômico: Simulações para Países e Estados Brasileiros.” *Análise Econômica* 22, no. 41 (Março): 211-239.
- ARROW, Kenneth J. 1961. “The Economic Implications of Learning by Doing.” *The Review of Economic Studies* 29, no. 3 (Junho): 155-173.
- ASTEBRO, Thomas; BAZZAZIAN, Navid. 2010. “Universities, Entrepreneurship and Local Economic Development.” In *Handbook of Research on Entrepreneurship and Regional Development*, edited by Michael Fritsch, 252-334. Cheltenham: Edward Elgar.
- BARRA, Cristian; ZOTTI, Roberto. 2016. “Investigating the Human Capital Development-growth Nexus: Does the Efficiency of Universities Matter?” *International Regional Science Review* 39, no. 1 (Janeiro): 1-41.
- BARRO, Robert J. 2013. “Education and Economic Growth.” *Annals of Economics and Finance* 14, no. 2: 301-328.
- BARRO, Robert J.; SALA-I-MARTIN, Xavier. 2004. *Economic Growth*. 2ed. Londres: MIT Press.
- BELOTTI, Frederico; ILARDI, Giuseppe. 2017. “Consistent inference in fixed-effects stochastic frontier models.” *Banca D'Italia Eurosystem Working Paper*, no. 1147 (Outubro): 1-57.
- BERRY, Christopher R.; GLAESER, Edward L. 2005. “The Divergence of Human Capital Levels across Cities.” *NBER Working Paper*, no. 11617 (Setembro): 1-52.
- BILLOR, Nedret *et al.* 2000. “BACON: blocked adaptive computationally efficient outlier nominators.” *Computational Statistics & Data Analysis* 34, no. 3 (Setembro): 279-298.
- BITTENCOURT, Geraldo M. *et al.* 2016. “Heterogeneidade institucional e o ingresso de investimento direto estrangeiro na economia brasileira.” *Estudos Econômicos* 46, no. 2 (Abril-Junho): 281-310.
- BRASIL. 1996. *Lei nº 9.394, de 20 de dezembro de 1996. Estabelece as Diretrizes e Bases da Educação Nacional*. Brasília: Diário Oficial da União.
- BRASIL. 2001. *Lei nº 10.172, de 9 de janeiro de 2001. Aprova o Plano Nacional de Educação e dá outras providências*. Brasília: Diário Oficial da União.
- BRASIL. 2001. *Lei nº 10.260, de 12 de julho de 2001. Dispõe sobre o Fundo de Financiamento ao estudante do Ensino Superior e dá outras providências*. Brasília: Diário Oficial da União.
- BRASIL. 2005. *Lei nº 11.096, de 13 de janeiro de 2005. Institui o Programa Universidade para Todos – PROUNI*. Brasília: Diário Oficial da União.
- BRASIL. 2006. *Decreto nº 5.773, de 9 de maio de 2006. Dispõe sobre o Exercício das Funções de Regulação, Supervisão e Avaliação de Instituições de Educação Superior e Cursos Superiores de Graduação e Sequenciais no Sistema Federal de Ensino*. Brasília: Diário Oficial da União.
- BRASIL. 2007. *Decreto nº 6.096, de 24 de abril de 2007. Institui o Programa de Apoio a Planos de Reestruturação e Expansão das Universidades Federais - REUNI*. Brasília: Diário Oficial da União.
- BRASIL. 2008. *Lei nº 11.892, de 29 de dezembro de 2008. Institui a Rede Federal de Educação Profissional, Científica e Tecnológica, cria os Institutos Federais de Educação, Ciência e Tecnologia, e dá outras providências*. Brasília: Diário Oficial da União.
- BRASIL. 2008. *Portaria Normativa nº 12, de 5 de setembro de 2008. Institui o Índice Geral de Cursos da Instituição de Educação Superior (IGC)*. Brasília: Diário Oficial da União.
- BRASIL. 2011. *Lei nº 12.527, de 18 de novembro de 2011. Regula o acesso a informações previsto na Constituição Federal*. Brasília: Diário Oficial da União.
- BRASIL. 2013. *Portaria Normativa nº 2, de 1 de fevereiro de 2013. Estabelece os procedimentos e o padrão decisório para os pedidos de autorização dos cursos de graduação em medicina ofertados por Instituições de Educação Superior - IES integrantes*

- do Sistema Federal de Ensino, protocolados no Ministério da Educação até o dia 31 de janeiro de 2013.* Brasília: Diário Oficial da União.
- BRASIL. 2014. *Lei nº 13.005, de 25 de junho de 2014. Aprova o Plano Nacional de Educação e dá outras providências.* Brasília: Diário Oficial da União.
- BRASIL. 2019. Ministério da Saúde. Monitoramento dos casos de arboviroses urbanas transmitidas pelo *Aedes* (dengue, chikungunya e Zika) até a Semana Epidemiológica 12 de 2019 e Levantamento Rápido de Índices para *Aedes aegypti* (LIRAA). *Boletim Epidemiológico* 13, no. 13 (Abril): 1-18.
- BUGARIN, Mauricio; MENEGUIN, Fernando B. 2016. “Incentivos à corrupção e à inação no serviço público: Uma análise de desenho de mecanismos” *Estudos Econômicos*, no. 1 (Janeiro-Março): 43-89.
- CALDARELLI, Carlos E. *et al.* 2015. “Instituições de Ensino Superior e Desenvolvimento Econômico: o caso das universidades estaduais paranaenses.” *Planejamento e Políticas Públicas*, no. 44 (Janeiro-Junho): 85-112.
- CHEN, Yi-Yi *et al.* 2014. “Consistent estimation of the fixed effects stochastic frontier model.” *Journal of Econometrics* 181, no. 2 (Agosto): 65-76.
- COSTA, Edward M. *et al.* 2015. “Dinâmica da Eficiência Produtiva das Instituições Federais de Ensino Superior.” *Planejamento e Políticas Públicas*, no. 44 (Janeiro-Junho): 51-84.
- DRUCKER, Joshua; GOLDSTEIN, Harvey. 2007. “Assessing the Regional Economic Development Impacts of Universities: A Review of Current Approaches.” *International Regional Science Review* 30, no. 1 (Janeiro): 20-46.
- FAÇANHA, L. O; MARINHO, A. 2001. “Instituições de ensino superior governamentais e particulares: avaliação comparativa de eficiência.” *Texto para Discussão IPEA*, no. 813 (Agosto): 1-33.
- FRAGA, Gilberto J.; BACHA, Carlos J. C. 2013. “Abertura Comercial, Capital Humano e Crescimento Econômico no Brasil.” *Pesquisa e Planejamento Econômico* 43, no. 2 (Agosto): 381-418.
- GÓES, Carlos. 2016. “Institutions and growth: A GMM/IV Panel VAR approach.” *Economics Letters* 138, (Janeiro): 85-91.
- GOLDSTEIN, Harvey A.; GLASER, Karin. 2012. “Research universities as actors in the governance of local and regional development.” *The Journal of Technology Transfer* 37, no. 2 (Abril): 158-174.
- GOODE, Richard B. 1959. “Adding to the Stock of Physical and Human Capital.” *The American Economic Review* 49, no. 2 (Maio): 147-155.
- GREENE, William H. 2012. *Econometric Analysis*. 7. ed. International Edition: Pearson.
- JONDROW, J. *et al.* 1982. “On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model.” *Journal of Econometrics* 19, no. 2-3 (Agosto): 233-238.
- LEE, Jong-Wha; LEE, Hanol. 2016. “Human capital in the long run.” *Journal of Development Economics* 122, (Setembro): 147-169.
- LUCAS, Robert E. 1988. “On The Mechanics of Economic Development.” *Journal of Monetary Economics* 22, (Fevereiro): 3-42.
- MILLE, Maryline. 2004. “The University, Knowledge Spillovers and Local Development: The Experience of a New University.” *Higher Education Management and Policy OECD* 16, no.3: 77-100.
- NAKABASHI, Luciano; FELIPE, Evânio. 2007. “Capital Humano nos Municípios Paranaenses.” *Análise Econômica* 25, no. 47 (Setembro): 7-22.
- NARITOMI, Joana *et al.* 2012. “Institutional Development and Colonial Heritage within Brazil.” *The Journal of Economic History* 72, no. 2 (Junho): 393-422.

- NORTH, Douglas C. 1991. "Institutions." *Journal of Economic Perspectives* 5, no. 1 (Winter): 97-12.
- OLSON, Mancur. 1996. "Distinguished Lecture on Economics in Government: Big Bills Left on the Sidewalk: Why Some Nations are Rich, and Others Poor." *The Journal of Economic Perspectives* 10, no. 2 (Spring): 3-24.
- PEREIRA, Ana Elisa G. *et al.* 2011. "Qualidade das Instituições e PIB *per capita* nos Municípios Brasileiros." *Texto para Discussão IPEA*, no. 1623 (Junho): 1-30.
- PUTNAM, Robert D. 2006. *Comunidade e Democracia: a experiência da Itália moderna*. 5. ed. Rio de Janeiro: FGV.
- RIBEIRO, Hilton M. D. *et al.* 2017. "Arranjos Institucionais e Desenvolvimento: uma Análise Multivariada e Espacial para Municípios de Minas Gerais." *Análise Econômica* 35, no. 68 (Setembro): 231-262.
- ROCHA, Roberto H. *et al.* 2017. "A Relação entre o Ensino Superior Público e Privado e a Renda e Emprego nos Municípios Brasileiros." *Pesquisa e Planejamento Econômico* 47, no. 3 (Dezembro): 39-69.
- RODRIG, Dani. 2000. "Institutions for high-quality growth: What they are and how to acquire them." *NBER Working Paper*, no. 7540 (Fevereiro): 1-48.
- ROMER, Paul M. 1986. "Increasing Returns and Long-Run Growth." *Journal of Political Economy* 94, no. 5 (Outubro): 1002-1037.
- SALA-I-MARTIN, Xavier. 2000. *Apuntes de crecimiento económico*. 2. ed. Barcelona: Antoni Bosch.
- SEN, Amartya. 1983. "Development: Which Way Now?" *The Economic Journal* 93, no. 372 (Dezembro): 745-762.
- SCHULTZ, Theodore W. 1961. "Investment in Human Capital." *The American Economic Review* 51, no. 1 (Março): 1-17.
- SCHÜNDELN, Matthias; PLAYFORTH, John. 2014. "Private versus social returns to human capital: Education and economic growth in India." *European Economic Review* 66, (Fevereiro): 266-283.
- SUZIGAN, Wilson; ALBUQUERQUE, Eduardo. M. 2008. "A interação entre universidades e empresas em perspectiva histórica no Brasil." *Texto para Discussão Cedeplar*, no. 329 (Março): 1-27.
- TIRYAKI, Gisele F. 2008. "Desenvolvimento institucional e o envolvimento do setor privado na provisão de infraestrutura." *Economia Aplicada* 12, no. 3 (Setembro): 499-525.
- WINDMEIJER, F. 2005. "A finite sample correction for the variance of linear efficient two-step GMM estimators." *Journal of Econometrics* 126, no. 1 (Maio): 25-51.