Pre-university education outputs in Egypt: does money matter?

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Abstract: The effect of school resources on education outputs has always been a debatable question. While supporters of the 'money matters' argument could find a significant relationship between the school resources and student's achievement, proponents of the 'money does not matter' argument could not. In this context, the current study aims at verifying empirically the hypothesis that the more the school resources of the public pre-university education system at the local level in Egypt, the higher will be the education performance at the same level. Using a panel dataset that covers 270 observations (27 governorates over the time period between fiscal years 2004/2005 and 2013/2014), this study finds a very little positive impact of per-student public expenditure on the student achievement, as measured by the graduation rate, at the preparatory educational level. In addition, this impact tends to be smaller for the governorates with a relatively high level of human development. The other school resources variables of pupil-teacher ratio, class size, and teachers' qualifications proved to have different effects on the student achievement by educational level.

Keywords: pre-university education; Egypt; education production functions; education finance; education resources; education outputs.

Reference to this paper should be made as follows: El Husseiny, I.A. and Amin, K.Z. (2018) 'Pre-university education outputs in Egypt: does money matter?', *Int. J. Education Economics and Development*, Vol. 9, No. 3, pp.210–235.

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This paper is a revised and expanded version of a paper entitled 'Pre-university education outcomes in Egypt: does money matter?' presented at MENA Social Policy Network Conference II 'Social Policy in the Middle East and North Africa: Challenges and Opportunities', Bath, UK, 20–21 November 2014.

1 Introduction

The effect of public expenditure on social services has always been a debatable question especially in developing countries and for a key service, such as education. Public expenditure on pre-university education is always justified by its social rate of return, which proved to be higher for primary and secondary education compared to tertiary education (Psacharopoulos, 1994; World Bank, 1995; Gupta et al., 2002). Case studies of countries which could achieve significant progress in primary and secondary education reveal that the equity of public expenditure on education by level which ensures quality of schools and effectiveness of learning; and the provision of adequate levels of expenditure for students, are among the key factors which might have been contributing to this success (Mehrotra, 1998). However, the relevant empirical analysis does not necessarily support the fact that school resources are significant for student achievement. In other words, while allocating public funds towards productive spending like education is usually perceived as a favourable approach, there is a little consensus on whether such expenditure significantly contributes to the improvement of student's educational performance. Some researchers have found little or insignificant impact of school (financial and physical) resources on education outputs concluding that money does not matter for student's achievement and that the socio-economic factors might have the dominant role in this regard. Others, however, have found a large significant and positive impact of the school resources on education outputs.

Given the fact that many developing countries experience unequal distribution of public expenditures on pre-university education among and within local jurisdictions, the question of 'does money matter' for the student's achievement seems more important and interesting at the local level.

Using regression analysis, this study aims at testing empirically the relationship between school resources and performance of the public pre-university education system at the local level in Egypt. This would help in deciding whether more school resources (including higher public expenditure) should be allocated to the public pre-university education system or not. A panel dataset that covers 270 observations (27 governorates over ten years extending from fiscal year 2004/2005 to fiscal year 2013/2014) is composed. This dataset includes variables on both of education resources (public expenditure per student, class size, pupil-teacher ratio, and teachers' qualifications) and student achievement (measured by the graduation rate) for the primary and preparatory educational levels of Egypt's public pre-university education system, at the governorate level.

This study comprises of six sections including this introduction. Section 2 reviews the literature on the relationship between school resources and student achievement. Section 3 concentrates on the structure of pre-university education system in Egypt and its fiscal aspects. Section 4 assesses the relationship between pre-university education resources and student achievement in Egypt; it also tackles the estimation methodology and data analysis. Section 5 presents and discusses the study findings and limitations. Section 6 concludes with providing a number of relevant policy implications.

2 School resources and student achievement: literature review

2.1 Education production function framework

Educational attainment in the literature of economics has been tackled through two main approaches. The first approach is based on 'human capital models', according to which a decision on the education level to be acquired is perceived as an 'investment' decision that is taken by individuals in light of the returns they expect to gain from education (Wilson, 2001). The second approach is based on the 'education production function models' that focus on the empirical effect of educational inputs that are related to school, student, and family characteristics on the educational attainment or the student performance as an output of the educational process (Polachek et al., 1978; MacPhail-Wilcox and King, 1986; Hedges et al., 1994; Wilson, 2001; Knoeppel et al., 2007; Deutsch et al., 2013). As contrary to the human capital models, education production models do not believe that individuals and their expected returns to education would affect the schooling decision (Wilson, 2001).

Studies that use the education production function framework differ in terms of the variables they use as 'inputs' and as 'outputs' with no consensus regarding how such variables should be exactly measured (Hedges et al., 1994).

Regarding the education inputs, the most commonly used measures include those variables that reflect school resources (such as expenditures per student, class size, pupil-teacher ratio, and teachers' characteristics); student characteristics and abilities; family background; and peer group effects (see Goldhaber and Brewer, 1997; Feinstein

and Symons, 1999; Sander, 1999; Wilson, 2001; Fedderke and Luiz, 2002; Aslam and Siddiqui, 2003; Dincer and Uysal, 2010; El Massah and Fadly, 2017). In addition, WöBmann et al. (2005) consider 'incentives' as an important input variable in the sense that rewards and penalties imposed on the actors in the education process would ultimately affect the education performance.

As for the educational outputs, it is noteworthy that the different terms of student 'achievement', student 'performance', and 'educational attainment' are used interchangeably in the reviewed literature on education production functions to represent the dependent variable in the estimated regressions which reflects the output of the educational process. However, researchers differ in terms of how they measure such a variable. In general, test scores represent the most commonly used measure of student's educational attainment (see Goldhaber and Brewer, 1997; Feinstein and Symons, 1999; Sander, 1999; Taylor, 1999; WöBmann et al., 2005; Ammermuller et al., 2005; Dincer and Uysal, 2010; El Massah and Fadly, 2017). The significant improvement in the publication of data from international student assessments such as the program for international student assessment (PISA) and the trends in international mathematics and science study (TIMSS) has contributed to this trend (Denny and Oppedisano, 2013).

Due to several factors including the data constraints which still represent a major problem in this field, some researchers have utilised variables that reflect the quantity, rather than the quality, of schooling achieved as measured by years of education, high school graduation, or college attendance (Wilson, 2001).

2.2 Graduation rates as an education output measure

Graduation rates have long been perceived as one of the most powerful indicators of the education system to measure success, which practically reflects the compliance with all requisites needed to finalise an educational program (Corrales et al., 2017). Accordingly, many researchers have focused on this measure of the educational outputs and provided analyses that covered a wide range of different aspects. These aspects have ranged from assessing the impact of education policy reforms and practice interventions on completion and graduation rates of both pre-university and higher education institutions (see Sanford and Hunter, 2011; Alzua et al., 2015; Freeman and Simonsen, 2015) to reviewing and assessing the statistical reliability of the existing data measures of school completion and graduation rates, as well as developing models to calculate the predicted graduation rates at postsecondary education institutions (see Warren, 2005; Bailey, 2006, respectively). Other researchers could identify some crucial factors that would support any collaborative effort to increase school graduation rates and prevent dropouts (see Israel, 2009; MacIver and Groginsky, 2011; Messacar and Oreopoulos, 2012).

In spite of that, fewer researchers have directly examined the relationship between school resources and graduation rates. For instance, Corrales et al. (2017) examined the relationship between school funding and graduation rates of Hispanic students in Texas school districts; Fedderke and Luiz (2002) utilised the matriculation pass rates as the education output measure in their estimation of the education production function in South Africa; and Wilson (2001) used high school graduation as the education output variable to examine the effects of education inputs either directly (through their effect on the production process associated with additional schooling), or indirectly (through their effect on the student's expected returns to graduation).

2.3 'Money matters' versus 'money does not matter' findings

Given that diversity in the measures used for both education inputs and education outputs, there is a little agreement in the literature regarding whether school resources would have a significant impact on students' learning and achievement (Verstegen and King, 1998; Ludwig and Bassi, 1999; Knoeppel et al., 2007). Two main reviews of literature on the relationship between school resources and student achievement can be distinguished in this context.[1]

The first review was guided by Hanushek (1986) who reviewed 147 regressions from different published studies on the effects of school characteristics on educational attainment. The main finding was that there seems to be no strong or systematic relationship between school resources (per-student expenditures; class size; pupil-teacher ratio; teacher's education, salary, experience and verbal abilities; facilities and administrative inputs) and student performance as measured by test scores in the majority of the reviewed studies. In other words, Hanushek's review of literature during the 1980s and 1990s led to the popular notion that 'money does not matter' for student achievement. The implication of such a conclusion, however, was not that governments should not increase their spending on education, but rather that money should be spent more effectively (Baker, 1991). MacPhail-Wilcox and King (1986) provided a similar conclusion by their comprehensive review of the literature on education production functions. Their review's main finding was that non-purchased resources including student characteristics and abilities; socio-economic status of student's family (like parental employment and education); characteristics of communities and peer group inputs may have more significant impact on student achievement compared to any purchased school resource.

The second major literature review on the relationship between school resources and student achievement was led by Hedges et al. (1994) and Greenwald et al. (1996) who, in response to the criticisms that were raised to challenge Hanushek's approach (see Baker, 1991), re-examined the same studies reviewed by Hanushek (1986), using different statistical methods for a synthesis of the results. Their review produced an opposing conclusion that 'money does matter', and that a broad range of school inputs (such as per-pupil expenditure, class size, pupil-teacher ratio, and teacher characteristics like education and experience) are positively and consistently correlated to student achievement suggesting that moderate increases in spending may be associated with significant increases in achievement.

The findings of both of the aforementioned reviews of literature on the relationship between school resources and student achievement were supported by the relatively recent empirical research. More specifically, while the argument that money does not matter for student achievement was supported by Feinstein and Symons (1999), Sander (1999), Aslam and Siddiqui (2003), Ammermuller et al. (2005), Houtenville and Conway (2008) and Dincer and Uysal (2010), who could find a weak or insignificant relationship between school resources and student achievement, the argument that money matters for educational outputs was supported by Taylor (1999), Wilson (2001), Fedderke and Luiz (2002), Gupta et al. (2002), Bacolod and Tobias (2006) and Steele et al. (2007), who could find strong evidence on the existence of a significant relationship between school resources and student achievement. Accordingly, one would argue that it is not the availability of money, but how such money is spent, that matters for student achievement (Jefferson, 2005).

2.4 Class size and student achievement

Class size is expected to have a negative impact on the student achievement in the sense that the more students per class, the less time will be allocated per student for exercises, discussions and interactions with the teacher. In addition, smaller classes would encourage teachers to utilise better or more effective teaching styles. This theoretical perception has been supported by some empirical works such as Keil and Partell (1997), Bonesronning (2003), and Monks and Schmidt (2010). However, a counter-intuitive finding that larger class sizes are beneficial for students has been reached by some other researchers (see Copper and Cohn, 1997; Denny and Oppedisano, 2013). This can be explained, among others, by social psychological factors according to which a student performs better when in a class with many students similar to oneself (Denny and Oppedisano, 2013). Another group of researchers has found poor or non-statistically significant impact of the class size on student achievement (see Sander, 1999; WöBmann et al., 2005; Bacolod and Tobias 2006; Dincer and Uysal, 2010).

In a review conducted by Hanushek (1999) on the class size effects, 15% of the reviewed studies found a significant negative effect, 13% found a significant positive effect, and the remaining 72% found non-statistically significant impact of class size on student achievement.

2.5 Pupil-teacher ratio and student achievement

Pupil-teacher ratio and student achievement are expected to be negatively correlated. A higher number of pupils assigned per teacher indicates that the working load per teacher is greater, which would negatively affect the performance of both teachers and students. The empirical results on the relationship between pupil-teacher ratio and student achievement, however, are mixed. While some researchers could find the expected negative sign of the pupil-teacher ratio in their estimated regressions (see Figlio, 1999; Wilson, 2001; Fedderke and Luiz, 2002; Steele et al., 2007), others found a positive sign of this variable indicating that lower pupil-teacher ratios are associated to lower levels of student achievement (see Dincer and Uysal, 2010). One of the explanations for this counter-intuitive finding might be that schools in deprived areas, which have particular teaching and disciplinary needs, may seek for or are given low pupil-teacher ratios (Feinstein and Symons, 1999). Another explanation might be that more students per teacher would induce more interaction among pupils. The latter explanation was provided by Aslam and Siddiqui (2003), who found both negative and positive effects of pupil-teacher ratio on student achievement in Pakistan's private and public schools, respectively. Dincer and Uysal (2010) concluded that there is an optimal pupil-teacher ratio beyond which further increases in this ratio would be associated with lower student achievement. Other studies found non-statistically significant relationship between pupil-teacher ratio and student achievement (see Feinstein and Symons, 1999; Houtenville and Conway, 2008; Lounkaew, 2013).

2.6 Per-student expenditure and student achievement

Per-student expenditure, which reflects the student's share in total expenditure on education, is expected to be positively linked to student achievement. Higher expenditure

per student indicates that more (recurrent and capital) financial resources are allocated to improve the student's educational environment in the form of higher salaries paid to teachers; more educational materials and facilities; and greater infrastructure investments. The positive and statistically significant effect of per-student expenditure on student achievement was highly supported by many researchers, such as: Taylor (1999), Sander (1999), Wilson (2001), Fedderke and Luiz (2002), Gupta et al. (2002), Steele et al. (2007) and Houtenville and Conway (2008).

2.7 Teachers' education and student achievement

The conventional wisdom suggests that highly educated teachers are capable of producing higher student achievement levels. The empirical evidence on the relationship between the education level of teachers (usually measured by the percentage of teachers with a Master's or Doctoral degree) and the student achievement, however, is ambiguous. While Luschei and Carnoy (2010) found a positive and statistically significant impact of holding postgraduate education by teachers on student achievement, other researchers found evidence that supports the lack of any significant relationship between teachers' education and the student's performance (see Goldhaber and Brewer, 1997; Figlio, 1999; Houtenville and Conway, 2008). Contrary to those findings, some researchers concluded that teachers' education exerts a negative and statistically significant impact on student achievement (Copper and Cohn, 1997; Aslam and Siddiqui, 2003). Copper and Cohn (1997) have explained this counter-intuitive finding by the lack of correspondence between subjects taught by teachers in schools and the postgraduate programs they completed, in addition to the poor quality of some postgraduate education programs thus the teaching abilities do not really improve.

2.8 Methodological issues

The mixed findings that have been reached by the different researchers regarding the relationship between school resources and student outcomes can be at large attributed to several methodological and empirical factors which may include:

a the choice of the relevant variables and how they are measured

b the unit of analysis (student, classroom, school, district, or state)

c the geographic scope of the data (within state or across states)

d the specification of the functional form (Sander, 1999; Taylor, 1999).

In addition, researchers differ in how they handle several estimation problems including the lagged effects of school resources on student achievement as well as the multiple outcomes of schools (Taylor, 1999). The endogeneity of school resources is considered also as one of the main cited methodological problems in the education production function relevant research. Since some of the explanatory variables used in estimation are endogenous and jointly determined with measures of achievement, the estimated effects of school resources on student achievement could be biased (Sander, 1999; Steele et al., 2007; Denny and Oppedisano, 2013). This might happen due to the correlation between observed and unobserved inputs (like ability), or the potential measurement errors (see Feinstein and Symons, 1999). Accordingly, a stronger positive relationship between

school resources and student achievement could be found by those researchers who accounted for the endogeneity problem by utilising different estimation methods (including the instrumental variables) (see Ludwig and Bassi, 1999; Steele et al., 2007). Moreover, De Witte et al. (2014) have noted that a change in education spending may have a different observed impact in terms of exam results depending on the exam system utilised. When exams and grading standards are set centrally rather than by schools, there will be no opportunity for teachers and/or schools to affect the grading structure when resources are increased to satisfy the policy makers' expectations regarding the improvement of students' achievement.

2.9 Study's contribution to the existing literature

The existing literature on pre-university education in Egypt mainly focuses on assessing the economic and social return on education. Furthermore, although studies have been conducted in an effort to describe separately the development of pre-university education expenditure and the development of selected education output variables such as student enrolment and graduation rates (see for example El-Baradie, 2000; El-Arabi, 2008; Ministry of Education, 2007), there is a much less research that examines the specific relationship between pre-university education resources and student achievement in Egypt. This tendency may be explained by two main factors. Firstly, there is a perception that there is often a need to inject more resources into the Egyptian education system, especially within the governmental sector, given the growing population and deteriorating educational assets. Secondly, there is an absence of a sufficient database to conduct a solid assessment on the effect of school resources on student achievement. While most of the literature on Egypt's pre-university education concentrates on the national, rather than the local, level due to the centralised nature of the system, the inefficiency of the intergovernmental transfer system adopted by the government regarding pre-university education sector implies that more studies are needed to be conducted at Egypt's local level (Amin, 2011).

Given the aforementioned context, this study attempts to contribute in filling the existing gap in the relevant literature by utilising the available databases to assess the relationship between the school resources (mainly public expenditure per student, class size, pupil-teacher ratio, and teachers' qualifications) and the student achievement (measured by graduation rates) in the public compulsory (primary and preparatory) education sector at the Governorate level, which is the highest local level in Egypt.

3 Pre-university education system in Egypt: structure and finance

Egypt's Constitution ensures the right to free compulsory education for all Egyptian children who are in the age group of 6–15 years. The pre-university education system in Egypt is composed of two main stages, namely: compulsory education (primary and preparatory levels), and secondary education. The primary education level lasts for six years and it corresponds to the age group of 6–11 years, while the preparatory level takes three years and corresponds to the age group of 12–14 years. In general, compulsory education in Egypt aims at providing children with adequate level of values, knowledge, and scientific and professional skills, which are consistent with their environments.

As for the secondary education stage, it corresponds to the age group of 15–17 years. Two main paths can be identified within this education stage, namely: the general secondary education, which lasts for three years and prepares students for the higher education and university education stages, and the technical (vocational) secondary education which extends from three to five years, and qualifies students to participate in the labour market. The decision about whether a student will be enrolled in general or vocational secondary education is mainly based on his/her performance in the final examination of the preparatory level, and also on the student's willingness as well as the available vacancies in either of the two paths.

Pre-university education system in Egypt also provides a kindergarten program for children in the age group of 4–5 years. This program is neither considered as part of the formal educational stages nor as compulsory education.

In spite of the fact that the pre-university education services in Egypt are provided by both public and private schools, the public sector dominates the pre-university education system. More specifically, according to the statistics of the Ministry of Education (MoE), around 91% of the total number of students who were enrolled in the pre-university education system in Egypt during the time period (2009/2010–2013/2014), in average, received their education from public schools. Moreover, public schools represented around 87% of the total number of pre-university education schools during the same period, in average.

The budgeting process of the pre-university education sector in Egypt is considered very complicated and scattered. From one side, the sector's budget is distributed amongst three components, namely:

a the budget of the MoE

b the budgets of the 27 education directorates (*Mudiriahs*) at the governorate level

c the budgets of the public service authorities affiliated to the sector, the most important of which is the general authority for educational buildings (GAEB).[2]

Each of these entities is considered as a separate budget authority that negotiates on its own budget with the Ministry of Finance (MoF) (see El Husseiny, 2016).

On the other side, the recurrent and investment budget allocations of the whole sector are not integrated since they are negotiated and decided by two different central ministries, namely: the MoF and the Ministry of Planning (MoP), respectively. Recurrent expenditure should be adjusted according to the development in education investments to take into account the long and medium-term operating and maintenance costs of these investments. This separation problem is deeper in the pre-university education sector since the MoF and the MoP negotiate with fragmented budget authorities rather than negotiating the consolidated sector's budget with the concerned Minister of Education. Moreover, since the formulation of Egypt's State budget does not apply a hard budget ceiling, the tradition is that the MoE and the other relevant budget authorities submit their budget proposals whose total costs are often right above the overall fiscal framework of the MoF. The proposed budgets are therefore approved at significantly lower levels than what was originally requested following bilateral negotiations between the MoF and the MoP from one hand, and the MoE and the other budget authorities affiliated to the pre-university education sector, from the other hand (El Husseiny, 2016).

As shown in Table 1, the sector's total budgetary allocations averaged around LE 41,383 million during the time period that extended from fiscal year 2008/2009 to fiscal

year 2013/2014. This represented around 2.9% of GDP and 8.9% of total public expenditures, in average. Moreover, the data indicates that the budgetary allocations to pre-university education sector have been increasing between the two fiscal years of 2008/2009 and 2013/2014, by almost 128% and 43% in nominal and real terms, respectively. It is noteworthy that according to Egypt's new Constitution of 2014, public expenditure on pre-university education should reach 4% of GNP.

Table 1 Public expenditure on pre-university education sector in Egypt

Item/year	*2008/2009*	*2009/2010*	*2010/2011*	*2011/2012*	*2012/2013*	*2013/2014*	*Period average*
Sector's total public expenditure in nominal terms (LE million)	27,448	32,039	35,459	40,543	50,179	62,631	41,383
Sector's total public expenditure in real terms (LE million) (CPI of Jan. 2010 = 100)	29,514	31,288	30,968	33,016	37,225	*42,238	34,042
Sector's total public expenditure as % of GDP	2.8%	2.8%	2.7%	2.7%	3.0%	**3.2%	2.9%
Sector's total public expenditure as % of overall public expenditures	8.0%	9.9%	8.8%	8.3%	9.4%	9.1%	8.9%

Notes: *CPI of 2013/2014 is estimated assuming a 10% inflation rate.
**GDP of 2013/2014 is projected assuming 15% annual increase in nominal terms.

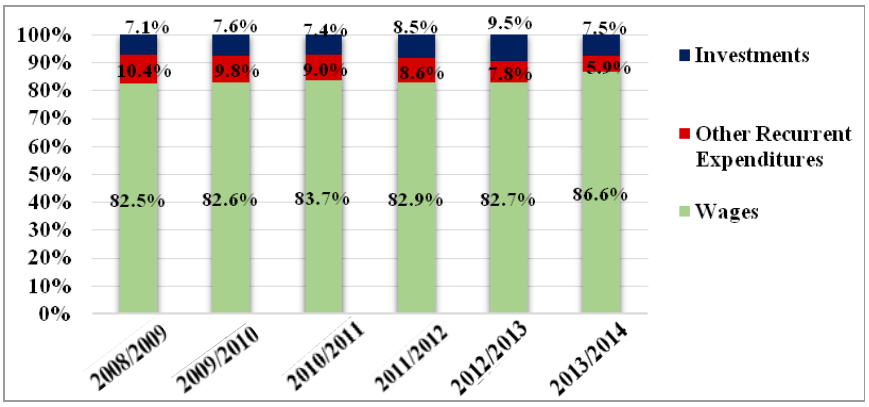
Source: Made by the authors based on: the estimates of the State's General Budget published by the MoF, GDP data at current prices and factor cost published by the MoP and CPI data published by the Central Bank of Egypt

As for the composition of pre-university education sector's budget, Figure 1 indicates that around 83.5% of the sector's total budget was allocated to the first chapter 'wages' during the time period (2008/2009–2013/2014), in average, compared to 8.6% and 7.9%, in average, for the 'other recurrent expenditures' and 'investments', respectively.

According to the administrative classification of the budget, and as presented in Figure 2, local administration (educational directorates) constituted the majority of the sector's budget (around 84.3%), in average, during the time period (2008/2009–2013/2014). This is due to the vast number of teachers and administrators who work in the sector. The MoE and the public service authorities affiliated to the sector accounted for average shares of 9.1% and 6.6% of the sector's budget during the same period, respectively. Out of the different public service authorities affiliated to the

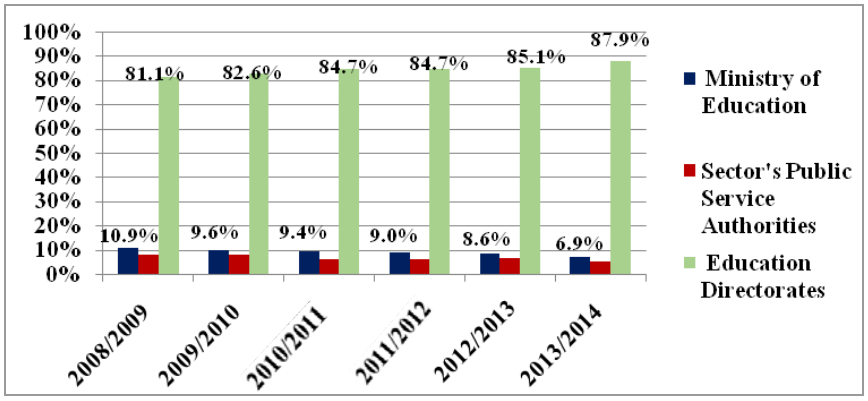
pre-university education sector, the GAEB is considered as the main entity that undertakes the majority of the sector's investments.

Figure 1 The composition of pre-university education sector's budget by economic classification (see online version for colours)



Source: Made by the authors based on the estimates of the State's General Budget published by the MoF (http://www.mof.gov.eg)

Figure 2 The composition of pre-university education sector's budget by administrative classification (see online version for colours)



Source: Made by the authors based on the estimates of the State's General Budget published by the MoF (http://www.mof.gov.eg)

This study focuses on the public compulsory (primary and preparatory) education in Egypt, which is usually known as the 'basic education'.[3] This focus can be justified by three main factors: First, during the time period that extended from fiscal year 2009/2010 to fiscal year 2013/2014, the total number of students who were enrolled in the public basic (primary and preparatory) schools averaged around 12.7 million, which represented 79% of the total number of students enrolled in the public pre-university education system, in average. Second, there is evidence that the social rate of return on education is higher for primary and preparatory stages than for the secondary one. Third, secondary education in Egypt, as mentioned above, has two tracks, general and vocational, each of

them has its own nature and performance indicators. This would complicate the task of including secondary education in our analysis, especially given the poor data available on the vocational system.

The net enrolment rates[4] in the primary and preparatory educational levels have been increasing over time. Data indicates that the net enrolment rate increased from 88.6% to 90.6% for primary education, and from 66.3% to 80.9% for preparatory education, between the two fiscal years of 2008/2009 and 2013/2014. According to the statistics of the MoE for the time period (2008/2009–2012/2013), around 89% of the total number of students who were enrolled in public primary and preparatory education schools, in average, could succeed in the final examination of the corresponding stage. However, significant discrepancies arise among the Egyptian governorates regarding the student achievement. For example, the graduation rate at the public primary education level in 2012/2013 ranged between 85% in Suhag and 97.5% in New Valley. The corresponding rate at the public preparatory education level ranged between 82% in Menia and 99.8% in New Valley.

4 Data and methods

This study utilises data on educational inputs and educational outputs collected from 27 Egyptian governorates during the time period between fiscal years 2004/2005 and 2013/2014. Two models are estimated separately for primary and preparatory educational levels. The graduation rate at each level is used as the dependent variable that measures the educational outputs. Five explanatory variables are used, namely: class size, pupil-teacher ratio, percentage of teachers with high qualifications, per-student public expenditure, and a dummy variable for the human development index.

The five explanatory variables are used to capture four groups of educational resources and structural factors that are proved to contribute to educational achievement as reflected by the literature review as follows:

1 class size variable is a good proxy to the available educational infrastructure

2 both pupil-teacher ratio and percentage of teachers with high qualifications reflect the educational process

3 per-student public expenditure expresses the pre-university education finance

4 human development index is a variable that captures the structural and unobservable factors, since it is a composite variable that includes income, health, and education indicators.

Based on this classification the model can be expressed as follows:

$$graduation_{it} = \alpha_0 + \alpha_1\, class\_size_{it} + \alpha_2\, pupil\_teacher_{it} + \alpha_3\, qualif\_teacher_{it} + \alpha_4\, perstudent\_exp_{it} + \alpha_5 \left(perstudent\_exp * HDI \right)_{it} + e_{it}$$

The two subscripts i and t reflect the cross-section (governorates) and the time-series (years) dimensions of the panel dataset utilised in the analysis, respectively. The interaction term (*perstudent_exp*HDI*) is added to test the hypothesis that the impact of

per-student public expenditure on graduation rates differs with the different levels of human development.

The model is estimated separately for primary and preparatory education levels using the least squares with the fixed effects and random effects (in cross section). The Hausman test is used to decide whether a model with random effects or that with fixed effects is more appropriate to be estimated.

The fiscal data that is issued by Egypt's MoF regarding public expenditure on pre-university education does not show the share of each educational level separately. Also, Egypt's MoE and its affiliated authorities do not provide any measure that takes into account the share of each governorate in the central expenditures on pre-university education. As a result, the authors followed the procedure described below for the measurement of per-student public expenditure at the primary and preparatory levels:

- The share of each governorate in the public expenditure of the GAEB, which is responsible for all long-term investments in pre-university education sector, is calculated by multiplying the governorate's relative share of total number of public schools at the national level by total public expenditure of the GAEB.

- The share of each governorate in the public expenditure of the MoE and the other public service authorities affiliated to it (except for the GAEB) is calculated by multiplying the governorate's relative share of total number of students enrolled in public pre-university education system at the national level by total public expenditure of both of the MoE and its affiliated public service authorities, except for the GAEB.

- Total public expenditure on pre-university education at the governorate level is calculated by adding up the sum of the governorate's share in total expenditure of the GAEB, the MoE and its other affiliated authorities, to the public expenditure of the educational directorate, which is the entity managing all educational activities at the governorate level.

- Total public expenditure on primary (preparatory) education at the governorate level is calculated by multiplying the governorate's total public expenditure on pre-university education by the relative share of public primary (preparatory) students in total number of students enrolled in public pre-university education system at the governorate level.

- Per-student public expenditure at the primary (preparatory) education level is calculated by dividing the governorate's total public expenditure on primary (preparatory) education by the governorate's total number of students enrolled in public primary (preparatory) schools.

The Appendix describes the variables included in the estimated models, the way implemented in measuring each of them, and the source of collected data.

Tables 2 and 3 as well as Figure 3 provide a descriptive analysis for the data utilised in the estimated models of this study. The tables indicate that the average class size for primary education was almost 38 students during the study's time frame compared to almost 36 students for preparatory education. The average of pupil-teacher ratio varied between primary and preparatory education levels, which scored almost 25 and 16, respectively.

Table 2 Compiled descriptive statistics of the primary education regression variables

Statistics	*class_size_pri*	*pupil_teacher_pri*	*qualif_teacher_pri*
Mean	38.29	24.65	47.18
Median	41.00	26.10	45.55
Maximum	59.00	44.63	99.24
Minimum	6.92	5.91	22.10
Std. dev.	9.81	7.25	11.78
Skewness	–0.84	–0.04	1.22
Kurtosis	3.60	3.39	6.17
Jarque-Bera	35.75	1.76	179.45
Probability	0.00	0.41	0.00
Sum	10,337.35	6,655.96	12,738.85
Sum sq. dev	25,866.10	14,128.33	37,325.23
Observations	270	270	270
Statistics	*perstudent_exp_pri*		*graduation_pri*
Mean	2,661.66		91.66
Median	2,229.17		91.80
Maximum	13,194.01		99.20
Minimum	852.56		78.30
Std. dev.	1,657.34		3.76
Skewness	2.54		–0.36
Kurtosis	12.65		2.93
Jarque-Bera	1,336.19		5.88
Probability	0.00		0.05
Sum	718,648.7		24,748.30
Sum sq. dev	7.39E+08		3,803.84
Observations	270		270

The two tables reflect that the education system in Egypt used to favour preparatory education, compared to primary education, regarding the quality of teachers. While the average percentage of teachers who hold at least a university degree was 47 in primary schools, the corresponding percentage for preparatory schools was almost 90. The average graduation rate was relatively high in both primary and preparatory education levels. It scored approximately 92% in primary education compared to almost 88% in preparatory education.

The methodology used in the measurement of per-student public expenditure was based on the assumption that public expenditure on pre-university education is distributed among the educational levels according to the number of students enrolled at each level. Accordingly, per-student public expenditure at the primary and preparatory educational levels was identical and averaged around 2,662 Egyptian pounds (around USD 148), as reflected by the two tables. The tables reflect a considerable range between minimum and maximum values for all the variables included in the study. This reflects the distribution inequality among the governorates regarding the variables of educational resources and

education achievement. This unequal distribution does not rule out the fact that most of the governorates realised progress regarding the analysis variables over this study's time frame. However, the centralised nature of the education system in Egypt in addition to the failure of the intergovernmental fiscal transfers within the system in tackling inequalities maintained the considerable gaps between governorates over time.

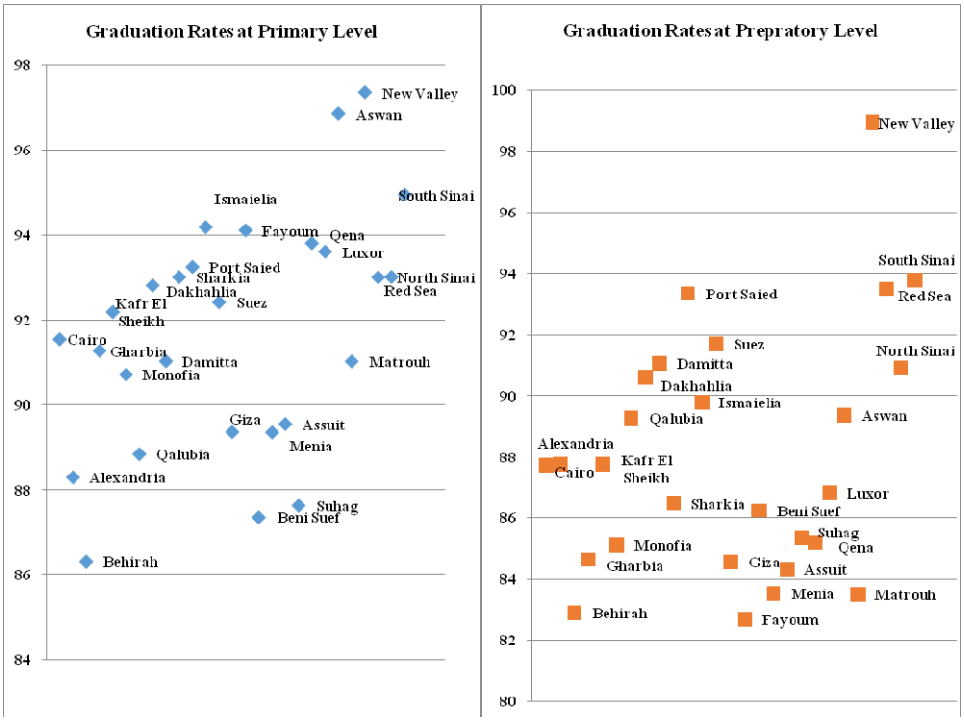
Table 3 Compiled descriptive statistics of the preparatory education regression variables

Statistics	*class_size_prep*	*pupil_teacher_prep*	*qualif_teacher_prep*
Mean	36.21	16.38	90.23
Median	38.31	16.34	90.93
Maximum	52.18	30.56	99.20
Minimum	5.00	4.37	71.73
Std. dev.	7.27	5.56	5.15
Skewness	–1.18	0.02	–0.73
Kurtosis	4.89	2.52	3.38
Jarque-Bera	102.65	2.63	25.53
Probability	0.00	0.27	0.00
Sum	9,777.94	4,421.92	24,361.26
Sum sq. dev	14,220.14	8,324.55	7,145.55
Observations	270	270	270
Statistics	*perstudent_exp_prep*		*graduation_prep*
Mean	2,661.66		87.91
Median	2,229.17		89.15
Maximum	13,194.01		99.75
Minimum	852.56		50.40
Std. dev.	1,657.34		7.26
Skewness	2.54		–1.26
Kurtosis	12.65		5.81
Jarque-Bera	1,336.19		159.82
Probability	0.00		0.00
Sum	718,648.7		23,734.93
Sum sq. dev	7.39E+08		14,185.76
Observations	270		270

Figure 3 displays the average graduation rate per governorate during the time frame of the study for the primary and preparatory educational levels separately. The figure reflects a variation among the governorates although the range of this variation is limited. At the primary level, the difference between the highest graduation rate, realised in the governorate of New Valley, and the lowest graduation rate, realised in the governorate of Behirah, is almost ten percentage points. At the preparatory level, the difference between the highest and the lowest graduation rates is 16 percentage points. The figure also shows that the behaviour of the same governorate differs from level to level. For example, the governorate of Fayoum ranked last in terms of the graduation rate at the preparatory

level, while it had an advanced rank at the primary level. Same behaviour has been exercised by many other governorates such as Aswan and Matrouh.

Figure 3 Scatter diagram for the average primary and preparatory graduation rates at the governorate level (2004/2005–2013/2014) (see online version for colours)



It is noteworthy that the data analysis also shows that the frontier governorates like Matrouh, New Valley, North Sinai, and South Sinai, which have a limited number of schools and students, experienced high pupil-teacher ratios and high expenditure per student values.

5 Findings, discussion, and limitations

5.1 Study findings and discussion

The Hausman test for correlated random effects implies the rejection of the null hypothesis at the 5% level of significance in both primary and preparatory education models. This means that the fixed, rather than the random, effects model is more appropriate and consistent for our data sample. Accordingly, the two specified models of primary and preparatory education are estimated using fixed effects. The estimation results are shown in Table 4.

As for the primary education model, column (1) in Table 4 indicates that class size has a positive and statistically significant relationship with graduation rates at the 5% significance level. The magnitude of the estimated coefficient, however, is quite small.

Increasing the class size by ten points is associated to an increase in the graduation rate by almost one percentage point. This observed positive effect of increased class size may appear to be counter-intuitive but it is not unusual. As mentioned earlier in the literature review section, some authors have explained this pattern by pointing to social psychological explanations according to which a student performs better when in a class with many students similar to him/herself. The larger the class size, the more students (who are similar) there will be, ceteris paribus (Denny and Oppedisano, 2013).

Pupil-teacher ratio has the expected negative sign and is statistically significant at the 1% level. Decreasing the pupil-teacher ratio by ten points is associated to an improvement in the graduation rate by around 1.7 percentage points. This can be explained by the fact that it is hard to control and discipline a large number of students at the primary education level and accordingly it becomes challenging to provide a high quality of education when pupil-teacher ratio is relatively high.

The coefficient of the variable that measures teachers' qualifications is negative and statistically significant at the 1% level; however, it is very small in magnitude. Interestingly, the percentage of teachers who hold high degree qualifications does not reflect the quality of education provided by teachers. Since other skills such as communication, presentation and reasoning skills unfortunately are not measured on a standardised basis; we were unable to include such skills in the model. The lack of incorporating these skills in teachers' qualifications might lead to the negative sign reflected in the results. Also, the poor level of education and training teachers receive in their colleges may explain the negative counter-intuitive sign, as well as the fact that primary education depends mainly on activities rather than knowledge.

Per-student public expenditure at the primary education level has a negative and statistically significant impact on graduation rates at the 5% level of significance; however, the magnitude of such an impact is very small so that it can be considered insignificant. This negative tiny impact of per-student public expenditure on graduation rates at the primary level indicates that public expenditure on this educational level lacks effectiveness. Moreover, this finding goes along with the intuition that primary education does not need as much expenditure as the preparatory level for instance since it merely depends on activities rather than knowledge.

Finally, the interaction term between per-student public expenditure and the HDI dummy is insignificant at the 5% level indicating that the impact of per-student public expenditure on graduation rates does not differ according to the human development status of the governorates. The adjusted R-squared reflects that the fixed effects model explains almost 57% of the variation in the graduation rate.

It is worth mentioning that we also categorised Egypt's governorates to upper, urban, frontier, and lower governorates and created a dummy for each of the first three categories to be used as control variables in the estimated random effects model. However, the null hypothesis of the Hausman test was rejected indicating that the fixed effects is the appropriate model. Since the fixed effects model controls for the time in-variant variables, these dummies were dropped from estimation.

Column (2) of Table 4 shows the results for the preparatory education model using fixed effects. Class size exhibits a positive relationship with graduation rate, however, this relationship is statistically insignificant at the 5% level. This finding is in line with the conclusions of Sander (1999), WöBmann et al. (2005), Bacolod and Tobias (2006), and Dincer and Uysal (2010), who found poor or non-statistically significant impact of the class size on student achievement.

Table 4 Fixed effects estimation results for the primary and preparatory education models

Variable	*(1)* *Primary education model estimated coefficients* *(Standard errors)*	*(2)* *Preparatory education model estimated coefficients* *(Standard errors)*
class_size_pri	0.10**	
	(0.05)	
pupil_teacher_pri	–0.17***	
	(0.05)	
qualif_teacher_pri	–0.06***	
	(0.02)	
perstudent_exp_pri	–0.0007**	
	(0.0003)	
*perstudent_exp_pri*HDI*	0.0006*	
	(0.0003)	
class_size_prep		0.15*
		(0.08)
pupil_teacher_prep		1.33***
		(0.14)
qualif_teacher_prep		0.25**
		(0.13)
perstudent_exp_prep		0.003***
		(0.0006)
*perstudent_exp_prep*HDI*		–0.003***
		(0.0006)
Constant	95.88***	34.17***
	(2.53)	(11.81)
Prob. (F-statistic)	0.00	0.00
Adjusted R-squared	0.57	0.54
Durbin-Watson Stat	1.9	1.8

Note: *, ** and *** indicate to the significance of the estimated coefficient at 10, 5, and 1% level of significance, respectively.

Interestingly, pupil-teacher ratio shows a positive and statistically significant relationship with preparatory education graduation rate at the 1% level. The magnitude of the estimated coefficient of this variable indicates that a one point increase in the pupil-teacher ratio is associated to around 1.3 percentage point increase in graduation rate. A possible explanation for the positive sign of pupil-teacher ratio is that the teaching style adopted by a teacher depends on the number of students he/she is assigned. Teachers facing a larger number of students may adopt a more disciplined style which might be more effective. Clear evidence on the relative effectiveness of teaching styles appears to be very rare, however (Denny and Oppedisano, 2013). In any case, our data reflects that the more students assigned to a teacher, the more effective the education

quality and hence the higher the graduation rate. This is the case only for preparatory education in which the core determinant of highly qualified students is the teachers' qualification and knowledge. Therefore teachers' qualifications variable is shown to be positive and statistically significant at the 5% level in contrast to the primary level where education merely depends on activities rather than knowledge.

The estimated effect of per-student public expenditure on graduation rate at the preparatory education level is positive and significant at the 1% level, which is intuitive as at this level of education, the government expenditures include many items, which have direct effect on the educational process and students' attainment such as science laboratories, computer labs, and libraries. However, the estimated effect is very small in magnitude indicating that relatively highly cost increases in per-student public expenditure would bring very little improvements in graduation rates.

Contrary to the primary education model, the human development status at the governorate level seems to affect the relationship between per-student public expenditure and graduation rates at the preparatory education level. This is reflected by the negative and statistically significant coefficient of the interaction term 'perstudent_exp_prep*HDI' which indicates that the impact of per-student public expenditure on graduation rate is lower for those governorates with a relatively high level of human development (where the HDI dummy equals 1) compared to those with a relatively low level of human development (where the HDI dummy equals 0). Put it differently, at the preparatory education level, the increased per-student public expenditure is expected to bring a greater improvement in the graduation rates at those governorates where the human development index is below the national level compared to those governorates where the human development index is equal to or above the national level.

The adjusted R-squared for the preparatory education model reflects that the selected variables explain almost 54% of the variation in the graduation rate.

5.2 Analysis limitations

The data produced by the governmental education system in Egypt is very poor. The MoE and the MoF mainly generate aggregated statistics. This is explained by the fact that Egypt does not implement a program-based approach in terms of institutional structure and budget in pre-university education sector. As explained in the methodology section of this study, the variable of expenditure per student is calculated based on a number of assumptions. The reason is that there is no real data collected on either the actual expenses by educational level, or the distribution of the general and administration cost among governorates and different educational levels.

Moreover, there is no comprehensive system to evaluate the capability and the qualification of teachers. The MoE classifies teachers according to the academic degrees they hold into two categories: 'teachers with at least a university degree' and 'teachers with lower than university degree'. Academic degrees do not measure the other skills that would affect teaching such as communication and presentation skills. The academic degree-based classification does not capture the experience of the teacher and his/her performance.

This study uses the variable of graduation rate to capture the educational output. There is no standardised nationwide test applied to the primary and preparatory students in Egypt. Each governorate puts its own exam at the end of primary and preparatory education levels. However, the MoE puts guidelines and standards for the education

directorate at the governorate level to be followed in exams formulation. Also, it reviews and approves the exams at the end of each of the two educational levels. Using the graduation rate rather than the test scores is mandatory as a result of lacking standardised national test. However, this measurement ignores the actual level of skills acquired by the graduated students and it limits the variation that would be generated in case of using test scores. Moreover, the MoE does not produce detailed data for each grade within the same educational stage. The data on class size, pupil-teacher ratio, and teachers' qualifications, for instance, is calculated as an average for each of the primary and preparatory educational stages. Thus, while the dependent variable used in the study (graduation rate) captures the education output at the last year of the educational stage (grade 6 for the primary model, and grade 9 for the preparatory model), explanatory variables capture the schooling inputs available throughout all years of a particular educational stage, in average. This limitation, however, is not expected to have a significant impact on our results given the fact that there should be some time lag between when educational inputs are made available and when they are fully reflected in the educational achievement level.

In addition, data on the socio-economic variables (including poverty rate, unemployment rate, illiteracy rate, family size, accessibility to public utilities, income level, etc.) is not available at the governorate level for most of the years covered by our study. This has constrained the authors' ability to test the hypothesis that the non-school resources and socio-economic factors are much more significant for the student achievement than the school resources. Accordingly, the authors had to employ the variable of human development index to control for structural aspects and the unobservable socio-economic factors. Since the government produced values for such index just twice during the time period of this study, a dummy variable has been created to classify the governorates into two categories; governorates with high human development index, more than the national value; and governorates with low human development index. This also limits variation for this variable.

6 Concluding remarks and policy implications

This study examined the relationship between school resources (mainly class size, pupil-teacher ratio, per-student public expenditure, and teachers' qualifications) and education outputs (measured by the graduation rates) at the public primary and preparatory education levels in Egypt. The panel dataset utilised by this study covered 270 observations that correspond to the 27 Egyptian governorates over the time period from fiscal year 2004/2005 to fiscal year 2013/2014.

The fixed effects estimation results indicate that the pupil-teacher ratio is the only school resource variable that matters for the graduation rate at the primary education level. Lower pupil-teacher ratios are associated with higher graduation rates at this educational stage. The other variables were found to be significant though with counter-intuitive signs, in addition, their estimated coefficients were very small in magnitude to argue that school resources matter for the educational output. At the preparatory education level, all of the school resources except for class size were statistically significant for the graduation rate at least at the 5% level. In contrary to the

primary education model, the coefficient of the pupil-teacher ratio in the preparatory education model was positive.

The findings of the current study indicate that an across-the-board policy that aims at decreasing class sizes at both the primary and preparatory public education levels might be ineffective in terms of improving the graduation rates. Moreover, while efforts need to be made in order to reduce the pupil-teacher ratios at the primary public education schools in order to enhance the graduation rate at this level, improving the qualifications of teachers and/or raising the per-student public expenditure might be more proper policy alternatives to enhance the graduation rates at the preparatory level.

In terms of the distribution of school resources among the educational levels, the study highlights the need of the MoE to reallocate the budget financial resources and teachers' qualifications away from the primary to the preparatory education level given the positive effect of these resources on the graduation rate at that level. This does not imply that the government should not allocate extra financial resources to the primary educational stage, but rather it reflects the government's need to spend more 'effectively'.

The existence of inequality among governorates as shown by the descriptive analysis of the data regarding the education resources does not seem as an influential factor in explaining the variation in graduation rates at the primary and preparatory educational levels. However, the authors found empirical evidence supporting the hypothesis that the relationship between expenditure per student and graduation rate at the preparatory level differs according to the governorate's level of human development.

In all cases, the findings of this study support the hypothesis that money may matter for educational outputs, however, its effect is not as large as what can be expected. The other non-school resources like student and family characteristics, as well as the various socio-economic factors, might be much more influential.

This study reflects the poor quality of education data in Egypt. Both the MoE and the MoF have to collect data at each educational level regarding input variables and expenditure allocations. The MoE should introduce standardised tests at the primary and preparatory educational levels to capture the real differences among governorates, districts, and schools in terms of education attainment. Furthermore, the data collection efforts by the authors show considerable deficiencies in calculating important variables like dropout rate, which is a key variable to monitor in a country that has around 40% of its population illiterates. It is also necessary to mention the importance of adopting a comprehensive approach in categorising and ranking teachers and schools. In addition, the provision of regular data on the socio-economic variables at the governorate level represents one of the crucial factors that would allow researchers to test the hypothesis that the non-school resources and socio-economic factors are much more significant for the student achievement than the school resources.

Finally, this study, given its above-mentioned limitations, may be considered as a serious starting point for moving the research agenda on pre-university education in Egypt towards more analytical and empirical research questions and issues. Given the positive economic and social externalities of education, further research efforts still need to be directed to address key and significant issues that include but are not limited to the family, socio-economic and peer effects; education expenditure efficiency; cost-benefit analyses; and effect of moving expenditure among different educational levels.

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Notes

1 It is worth mentioning that the research on education production functions has gained a particular attention since the release of the Coleman et al.'s report 'equality of educational opportunity' in 1966. The main finding of such report was that "schools bring little influence to bear on a child's achievement that is independent of his background and general social context" (1966, p.8).

2 The other public service authorities include: the Education Improvement Fund, the General Authority of Literacy and Adult Education, the Education Development Projects Fund, the Academy of Teacher Professional Development, the National Centre for Educational Examination and Evaluation, the National Centre for Educational Research and Development, and the Regional Centre for Adult Education.

3 It is noteworthy that the 2014's Constitution considered the secondary education (general or vocational) as another stage of the compulsory education beside the primary and preparatory stages.

4 Net enrolment rate for a specific educational level is the ratio of students who are enrolled in such a level and whose ages correctly correspond to the age group of that level, to total number of population in the age group that corresponds to that level.

Appendix

Table A1 Description and measurement of the study's variables

Variable name	*Variable description and measurement*	*Data source*
graduation_pri	Graduation rate at the primary education level measured by the percentage of students who passed the final examination of grade 6 in public schools.	The Annual Statistical Book, MoE
graduation_prep	Graduation rate at the preparatory education level measured by the percentage of students who passed the final examination of grade 9 in public schools.	
class_size_pri	Class size at the primary education level reflecting the total number of students per class in the public primary education schools.	The Annual Statistical Book, MoE
class_size_prep	Class size at the preparatory education level reflecting the total number of students per class in the public preparatory education schools.	
pupil_teacher_pri	Pupil-teacher ratio (total number of students per teacher) in primary education public schools.	The Annual Statistical Book, MoE
pupil_teacher_prep	Pupil-teacher ratio (total number of students per teacher) in preparatory education public schools.	
qualif_teacher_pri	Ratio of highly qualified teachers at the primary education level. This variable is calculated by the authors as the ratio of teachers who hold high qualifications (teachers with at least a university degree) to total number of teachers at the public primary education level.	The Annual Statistical Book, MoE
qualif_teacher_prep	Ratio of highly qualified teachers at the preparatory education level. This variable is calculated by the authors as the ratio of teachers who hold high qualifications (teachers with at least a university degree) to total number of teachers at the public preparatory education level.	

Table A1 Description and measurement of the study's variables (continued)

Variable name	*Variable description and measurement*	*Data source*
perstudent _exp_pri	Per-student public expenditure at the primary education level. This variable is measured as described in the text.	Egypt's State budget according to the functional classification, MoF and the Annual Statistical Book, MoE
perstudent_exp_prep	Per-student public expenditure at the preparatory education level. This variable is measured as described in the text.	
HDI	A dummy variable that takes the value '1' if the human development index of a given governorate in year 2002 is greater than or equal to 0.687 which represents the national value of the same year, and takes the value '0' otherwise.	Egypt Human Development Report (2004), United Nations Development Program (UNDP) and Egypt's Institute of National Planning.