Managerial Effort under Asymmetric Information: The Case of Public Schools in Brazil

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Abstract

This paper uses a principal-agent model to investigate how public school managers react to government incentives based on previous school performance. Using data from the Brazilian Student Evaluation Exam (Prova Brasil) and the School Census, we estimate a managerial effort function by quantile regression. The findings show a regular non-linear relationship between managerial effort and lagged school performance, indicating that marginal effort is decreasing when a previously ineffective school manager becomes effective on reaching a performance goal. This evidence is in line with the adopted theoretical approach and provides new parameters for educational policies designs.

Keywords: School management, Managerial effort, Educational goals, Asymmetric information.

Resumo

Este trabalho utiliza um modelo de principal-agente para investigar como diretores de escolas públicas reagem a incentivos do governo com base no desempenho escolar defasado. Usando dados da Prova Brasil e do Censo Escolar, estimamos uma função de esforço gerencial por regressão quantílica. Os resultados mostram uma relação não-linear com regularidade entre esforço gerencial e desempenho escolar defasado, indicando que o esforço marginal é decrescente quando um diretor previamente ineficaz atinge uma meta de desempenho escolar. Essa evidência está em linha com a abordagem teórica adotada e fornece novos parâmetros para formulação de políticas educacionais.

Palavras-chave: Gestão escolar, Esforço gerencial, Metas educacionais, Informação assimétrica.

Área 8: Microeconomia, Métodos Quantitativos e Finanças

JEL Code: I21, H52, H40.

1. Introduction

In Brazil, one can say that the purpose of universal primary education has been achieved. According to the Population Censuses of 1991 and 2010, conducted by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE, 2013), the school attendance of individuals between 6 and 14 years of age reached 96.7% in 2010, from a frequency rate of 75.5% at the beginning of the 1990s; furthermore, the population's illiteracy rate at 15 years of age or older decreased from 20.1% to 9.6%, a result possibly associated with the universalization of elementary education in the country.

Despite this improvement, the quality of education in Brazil is well below the levels observed in developed countries. According to the report of results from the Programme for International Student Assessment (PISA) of 2012, provided by the Organization for Economic Cooperation and Development (OECD), Brazil

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is in 58th place among the 65 countries evaluated in the average score in mathematics, surpassed by Latin American countries such as Costa Rica, Uruguay, Mexico, and Chile (OECD, 2014). In this environment of low-quality education, the increase in average schooling in Brazil may not have the expected effectiveness in economic growth, given the direct relationship between the development of cognitive skills and the dynamism of an economy (Hanushek and Woessmann, 2008, Hanushek, 2013).

A relevant question for empirical research on education is the understanding of the role of public schools in producing real differences for students in learning gains and not merely replicating the socioeconomic conditions that are beyond the control of school management (Hanushek, 1986). In this sense, the institutional dimension that governs incentives for the degree of commitment of public school manager[1] is critical to the quality of the educational system, especially when the mechanisms to control managerial effort are not well defined and/or have informational restrictions on behalf of the authorities responsible for all schools of a given region.

Studies on education have revealed that the school manager, as the school's leader, plays an important role in the educational outcomes of students (Eberts and Stone, 1988, Brewer, 1993, Ross and Gray, 2006, Gates et al., 2006, Robinson et al., 2008, Béteille et al., 2011, Coelli and Green, 2012, Miller, 2013). According to Béteille et al. (2011), this role proves to be greater in schools with an unfavorable socioeconomic context, low levels of educational performance, and a greater number of inexperienced teachers.

Additionally, the effects of the management on school performance occur through a variety of mechanisms, including the following: the motivation of the school's staff, composed of officials and teachers; the articulation of educational vision and goals; the resolution of interpersonal conflicts at school; the allocation of school resources; and the development of organizational structures to support teaching and learning (Eberts and Stone, 1988, Ballou and Podgursky, 1995, Grissom and Loeb, 2011, Loeb et al., 2012).

In Brazil, much of the literature has been devoted to researching the relationship between the socioeconomic background of students and the results on educational performance indicators (Gomes-Neto and Hanushek, 1994, Soares and Andrade, 2006, Machado and Gonzaga, 2007, Sampaio et al., 2011, Almeida, 2014). The documented results confirm the relevance of the socioeconomic background of students in academic performance, showing that Brazilian schools generally have little effect on cognitive gains.

In this context, the literature on school management remains in its infancy, meaning much of the evidence found is based only on empirical relationships. On the other hand, as noted by Ferris (1992), the interests of the public administration (principal) and the school manager (agent) cannot be the same. The school manager may have either different conceptions, multiple purposes and definitions of educational performance or other goals that conflict with the objectives of the public administration (Dixit, 2002). Such purposes are both legitimate and uncontradictory, but they compete with each other for the scarce resources that schools have. Thus, the principal-agent conflict can arise when higher authorities (such as state and local governments) and the school manager choose different purposes.

In this paper we uses a theoretical principal-agent model that incorporates asymmetric information in the relationship between local government administration and school manager. In particular, we explore how managers react to government signaling mechanisms based on previous performance (achieving educational goals).

In addition to the introduction, the article has 5 other parts. Section 2 presents the principal-agent theoretical model. The empirical strategy used to evaluate the theoretical propositions for the Brazilian case is detailed in Section 3. In Section 4, the database, sample selection, and variables used are described. In Section 5, there is a discussion of the results. Lastly, Section 6 is reserved for final remarks.

[1] In this paper, the term school manager is used as equivalent of school principal to avoid confusion with the expression of the principal-agent model.

2. Asymmetric information and incentives for school management

The relationship between managers of public schools and rulers can involve costs caused by information asymmetries (Ferris, 1992). Generally, public school managers better know their own level of effort[2] than the municipal, state, or federal administrator, which can induce changes in behavior characterized by the misalignment of interests. By contrast, the means available to the government to monitor the activities of the school managers, such as school indicators on standardized tests from previous years, are restricted and limited. According to Dixit (2002), the use of such information may generate useful signals for the government to devise incentives and therefore to change the behavior of school managers in terms of effort.

The model developed below, inspired on Hart (1983), Dixit (2002), Cahuc and Zylberberg (2004), Edmans et al. (2009), highlights problems involved in the principal-agent relationship in a context of asymmetric information. However, we emphasize and adapt this problem in the case of public schools. Public school managers represent the agent and the government (municipal or state), the principal. In the first part of this section, the determinants of the agent's managerial effort and its relationship to the degree of contractual incentives provided by the principal's interests are discussed. Next, the principal-agent model is expanded with the incorporation of the previous distribution of school performance in terms of educational goals. In this context, an analysis of the effects of this signaling mechanism on determining contracts (incentive design) and the behavior of school managers is conducted.

2.1. A theoretical principal-agent model

The public administrator is responsible for all schools in a given region. Its utility function u_p is represented by:

$$u^p = k(e(\delta)) - c_p(e(\delta)), \tag{1}$$

where $k(.)$ is a function which represents a technology to produce political capital[3]; $c_p(.)$ is a cost function in monitoring agent activities under asymmetric information; $e(.)$ is an effort function of agent, which directly depends on contract price $\delta \geq 0$, $e' > 0$.

Equation (1) indicates that the well-being of the principal is the difference between political capital $k(e)$ and monitoring costs $c_p(e)$ and that both functions depend on agent's managerial effort. We suppose political capital formation under decreasing marginal productivity, $k' > 0, k'' < 0$, and increasing marginal costs of monitoring[4], $c'_p > 0$.

We assume that the agent responds to monetary and non-monetary incentives, i.e, his managerial effort yields "social reputation" to the principal, k, and it is paid at $\delta > 0$, a contract price which means an award for productivity[5] (Dixit, 2002, Edmans et al., 2009). However, the agent's effort in school generates an opportunity cost because it implies less time devoted to leisure or other activities that provide greater private benefit. The agent's utility function u_a is determined by the net benefit of his/her efforts:

$$u_a = w + \delta k(e) - c_a(e), \tag{2}$$

where w is fixed remuneration on public sector; $c_a(.)$ is the agent's cost of opportunity (disutility of time spent at work) which is increasing in effort $(c'_a > 0, c_a(0) > 0)$.

[2]In this study, the effort of a school manager is understood as any proactive action that is aligned with the improvement of school results.

[3]This function yields a non-monetary compensation – political capital accumulated by the principal. It is expressed, for example, by issues tied to reputation and political prestige in the community (voters), which is a vital factor for remaining in elective public offices.

[4]To avoid a corner solution, we also assume a fixed cost of monitoring $c_p(0) > 0$.

[5]By simplicity, whether δ is a monetary incentive, we suppose that it generates a low marginal impact on the government budget.

The solution of the principal-agent model (1)-(2), in a case in which there is an incentive design for the agent ($\delta > 0$), requires that the principal choose a reward for productivity considering the agent's preferences. Therefore, the first order condition for agent's optimal effort e^* under any incentive contract $\delta > 0$ is given by maximizing the utility function (2):

$$\delta k'(e^*) = c'_a(e^*). \tag{3}$$

Equation (3) shows that optimal agent's effort is reached by equality between marginals benefit and cost.

The first order condition for principal's optimal contract price δ^* determination yields:

$$\frac{dk}{de}(\delta^*) = \frac{dc_p}{de}(\delta^*). \tag{4}$$

According to Equation (4), the optimal contract requires that marginal benefit of agent's effort be equal to marginal cost of monitoring.

In order to discuss explicit solutions for the problem above, we assume the following specification for political capital production:

$$k(e) = s_0 + e - (e - \overline{e})^2. \tag{5}$$

where $s_0 \geq 0$ is the initial stock of the principal's "social reputation"; $e \in [0, \overline{e}]$ is the degree of the agent's managerial effort and $\overline{e} > 0$ is the maximum effort supported by the agent[6].

In the case of minimal effort on the part of the agent ($e = 0$), the political capital of the principal would be reduced by $s_0 - \overline{e}^2$, whereas for maximum effort $\overline{e}$, the accumulation of maximum capital would be given by $k(\overline{e}) = s_0 + \overline{e}$, according to Equation (5). Furthermore, it is assumed that the process of political capital formation is not linear and is subject to diminishing marginal productivity. For example, an increase in the managerial effort of an agent who initially has low productivity is valuable to society, which quickly assimilates this change in behavior and transfers it in the form of a higher reputation for the principal. With respect to a very skilled agent, an increase in effort is also transferred to society in gains of political capital but at a relatively lower rate[7].

To keep the simplicity, we also assume the case where both costs functions are linear. Thus, the principal's monitoring cost and the agent's opportunity cost are respectively given by:

$$c_p(e) = \alpha_0 + \alpha e, \tag{6}$$

$$c_a(e) = \theta_0 + \theta e, \tag{7}$$

where α e θ represent marginal costs, while $\alpha_0 > 0$ and $\theta_0 > 0$ are fixed costs.

In a case in which there is no contract (explicit or implicit) between the principal and the agent ($\delta = 0$), the agent's optimal managerial effort is the minimum value $e^* = 0$, and the "initial reputation" of the principal is reduced by $\overline{e}^2$. Therefore, in the absence of signaling mechanisms, the agent maintains a position of evading his/her responsibilities to improve the teaching and learning process of the school environment (moral hazard).

On the other hand, using the condition (4) is straightforward to show that agent's effort function for any contract price $\delta > 0$ is written as:

$$e^*(\delta) = \frac{1}{2}\left(1 - \frac{\theta}{\delta}\right) + \overline{e}. \tag{8}$$

[6]It may be positively associated to worklife cycle (age) and personal health conditions.

[7]Note that $k'(e) = 1 - 2(e - \overline{e}) > 0 \ \forall \ e \leq \overline{e}$; $k''(e) = -2 < 0 \ \forall \ e \in [0, \overline{e}]$.

Equation (8) shows that managerial effort[8] has a direct relationship with the parameter of incentives $e'_\delta > 0$ and an inverse relationship with the agent's marginal opportunity cost $e'_\theta < 0$. However, the agent's effective behavior is conditioned at the choice of an optimal contract for the principal, as stated in the following theorem.

Theorem 1. (Optimal contract) *Let e^* be the agent's optimal level of effort. Then, the optimal contract (δ^*) agreed upon by the principal and the agent that maximizes the utility of the former is established by the ratio of the monitoring cost and the opportunity cost of the school manager:*

$$\delta^* = \frac{\theta}{\alpha}. \tag{9}$$

Theorem 1 reveals that the optimal choice of contract depends on the ratio of marginal costs between the agent and the principal. For example, if the marginal cost of monitoring the agent α is high, then there will be little benefit for the principal to reward the agent's productivity. If the agent has a high marginal opportunity cost for effort at school θ, then she/he should be compensated with more incentives.

2.2. Asymmetric information and managerial effort

The main consequence of Theorem 1 is a negative relationship between asymmetric information degree and school manager effort. The corollary below summarizes this result.

Corollary 2. (Asymmetric information and managerial effort) *Given the optimal contract δ^*, the agent's managerial effort is negatively related to the principal's marginal cost in monitoring school management:*

$$e^*(\alpha) = \frac{1}{2}\left[1 - \alpha\right] + \overline{e}. \tag{10}$$

Corollary 2 suggests that the value α is decisive in the incentive design and the agent's managerial effort[9]. Furthermore, it is reasonable to assume that α is, on one hand, directly related to the asymmetric information between the principal and the agent and, on the other hand, negatively associated with the degree of the principal's commitment to the public administration of education. First, the lower the access to information on the agent's activities is, the greater the time/effort that the principal must use in monitoring the agent with regard to contractual rules (educational guidelines). Second, a principal who is very committed to educational management may have a low marginal valuation of time spent on other activities that generate private profit and thus can better address monitoring costs.

By contrast, any structural changes involving major assignments for the public administrator (principal) and/or centralization of school management[10] can also increase the marginal cost of monitoring the education system and therefore produce lower agent productivity.

2.3. Incentive design and managerial effort

According to Cahuc and Zylberberg (2004), the principal in most circumstances can reduce the information asymmetry evaluating the accuracy, speed of response and quality of the tasks performed by the agent. In educational area, information asymmetry problems can be managed based on the analysis of previous indicators of school performance on standardized tests. In this case, the rulers has outdated information on the performance of schools in the achievement of educational goals and may discriminate between incentives according to the initial distribution of the degree of effectiveness in meeting the learning goals at the school.

[8]Two corner solution are possible. The first $e^* = \overline{e}$ requires $\delta = \theta$ and the second $e^* = 0$ is related to $\delta = \frac{\theta}{1+2\overline{e}}$. Therefore, a necessary condition to an interior solution is $\frac{\theta}{1+2\overline{e}} < \delta < \theta$.

[9]To ensure that the solution is interior, it is necessary that: $1 < \alpha < 1 + 2\overline{e}$.

[10]Centralized management would tend to raise the monitoring costs in situations that allow "professional" relationships between the principal and the agent. In the case of non-professional proximity, decentralization does not necessarily imply lower monitoring costs because this closeness could hinder the degree of recovery, even resulting in possible moral hazard problems.

Consider an extension of the principal-agent model (1)-(3) with a goal system (signaling mechanism) established by an external regulatory agency. If this agency sets a goal for educational outcomes $\overline{\gamma}$, then the principal knows the initial distribution of the degree of agent's effectiveness in achieving this goal γ_0. Therefore, two scenarios must be accounted for: (a) ineffective agent, if $\gamma_0 < \overline{\gamma}$; and (b) effective agent, if $\gamma_0 \geq \overline{\gamma}$.

In this goal system, the principal's political formation also depends on interaction between current agent's effort and its previous performance in terms of the distance from the established target $\overline{\gamma}$. Thus, we assume $\gamma_0 \neq \overline{\gamma}$ and rewrite Equation (5) as:

$$k(e) = s_0 + [1 + (\gamma_0 - \overline{\gamma})]\, e + (e - \overline{e})^2. \tag{11}$$

On the other hand, it is possible that marginal cost of monitoring agent's behavior set according to previous information about γ_0. To make it tractable, we suppose that principal's cost in monitoring agent's is given by:

$$c_p(e) = \alpha_0 + [\alpha + (\gamma_0 - \overline{\gamma})]\, e. \tag{12}$$

As shown in Equation (12), a goal system allows some knowledge about previous agent's performance and it affects the strength of asymmetric information. Then, monitoring one more unit of ineffective agent's effort costs $\alpha + |\gamma_0 - \overline{\gamma}|$ to government, while getting additional information about the behavior of effective agent requires $\alpha - |\gamma_0 - \overline{\gamma}|$ at margin[11]. Moreover, using Theorem (1) is possible to demonstrate that optimal contract price is relatively high in the case of previous effectiveness, i.e, $\delta_f^* < \delta^* < \delta_s^*$, where δ^* is the optimal contract price without a goal system ($\gamma_0 = \overline{\gamma}$), s and f are used to index the information about agent's effectiveness and ineffectiveness, respectively.

Considering two possible regime equilibrium (δ_f^*, e_f^*) and (δ_s^*, e_s^*) – one for each scenario –, it can be demonstrated not only that agent's effort change, but also that marginal effort is decreasing when a previous ineffective agent becomes effective on reaching system goals. This occurs because agent's effort function is non-linear (concave) on contract price as summarized by the corollary below.

Corollary 3. (Signaling, optimal contract and managerial effort) *Given different optimal contracts δ_f^*, δ_s^*, which are established according to the degree of effectiveness of each agent in meeting goals ($\gamma_0 - \overline{\gamma}$), the marginal effort of agents with low initial effectiveness in response to an increase in incentives will be greater than that of agents with higher effectiveness in educational outcomes:*

$$\frac{\partial e_f^*}{\partial \delta_f} > \frac{\partial e_s^*}{\partial \delta_s}. \tag{13}$$

In general, Corollary 3 indicates that if the initial distribution of educational outcomes enables the signaling of contractual amounts conditioned on monitoring costs, then any contractual stimuli should produce relatively higher marginal efforts for school managers with low commitment to their management activities.

3. Empirical strategy

In this section, the empirical strategy of the present study is presented to test the main results of the theoretical model developed. First, the methodology used in calculating the Index of Managerial Effort (IME), which represents a *proxy* for the agent's level of effort, is described. Next, observations are made regarding the econometric model.

3.1. Item Response Theory and the Index of Managerial Effort

Item Response Theory (IRT) is part of the framework of psychometrics, which enables an identification of the underlying properties of individuals' responses on tests, quizzes, and other similar instruments that

[11] To ensure a positive marginal cost we assume that $\alpha + (\gamma_0 - \overline{\gamma}) > 0$.

measure skills, attitudes, and other unobservable (or latent) characteristics, as highlighted by Baker (2001) and van der Linden and Hambleton (2010).

In this approach, the probability of an individual correctly answering a given item is directly proportional to latent capacity (Θ), using a logistic function to model the relationship. When considering a dichotomous response item, the Item Characteristic Curve (ICC) depends on 2 parameters: a parameter for difficulty (d), which determines the position of the ICC; and a parameter for discrimination (a), which indicates the slope of the ICC. Thus, the ICC can be estimated using the Maximum Likelihood method (ML):

$$\Pr(U_{ij} = 1|\Theta_i) = \frac{1}{1 + \exp[-a_j(\Theta_i - d_j)]}, \tag{14}$$

where $\Pr(U_{ij} = 1|\Theta_i)$ is the probability of individual i's correctly answering j-th item, conditioning the value on latent trait i, Θ_i; a_j is the discrimination parameter of item j; d_j is the difficulty parameter of item j, defined by the point on the ability scale where the probability of success is 50% with $d \in (-\infty, +\infty)$; Θ_i is the ability level of the individual examined, with $\Theta_i \in (-\infty, +\infty)$; and U_{ij} is the response of individual i for item j, with $U_{ij} = 1$ if the response is correct, $U_{ij} = 0$ if not.

In a case in which $a_j = 1$ in Equation (12), the flatter the ICC is, the lower the power of item discrimination between individuals with low and high ability. Regarding the position of the ICC, an item with greater difficulty (d_j) requires a higher level of the latent trait, meaning that the individual has at least a 50% chance of success in the response.

As some characteristics of the evaluated items may involve ordered polychotomous responses, we adopt an extension of the IRT model, such as the Generalized Partial Credit Model (GPCM) of Muraki (1992) and Muraki (1993), which generalizes the model represented by Equation (14). In this case, the expression of the GPCM that adjusts the ICC is defined by Equation (15), which shows the probability of an individual's answering k-th category of the m_j categories available for item j. The estimation process of the parameters is also performed by ML.

$$\Pr_{jk}(U_{ij} = k|\Theta_i) = \frac{\exp[\sum_{v=1}^{k} a_j(\Theta_i - d_{jv})]}{\sum_{c=1}^{m_j}[\exp \sum_{v=1}^{c} a_j(\Theta_i - d_{jv})]}, \tag{15}$$

where d_{j1} is defined arbitrarily, assuming the value of 0. When the choices are dichotomous ($m_j = 2$), the GPCM reduces the IRT model for the case of dichotomous answers.

The estimation of the parameters of the items consists of a calibration process for IRT. Among the different calibration techniques, the *Expectation–Maximization* (EM) algorithm is used, suitable for complex ML problems because it enables the estimation of parameters for items, $\boldsymbol{\eta}$, iteratively in the case of unobserved random variables, Θ_i (Andrade et al., 2000). By calibrating parameters a and d for each item j, the estimate of Θ_i can be performed using the *Bayesian* method known as the *Expected a Posteriori* (EAP) estimator or the *Posterior* mean estimate. The Bayesian estimate for Θ_i is basically composed of the definition of distributions *a priori* for the parameters of interest, the construction of the new *a posteriori* distribution, and the estimate of Θ_i based on the characteristics of the *a posteriori* distribution (van der Linden and Hambleton, 2010).

Using the responses of school managers and teachers on issues involving the managers' proactive behavior, incentive practices, and teachers' awareness of management practices and management actions, this research uses the value of Θ_i as a *proxy* for the IME. In the database section, the items considered are further detailed. Moreover, in order to simplify the interpretation, we normalize the IME to range from 0 to 100% by the following expression: $IME = \frac{\Theta - \min(\Theta)}{\max(\Theta) - \min(\Theta)} \times 100$, where minimum and maximum values represent the theoretical results of latent skills. IME is equals to 100% means that the agent is at the maximum level of managerial effort among the evaluated items, while $IME = 0$ represents the minimum effort.

3.2. Econometric Model

We propose an empirical model which is a stochastic counterpart of Equation (8) under two different regimes according to previous school performance in achieving educational system goals (Corollary 3).

Thus, controlling IME variation for school manager attributes, locational and institutional factors, we investigate the presence of non-linearity in managerial effort function, i.e, if school managers change their marginal productivity after reaching educational system goal. Accordingly, consider the following model:

$$IME_{i,\tau} = \alpha_{1,\tau} E_{(t-1)i} + \alpha_{2,\tau}[E_{(t-1)i} - 1] \times [D = 1 | E_{(t-1)i} \geq 1] + X\varphi_\tau + \xi_{i,\tau}, \tag{16}$$

where $IME_{i,\tau} \in [0, 100\%]$ is the Index of Managerial Effort of the i-th school manager in quantile $\tau \in [0, 1]$; $E_{t-1} \in [0, +\infty]$ is the previous rate of effectiveness in terms of achieving a goal in education, whose goal is normalized to 1; D is a binary variable that receives the value of 1 if the managed school has achieved the goal in the previous period and has a value equal to 0 if not; X is a matrix that incorporates variables regarding the manager's attributes (gender, education, and experience), which are related to maximum effort supported by manager; school environment, such as socioeconomic status of students, proportion of temporary teachers, infrastructure, school size, school system, the appointment to the position of school manager and location factors (regional variables and area of location)[12]; $\alpha_{1,\tau}$ and $\alpha_{2,\tau}$ are parameters; φ_τ is a vector of parameters; and $\xi_{i,\tau}$ a random error term.

According to the result shown in Corollary 3 of subsection 2.3, it is expected that there is a non-linear function of effort around the goal for educational results $\alpha_{1,\tau} > 0$ and $\alpha_{2,\tau} < 0$, that is, managers whose schools were ineffective in fulfilling the IDEB[13] goal in period $t - 1$ should have a steeper effort function than effective managers. In other words, the use of prior information on school performance can induce different incentives for effective and ineffective schools and ultimately produce different results based on changes in incentives, in particular regarding the marginal productivity of school managers.

In Brazil, the IDEB – created in 2007 by the Anísio Teixeira National Institute of Educational Studies and Research (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira - INEP) – is considered an indicator of educational quality that links student's academic progress and performance averages in mathematics and in Portuguese language on standardized tests. With this indicator, INEP traces educational quality goals for education systems (INEP, 2007). Therefore, one can consider the level of school management effectiveness in terms of educational quality (E_{t-1}) based on the relative distance between the actual IDEB and the goal IDEB for the school i in a given period: $E_{(t-1)i} = Ideb_{(t-1)i}/Ideb^{e}_{(t-1)i}$. Thus, the ineffective schools have $E_{t-1} < 1$ and the effective $E \geq 1$.

The estimation of Equation (16) was performed by quantile regression (QR), with emphasis on 10th (inferior), 50th (median), and 90th (superior) quantiles, enabling the verification of possible behavioral changes over the distribution of effort. Moreover, according to Koenker (2005), one of the advantages of using QR is that it neither assumes that the random error term has a Gaussian distribution nor that it is homoscedastic.

4. Database and treatment of variables

The data used in the present study for the empirical model refer to public schools (state and local) in the first stage of primary education and come from microdata from the Brazilian Student Evaluation Exam (Prova Brasil – PB) in 2011 and 2013 and the School Census[14] for 2011, available on the website of the INEP. PB records various types of information on the characteristics of the students finishing the final years of the 2 phases of elementary school and on teachers, schools and managers, thus allowing research on a wide range of possible factors related to school performance. In turn, the school census shows a snapshot of enrollment, teachers, and classes in all public and private schools in Brazil, including infrastructure characteristics for basic education.

Since 2007, INEP and the Ministry of Education have provided information on the IDEB, including actual and projected performance, which enables the identification of schools that are meeting educational

[12] A detailed description of the covariates in the model is given in the section on the database and treatments of variables.

[13] IDEB is the Basic Education Development Index (Índice de Desenvolvimento da Educação Básica).

[14] It is noteworthy that the managerial effort of school managers in 2011 is related to the school's math score in the PB in the years 2011 and 2013 at the end of the results section.

quality goals. In this scenario, the effectiveness level of school management in terms of meeting IDEB goals, despite the delay in disclosure, is an instrument of control and a signaling mechanism for the public administration in the regulation and recovery of the commitment of public school managers, mainly for ineffective schools.

4.1. Calculation of Indices for Managerial Effort, Socioeconomic Level of Students, and School Infrastructure

We compute an indicator for the school manager effort (IME) with the application of IRT to 2 sets of data on the managerial characteristics of the school manager collected in the questionnaires from PB in 2011: (a) questions answered by the manager him/herself and (b) questions answered by school teachers. These questions address actions to improve the updating process, teaching, and learning in schools, and they also capture the perception of teachers regarding the school manager's performance (Ballou and Podgursky, 1995). Out of 212 questions in the questionnaire for the school manager in PB, 19 questions related to the proactive attitude of the school's management, which were converted into 16 items[15]. In turn, the teacher questionnaire, in the 2011 PB, consists of 152 questions (teacher profile, training, perceptions of school functioning, violence, teaching practices, etc.), 9 of which specifically address teachers' opinions on the managerial performance of the school manager.

To combine the information on managerial actions according to answers from the school managers and teachers, the school managers' IME was computed using Equation 17. The calculation of the IME, using the average of $\hat{\Theta}_1$ and $\hat{\Theta}_2$, aims to compute the manager's effort with less bias.

$$IME_i = 2^{-1}\left[\hat{\Theta}_{1i} + \frac{1}{J}\sum_{j=1}^{J}\hat{\Theta}_{2ij}\right], \tag{17}$$

where $IME_i \in [0; 100\%]$ is the total Index of the Managerial Effort of the i-th school manager; $\hat{\Theta}_{1i}$ is the Index of Managerial Effort according to the items directed to the i-th school manager; $\hat{\Theta}_{2ij}$ is the Index of Managerial Effort according to the perception of the j-th teacher regarding of the i-th school manager; and J is the total number of teachers interviewed at the school i. The school managers with the highest level of IME have greater proactive practices, with 0 is minimum effort and 100% represents maximum effort.

It is important to note that both $\hat{\Theta}_{1i}$ and $\hat{\Theta}_{2ij}$ were calculated using IRT, considering the EAP estimator for respective samples of 55,063 school managers and 226,098 teachers with at least 50% valid responses for the items considered[16].

Table 1 stands for the 16 items selected for the school manager and employees in the calculation of Θ_{1i}, in addition to the scale of responses, the numbers of questions in the manager questionnaire of PB, the relative frequency of responses to the choices available in each of the items, and the parameters of discrimination (a) and difficulty (d) of each item estimated by IRT.

[15]Of the 24 questions related to actions of managerial effort, a total of 79% of these questions was used, considering that the others address, for example, detailing the composition of the school board and programs that depend on conditions of school demand (such as student admissions criteria).

[16]In the case of estimates Θ_{1i} and parameters of the ICC, a sample of 55,063 school managers, equivalent to 97.9% of managers surveyed in PB in 2011, was considered. The sample selected for teachers (226,098) corresponds to 74.3% of the teachers questioned in the same survey. It is important to emphasize that to better calibrate the parameters of the IRT model and discriminate latent abilities in the questionnaire responses, the number of observations used includes a greater number of public schools than that used in the final sample of the research. This strategy is consistent with the ML model used to calculate the parameters of interest.

Table 1: Description of selected items in the questionnaire of school managers

Item	Description	Scale	Question*	%	a	d
1	Participation and use of knowledge acquired in continuing education	(0-3)	11, 12 and 13		0.24	
	Never use or did not participate	0		9.7	0.00	0.00
	Almost never use	1		0.3	1.00	-3.33
	Eventually	2		8.9	2.00	0.09
	Frequently	3		81.1	3.00	2.30
2	Promotion of continuing education activity	(0-1)	22 and 23	62.9	0.80	0.60
3	Frequency of school board meeting	(0-3)	24		0.34	
	There is no meeting or no participation	0		11.6	0.00	0.00
	Once	1		4.8	1.00	-0.68
	Twice	2		15.2	2.00	0.55
	Three times or more	3		68.4	3.00	2.05
4	Frequency of class council meeting	(0-3)	29		0.44	
	There is no meeting or never	0		13.0	0.00	0.00
	Once	1		4.7	1.00	-0.98
	Twice	2		13.1	2.00	0.15
	Three times or more	3		69.1	3.00	1.77
5	About preparing the school education program	(0-4)	30		0.29	
	There is no project	0		3.9	0.00	0.00
	There is project, but do not know on how to development	1		1.4	1.00	-0.82
	Prepared by government	2		15.2	2.00	1.75
	Prepared by school manager	3		0.2	3.00	-2.46
	Participatory	4		79.3	4.00	3.48
6	Existence of criteria for formation of classes	(0-1)	33	74.3	0.34	1.09
7	Existence of criteria for assigning classes to teachers	(0-1)	34	67.0	0.16	0.72
8	Promotion of program to reduce school dropout	(0-1)	36	70.0	1.68	1.26
9	Promotion of program to reduce school disapproval	(0-1)	37	74.9	2.64	2.12
10	Promotion of program to support learning	(0-1)	38	79.5	1.61	1.94
11	School managers share experiences with other managers	(0-1)	67	94.0	0.39	2.82
	Guidelines to prevent student absences					
12	Teachers talk with students	(0-1)	39	98.2	0.71	4.25
13	Notice by written communication to parents	(0-1)	40	87.4	0.98	2.25
14	Parents are called to speak at meetings	(0-1)	41	93.5	0.20	2.68
15	Parents are called to school to individual conversation	(0-1)	42	97.9	1.09	4.37
16	School sends someone to the student's home	(0-1)	43	65.5	0.42	0.67
	Observations	55,063				

Source: Test Brazil (Prova Brasil)/Inep 2011. Prepared by authors. For dichotomous items, with scale 0-1, it is assumed the value 1 for answers yes and 0 otherwise.
Note: *It refers to the number of questions in the original questionnaire of school managers in Test Brazil.

As highlighted in the data, most of the items are dichotomous, with 1/4 having more than 2 ordinal choices, and there is a higher concentration of responses in the choices of the items with a positive direction. However, only in 4 items is the relative frequency of responses greater than 90%. With regard to the parameters estimated by IRT, it is noted that items that have greater power to discriminate between low and high latent ability of managers are, respectively, the variables related to the promotion of programs to reduce disapproval ($a = 2.64$), reduce school dropout ($a = 1.68$) and support learning ($a = 1.61$). These items are relatively more important in the calculation of Θ_{1i}. By contrast, questions on the criteria for assigning classes to teachers, the guidelines to prevent student absences where parents are called to speak at meetings, and participation in continuing education have the lowest values for the discrimination parameter in the ICC.

The difficulty of the item is another important parameter in calculating Θ_{1i}. Thus, the managers' actions in guiding staff to reduce student absences (specifically items 12 and 15) and the choice on participatory development of the education program are the issues that require a higher level of managerial effort for a positive response, with a probability of at least 50%. In the case of item 5 for the choice of scale 4, for example, a latent ability of 3.48 is the minimum amount required for a response with a high chance of success for a manager who adopts this type of action in school. Meanwhile, for this same item for the choice of scale 3, the required skill level would be lower, given that $d = -2.46$, indicating a lower degree of difficulty for the response.

Table 2 reports the 9 items in the teacher questionnaire from PB that were used to estimate Θ_{2ij}. The selected questions attempt to capture the perceptions of teachers regarding the managers practices. The data presented refer to the description of the items, scale, question number in the teacher questionnaire in PB, the percentage of answers to the options available in each of the items, and the parameters of discrimination

(a) and difficulty (d). In this case, the scale of all items considered is a *Likert* scale, in which teachers give their opinions on the administrative characteristics of school manager according to the following options: 0 – completely disagree, 1 – disagree, 2 – indifferent, 3 – agree, and 4 – completely agree.

Based on the responses, there is a tendency for teachers to evaluate the managers with the most favorable scales (3 and 4) due to the higher percentage of responses attributed to partial and full agreement with the managerial attitudes. Accordingly, items that have greater power to discriminate between managers with low and high latent ability from the perspective of teachers are, respectively: trust in the school manager as a professional ($a = 4.24$), managerial attitudes that give special attention to student learning ($a = 3.80$) and encourage innovative activities ($a = 3.55$). In comparison, items 9, 7, and 6 show lower power of discrimination. According to the parameter of difficulty, the options of scale 3 and scale 4 of item 2 require the highest value of latent ability, whereas the options of scale 0 of all 0 items requires the lowest latent ability ($d = 0$).

It is noteworthy that the explanatory variables related to the socioeconomic status of students (SSS) and the school infrastructure indicator (SII) were also calculated for IRT. To calculate the SII, a model was used with 2 parameters with dichotomous responses from a set of 52,488 schools with at least 50% valid responses, whereas, for the SSS, GPCM was used with a sample of 1,974,016 students, in which the SSS of the school is defined by the average of the students' SSS. The items that compose these indicators is based on other studies applied to Brazil, such as Soares and Andrade (2006) and Alves and Soares (2012) for the case of socioeconomic status and Soares-Neto et al. (2013) for school infrastructure.

4.2. Sample Selection and Descriptive Statistics

In accordance with the objective of this study, we made a series of cuts from the main sample. Of the total of 56,222 federal, state, and municipal schools in the sample of PB from 2011, only state and municipal schools were considered with grades in PB from 2011 and 2013 for students from the 5^{th} year of primary school, with IME, SII, and SSS estimated for 2011 and with no missing observations in the set of selected variables. After these filters, the final sample was composed of 23,887 state and municipal schools.

Based on Ballou and Podgursky (1995), we select a set of variables for empirical analysis. They can be grouped into the following dimensions:

Table 2: Description of selected items in the questionnaire of teachers

Item	Description	Response code	Question*	%	a	d
1	School manager motivates teachers	(0-4)	60		3.06	
	Completely disagree	0		2.4	0.00	0.00
	Disagree	1		4.5	1.00	5.45
	Indifferent	2		18.1	2.00	10.26
	Agree	3		40.4	3.00	12.78
	Completely agree	4		34.5	4.00	11.57
2	Trust in the school manager as a professional	(0-4)	61		4.24	
	Completely disagree	0		1.4	0.00	0.00
	Disagree	1		3.2	1.00	8.36
	Indifferent	2		12.3	2.00	15.33
	Agree	3		38.8	3.00	19.75
	Completely agree	4		44.3	4.00	19.48
3	School manager can teachers strive in class	(0-4)	62		2.76	
	Completely disagree	0		1.3	0.00	0.00
	Disagree	1		5.3	1.00	5.94
	Indifferent	2		14.4	2.00	10.13
	Agree	3		45.6	3.00	12.94
	Completely agree	4		33.4	4.00	11.71
4	School manager encourages innovative activities	(0-4)	63		3.55	
	Completely disagree	0		1.5	0.00	0.00
	Disagree	1		4.4	1.00	7.09
	Indifferent	2		14.4	2.00	12.59
	Agree	3		41.5	3.00	15.99
	Completely agree	4		38.1	4.00	15.04
5	Managerial attitudes that give special attention to student learning	(0-4)	64		3.80	
	Completely disagree	0		1.4	0.00	0.00
	Disagree	1		4.3	1.00	7.67
	Indifferent	2		13.6	2.00	13.56
	Agree	3		43.1	3.00	17.29
	Completely agree	4		37.5	4.00	16.21
6	School manager gives special attention to administrative rules	(0-4)	65		2.31	
	Completely disagree	0		0.6	0.00	0.00
	Disagree	1		1.9	1.00	5.56
	Indifferent	2		7.4	2.00	10.13
	Agree	3		45.8	3.00	13.81
	Completely agree	4		44.4	4.00	13.57
7	School manager gives special attention to school maintenance	(0-4)	66		2.24	
	Completely disagree	0		0.7	0.00	0.00
	Disagree	1		2.2	1.00	5.26
	Indifferent	2		7.1	2.00	9.48
	Agree	3		44.3	3.00	13.10
	Completely agree	4		45.8	4.00	12.98
8	Teachers feel respected by school manager	(0-4)	67		2.34	
	Completely disagree	0		0.9	0.00	0.00
	Disagree	1		1.6	1.00	4.94
	Indifferent	2		5.7	2.00	9.50
	Agree	3		35.4	3.00	13.42
	Completely agree	4		56.4	4.00	14.10
9	School manager, teachers and staff collaborate for the best school run	(0-4)	74		1.63	
	Completely disagree	0		0.5	0.00	0.00
	Disagree	1		2.2	1.00	4.34
	Indifferent	2		6.8	2.00	7.56
	Agree	3		44.7	3.00	10.62
	Completely agree	4		45.8	4.00	10.52
	Observations	226,098				

Source: Test Brazil (Prova Brasil)/Inep 2011. Prepared by authors.
Note: *It refers to the question order in the original questionnaire of teachers in Test Brazil.

- *Signaling mechanisms* - the level of school effectiveness in fulfilling the IDEB goal in 2009 (E), defined by the ratio of the IDEB goal for the school and the actual IDEB (this variable is determined by INEP);

- *School Context* – the school size (total enrollment by 1,000, according to data from the School Census of 2011); a binary variable for the school system (state or municipal); a dummy variable for the manager position (occupied by appointment or other criteria); the school size squared; the average socioeconomic status of students (SSS), the school infrastructure index (SII); a percentage indicator of

temporary teachers (a binary variable that has a value of 1 if the school has more than 50% ineffective teachers and 0 if not);

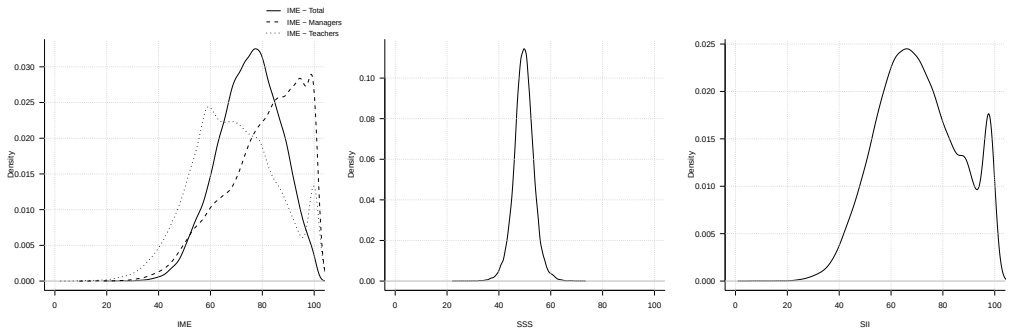
- *Manager's attributes* - gender (a binary variable that is 1 if the manager is male and 0 if female); higher education (a dummy equal to 1 if the manager has higher education and 0 if not); and time working for the school (a set of 8 dummy variables with a value of 1 according to the manager's experience and 0 if not);

- *Location factors* - binary variables for location, referring to sector (a binary variable that has a value of 1 if the school is in urban areas and 0 if located in the countryside), and for states, including the Federal District (a set of dummy variables with a value of 1 based on the federal unit where the school is located and 0 if not).

Figure 1 presents the estimates of probability densities for the IME, SII, and SSS indicators obtained by IRT. The descriptive statistics of the selected variables are presented in Table 3 below.

Figure 1: Probability densities for selected indicators

(a) IME (b) SSS (c) SII



Source: Prepared by authors.

Note: Density estimates using the *Kernel* function with *Gaussian* core. The following optimal parameters were used for smoothing the densities of the IME: 1.423 - Total IME; 1.788 for IME - based on the school manager survey; and 1.941 for IME - based on the teacher survey. Regarding the densities of SSS and SII, the following values were adopted: 0.4171 and 1.883, respectively.

Figure 1a shows that the distributions of the variables of the IME based on the information provided by the school manager (IME - Manager) and the IME of the manager based on the teachers' perceptions (IME - Teachers) record different characteristics. While IME - Manager has an asymmetric distribution to the left, IME - Teachers has a bimodal distribution. In the first case, there is a high concentration of the probability of managers who report productive practices. In the second, there is a group of teachers who report that the manager's effort is below average and another group that reports above average management practices. However, when considering the distribution of the total IME (see Equation (17), the distribution presents symmetry/unimodality, that is, the distribution becomes not biased after weighting the information provided by the managers themselves and the teachers.

With respect to the distribution of the SSS, one can see a symmetrical format around the mean (-0.01); see Figure 1b. Figure 1c shows that the SII distribution is bimodal, i.e., there is a group of schools with infrastructure conditions below the central value (median) and another group of schools with good infrastructure conditions (mode higher than the median).

Table 3: Descriptive Statistics

Variables	Mean	S.D.	Min	Max
IME - total	74.8931	11.8775	23.3264	100.0000
Effectiveness in 2009 (E)	1.1005	0.1731	0.1395	2.8261
$(E-1) \times (D=1 \mid E \geq 1)$	0.1241	0.1439	0.0000	1.8261
State schools	0.2728	0.4454	0.0000	1.0000
Municipal schools	0.7272	0.4454	0.0000	1.0000
School manager position occupied by election and/or selection	0.4600	0.4984	0.0000	1.0000
School manager position occupied by appointment	0.5400	0.4984	0.0000	1.0000
School size (enrollment/1.000)	0.6369	0.3996	0.0500	7.4740
School size^2	0.5653	0.9487	0.0025	55.8607
SSS	49.6110	3.8768	23.3228	72.1094
SII	70.5254	15.7132	6.6930	100.0000
Temporary teachers $\leq$50%	0.7881	0.4086	0.0000	1.0000
Temporary teachers >50%	0.2119	0.4086	0.0000	1.0000
Female (School manager)	0.8627	0.3441	0.0000	1.0000
Male (School manager)	0.1373	0.3441	0.0000	1.0000
No higher education (School manager)	0.0459	0.2092	0.0000	1.0000
Higher education (School manager)	0.9541	0.2092	0.0000	1.0000
Years of experience of the manager at the school: $<$ 1 year	0.1763	0.3811	0.0000	1.0000
Years of experience of the manager at the school: 1 to 2 years	0.1434	0.3505	0.0000	1.0000
Years of experience of the manager at the school: 2 to 5 years	0.3356	0.4722	0.0000	1.0000
Years of experience of the manager at the school: 5 to 7 years	0.1227	0.3282	0.0000	1.0000
Years of experience of the manager at the school: 7 to 10 years	0.1058	0.3076	0.0000	1.0000
Years of experience of the manager at the school: 10 to 15 years	0.0767	0.2661	0.0000	1.0000
Years of experience of the manager at the school: 15 to 20 years	0.0255	0.1575	0.0000	1.0000
Years of experience of the manager at the school: $>$ 20 years	0.0139	0.1171	0.0000	1.0000
Rural areas	0.0110	0.1044	0.0000	1.0000
Urban areas	0.9890	0.1044	0.0000	1.0000
Acre	0.0052	0.0719	0.0000	1.0000
Alagoas	0.0152	0.1225	0.0000	1.0000
Amazonas	0.0203	0.1409	0.0000	1.0000
Amapa	0.0046	0.0680	0.0000	1.0000
Bahia	0.0609	0.2392	0.0000	1.0000
Ceara	0.0418	0.2001	0.0000	1.0000
Distrito Federal	0.0096	0.0977	0.0000	1.0000
Espirito Santo	0.0208	0.1429	0.0000	1.0000
Goias	0.0368	0.1884	0.0000	1.0000
Maranhao	0.0280	0.1650	0.0000	1.0000
Minas Gerais	0.1270	0.3330	0.0000	1.0000
Mato Grosso do Sul	0.0202	0.1408	0.0000	1.0000
Mato Grosso	0.0213	0.1444	0.0000	1.0000
Para	0.0381	0.1915	0.0000	1.0000
Paraiba	0.0237	0.1521	0.0000	1.0000
Pernambuco	0.0389	0.1933	0.0000	1.0000
Piaui	0.0149	0.1212	0.0000	1.0000
Parana	0.0663	0.2488	0.0000	1.0000
Rio de Janeiro	0.0713	0.2574	0.0000	1.0000
Rio Grande do Norte	0.0206	0.1419	0.0000	1.0000
Rondônia	0.0096	0.0977	0.0000	1.0000
Roraima	0.0027	0.0521	0.0000	1.0000
Rio Grande do Sul	0.0695	0.2542	0.0000	1.0000
Santa Catarina	0.0457	0.2089	0.0000	1.0000
Sergipe	0.0109	0.1040	0.0000	1.0000
Sao Paulo	0.1627	0.3691	0.0000	1.0000
Tocantins	0.0131	0.1137	0.0000	1.0000

Source: Test Brazil (Prova Brasil) and School Census. Prepared by authors.

According to the descriptive statistics reported in Table 3, most managers are women (86.3%), have higher education (95.4%), and have between 2 and 5 years of experience in school management (33.6%); 54% of them took the position through a technical or policy appointment. On average, schools have 636 students enrolled, with the majority being male (51%). By contrast, 72.7% of schools are part of the municipal school, 78.8% record that more than half of the teaching staff is composed of non-temporary workers, and 98.9% are located in urban areas, especially in the states of São Paulo (16.3%), Minas Gerais (12.7%), and Rio de Janeiro (7.1%).

In terms of proficiency, the math average scores among schools in 2011 and in 2013 were 208.9 and

210.1 points on the SAEB scale[17], respectively. Additionally, the average value of the effectiveness index in 2009 (1.10) shows that the typical school in the selected sample exceeded the goal for the IDEB.

The proportion of students who work is 13.4%, while the age-grade discrepancy indicator (0.86) shows that, on average, the typical student is behind the grade suitable for his/her age.

5. Results

Table 4 presents the results of estimates from the function of managerial effort of public school managers (see Equation 16). Four regressions were performed: one regression using Ordinary Least Squares (OLS) and 3 quantile regressions using ML for the quantiles 0.50 (median), 0.10 (lower quantile), and 0.90 (higher quantile). This strategy allows us to evaluate how the determinants of the agents' managerial effort behave in different parts of the distribution of effort and to ensure greater flexibility in the stochastic distribution of this variable (Koenker, 2005).

Before driving the analysis for the main question in this empirical part (the test about corollary 3), we will make a brief discussion of the control variables and manager's attributes. The results of Table 4 are also highly suggestive with regard to possible differences in the productivity of managers according to the degree of centralization/decentralization of the public management of education. It is worth noting that the estimated coefficients for the variables "municipal school" and "appointed position" are negative and statistically significant at 1% in all regressions.

More specifically, the findings suggest that managers in municipal schools (decentralized management) have a lower IME compared to managers in state schools (centralized management – omitted category). This result indicates that the decentralization theorem[18], as highlighted by Oates (1972), does not generate incentives for increased managerial effort in Brazilian public schools. A possible explanation for this evidence is the presence of moral hazard generated by greater proximity between the rulers and municipal school managers in small towns[19] or higher information costs than centralized case, which may not stimulate incentive mechanisms for productivity. According to Prud'homme (1995), the benefits of decentralization in allocative efficiency are not as obvious as indicated by decentralization theorem, in which there may be some practical dangers: low administrative and technical capacity, lack of transparency and modern management processes etc.

When technically or politically appointed managers are compared with managers who received this position by other means (election, for example), the results show that there is less managerial effort in the group of appointed managers. Considering Tucker and Codding (2002) and Dixit (2002) about theory of incentives, the manager's appointment position can increase the marginal cost of monitoring, because the collection channels by principal are more politically costly, which may imply a lower result of agent's efforts. Thus, based on empirical results, schools with managers appointed by rulers tend to practice less effort, given a higher cost of the ruler to require a greater commitment.

The size of the school, measured by quantitative enrollment, is an indicator of the scale of operation of supplying educational services, meaning that school units of different sizes can have different contexts for the manager's performance. These findings initially indicate a non-linear (U-shaped) relationship between school size and the manager's effort in the models considered, except for the estimated coefficients for the 0.10 *quantile*. In the case of the models conditioned for the mean, median, and 0.90 *quantile*, the inflection point is 3,200, 2,700 and 2,300 enrolled students, respectively. Thus, for increments of students in school units with enrollments below these numbers, the relationship between school size and the IME is negative.

[17]National Basic Education Assessment System (Sistema de Avaliação da Educação Básica – SAEB) scale is composed by intervals of PB proficiency levels which aims to identify the student's cognitive skills. For more details, see `http://provabrasil.inep.gov.br/escalas-da-prova-brasil-e-saeb`.

[18]The decentralization theorem of Oates (1972) notes that the provision of public services tends to be more efficient when it is performed in a decentralized manner, given the better identification of local preferences.

[19]In Brazil, according to the Population Census of 2010, approximately 90% of Brazilian municipalities have up to 50,000 inhabitants, and more than 70% have 20,000 or fewer inhabitants, which suggests a large number of municipalities with small populations.

Table 4: Regression model for mean and selected quantiles. Dependent variable: IME

Covariates	OLS	Quantile Regression		
		Median	10th quantile	90th quantile
Signaling mechanisms				
Effectiveness in 2009 (E)	10.7016***	10.7624***	12.2078***	11.0126***
	(1.3084)	(1.9784)	(1.6705)	(2.3443)
$(E-1) \times (D=1 \mid E \geq 1)$	-7.4315***	-6.9773***	-8.5030***	-8.1479***
	(1.5730)	(2.3029)	(2.0815)	(2.7385)
Control variables				
State schools (omitted)				
Municipal schools	-1.0723***	-1.2774***	-1.1598***	-0.8355***
	(0.1802)	(0.2274)	(0.2884)	(0.2605)
Manager position occupied by election/selection (omitted)				
Manager position occupied by appointment	-1.8590***	-1.7663***	-2.0247***	-1.7394***
	(0.1552)	(0.1967)	(0.2542)	(0.2366)
School size (enrollment/1.000)	-1.9181***	-1.6012***	-0.3090	-5.4561***
	(0.3713)	(0.5465)	(1.0249)	(0.9988)
(School size)^2	0.2954*	0.2687	0.1779	1.1051**
	(0.1526)	(0.2423)	(0.5405)	(0.4685)
SII	0.0928***	0.0962***	0.1043***	0.0688***
	(0.0047)	(0.0059)	(0.0076)	(0.0070)
Temporary teachers $\leq$50% (omitted)				
Temporary teachers $>$50%	-0.1497	-0.0926	-0.3738	0.1471
	(0.1754)	(0.2130)	(0.2641)	(0.2558)
SSS	0.0284	0.0365	0.0211	0.0127
	(0.0178)	(0.0233)	(0.0284)	(0.0279)
Rural areas (omitted)				
Urban areas	0.5970	0.7474	1.6739*	-0.1286
	(0.6654)	(1.0548)	(0.8945)	(2.0127)
Manager's attributes				
Female (omitted)				
Male	-1.6292***	-1.7849***	-1.5872***	-1.4241***
	(0.2052)	(0.2733)	(0.3394)	(0.3085)
No higher education (omitted)				
Higher education	2.4943***	2.5690***	2.4232***	2.0916***
	(0.3384)	(0.4738)	(0.4008)	(0.7190)
Experience in school: $<$ 1 year (omitted)				
Experience in school: 1 to 2 years	1.5229***	1.5879***	1.1204***	1.6530***
	(0.2486)	(0.3124)	(0.4077)	(0.4039)
Experience in school: 2 to 5 years	2.5320***	2.5327***	2.3621***	2.5880***
	(0.2065)	(0.2586)	(0.3256)	(0.3706)
Experience in school: 5 to 7 years	3.5973***	3.9370***	2.9987***	3.4724***
	(0.2617)	(0.3257)	(0.4595)	(0.3936)
Experience in school: 7 to 10 years	4.0609***	4.4193***	3.8534***	3.7469***
	(0.2743)	(0.3560)	(0.4061)	(0.4429)
Experience in school: 10 to 15 years	5.0900***	5.2970***	5.1747***	5.1147***
	(0.3061)	(0.3923)	(0.4717)	(0.4896)
Experience in school: 15 to 20 years	4.8204***	4.9638***	4.8808***	3.2580***
	(0.4696)	(0.6316)	(0.9006)	(0.6367)
Experience in school: > 20 years	5.8851***	5.8228***	6.2846***	5.5454***
	(0.6147)	(0.9444)	(0.6152)	(1.0061)
(Intercept)	58.5786***	57.8264***	42.3423***	75.5578***
	(1.7565)	(2.5736)	(2.4546)	(3.4640)
Fixed effect by states	Yes	Yes	Yes	Yes
Observations	23,887	23,887	23,887	23,887
Adjusted R^2 for OLS / Pseudo R^2 for QR	0.1931	0.1081	0.1246	0.0788

Source: Test Brazil and School Census. Prepared by authors.
Note: Standard error in brackets. *** p-value<1%. ** p-value<5%. * p-value<10%.

By contrast, in schools with enrollments above these thresholds, there is a positive relationship. However, given the small amount of public schools with over 2,300 enrolled students (corresponding to only 0.4% of the total number of public schools in the sample), the relationship between school size and the IME is mainly negative. Therefore, in general, larger schools and thus schools with a more complex organization tend to increase the opportunity cost of the manager's effort. This result is not observed for the locus of the conditional distribution of the IME for the less hardworking managers (0.10 *quantile*), indicating that the efforts made by these individuals do not depend on the range of educational services offered.

Additionally, with regard to the school context, the empirical results show that managers in public schools with better infrastructure conditions put forward more effort in terms of management practices, suggesting the importance of the complementarity between physical capital and human capital.Furthermore,

this result indicates that, in schools with poor infrastructure, the managers feel less encouraged to apply more managerial effort. By contrast, in schools where there are students with higher socioeconomic status, there also seems to be more managerial effort from the managers, possibly due to the greater weight of family participation in schools, which contributes to forcing more proactive behavior from the school manager.

The findings also show interesting aspects in the relationship between the IME and the personal attributes (gender, education, and experience). In all regressions presented in Table 4, there is evidence that male managers show relatively less effort than female managers (base category) and that managers with a *Superior* educational level record greater managerial effort compared to those with a lower education (omitted category). Moreover, it is observed that in general, managers with more time working in school management have increased efforts in management practices compared with inexperienced managers (less than 1 year of work at the school – the reference category).

The signaling system of efforts through educational goals for each school seems to be insufficient in eliminating the behavioral changes of public school manager (moral hazard). In this sense, the results for the variable $[E_{(t-1)i} - 1] \times [D = 1|E_{(t-1)i} \geq 1]$ suggest that there is a nonlinear (concave) response of the agents' managerial effort in terms of the school's position with respect to the IDEB goal in the previous period. That is, school managers who were ineffective in achieving the projected IDEB in the previous period record marginal productivity/effort in response to higher incentives compared to agents whose schools were effective, supporting the theoretical approach of the present study (see Corollary 3). Figure 2 reports that this result does not show much heterogeneity over the conditional distribution of the IME, including the most extreme quantile.

With regard to the evidence noted above, the findings are fairly regular, especially when the coefficients estimated by OLS and quantile regressions are collated (Figure 2 reinforces this result). For example, the quantile regression for the median, the coefficient associated with the variable "Effectiveness in 2009", is positive and statistically significant at 1%, whereas the estimated coefficient for the iterated variable, slope change, $(E - 1) \times (D = 1|E \geq 1)$ is negative and also significant at 1%. It is also possible to observe similar results for the estimates produced by OLS and quantile regression in the lower and upper parts of the distribution of the IME.

Thus, the results suggest that if a typical manager of an ineffective public school receives an incentive to closely approach the projected academic achievement, then this condition would lead to an additional effort that is higher than that observed for a manager whose school has already met the goal proposed by the government. These behavioral differences between groups of managers conditioned on the initial distribution of the degree of effectiveness/ineffectiveness can be explained by the existence of moral hazard in the relationship between school managers and rulers.

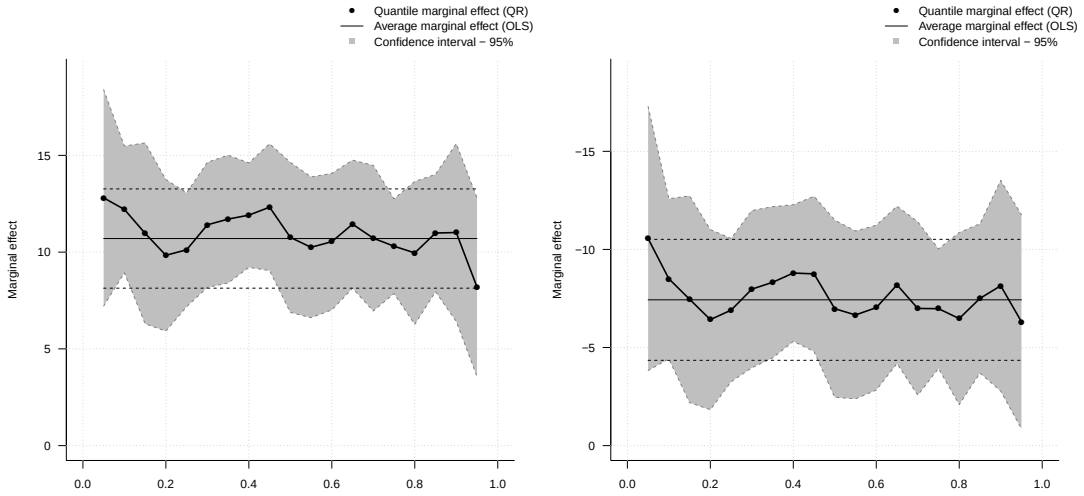
6. Final Remarks

The theoretical principal-agent model presented in this article suggests that a public school manager may respond with more managerial effort in the face of a better incentive structure. However, the parameters of the contractual design between a ruler and manager, in line with the interests of the ruler, depend on the ratio of the manager's marginal opportunity cost and the principal's marginal cost of monitoring the agent's effort.

Under optimal contract arrangements, the agent's managerial effort has an inverse relationship with the marginal cost of monitoring. This result is expanded for the case in which there is a system of educational performance goals and the schools' distribution is known and acts as a signaling mechanism in the principal-agent relationship. Thus, under the assumption of the same opportunity cost for agents, it is shown that the principal should apply incentives that are directly related to their previous performance (due to different monitoring costs) and, in this case, the function of the managerial effort becomes nonlinear around the school's goal.

Figure 2: Quantile marginal effect of signaling mechanisms on IME

(a) Effectiveness in 2009 (E) (b) $(E-1) \times (D=1|E \geq 1)$



Source: Prepared by authors.

The empirical findings showed that political or technical appointment to the post of school management is a practice that reduce agents' managerial effort. In line with the developed theoretical approach, this study found that through improvements in contractual incentives, ineffective school managers can increase their effort more sharply than those who are active in effective schools. This evidence characterizes the presence of moral hazard, despite the signaling mechanism using goals for quality educational levels. Thus, there seems to be a need for contractual designs that establish criteria for awards/punishment conditioned on the distribution of educational outcomes.

Based on the theoretical propositions and the empirical evidence, educational policies in Brazil should pay special attention to the managerial aspects of school units. In this study, the prominent role of school managers in developing organizational structures to support teaching and learning can be observed in the positive correlation between the level of proficiency in the school's mathematics and the IME, particularly in schools with the worst levels of proficiency. Therefore, it is extremely important to adapt the existing signaling mechanisms – fluid educational goals instead of goals designed by information at the starting point on proficiency level and a shorter delay in data collection on educational performance, among other things – or to create new mechanisms that act to reduce problems such as moral hazard.

Taking into account the relevance of the issue presented in this study, future research may propose a dynamic extension of the theoretical model to assess the trajectories of managerial effort over time and/or to evaluate the behavior of individuals in the face of a sequential game. Empirically, further studies on this issue may advance the use of variables that best capture, for example, monitoring costs and test the moral hazard hypothesis with longitudinal data on school managers and verify the effects of the IME on the performance of students using, for example, multilevel models.

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