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Quantifying the benefits of digitalizing and centralizing teacher applications and assignment

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Inter-American Development Bank
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Abstract

Teachers are the most important and expensive input when it comes to improving the quality of education. In many Latin American countries, the decentralized way in which teachers are assigned is extremely costly and inefficient and lacks objectivity. This document advocates the implementation of digital centralized teacher assignment systems as more efficient, equitable, objective, and cost-effective. Using administrative data from Ecuador, this study estimates that the implementation of digital centralization could have an annual impact of over USD 17 million. This figure takes into account the direct implementation costs, the savings generated by the transition, and the learning gains achieved by improving the assignment of better-quality teachers and reducing the number of empty vacancies. These results confirm that this policy is not only efficient, but also cost-efficient.

Keywords: centralized assignment, cost-effectiveness, teacher quality, teachers

Contents

1	Introduction	02
2	Teacher assignment systems	03
2.1	Types of teaching positions	03
2.2	Overview of the continent	04
2.3	Types of assignment systems	05
3	Implementation costs and savings	08
3.1	Costs	08
3.2	Savings	09
4	Benefits	10
4.1	Short term	10
4.2	Medium and long term	11
4.3	Estimation exercise: <i>Learning gains</i>	12
5	Extended analysis	14
6	Conclusion	15
	References	16
	Appendices	17
A	Costing assumptions	17
B	Calculation formulas	18
C	Costing assumptions: Ten-year projection	20
D	<i>Cerrando Brechas</i> and cost per student	20

1. Introduction

Teachers are the most important educational factor for improving the quality of education because they contribute to the reduction of learning gaps and have long-term effects on outcomes such as students' decisions about higher education or their performance in the labor market (Chetty et al., 2014 a,b; Araujo et al., 2016; Hanushek et al., 2014; Rockoff, 2004). Teachers are also the most expensive input in education systems, accounting for around 11% and 12% of total government spending in upper-middle and lower-middle-income countries, respectively (Crawford, 2020). Given the cost and importance of assigning teachers to schools, the efficiency with which teachers and schools are matched minimizes the costs of the education system and, at the same time, maximizes the gains for students.

This is particularly relevant in Latin America where this spending is highly inefficient because teacher selection and assignment practices are not subject to clear rules, resulting in a wide margin of discretion and a lack of transparency in the criteria for evaluating, selecting, and assigning applicants. This also makes for an environment that is conducive to corruption, undermining teachers' trust in the system and biasing demand. This, in turn, has serious consequences for educational equity and assignment efficiency, produces congestion and poor matches between teachers and schools, and increases turnover, unfilled teaching positions, and the need to hire temporary teachers. These inefficiencies also lead to dissatisfaction and increase mistrust of governments and discontent (Bertoni et al., 2020b; Flores et al., 2014).

This technical note advocates the implementation of a digital centralized teacher selection and assignment system because it enables local governments to save millions of dollars each year whilst also improving assignment efficiency and the quality of the teachers assigned. For a country like Ecuador, we estimate that transitioning to a system of this type would generate an annual saving of over USD 2.6 million for the central government. Moreover, this figure underestimates the policy's true impact because it does not consider the benefits of improved assignment efficiency for student achievement. In a conservative estimate of savings in the form of benefits, we calculate that the state ceases to spend up to USD 15 million.¹

The implementation of policies of this type offers a cost-efficient and cost-effective solution to the problem of teacher assignment in the continent. Digital centralization of teacher assignment is a clear proposal to help governments reduce friction in the teacher labor market and achieve important fiscal savings by targeting Latin American education systems' single largest item of expenditure.

¹For this calculation, see Section 4.3.

2. Teacher assignment systems

2.1 Types of teaching positions

Throughout this document, when we refer to teaching vacancies, we are talking about permanent job openings for teachers recently graduated from higher education. This distinction is important because the teacher labor market distinguishes the following types of applicants: (i) recently graduated teachers seeking their first job in a permanent position; (ii) teachers looking to move from one permanent position to another; and (iii) teachers seeking a temporary position in some school.

Teachers seeking to move from one permanent position to another are often part of a phenomenon of high turnover. In countries like Chile, a lack of information during the hiring process means that many teachers leave a permanent position soon after being hired because they are not happy with the school climate, the salary, or other working conditions (Flores et al., 2014). This turnover is a result of both information asymmetries and poor matching in teacher assignment.

Moreover, the inability to fill permanent positions encourages the hiring of teachers on a temporary contract. In countries like Brazil, where there is no obligation to hold regular application processes for assigning permanent teachers, there is an even stronger incentive for temporary hiring, and governments prefer to keep temporary teachers even when suitable candidates are available for permanent positions (Bertoni et al., 2020b). The use of temporary teachers has important consequences because high teacher turnover negatively affects the academic performance of students, an impact that is particularly marked in the case of low-income students (Marotta, 2019).

This document analyzes and offers recommendations for the labor market of the first type of applicant (recent graduates seeking permanent positions). However, we believe that our recommendations can be beneficial for all other types of application processes, where the transition to a digital centralized system not only generates important savings, but can also boost allocation efficiency and the quality of the teachers assigned.

2.2 Overview of the continent

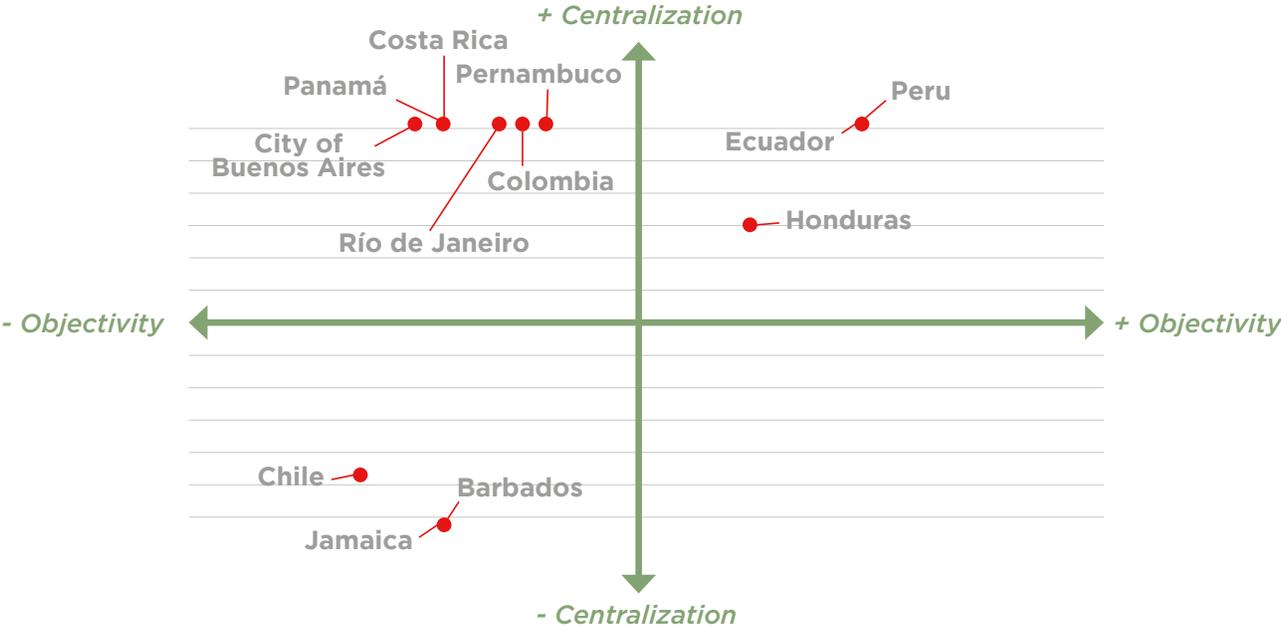
In this note, we refer to two main types of systems (centralized and traditional). However, in Latin America, there is a spectrum of teacher assignment policies, with varying levels of centralization and margin of discretion. Unlike student assignment, teacher assignment is essentially a job search problem and, therefore, calls for the incorporation of a selection component to measure and compare applicants' qualifications.

One characteristic that permits the comparison of different selection and assignment systems is their level of centralization. Countries like Barbados and Jamaica are examples of extreme decentralization, with the entire selection and assignment process taking place at the school level, while countries like Ecuador, Peru, Panama, Costa Rica, and Honduras have fully centralized systems under which the entire process is carried out by a single national entity. Between these two extremes, there are territories with different levels of centralization. In Brazil, the process is left to each state so, for example, Rio de Janeiro and Pernambuco carry out their processes independently, the former through its Regional Education Coordinator (CRE) and the latter through its Regional Education Office (GRE) (Bertoni et al., 2020a). In other words, these processes are also centralized, but they occur at the municipal or state level rather than the national level. In Colombia, the process's rules and criteria are defined centrally but vacancies and applications are handled by one of the 96 Certified Territorial Entities (ETCs) (MINEDUCACION, 2021).

Another key characteristic of systems is their level of objectivity in selection and assignment decisions. In Chile, the state requires that applicants have a teaching degree but all other selection and assignment criteria are left at the discretion of school administrators (which may be a municipal government or a private state-funded organization), implying an absence of standardized selection parameters. At the other extreme, countries like Ecuador and Peru use an algorithm based on pre-established criteria to assign teachers, resulting in greater objectivity and implying that all teachers are assigned under the same set of rules. Other systems, such as those of Pernambuco and Colombia, have varying margins of discretion since, although they establish more objective selection criteria (such as minimum scores in standardized assessments), positions are assigned by a local administrator in a public act and there is no guarantee that the administrator is applying objective selection criteria or being transparent about the vacancies available (Bertoni et al., 2020a). All systems, except for those of Ecuador and Peru, have a low level of objectivity and a lack of transparency.

Figure 1 compares some of the different systems found in Latin America. The vertical axis measures the centralization of the assignment policy from the lowest level, where the process is carried out at the level of each school, to the highest level, where it is carried out at a single level, whether the central government or a local administrative entity. The horizontal axis classifies systems by their level of objectivity, ranging from the least objective, where the person making the decision does so discretionally and with a lack of transparency, to one in which a mathematical algorithm, based on defined, non-discretionary parameters known to the applicants, is used. This comparison is for the purposes of illustration. It is not based on objective scores and is intended only to provide an overview of the differences and similarities between teacher assignment systems.

Figure 1



2.3 Types of assignment system

As indicated in Section 2.2, teacher selection and assignment policies vary widely around the continent. However, for the sake of simplicity, this note considers three types of systems – decentralized, semi-centralized, and centralized – and estimates the savings that can be achieved through a transition to a fully centralized system from a semi-centralized one and from a completely decentralized one.

The three systems are defined as follows:

- **Traditional or decentralized assignment system:** Under a system of this type, each school has its own teacher evaluation and selection process, advertises vacancies through its own means and defines the dates when the process will take place. Applicants must attend each evaluation and application process in person. If there are more applicants than vacancies, each school defines the criteria for breaking ties between candidates. The great dispersion of processes implies that it is very difficult for the authorities to regulate and monitor them and, therefore, the quality of the teachers assigned. One example of a system of this type

is Chile where each public school advertises its vacancies separately without any coordination. For teachers, this implies high job search and application costs in an extremely discretionary process.

- **Semi-centralized assignment system:** By comparison with centralized systems, semi-centralized systems have lower job search costs and selection is less discretionary. These systems are common in federal countries, which have a lower level of administrative centralization, and can mean a reduction in job search costs because information about vacancies tends to be collected and made available in a single place and time, usually through a public act. There is also a narrower margin of discretion because, in these cases, there is a prior evaluation to assess and order candidates according to their performance. However, despite these improvements, systems of this type are not immune to problems and can still lack objectivity in assigning vacancies, potentially leading to problems of corruption and loss of trust in the institution. One example of a system of this type is the city of Recife in the state of Pernambuco in Brazil, where vacancies are assigned in a public act and teachers are subject to prior evaluation, but negotiations for the available vacancies take place behind closed doors, creating fertile ground for a lack of probity.
- **Centralized assignment system:** Under these systems, applicants access an online platform with information about all the available vacancies. Each selection process involves an evaluation,² comprising one or more stages, whose requirements and parameters are defined by the authority. The criteria for breaking ties are established in advance by the corresponding authority and are communicated clearly and transparently to both teachers and the educational institutions involved. This authority, not the schools, also determines the final assignment using an algorithm that takes into account applicants' scores in the evaluation process and may or may not consider their preferences. Finally, teachers and schools are informed about the assignment results. An example of a system of this type is Ecuador's *Quiero ser Maestro* (I Want to be a Teacher) process in which candidates undergo a nationwide evaluation process, the results of which form part of a score that determines their priority at the time of their assignment. This system also considers other factors in their assignment, such as their preferences and the type of school to which they apply.

The evaluation process used in these systems can include a personal interview, a standardized test to measure skills, psychological assessments, and demonstration classes, among other components. What changes from one system to another is who designs and administers the different evaluations and announces the results.

Each of these processes involves three stakeholders: the process's administrator (typically the state through the central or local government), the schools, and teachers. Table 1 shows the actions taken by each of these stakeholders in the different types of system and the associated costs.

² Although the score obtained may be used by the applicant in one or more processes as determined by the authority.

Table 1 Assignment systems by situations faced by stakeholders

	DECENTRALIZED SYSTEM	SEMI-CENTRALIZED SYSTEM	CENTRALIZED SYSTEM
ADMINISTRATOR	<ul style="list-style-type: none"> • Monitoring: Both the evaluation process and the assignment process must be monitored at the level of each school, which is very costly. • Support for teachers: The great dispersion of selection processes makes it difficult to provide support for teachers during the evaluation and application process. • Coordination with schools: Administrators (often municipal governments) must coordinate with schools in implementing the selection, assignment, and hiring process. Each administrative entity must interact individually with each school. This coordination demands time on the part of the municipal government and its personnel. 	<ul style="list-style-type: none"> • Communication of the terms of the policy: The information available about the vacancies is collected and the dates of the public act are communicated. • Implementation of a single evaluation system: This may comprise one or more stages and be in-person or not. The frequency with which the evaluation takes place and the duration of the validity of the degrees obtained are determined by each authority. • Assignment of vacancies: This takes place in person and involves case-by-case review of applications. • Monitoring: If monitoring takes place, it is at the centralized level. 	<ul style="list-style-type: none"> • Creation of the algorithm and establishment of the assignment and selection criteria. • Construction of the technological infrastructure: As a minimum, a website is required to post vacancies and allow teachers to submit applications. • Communication of the terms of the policy: Vacancies and the dates of the process, as well as the criteria for assignment and to break ties, are published at the centralized level. • Implementation of a single evaluation system: This may comprise one or more stages and be in-person or not. The frequency with which the evaluation takes place and the duration of the validity of the degrees obtained are determined by each authority. • Coordination and annual maintenance of the process. • Support for candidates during the process, provided remotely or through support desks. • Centralized monitoring.
SCHOOLS	<ul style="list-style-type: none"> • Publication of vacancies: Each school publishes its vacancies and sets the dates of the process according to its own means and norms. • Evaluation process: This involves in-person reception of candidates, definition of evaluation criteria, implementation of the process, and communication of the results. • Selection process: This involves comparison of candidates, decisions about the teachers selected, and communication of the results. • Expenditure: All this process implies spending on supplies and support personnel for each establishment in addition to the cost of designing and preparing the evaluation. 	<ul style="list-style-type: none"> • Publication of vacancies: Each establishment informs the centralized body about the positions available. 	<ul style="list-style-type: none"> • Publication of vacancies: Each establishment informs the centralized body about the positions available.
TEACHERS	<ul style="list-style-type: none"> • Search for vacancies: The information comes from multiple sources and is published at different dates, implying high barriers of access. • Application: Candidates have to go in person – during working hours – to each institution (school) to which they wish to apply in order to submit their details and express their interest in participating in the selection process. • Evaluation: Candidates have to go in person – during working hours – to each institution to which they wish to apply. This tends to take several hours and involve transport costs. • Assignment: The criteria depend on each establishment and are not always clear, leading to mistrust and a lack of transparency. 	<ul style="list-style-type: none"> • Evaluation: This takes place a maximum of once per process (regardless of the number of schools to which a candidate is applying). The evaluation criteria are established by the administrative body. The evaluation is usually only valid for applications to schools within the administrator’s jurisdiction (municipal district, city, or state). • Application and assignment: This takes place in person through a public act, usually during working hours. Teachers are assigned according to criteria and priorities established by the administrator and are not always known in advance by the applicants. 	<ul style="list-style-type: none"> • Search for vacancies: All the information is centralized. A connection to internet and a device to access it reduce barriers of access. • Evaluation: This takes place a maximum of once per process (regardless of the number of schools to which a candidate is applying). There is a drastic reduction in opportunity costs. The parameters for the selection of teachers are standardized. • Application: This takes place online and can, therefore, be carried out outside working hours. Opportunity costs are drastically reduced and transport costs are eliminated. • Assignment: Teachers are assigned according to criteria and priorities that are known to all the applicants and all the schools.

3. Implementation costs and savings

Most of the estimates of the costs and savings associated with this policy are based on information from Ecuador, a country that uses a centralized assignment system under which the Quiero ser Maestro process is now in its eighth version. The costs of creating the algorithm and installing the technological infrastructure are based on information from Peru, which also has a centralized teacher assignment system and is currently implementing the 2022 version of its *Nombramiento Docente* (Teacher Appointment) process. It was not possible to obtain all cost sources from a single country and the source of each cost/saving is, therefore, indicated where applicable.

For this cost analysis, a commonly used strategy known as the ingredients method is employed. It seeks to identify the key components in the functioning of each process and assign them a value so that comparisons between the costs of each system are comprehensive and ensure their complete operation.

3.1 Costs

All expenditures arising directly from the implementation and maintenance of a centralized selection and assignment system are considered costs. When available, the source of the figure is indicated in a footnote. The assumptions and calculation formulas used in the estimation can be found in the appendix. All values are expressed in US dollars (USD).

It is important to bear in mind that a universe of 23,000 applicants was considered (Appendix A) and that the search for vacancies and the evaluation process take place during working hours, implying an opportunity cost greater than zero. This cost could be eliminated if it is assumed that the search and application process takes place online outside working hours.

Table 2 Costs of implementing a centralized teacher assignment system

	COSTS Description	Total (USD mill.)	By applicant (USD)
ADMINISTRATOR	• Algorithm team and construction of technological infrastructure	\$ 0.248	\$ 10.77
	• Annual administration of the process	\$ 0.050	\$ 2.17
	• Annual maintenance of the process	\$ 0.007	\$ 0.304
	• Support for applicants during the process, provided remotely or through support desks	\$ 0.003	\$ 0.13
	• Centralized monitoring	\$ 0.007	\$ 0.298
	• Evaluation of teachers for their assignment	\$ 0.345	\$ 15.00
SCHOOLS	• Publication of vacancies and related information using the digital platform	\$ 0.1095	\$ 4.76
TEACHERS	• Creation of profile, provision of applicants' information, search for vacancies, and application to schools using the digital platform	\$ 0.0534	\$ 2.32
	• Evaluation of teachers for their assignment	\$ 0.4272	\$ 18.57
TOTAL		\$ 1.25	\$ 54

Table 2 provides details of the main types of costs considered in this analysis. The total cost of implementing this teacher assignment policy is an estimated USD 1.25 million, of which approximately USD 1 million recurs annually. The largest component of this cost is the annual teacher evaluation process, which is carried out by the process administrator but also affects applicants through its opportunity cost. This process is necessary to obtain a measure of teacher quality and establish prioritization mechanisms for assigning positions and breaking ties between candidates. The analysis presented here assumes that the evaluation process is carried out annually, although experience indicates that, in centralized systems, it is less frequent.

It can be seen that implementing this new system also entails costs for schools, due to the time and personnel needed to gather the information required to advertise vacancies on the digital platform.

3.2 Savings

Savings are defined as all the costs of a traditional decentralized teacher assignment system that cease to exist as a result of centralization through a digital platform. When available, the source of the figure is indicated in a footnote. The assumptions and calculation formulas used in the estimation can be found in the appendix. All values are expressed in US dollars (USD).

This analysis reflects the significant losses of time and money that decentralized teacher selection and assignment systems imply for all the parties involved, as well as the considerable costs for schools, which each have to implement an evaluation process.

Table 3 Savings as a result of moving to a centralized teacher assignment system from a decentralized or semi-centralized system

	SAVINGS Description	Decentralized		Semi-centralized	
		Total (USD mill.)	By applicant (USD)	Total (USD mill.)	By applicant (USD)
ADMINISTRATOR	• Personnel and supplies used in the application process, the review of applicants' information, the assignment process, and communication of the results	-	-	\$ 0.482	\$ 20.933
	• Monitoring of the process	-	-	\$ 0.082	\$ 3.571
	• Evaluation of teachers for their assignment	-	-	\$ 0.345	\$ 15.000
SCHOOLS	• Personnel and supplies used in the application process, the review of applicants' information, the assignment process, and communication of the results	\$ 0.874	\$ 38.000	-	-
	• Evaluation of teachers for their assignment	\$ 1.726	\$ 75.000	-	-
	• Estimation of teacher vacancies and communication to administrator	-	-	\$ 0.055	\$ 2.380
TEACHERS	• In-person application to three schools, including transport costs	\$ 2.406	\$ 104.583	\$ 0.848	\$ 36.871
	• Evaluation of teachers for their assignment	\$ 1.068	\$ 46.420	\$ 0.214	\$ 9.284
TOTAL		\$ 6.10	\$ 265.19	\$ 2.03	\$ 88.04

This suggests that the implementation of a digital centralized teacher evaluation and assignment policy produces a net annual saving of over USD 4.5 million when moving from a completely decentralized to a centralized system, due principally to savings on the time and work of teachers and schools.

Based on the estimations carried out and taking a country like Ecuador as an example, the net saving achieved by transitioning from a completely decentralized or semi-centralized system can be calculated as:

Net Saving decentralized = Savings decentralized - Costs = USD 6.10 million - USD 1.25 million = USD 4.85 million

Net Saving semi-centralized = Savings semi-centralized - Costs = USD 2.03 million - USD 1.25 million = USD 0.78 million

4. Benefits

The implementation of a digital centralized selection and assignment system has a range of benefits and spillovers that, albeit not quantified in this document, help to boost the net benefit and strengthen the argument that it is a cost-effective policy. Once this category has been quantified, the policy's net impact on costs can be calculated as:

Net Impact = Total Benefits + Savings - Costs

4.1 Short term

The most immediate benefit arises from a reduction in search and information frictions. Online application through a platform showing all the available teacher vacancies reduces the time involved in searching for positions and applying. This is important because these processes tend to have a high opportunity cost and be a source of discontent among participants. The better access to information afforded by digital centralization, therefore, directly benefits applicants, especially those with fewer resources. Rural, remote, and/or socioeconomically vulnerable schools also benefit by being able to communicate and promote their vacancies to a broader audience at a low cost.

The increased availability of information also favors compatibility between the school and the teacher. If the platform implemented provides more information about an educational institution (such as its infrastructure, teaching staff, and educational project), applicants are better placed to judge their potential compatibility with it. Flores et al. (2014) suggest that greater knowledge about the characteristics of the school and the school community before applying can prevent rejection of the position offered through the evaluation and assignment process as well as early resignation and dismissals due to poor compatibility. Dismissing teachers who prove ineffective in the classroom is a lengthy and costly process. Chait (2010) reports that firing a teacher in the city of New York can have a cost of around USD 250,000.

Another important benefit is a narrower margin of discretion in selection and assignment decisions. In decentralized and semi-centralized systems, selection depends on the personal criterion of public officials, who may or may not follow the established guidelines. This creates fertile ground for corruption. By contrast, under a digital centralized system, teachers' knowledge of the evaluation criteria and the assignment rules favors transparency and their trust in the system. This reduction in the margin of discretion can even improve teacher quality: Estrada (2019) found that teachers assigned in a discretionary manner tend to perform worse than those chosen under a set of established rules (as would be the case under a centralized system).

Finally, because teachers must register on the platform in order to be assigned, digital centralization implies the creation of a database with information about applicants and their contact details, which is itself a very valuable asset for the administrative body in question. This fosters communication between teachers and the government (central or local), facilitating the provision of information about regulation, new public policies, and training opportunities. One key example of this is Ecuador's *Quiero ser Maestro 7* (QSM7) process in which the NGO ConsiliumBots – in partnership with the Inter-American Development Bank and the country's Education Ministry – used the contact information generated during the registration of applicants to send reminders during the application period. In addition, a survey could be sent to the participants to measure their satisfaction in order to improve subsequent processes. Neither intervention would have been possible without this database.

4.2 Medium and long term

The implementation of a centralized system can have positive effects on teacher quality. This has been seen in *Quiero ser Maestro* in Ecuador where the quality of the teachers assigned improved in 32.29% of the vacancies filled (Elacqua et al., 2022). For students, this implies great learning gains that, as estimated below, also have economic benefits.

Digital centralization promises to improve the quality of the teachers assigned and, in this way, reduce the cost that dismissals have and their impact on students.

In the medium term, centralized systems may help to improve the planning capabilities of the local or central government. It is important to know the location of both applicants and schools with vacancies, and the platform can be used to gather the corresponding geo-referenced information. This can, in turn, be used to identify geographical areas or teaching areas with a shortage or excess of teachers, permitting the design of public policies with incentives to correct this situation. Examples of policies along these lines include bonuses (or other types of monetary or non-monetary incentives) for teachers who choose to work in areas that are more remote or rural, have a large indigenous population, or are of a lower socioeconomic level.

As in the case of student assignment, centralization through a virtual platform permits the implementation of interventions to improve well-being. In Peru, an intervention to draw attention to extrinsic motivations (monetary incentives) and intrinsic motivations (appealing to vocation) resulted in an increase of up to 3% in the proportion of vulnerable schools chosen by teachers and of up to 6% in the probability of being assigned to a vulnerable school. Similarly, in Ecuador, an intervention that changed how information is presented – highlighting vulnerable schools – led to an increase of up to 9% in the proportion of teachers who chose a vulnerable school and up to 4% in the probability of being assigned to a vulnerable school. (Ajzenman et al., 2023, 2020).

It is also possible to implement so-called smart platforms that can provide applicants with personalized information in order to improve both the quality and efficiency of assignment. In addition, the data generated during the information process can be used to enhance the efficiency of existing policies through better targeting of certain subsidies, particularly those to encourage applications to rural, remote, or more vulnerable schools. In a study of a monetary bonus policy for teachers in Peru, Bobba et al. (2021) found that it is possible to improve the efficiency of teacher allocation to rural schools, saving 30% of the policy's total budget. Another extremely important point is the effect that policies of this type have on the teacher labor market. This market, like many others, is subject to frictions due to the decentralization of negotiations between – in this case – teachers seeking employment and schools with job openings. As mentioned above, centralized assignment policies reduce these frictions and this can have significant implications for the unemployment rate.

Finally, another potential benefit is the reduction in the use of temporary teachers. These positions are generally created in the face of a shortage of full-time teachers (Bertoni et al., 2020b). As indicated above, this practice is relevant because high teacher turnover negatively affects students' academic performance and, particularly, that of low-income students (Marotta, 2019). Digital centralization could help to reduce teacher shortages through a number of the channels mentioned: improved information, the implementation of interventions, and targeted monetary incentives, among others.

4.3 Estimation exercise: *Learning Gains*

As an exercise, we use the results of earlier research on the impact of better teachers on student achievement and, particularly, the *Quiero ser Maestro 7* (QSM7) and *Cerrando Brechas* (Closing Gaps) interventions.

Quiero ser Maestro 7 was the seventh version of Ecuador's centralized teacher assignment process. It included interventions with smart platforms and found that they increased the assignment of teachers, reducing the number of unfilled positions and, therefore, the number of students without a permanent teacher.

In the simulated partial assignment, 2,190 positions remained empty compared to 911 in the final assignment. This implies 1,279 fewer empty positions, equivalent to a reduction of 15.87 percentage points (from 27.18% to 11.31%). These interventions also serve to improve assignment of the best-qualified teachers.³ In *Quiero ser Maestro 7*, the quality of the teachers assigned also improved in 32.29% of the total vacancies (2,602 vacancies) when comparing assignment before and after the intervention.

According to the World Bank, each teacher in Ecuador has 24.26 students. Therefore, improving the quality of teachers in 2,602 vacancies implies that 63,124 students have classes with a better-qualified teacher (Elacqua et al., 2022).

Ecuador's *Cerrando Brechas* program measures the impact of improving teacher quality and estimates that this effect is equivalent to 0.11 standard deviations. According to the OECD, a student learns around one standard deviation each year, so *Cerrando Brechas* has an effect on learning that is equivalent to one-third of the school year. The number of vacancies where teacher quality improves is calculated as a proportion of the total teaching staff. For Ecuador, this is equivalent to 1.6%.

The World Bank estimates that the annual cost per student in Ecuador is 9.5% of GDP per capita (2016) or USD 590.3. One-third of this cost is USD 196.8. For the QSM7 process, the improvement in teacher quality would impact 63,124 students, generating an annual benefit equivalent to USD 12,422,803. Details of the calculation can be found in Appendix 7.

³ Qualification is through an examination process that considers an evaluation of teachers' knowledge, their professional experience, their performance in "trial classes", and a mark-up for compliance with certain eligibility criteria (Elacqua et al., 2022).

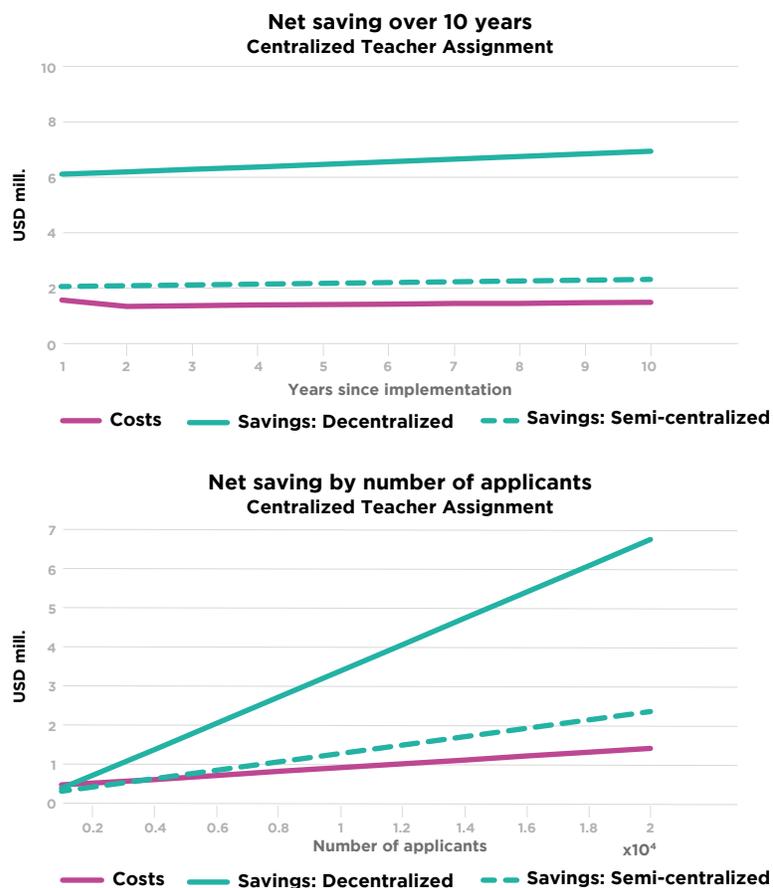
5. Extended analysis

Figure 1 shows a sustainability analysis of the policy, examining the evolution of the costs and savings in two dimensions: over time and as the number of applicants increases.

The upper panel shows the projection of costs and savings during the first ten years of the policy's implementation. The trajectory of costs reflects a high initial one-off cost that occurs only in the first year so that, in the second year, the cost drops and then depends almost exclusively on the number of participants in the system, holding relatively stable over the years. The trajectory of savings, on the other hand, varies with the growth of the population aged 20-59 years, which represents the cost of maintaining a decentralized system over time. To simplify the analysis over time and avoid introducing other considerations, the estimates do not incorporate rates of return or adjustments for inflation. The amounts are expressed in absolute values at constant prices.

The lower panel shows costs and savings by the number of applicants, indicating that both increase with the number of participants. However, savings do so more quickly. Costs exceed savings up to around 1,800 applicants, which is well below the nearly 20,000 candidates estimated for this exercise. It is important to bear in mind that, in addition to the creation of the algorithm and the construction of technological infrastructure, the largest cost corresponds to the design and implementation of the evaluation system which, in Ecuador, reaches USD 15 per applicant. This cost will vary from country to country, so this threshold is not fixed and will depend on local conditions.

Figure 1 Projection of costs and savings over 10 years compared to hypothetical benefits



In summary, taking into account all the costs, savings, and benefits indicated above, the net impact of the transition from a decentralized or semi-centralized system to a centralized system can be calculated as:

Net Impact decentralized = Total benefits + Savings decentralized - Costs

Net Impact decentralized = USD 12.42 million + USD 6.10 million - USD 1.25 million = USD 17.27 million

Net Impact semi-centralized = Total benefits + Savings semi-centralized - Costs

Net Impact semi-centralized = USD 12.42 million + USD 2.03 million - USD 1.25 million = USD 13.20 million

Depending on the system from which the transition is made, the net impact varies between USD 13.20 million and USD 17.27 million, with most of the savings attributable to the learning gains generated by the new policy. However, in both cases, the policy is cost-effective as from the first year of its implementation, producing net savings of between USD 780,000 and USD 4.85 million.

6. Conclusion

This technical note proposes a change in teacher assignment policies in Latin America, moving from a decentralized system to a digital centralized system. Using the example of teacher assignment in Ecuador, it estimates that the implementation of a system like Ecuador's *Quiero ser Maestro* can generate an annual saving of over USD 17 million when the transition is from a totally decentralized system. It also analyzes the costs and savings of transitioning from a semi-centralized system and, in this case, estimates that the annual saving reaches almost USD 800,000, not including learning gains or other benefits. In addition, sustainability analysis of the policy concludes that the saving increase over time and with the number of applicants.

The change to a digital centralized assignment and evaluation system not only produces great improvements in learning levels and the efficiency of teacher matching, but also enhances transparency and equity. In addition, it can serve as a great ally for local governments, saving millions of dollars for the system administrator (typically a municipal government or local education authority), schools (which are also part of the state), and the applicants themselves.

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Appendices

APPENDIX A: COSTING ASSUMPTIONS

- **Exchange rate:** An exchange rate of USD 1 = 3.7 Peruvian soles (PEN), the closing rate on April 5, 2022, is used.
- **Teaching staff:** A universe of 164,344 teachers in non-private institutions in Ecuador is considered.
- **Number of applicants:** This is calculated as 7% of the total teaching staff (only establishments with state financing) in the previous year. This figure was obtained from Ecuador's centralized teacher assignment processes and, for the purposes of this analysis, corresponds to 11,505 teachers.
- **Number of schools:** For 2021, 13,144 non-private educational institutions (state schools, state-financed but privately-managed schools, and municipal schools) are considered.
- **Opportunity cost for teachers:** Ecuador's Unified Basic Wage (SUB) for 2021 (USD 400) is used, assuming a working week of 45 hours and a working month of 180 hours.
- **Application time:** In a decentralized system, teachers are assumed to take 60 minutes to submit an application and 30 minutes for the complete process in a centralized system, both carried out during working hours.
- **Transport costs:** It is assumed that each teacher has to travel 30 minutes to the place for application and evaluation. The cost of this journey is the fare on local public transport (USD 0.4 in the case of Ecuador), plus the opportunity cost of the time involved.
- **Number of applications per teacher:** In both systems, teachers are assumed to submit five applications. This figure is based on the maximum number of applications permitted in Ecuador's Quiero ser Maestro system.
- **Expenditure on salaries of teachers and other state officials:** The analysis takes the average wage of public-sector employees in Ecuador, according to the scale of public-sector remunerations for 2021 (USD 1,500), to quantify expenditure on administrative personnel, school directors (who participate directly in the hiring process) and ministerial personnel (coordination and monitoring process). The wage of teachers is based on information from Ecuador's Education Ministry for 2021 (USD 817).
- **Monitoring:** It is assumed that, under a traditional system, monitoring takes place at the school level and takes 30 minutes per school. For a digital centralized system, the time is zero because the information is available instantaneously on the platform.
- **Time to calculate and report vacancies:** It is assumed that each school spends an hour on reviewing, calculating, and updating the available vacancies on the online platform. This task is carried out by a person who receives a wage equivalent to the average wage of a public official.

APPENDIX B: CALCULATION FORMULAS

For a country i in year t

B.1 Costs:

Costs for the administrator:

- **Evaluation cost:** USD 15 per applicant.

$$evaluation_admincost_{it} = evaluation_cost_{it} * applicants_{it} \quad (B.1)$$

where: $evaluation_cost_{it} = 15$.

Costs for schools:

- **Cost of publishing vacancies:**

$$staffit = \frac{gov_wage_{it}}{monthly_hours_{it}} * time_per_school_{it} * schools_{it} \quad (B.2)$$

where: $time_per_school_{it} = 1$.

Costs for teachers:

- **Application cost:**

$$application_cost_{it} = \frac{teacher_wage_{it}}{monthly_hours_{it}} * application_time_{it} * applicants_{it} \quad (B.3)$$

where: $application_time_{it} = 0,5$.

- **Evaluation cost:** Considers the teacher's opportunity cost.

$$evaluation_oppcost_{it} = \frac{teacher_wage_{it}}{monthly_hours_{it}} * evaluation_time_{it} * applicants_{it} \quad (B.4)$$

- **Transport cost:** Considers the opportunity cost of travel time and the fare on public transport.

$$transport_cost_{it} = \frac{teacher_wage_{it}}{monthly_hours_{it}} * transport_time_{it} * applicants_{it} + (bus_fare_{it} * applicants_{it}) \quad (B.5)$$

B.2 Savings:

Savings for the administrator:

- Saving on personnel:

$$\begin{aligned} \text{staff_savings} = & \frac{\text{government_wage}_{it}}{\text{monthly_hours}_{it}} \times n_applications_{it} \times applicants_{it} \times \text{staff_time}_{it} \\ & + \frac{\text{government_wage}_{it}}{\text{monthly_hours}_{it}} \times \text{evaluation_time}_{it} \times applicants_{it} \end{aligned} \quad (\text{B.6})$$

- Saving on supplies: A standard cost of USD 0.1. per applicant is assumed.

$$\text{supplies_savings}_{it} = 0,1 \times n_applications_{it} \times applicants_{it} \quad (\text{B.7})$$

- Saving on monitoring:

$$\text{monitoring_savings} = \frac{\text{government_wage}_{it}}{\text{monthly_hours}_{it}} \times \text{monitoring_times}_{it} \times schools_{it} \quad (\text{B.8})$$

Savings for applicants:

- Saving on search and application:

$$\text{application_savings}_{it} = \frac{\text{teacher_wage}_{it}}{\text{monthly_hours}_{it}} \times \text{application_time}_{it} \times n_applications_{it} \times applicants_{it} \quad (\text{B.9})$$

where: $\text{application_time}_{it} = 1$.

- Saving on evaluation time:

$$\text{evaluation_savings}_{it} = \frac{\text{teacher_wage}_{it}}{\text{monthly_hours}_{it}} \times \text{evaluation_time}_{it} \times n_applications_{it} \times applicants_{it} \quad (\text{B.10})$$

- Saving on transportation time:

$$\begin{aligned} \text{transport_savings}_{it} = & \frac{\text{teacher_wage}_{it}}{\text{monthly_hours}_{it}} \times \text{transport_time}_{it} \times n_applications_{it} \times applicants_{it} \\ & + \text{bus_fare}_{it} \times n_applications_{it} \times applicants_{it} \end{aligned} \quad (\text{B.11})$$

APPENDIX C: COSTING ASSUMPTIONS: TEN-YEAR PROJECTION

The previous assumptions are maintained and the following additional assumptions are incorporated:

- **Teachers as a percentage of the population:** According to the United Nations, the number of 24-64 year-olds in Ecuador reached 8,343,506 in 2020 of whom teachers represented 0.14%.
- **Population projections:** To model the number of applicants in the ten years as from the policy's implementation, the United Nations ten-year population projections⁴ were used. They indicate 1.45% annual growth of the population aged 20-59 years.
- **Expenditure on information interventions:** The early years of the policy's implementation call for an additional effort to ensure that teachers know and become familiar with the new system. In the first year, spending on these activities is assumed to be 25% above that in their stationary state. It is, therefore, assumed that this spending drops by 5% in each of the first five years.

APPENDIX D: CERRANDO BRECHAS AND COSTS PER STUDENT

Learning gains can be calculated as:

$$\begin{aligned} \text{learning_gains} = & \text{pc_improved} \times \text{teachers} \times \text{student_teacher_ratio} \\ & \times \text{learning_effect} \times \text{student_expenditure} \times \text{gdp}_{pc} \end{aligned} \quad (12)$$

where::

- **pc_improved:** Indicates the vacancies where teacher quality improves as a percentage of the total teaching staff.
- **teachers:** Corresponds to the staff of teachers employed in non-private establishments in each country.
- **student_teacher_ratio:** Corresponds to the average number of students per teacher.
- **learning_effect:** Coefficient that quantifies the effect of a good teacher on learning, obtained from the Cerrando Brechas study.
- **gdp_{pc}:** Gross domestic product per capita.

⁴<https://population.un.org/wpp/Download/Standard/Population/>