# Effects and Mechanisms of CEOs Quality in Public Education *

May 2019

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Abstract

The 'CEOs' of public schools in many countries have authority and responsibilities that can greatly affect the quality of schooling. In this paper we estimate the quality of CEOs in public education in Israel and in a second step show that it has positive effects on students' learning and behavioural outcomes. The effect is highly non-linear, derived mostly from the most effective CEOs. We then examine the mechanisms, focusing on school management practices and find that effective CEOs lead to more focused school priorities, clearly defined working procedures, targeted programs which improve climate and reduce violence and bullying in school, replacement of school principals, with no effect on school resources.

* We benefited from comments and suggestions by Ema Duccini, Naomi Hausman, Rolant Rathelet, Moshe Shayo, and participants in seminars at the Hebrew University, University of Warwick, University College London, the Madrid January 2017 Education Conference, CESifo Economics of Education Network 2017 Conference, and the 2017 NBER Summer Institute Conference in Personnel Economics. We thank Elior Cohen for providing excellent research assistance during the early stages of this study. The first author acknowledges financial support for this project from the European Research Council through ERC Advance Grant 323439, CAGE at Warwick and the Falk Institute in Jerusalem.

## 1. Introduction

Recent studies examined the relationship between management quality and productivity in the public sector. Di Liberto (2013), Bloom et al. (2015) and Bryson et al. (2017) have extended the World Management Survey methodology to measure management practices in schools, and present descriptive evidence about the quality of management by school principals and education outcomes in several countries. They show that better quality management is strongly associated with better educational outcomes, but they cannot establish causality in this relationship. Branch et al. (2012), Coelli and Green (2012), and Dhuey and Smith (forthcoming) study school principals' leadership roles and measure the correlation with school outcomes. Bloom, Propper et al. (2015), McCormack et al. (2013), and Rasul and Rogger (2013) study management practices in public sector institutions and other government agencies. In this paper we focus on measuring the effect of CEOs in public education on the education outcomes of students and schools and the channels of these effects.[1] School CEOs are the CEOs of a cluster of schools within a school district or a local school authority. In Israel, as in many other countries, these CEOs have wide responsibilities that affect school quality and output. For example, they are the direct managers of school principals and draw their authority from the district or regional education director. In recent years this model of CEO as school CEO has been criticized as inefficient, too procedural, anachronistic and not innovative, and insignificant in its impact on the quality of schools. Many countries have reacted to this perceived inefficiency with extensive management reform in public education.[2]

However, the link between management quality and the effectiveness/productivity of schools has not been studied as carefully as, for example, the impact of teachers' value added (Rivkin et al 2005, Rothstein 2010, Jacob et al 2010, 2016, Chetty et al 2014a, 2014b). This paper provides empirical evidence about the causal effect of management quality in public education on students' cognitive and non-cognitive schooling outcomes and explores some of the relevant mechanisms. We measure CEOs quality by a measure that is similar in spirit to teachers' value added based on students' test scores, and in a second step we estimate the effect on students' cognitive and behavioural outcomes. Our measures of CEOs quality is based on panel data on schools and not students, where each school is observed three

[1] Superintendent is the title used in the US and in some other countries. In the UK the title used is Chief Education Officer, in Canada it is Director of Education.

[2] For example, England, New Zealand, Finland and Chile introduced global transformation in the organization and regulation of their education system and in the role of supervision of schools (UNESCO 2007). In some countries profound structural changes have been introduced, for example, changing school structures (charter schools in the US and school academies in the UK), accountability measures (performance league tables and closure of failing schools as in the US No Child Left Behind), and programs that enhance school competition (voucher programs, free school choice, financial incentives to staff and students). Only few of these programs were expanded at scale, partly because of their lack of popularity among educational practitioners, who believe that the current system of management and supervision in public education maintains proper motivation and quality in schools.

time, and therefore it is not as detailed and refined as measures of teachers' value added in recent studies. Yet our study makes a significant progress in the context of measuring management quality and its effect in education and more general in other public sector activities.

The role and responsibilities of Schools' CEOs vary across countries but it is common for them to set the tone, chart the course of the district or sub-district, and work closely with the school board or district board of trustees. School CEOs are responsible for hiring and supervising school principals and teachers, including the decision to grant tenure to novice teachers. It is the CEO's job to evaluate school principals' performances and ensure that they are effective leaders, working with teachers to serve the needs of students and meet the district goals. The CEO must respond to demands from all other constituencies in the district or sub-district: the teachers, students, parents, and the community at large. In some countries, CEOs can affect the allocation of financial and human resources in the district. Therefore, a high quality CEO can have an important effect on the quality of a school and on students' academic achievements.

Since it is plausible that struggling schools/districts are more likely to be allocated to a good CEO, non-random matching of schools and CEOs can lead to biased measures of CEOs' quality. We provide evidence that on average show that this concern does not matter in the Israeli context and in the sample and period that we examine. First, we exploit a quasi-random pairing of CEOs and schools that results from a Ministry of Education rule, under which the CEOs' 'supervision area' must change every 3-5 years, leading to schools being reshuffled across CEOs' clusters. The implementation of this regulation is closely linked to CEOs' retirement and sometimes, though not very often, to promotion of CEOs within the Ministry of Education. Such exits lead to new CEOs entering and to some reshuffling of schools across existing CEOs. Most often, the whole cluster of schools of a retiring CEO is transferred as a group to a different CEO. Clearly there should be no concern for sorting in such cases and we show evidence that supports our claim of random matching of schools and CEOs. Secondly, we show that the probability of having a CEO change is unrelated to school characteristics and outcomes. We show that a new CEO's quality is unrelated to school characteristics and outcomes. We also show that the quality of the new and old school's CEOs are not correlated.[3]

We estimate CEOs' quality based on two different methods. The first is an innovative split-sample approach that we use to derive estimates based on CEO fixed effect in a school production equation. The other examines changes in quality following a change of CEO. In the first, CEO fixed effects are estimated for the sample of schools that retain the same CEO throughout the period. Separate

[3] Interrelationships between schools that are clustered in a district, some of which may overlap with the 'patch' that the CEO is responsible for, may be a concern. For example, such interrelationships may result from common catchment areas, leading to movement of pupils across school within the set for which a superintendent is responsible. However, catchment areas are specific to each school and they do not overlap across schools or school districts. But any such related examples are dealt with in our model by the fact that schools are moving across superintendents and that these movements are not correlated with school's characteristics or outcomes, or with other reasons such as transport patterns changing or changes in enrolment.

estimates are produced for each sub-period of the sample with no structure imposed on the data even though it is possible that the influence of a CEO increase over time as the effects of a prior CEO wane. However, since we observe only two years of a given CEO regime, we prefer to generate two independent quality measure and assess their correlation. These CEO quality estimates are then used as explanatory variables in achievement regressions for schools that switch CEOs to confirm that they are meaningful. In the second method we exploit CEOs turnover and measure their quality based on schools that switched to a new CEO. We regress test score change between two periods on the changes in characteristics and a CEO fixed effect. This CEO quality estimate is then used as treatment in outcomes' regressions with a sample of schools that did not switch CEO. It is important to note that in both methods the schools that are used in the first step are not used in the second and vice versa. This guarantee out of sample measure of quality of schools' CEOs. It is important to note that each of these methods have some limitations which we discuss in section 5 of the paper. The fact that ranking of CEOs obtained from these two methods are highly positively correlated and that the estimated effect of these two alternative CEOs' quality measures on students' test scores are very similar is somewhat reassuring that these concerns are serious limitation in our context.

For learning outcomes, we use test scores in national exams in primary and middle schools in Israel in math, Hebrew, and English. We also examine effects on students' behavioural outcomes, in particular measures of bullying and violence in school and students' social skills and behaviour. As potential mechanisms for the effect of CEO quality we focus on several management practices of school principals.

The results show that the quality of CEOs has positive and significant effects on students' academic achievements. A one standard deviation improvement in management-supervision quality increases students' test scores in math, English and Hebrew by 0.04 standard deviation. These positive within-school estimates contrast with the "naïve" OLS estimates which are actually negative, reflecting a negative selection pattern in the sorting of CEOs to schools. The effect is non-linear, being higher for the highest quality CEOs. The treatment effect is on the same scale when estimation is by subject. Interestingly, female CEOs have higher quality and higher impact on students' outcomes.

This paper also contributes to several literatures. First, and more generally, we contribute to the emerging literature investigating management practices in public sector institutions (For examples see McCormack, Propper, and Smith (2013), Rasul and Rogger (2013), and Bloom, Propper, Seiler and Van Reenen (2015)). Secondly, this paper is related to recent research on the effect of school principals and leadership (for examples see Branch, Hanushek, and Rivkin (2012), Clark, Martorell, and Rockoff (2009), Béteille, Kalogrides, and Loeb (2012), and Horng, Klasik, and Loeb (2010)). Finally, we link to work on teachers' value added and its effect on students' academic achievement (Rockoff 2004, Rivkin et al (2005), Jacob (2010), Rothstein (2010), Bacher-Hicks, Kane, and Staiger (2014), and Chetty et al. (2014)).

The rest of the paper is organized as follows. Section 2 presents institutional background of the system of CEOs (superintendents) in Israel and elsewhere. Section 3 describes the data and provides descriptive statistics. Section 4 presents the empirical framework and identification strategy and the results regarding the effect on students' outcomes. Section 5 presents evidence on the mechanisms of the effect of CEO quality. Section 6 offers a summary and some conclusions.

## 2. Context and Background

There are school supervision services in nearly all countries.[4] Their key role is to monitor the quality of education, i.e. schools and teachers, and support their improvement, creating two distinct but complementary tasks: on the one hand, to control and evaluate and, on the other hand, to advise and support teachers and head-teachers. CEOs (in some countries they are called supervisors) are based outside the school at a local or regional government body overseeing public schools. Each CEO is assigned a number of schools, to which they make regular visits every year. The role and powers of the CEO vary considerably between countries, however, their tasks generally include: supervising implementation of government education policy, regulations, and national curriculum, advising on teaching methods, supervising, guiding and assessing teachers on probation, liaising with and advising headmasters, guiding schools in responding to patterns of problems and needs, and reporting on periodic inspections. Some countries, for example Spain, separate the administrative from the pedagogic tasks of supervisors. Other countries tend to separate control and support roles. This has been the case mainly in countries with strong school-based management practices such as New Zealand and the UK. Some countries adopted a management-supervision approach directed towards the school as a whole and less on individual teachers. A noticeable example is the OSTED school audit system in the UK. In France, CEOs produce regular reports on issues based on specific fieldwork and special school visits. In few countries, schools use self-assessment instead of external supervision. Finland follows this model, and quality control is entirely entrusted to teachers. Other countries use a model that combines internal school evaluation and assessment with external supervision (New Zealand, Wales, Australia, and Chile).

School CEOs in Israel are Ministry of Education staff. While a school principal is responsible for the day-to-day administration of school, the school CEO has a diverse range of activities and responsibilities, both at the macro and micro level. At the 'macro' level he oversees the development of each school's annual strategic action plan in line with its school charter, which sets out the educational objectives for the school under the national curriculum framework. The CEO also oversees implementation of the action plan, and is responsible for decisions about hiring, placement and transfer of teachers. At the 'micro' level, he assesses teachers' performance, provides pedagogic guidance and

[4] Much of the material in this section is based on "Reforming School Supervision for Quality Improvement", United Nations, International Institute for Educational Planning, UNESCO 2007.

know-how to school principals and teachers, decides about tenure and dismissal of teachers, and deals with students' extreme disciplinary violations, including the approval of temporary or permanent expulsion of students. To carry out these tasks, the CEO visits every school a few times a year, meets with the school principal and members of the school senior leadership team, attends classes, mainly of novice teachers, and holds confidential meetings with teachers and staff. He is expected to develop a safe and trusting relationship with his supervisees and use these meetings to talk about all elements of their practice, including emotional and psychological difficulties at work. It is the CEO's responsibility to encourage teachers and school principals to improve their classroom instruction, and ensure that they work within the norm, policies, and codes of practice of the Ministry of Education and the law. The CEO should monitor training and teaching progress and ensure that novice teachers receive appropriate career guidance. Following each school visit, the CEO should submit a report to the school district director. Supervisees should receive relevant parts of the report and be able to comment on their assessment and on the support provided, and to discuss any problems that were identified.

The majority of school CEOs in Israel adopt a hierarchical approach, conducting their interaction with teachers and school principals as an educational authority, and the school staff view them as the highest pedagogical authority. In accordance with the State Education Law, the Ministry of Education is the CEOs' employer, navigate and guide them in their work. Most CEOs in their daily work are part of the staff of regional directors (there are seven regions in the country). Each CEO is in charge of a number of schools. Every 3 to 5 years CEOs rotate to a different "supervision zone", or there is a broad reallocation of schools they supervise. This rotation of CEO's is crucial to the design of estimation and identification used in this paper and therefore greater description of this appears in a later section.

## 3. Data

The data we use in this study are based on the Growth and Effectiveness Measures for Schools (GEMS - Meizav in Hebrew) datasets for the years 2002-2005. The GEMS was administered for the first time in 2002 and it includes a series of tests and questionnaires administered by the Division of Evaluation and Measurement of the Ministry of Education.[5] The GEMS is administered towards the end (from mid-May to mid-June) of each school year to a representative 1-in-2 sample of all elementary and middle schools in Israel, so that each school participates in GEMS once every two years. The GEMS data include test scores of fifth- (primary school) and eighth- (middle school) grade students in math, science, Hebrew, and English. In principal, all students except those in special education classes are tested and the proportion of students tested is above 90 percent. The raw test scores used a 1-to-100 scale that we transform into z-scores to facilitate interpretation of the results.

[5] The GEMS is not administered for school accountability purposes and only aggregated results at the district level are published. For more information on the GEMS see the Division of Evaluation and Measurement website (in Hebrew): http://cms.education.gov.il/educationcms/units/rama/odotrama/odot.htm.

The test scores for the years 2002-2005 are linked to student administrative records collected by the Ministry of Education. The administrative records include student demographics, which we use to construct all measures of students' background characteristics. Using the linked datasets, we build a panel for elementary schools with test scores for the years 2002-2005. The sample is restricted to Jewish public schools that follow the same national curriculum and participate in the GEMS national testing. For these reasons we exclude the religious Orthodox Jewish schools and the Arab schools. There are 939 elementary schools with test score data. Since every school is sampled once in two years, we have two observations of the same school for more than 90 percent of the schools.

The GEMS also includes interviews with all teachers and the school principal. The questionnaire for 'home class' teachers[6] of all classes included questions about instruction time in each subject and the total instruction time per week. We use teachers' responses to these items to compute the school average for fifth-grade instruction time in each subject. Though there was very little difference between or among fifth-grade classes in a school in these time inputs, we still prefer to use the school-level mean per grade to avoid any biases that might be caused by sorting of students into certain classrooms and setting time allocations for given academic subjects according to those students' particular strengths and weaknesses. In any case, the grade- and class-level measures of these time inputs are very highly correlated.

The school principal questionnaire includes questions on pedagogical and management practices in school. However, as a public sector and as educational systems, it is clear that these questions do not relate too closely to management practices used in the broader economics management literature. They are not measures of incentives, monitoring or organisation of production. They are more outcome measures of management practices rather than details of the practices, yet they do capture channels through which CEO of a cluster of school can have an impact on schooling quality. We use the following questions from the principal questionnaire which are most closely related to: (1)

"Did the school evaluate its environment and discipline?" and (2) "Does the school have interventions related to values, norms and discipline?". We also use items from the GEMS student questionnaire that address various aspects of the school and their learning environment. We concentrate on the section of the questionnaire that provides information on student satisfaction in school and on the violent behaviour of other students. In this section students are asked to rate the extent to which they agree with a series of statements on a six-point scale ranging from "strongly disagree" to "strongly agree". These items include: (1) "There are many fights among students in my classroom"; (2) "Sometimes I'm scared to go to school because there are violent students"; (3) "This year I was involved in many fights"; (4) "When I have a problem at school there is always someone I can turn to (from the

[6] A 'home class' teacher in primary school in Israel teaches most weekly sessions of his class, and has additional duties such as taking attendance registers, acting as intermediary in cases of conflict, collating other teachers' impressions of the class and of individual students in preparation for the quarterly report, liaising with parents and various other administrative tasks.

teaching staff)"; (5) “I am satisfied in school”; and (6) “I feel well-adjusted socially in my class”. We transformed students’ responses to these items into standardized z-scores.[7]

**4. The Quasi-Random Pairing of Schools and CEOs**

The pairing of schools and CEOs may be non-random. For example, school authorities may place more proven and effective CEOs in weaker or failing schools, or experienced CEOs may prefer to work in better schools. Therefore, the potential endogenous sorting of CEOs in schools has to be accounted for when measuring unbiased CEOs’ quality. The administrative structure of CEOs in Israel and the schools they manage offers a way to measure CEOs’ quality that is not affected by endogenous sorting of CEOs. Israel’s public education system has seven geographical regions, each headed by a regional director that reports directly to the general director of the Ministry of Education. All schools within each of the seven regions are under the directorate of the regional director. Each region has several CEOs and each is in charge of a number of schools. Except for the large cities (Jerusalem, Tel Aviv, Haifa, Beer-Sheba, Rishon-Lezion), all other localities have only one CEO who supervises all schools in the locality. Each such CEO will manage few localities that are close geographically. This is clearly evident from the information presented in Maps 1-6. Each map presents the geographical distribution of the schools by CEO in each of the seven regions in 2005. The spatial clustering of the schools of each CEO clearly suggests matching of schools and CEOs are based on geographic considerations. About 77 percent of schools in our sample are in municipalities with a single CEO and about 82 percent of these schools have a CEO who oversees schools in more than one municipality. Every change of a CEO in these municipalities involves all schools, minimizing in this context the scope for selective matching between CEOs and schools.

The large cities noted above have more than one CEO: the first three have 3 CEOs and the other two cities have 2. The distribution of schools of each CEO in these large cities is also clustered geographically, shown in Maps 1-6. The schools that are included in each CEO cluster are mostly the same over time, particularly when there is a change of CEO.

The Ministry of Education reassigns CEOs every 3-5 years.[8] This is often implemented in conjunction with the departures of CEOs due to retirement – rarely due to promotion. Our panel data for the period 2002-2005 includes 771 schools that appear in the sample each of the four years. There are three potential transition points, one for every two adjacent years and 402 schools (52%) switched CEO at least once within this period. This transition rate implies that a school will indeed have a new

[7] We experimented with binary versions of these variables denoting above median answers and also using them linearly and the results were not different, confirming that the evidence regarding these variables is not a feature of this particular transformation of the data.

[8] https://he.wikipedia.org/wiki/%D7%9E%D7%A4%D7%A7%D7%97_(%D7%97%D7%99%D7%A0%D7%95%D7%9A). The Wikipedia text is in Hebrew.

CEO every 5-6 years. Very often, the whole cluster of schools of a retiring CEO is transferred as a group to a novice or veteran CEO. Fifteen percent of the changes in the pairing of schools and CEOs results from such reassignment and an additional 61 percent of the transitions result from a transfer of at least 5 schools from a retired or promoted CEO to different CEO. Clearly when the reassignment involves such large number of schools as in these cases, we can confidently rule out any endogenous sorting that might lead to selection bias in the measure of CEO quality an in the treatment effects estimates. The reassignment of one or two schools to a new or veteran CEO accounts for only 9 percent of all reassigned schools (40 out of 459). The reassignment of three or more schools to a new or veteran CEO accounts for 91 percent of all reassigned schools. In fact, out of the 40 schools reassigned as a single or a couple of schools in the reassigned cluster, the reassignments of 25 schools seem to be driven by spatial reasons, as the reassigned schools are geographically closer to the receiving CEO's cluster of schools. Clearly there should be little concern for endogenous sorting in these transitions.

Some evidence for the lack of endogenous sorting of CEOs can be seen in Figures 1-3 which are representative examples of patterns of turnover of CEOs following a retirement of one or more CEOs. Figure 1 presents the changes in the Central educational district following the retirement of two CEOs. All of Ruth's (this and other names in the paper are fictitious) schools were transferred to Rebecca (a new CEO) and all of Amalia's schools were transferred to Hannah (a veteran CEO). Rebecca received also ten schools from Johanna. The transfer in bloc of such large number of schools between pairs of CEOs clearly suggests that there was no sorting involved. However, Figure 1 show transfers of smaller numbers of schools between CEOs, in most cases 1 or 2 schools, which may involve sorting. In Figure 2 Judith, a CEO in South district, retired and her 13 schools were distributed between 4 other CEOs. Figure 3 shows transitions in the Haifa district in 2003-2004. There are 8 pairwise transfers, five of them involving a move 5 or 6 schools. In most cases the number of outgoing and incoming schools of a CEO are equal or almost equal.

## 5. Measuring CEOs' Quality

We estimate CEOs' quality in two different ways. In the first method (I), using the sample of schools that did not change their CEO during the study period ('the non-switchers') we estimate an education production function like equation (1) while adding to it a CEOs' fixed effect and use these estimated effects as measures of CEOs' quality. In a second step we estimate the effect of these CEOs' quality on outcomes of schools that did change their CEOs (the 'switchers'). Using two different samples in the two steps of this procedure guarantees that the CEO fixed effect does not reflect specific characteristics of the schools that are included in the sample in the second step. This 'out of sample' procedure of estimating the CEO fixed effect is crucial even though we estimate the role of CEOs of education districts in a framework where we can control for observable and unobservable differences across schools. For this purpose, we construct a CEO-school matched panel data set, where we track CEOs' across different schools over time. This allows us to estimate how much of the unexplained

variation in schools' average outcomes can be attributed to CEO quality (fixed effects), after controlling for schools' fixed effects and time-varying school characteristics. The second method (II) reverses the role of 'switchers' and 'non-switchers': We exploit CEOs' turnover, using schools that were assigned a new CEO ('switchers') and measure quality as the CEO 'fixed effect' in a regression of the change in schools' mean test scores as a dependent variable. In a second step, we estimate the effect of the quality of these CEOs on mean test scores of the sample of the `non-switchers', the schools that were not assigned a new CEO. Both methods rely on the assumption that schools that are part of a CEO's cluster of schools, do not share any other common factors that can correlate with their residual test scores (method I) or their residual growth in test scores (method II). Both methods are similar in spirit to the models that are used to estimate the effect of individual managers on corporate behavior and performance (Bertand and Schohar 2003).

We show below that the percentile ranking of CEOs' quality derived from these alternative methods are highly correlated. We also show that the two series of quality, based on the second method (one for each year) are also highly correlated. Finally, we will observe that the estimated treatment effects obtained from quality I and quality II are very similar.

We specify an education production function that includes an input that captures CEO quality in addition to the standard school and student level inputs:

$$Y_{js} = \alpha_j + \gamma\, O_s + \beta\, X_j + \Lambda\, LA_j + u_{js} \qquad (1)$$

where $Y_{js}$ is the average learning outcome of students in school $j$ that is assigned to CEO $s$. We use test scores in national exams in primary (5th grade) and middle school (8th grade) in Israel in math, Hebrew, and English as measures of learning outcomes. We also examine effects on students' behavioural outcomes, in particular measures of bullying and violence in school and students' social skills and behavior. As potential mechanisms for the effect of CEOs' quality we focus on several management practices of school principals. $\alpha_j$ is a school fixed effect, $O_s$ captures the quality of CEO $s$, $X_j$ is a set of potentially time varying covariates of school $j$ (including students' characteristics, school enrolment, number of classes), $LA_j$ is a vector of lagged test scores in Hebrew and math and $u_{js}$ is a mean zero residual.

The parameter of interest is $\gamma$ but $O_s$ is unobserved and therefore has to be estimated. Since CEO value-added might be measured with error, it can be correlated with $u_{js}$ and therefore with school specific outcomes shocks which are part of the error term in equation (1). To avoid this problem, we use the same approach as in recent studies of teachers' value added, for example Jacob et al (2010), where estimation of the value-added of a student's teacher does not incorporate information from that student's cohort. In our case, this approach implies that the estimation of the value-added of a school's CEO does not incorporate information from that school. Stated differently, the quality of a school's CEO is estimated out of sample for every school for every period. Stated explicitly, in the first method we first measure quality based on 'non-switchers' and in a second step estimate its effect using the

sample of 'switchers'. In the second method we first measure quality based on 'switchers' and in a second step estimate its effect using the sample of 'non-switchers'.

***Method I: Measuring CEOs' Quality Based on 'Non-Switchers'***

Based on the non-switchers' sample (schools that stayed with the same CEO during the two years), we estimate equation (1) while including a dummy variable for each CEO. The practical representation of this specification is that a vector of CEOs' fixed effects is included in equation (1) and the estimates of these fixed effects are the measure of CEOs'' quality.[9] We estimate this regression separately for each of the sub-periods: period one includes 2002 and 2003 and periods two includes 2004 and 2005. Each school is included once in each of these regressions because the test scores data is available for each school in one of the two years within each of these two periods. We insure that the CEOs' fixed effects picks up only the CEO's quality by including many students' and school level controls in equation (1), in particular lagged school level means test scores, as done in the above-referenced studies on teachers' value added. The student controls (the $X_j$ vector) include an indicator for male students, number of siblings, an immigrant indicator, father's and mother's years of schooling, six indicators of student's ethnicity, school enrolment and number of classes. The means and standard deviations for these variables are presented in Table 2's columns 1 and 3 for each of the two periods, respectively. The school level controls include the 1991 schools standardized test scores means of 4$^{th}$ and 5$^{th}$ grade in Hebrew and math. The point estimates of the control variables have the expected signs: boys have 0.10- 0.13 standard deviation lower test scores than girls, number of siblings is negatively correlated with test scores, immigrants and students from Asia-Africa and Ethiopian ethnic background have negative correlation with test scores, and parental schooling and ethnicity from Europe, America, Israel and the former Soviet Union has positive correlation with test scores. The school average lagged test score in Hebrew has a significant positive effect on current outcomes but the estimate of the lagged math test score is zero. These estimates are much weaker, because the school test score means are highly correlated with the school means of students' characteristics that are also included in these regressions.

Table 2 columns 2 and 4 present the regression estimates of equation (1), once based on the first period (2002 and 2003) data and second time based on the second period (2004 and 2005) data. From each regression we recover the CEOs' estimated fixed effects. We standardized the CEOs' fixed effects as a z-scores distribution with mean zero and standard deviation one. Figure 6 displays the two distributions (first and second period) of the standardized quality measure of 47 CEOs that are in charge of 497 schools. The two distributions look similar, and their equality is not rejected in a two-sample KS test though we note that in a small sample it is not easy to detect small differences. The correlation coefficient between these two value-added measures of each CEO is 0.62. Note that the variation in

[9] This approach is identical to the method used in Rivkin et al (2005) and Jacob (2010) who measured teachers' value added as teachers fixed effects and also very similar to the method used in Rothstein (2010) and Chetty et al. (2014) in a teachers' value added context as well.

CEO's quality which span over four standard-deviations may be large enough to allow estimating its impact on schools' academic and non-academic outcomes.

Next we assess how sensitive are these quality estimates to the fact that we use as controls lagged school mean test scores of a decade ago. Note that these controls are meant to ensure that the CEO fixed effect does not capture some unobserved school-specific characteristics. Although short lags would have been better for this purpose, the 1991 scores that we use do just as well. Figure 7 displays the distributions of student-level estimated standardized quality of the 2004-2005 period using alternative lagged scores sets as controls. This can be seen from the following results. The distribution of quality using the 1991 lagged scores as controls and the quality distributions using 2002-2003 lagged scores look identical, and equality of any distribution pair cannot be rejected by a two-sample KS test. This provides important support to the validity of our quality estimates as capturing CEO's quality and not something else about schools or students.

The methodology and results of this method are subject to some concerns and we discuss them here. First, there are no controls for achievement at the very beginning of the CEO's tenure. Rather we sue achievement about ten years earlier as a primary control. Despite the fact that it is highly predictive of current achievement, it might fail to capture very recent school influences that could introduce bias. Second, the possibility of correlated shocks remains even though we show that CEO clusters within a school district are not distinguishable in terms of observables. An example of a cluster specific unobserved shock is the entry of a new school to an existing cluster managed by the CEO. Both the CEO switch and the addition to the cluster are shocks that may well affect both incumbent and entering schools as the CEO must reallocate time and attention. In poor-performing clusters the CEO may struggle to work with the new school, while in well-performing clusters with stable schools the superintendent may be able to devote much more effort to the new entrant. Another potential concern is the attribution of effects to the CEO in a context where the CEO play an important role in choosing school principals. As an example, school leaders in the cluster might influence the performance of cluster entrants, and those school leaders may have been selected by a previous superintendent. However, even if this is a likely scenario, it can be viewed as another channel of the effect of a CEO: selecting school principals that might have spill-over effects on other school principal in the CEO's cluster.

***Method II: Measuring CEOs' Quality Based on Switchers***

We specify a school level quality regression:

$$Y_{j1} - Y_{j0} = \gamma\, O_{sj1} + \beta\,(X_{j1} - X_{j0}) + \delta\,(S_{j1} - S_{j0}) + \mu\, Y_{jl} + u_{j1} \qquad (2)$$

when the dependent variable is the change in test score between period 0 and period 1. $\hat{O}_{js1}$ is the new CEO $j$ in period 1 of school s. $X_{j0}$ and $S_{j0}$ are the students' and school's mean characteristics in the first period and $X_{j1}$ and $S_{j1}$ are the respective means in the second period. $(X_{j1} - X_{j0})$ and $(S_{j1} - S_{j0})$ are the changes in students' and school's characteristics. CEO fixed effect $O_j$ is the mean residual change in

test scores (quality) of the schools that are part of the cluster of CEO $j$. $Y_{jl}$ is the lagged test scores in math, English and Hebrew. As lagged test scores we use the earliest test scores data available for all schools from a national testing program in 1991 and 1992. The 1991 data include test scores in Hebrew and math in 4th and 5th grade and the 1992 data include test scores of 3rd graders in the same subjects. Even though these data are from more than a decade ago, they are strong and precise predictors of the 2002-2005 test scores. For example, the $R^2$ of a regression of the 2002-2003 stacked test score in Hebrew and math on the 2004-05 respective test scores is 0.42. The $R^2$ when the 1991 test scores replace the 2002-2003 scores is 0.41. Furthermore, when the 1991 test scores are included jointly with the 2002-2003 test scores in a regression of the 2004-05 test scores, both lagged sets of test scores have positive and similar coefficients.[10]

We combine all observed data throughout the study period, 2002-2005, for the estimation of CEO's quality. Table 3 presents the estimates of equation (2). The $X_j$ vector includes an indicator for male students, number of siblings, an immigrant indicator, father's and mother's years of schooling, six student's ethnicity indicators, school enrolment and number of classes. The means and standard deviations for these variables are presented in column 1 of Table 3. Most of the estimated coefficients of the right-hand side variables are different from zero except for the two parental education variables. This pattern is most likely a result of the stability of the characteristics of a school within this short period. From this regression we recover the CEOs' fixed effects. These are then standardized as a z-scores distribution with mean zero and standard deviation one. Figure 8 displays the distribution of the standardized quality measure of 44 CEOs that are in charge of 226 schools.[11] It is clear that there less variation in this measure than in the first measure displayed in Figure 6 but as will be shown it is large enough to permit estimation of its effect on students' outcomes and get estimates that are very similar to those obtained using the first quality measure.

We note two assumptions that are implicit in the model of estimating CEO's quality II. First, the fifth-grade students tested in the later year were third grade students under the previous CEO and we assume that the change in 5th grade scores provides a good measure of superintendent quality, even though learning is likely a cumulative process. Secondly, even though it might matter whether the tested year is the first or second of the CEO's tenure in the school, we do not distinguish between these two possibilities. We think this is a reasonable assumption as CEO's tenure in a given school is about five years and therefore any systematic decline or improvement in achievement during the first two years is likely to be similar.

[10] We don't present these results in the paper and they are available from the authors upon request.

[11] We also estimated the quality regression where school means data replaces student-individual in outcome test scores and student characteristics. The distribution of the CEOs' quality values looks identical to that displayed in Figure 2.

The correlation coefficient between the two measures of CEO quality, based on the sample that includes all CEOs for which we computed quality I and II, is 0.61. It is very re-assuring that these two alternative measures, based on very different methods and samples, are highly correlated.

***Are Switching Schools and CEOs Quasi-Randomly Matched? Are schools that changed or remained with the same CEO observationally equivalent?***

In this section we show that the likelihood that a school experienced a match with a new CEO is unrelated to the CEO's quality or to the school characteristics. This is an expected result, given the details in section 2 clarifying that changes in CEO-school paring are related to personal and geographical considerations, and not to the relationship between the school and the quality of its CEO. In Table 4, we present summary statistics for the variables used in the analysis. Column 1 presents the means for the sample of all schools that did not change CEO during the period of the study, and column 2 presents the respective means for the schools that did change CEO during this period. Panel A includes 13 schools' mean of its students and other characteristics (gender, number of siblings, immigrant status, mother and father years of education, and 6 ethnic origin indicators, enrolment and number of classes). Panel B includes schools' mean of its students' test scores in national standardized exams in math, Hebrew and English. The 497 schools that stayed with the same CEO during the study period had 63,979 students and 47 CEOs. The 82 schools that switched CEO between 2002 and 2004 or between 2003 and 2005 had 10,293 students and 29 CEOs.

In column 3 we present the balancing tests between columns 1 and 2, which are a test of a correlation between the probability of a school changing CEO and its observable characteristics. There are 16 parameter estimates and only one of them is statistically different from zero. With respect to the proportion of Asia-Africa ethnicity, the difference is larger and more significant. However, it should be noted that the two groups are statistically indistinguishable in terms of their parental years of schooling and in terms of the average test scores in each of the three subjects, both in terms of the absolute differences and their statistical significance. We view this evidence as suggestive of no particular pattern of selection in the probability of changing CEO, and definitely no correlation with students' socio-economic background and test scores.

Next we estimate whether quality of the incoming CEO is correlated with observable school characteristics and outcomes. We use the quality based on method I and method II. These balancing tests are presented in columns 4-5 of Table 4. In column 4 we present the estimates based on quality I. The sample includes only the 82 schools (10,249 students and 29 CEOs) that switched CEO between 2002 and 2004 or between 2003 and 2005. Four of the 16 estimates in column 4 are statistically different from zero: ethnicity Israel and ethnicity Europe-America are positively and negatively correlated, respectively, with CEO quality. These two ethnic groups have higher socio-economic backgrounds than the other ethnic groups so we expect that they will have the same direction of selection. But we see that these two ethnic indicators have the opposite sign of their correlation with CEO quality, one positive

and the other negative, suggesting perhaps that their significance imbalance does not reflect a systematic selection pattern in the assignment of schools to CEOs. The evidence is a clear indication that overall this quality measure is not systematically correlated with students' and schools' observed background variables. Particularly reassuring is the lack of any correlation with student's parental education and with lagged test scores in panel B. Another point that underscores the relatively marginal importance of these imbalances is that our model of estimating the effect of quality I on school outcomes includes a school fixed effect that is feasible because we observe each school with two different CEOs. In column 5, we present estimates based on quality II. The sample includes 301 schools that did not change CEO. Only one of the 16 estimates is statistically different from zero, ethnicity Ethiopian.

**6. Estimated Impact of CEOs' Quality**

We estimate equation (1) twice, first using school level means for all variables and secondly with student level data. Using student micro data of course allows estimation with much larger sample, leading to more precise estimates. It also allows estimation of treatment heterogeneity by students' characteristics: particularly important in this context is the heterogeneity of the effect of CEO quality by students' socio-economic background.

The first row of Table 6 presents estimations with school level data of the effect of CEO quality on students' achievement in math, English, and Hebrew. In columns 1-4 we present the estimates of the effect of quality based on the first measure. Here we use the sample of 'switchers', schools that changed CEO between two periods. These schools will have a different CEO in each period and so their CEO $\hat{O}_{jst}$ quality will be period ($t$) specific. We prefer using the CEO quality measure from the "opposite" time period, i.e. using the 2002-03 measure of CEO Quality for a CEO where that measure is related to a school's outcomes in 20040-05 and vice versa. We think this 'conservative' approach is preferred over using the common element of quality of CEO from both estimates, especially if there are time-specific shocks to the cluster of schools that affect the measures of CEO quality in specific time periods. The GEMS data provides panel data on schools where each school participates in two rounds of national testing, between which it experiences a change in its CEO. Schools that participate in the 2002 testing round are also included in 2004. Similarly, schools included in the 2003 testing are also included in 2005. We stack this panel data so that $\alpha_j$ can be estimated as a school fixed effect. The advantage of this school fixed effect model (which is equivalent to a difference equation at the school level) is that it controls for omitted time-invariant variables biases that could potentially be correlated to CEOs' quality. We report results from four different specifications. In column 1 the regression includes year effect as a control; in column 2 subject fixed effects are added as a control; in column 3 schools' and mean students' characteristics are added as well, and in the fourth specification, reported in column 4, we also include school fixed effects. The estimates in columns 1-3 are negative but small and not significantly different from zero. The within school estimate (regressions with schools fixed effect) presented in column 4 is, however, positive, 0.038, and significantly different from zero at the 5 percent

level of significance, suggesting that one standard deviation increase in CEO quality increases test scores in the three subjects by 3.8 percent of a standard deviation of the test score distribution. In the second row of Table 6 we present the estimates based on the students' sample. Standard errors are therefore clustered at the CEO level by year level. The estimates in this row are similar to those presented in the first row. The respective estimate in this sample is 0.040 (se=0.015).[12]

In columns 5-7 we report results based on the second quality measure from three different specifications, identical to those in columns 1-3. The unit of observation is the student, but the level of treatment is at the school level. The estimates in columns 5-7 are positive but only the estimate in column 7, 0.061, is significantly different from zero at the 5 percent level of significance. Since both the CEO quality and the test scores are standardized to mean zero and a unit standard deviation, this estimated effect implies that one standard deviation increase in CEO quality increases test scores in the three subjects by 6.1 percent of a standard deviation of the test score distribution. The respective estimate using student level data is 0.053 and it is only significant at the 10 percent level of significance. This effect implies that one standard deviation increase in CEO quality increases test scores in the three subjects by 5.3 percent of a standard deviation in the test score distribution.

Remarkably, the two measures of CEO quality yield similar estimated effect sizes, especially when comparing the estimates using the micro students' data: 0.053 versus 0.040. Both are statistically different from zero but their confidence intervals overlap.

As a robustness check of our results, we also estimated the effect of the CEO's quality measure using two alternative estimation strategies. In the first strategy we implement a Bayes shrinkage estimation strategy and construct an unbiased measure of CEO quality that accounts for noise in the measurement. Using this approach, the noisy measure of a CEO quality is multiplied by an estimate of its reliability, where the reliability of a noisy measure is the ratio of signal variance to signal variance plus noise variance. Thus, less reliable measures are shrunk back toward the mean of the distribution of

[12] These results are robust to the exclusion of the 15 schools that were reassigned as a single-school or two-schools cluster and their reassignment shows no clear spatial logic as discussed in section 4 (See Table A1.) In fact, results are also robust to the exclusion of all the 40 schools that were reassigned as a single-school or two-schools cluster, regardless of spatial distribution (See Table A2.)

the CEO quality measure.[13] In the second strategy we use a two-step bootstrapping algorithm to account for the estimation of CEOs' quality as a first step, and adjust their estimated standard errors.[14]

In both of these alternative estimation strategies we use both measures of quality based on method I and II and we focus on the specification that includes school fixed effects. The results are presented in Table 7. The two alternative estimation strategies yield similar results to the respective estimates presented in Table 6. The standard errors of the bootstrapping algorithm are almost identical to those of the preferred specification, and accounting for the fact that empirical Bayes estimates are smaller in absolute values than the initial estimates because of the shrinkage procedure (before standardization, the pre-shrinkage mean value of CEO quality is -0.17 while its post-shrinkage value is 0.013), we compare the elasticities of CEO quality effects at their mean values which yields comparable outcomes.

It is useful to benchmark the effect sizes presented in columns 4 and 7 of Table 6 against the effect of teachers' value added. For example, the findings of Rockoff (2004) and Rivkin, Hanushek, and Kain (2005) both suggest a one standard deviation increase in teacher quality improves student math scores by about 0.1 standard deviations. Aaronson, Barrow, and Sander (2007) find similar results using high school data. Branch et al (2012) report that a one standard deviation increase in principal leadership (i.e., a principal in the top 16 percent of the quality distribution) leads to 0.05 standard deviation gain in test scores of all students in the school. Chetty (2014b) finds that one standard deviation improvement in teacher value added in a single grade in primary school in NY City raises the probability of college attendance at age 20 by 0.82 percentage points, relative to a sample mean of 37%. In comparison to other schooling interventions, it would require one additional hour of instruction per week in math, Hebrew and English (a 25 percent increase) in order to achieve the same effect as a one standard deviation increase in CEO value-added (Lavy 2015).

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[13] Following Morris (1983) and the teacher value added literature (for example, Kane and Staiger (2008) we construct the EB shrinkage factor for superintendent *i* by the ratio of signal variance to signal variance plus noise variance of superintendent *i*. In a similar way to the teacher value added literature, we assume that the measure of superintendent bias includes an error component. Thus, estimating CEOs' effects on students' test scores enables separation of the signal variance (variance of CEOs' effects) and noise variance of superintendent *i* (variance of the residuals for superintendent *i*). The EB estimate for each superintendent is a weighted average of the superintendent estimated effect and the mean of superintendent estimates, where the weight is the EB shrinkage factor. Implementing this methodology, the less reliable estimates of superintendent quality (those with a large variation in estimated residuals) are shrunk towards the mean of superintendent estimates.

[14] The bootstrap estimates of the standard errors are constructed as follows. In a first step, a random sample with replacement is drawn from each CEOs' schools. A new measurement of superintendent bias for each superintendent is created, based on the new sample of schools. In a second step, the effect of these new quality measures on student test scores in 5th grade is estimated (based on the preferred specification presented in Table 6) and the coefficients are stored. This process of two-step bootstrap sampling and estimation is repeated 1,000 times. The standard deviations in the sample of 1,000 observations of coefficient estimates from the second step are the bootstrap standard errors of the estimated effects of superintendent quality.

Since 80 percent of the CEOs in our sample are female, we report in Panel B, third and fourth rows of Table 6, the estimates from regressions when the sample is restricted to schools with female CEOs. The estimated effect based on the school level means is 0.048 (se=0.022) when using the first quality measure and 0.063 (se=0.032) when using the second quality measure, both larger than the full sample estimates but not significantly different from them. The two estimates obtained from the students' sample level regressions are 0.053 and 0.055.

In Panel C we present evidence based on sub-samples of students by parental education. Father's or mother's years of schooling are good proxies for student's socio-economic background. Research on the causal impact of school inputs suggest that students from poorer backgrounds benefit more from factors such lower class size, remedial education, higher quality peers and teacher quality.[15] Our estimates show no such differences with respect to the effect of management quality in public education.

To check for potential non-linearity in the effect of CEO quality, we report in Table 8 estimates where we divide the distribution to ranges from low to high. First we split the range above and below the median of CEO's quality. Using quality I, the estimate for the indicator of above median quality is 0.065 (se=0.036) and using quality II yields a marginally higher estimate, 0.082 (se=0.036). Secondly, we divide the distribution to quartiles of CEO's quality. The estimates for three upper quartile quality indicators are increasing monotonically: with quality I the estimates are 0.031, 0.055, and 0.130. With quality II they are 0.080, 0.099, and 0.135, suggesting a non-linear effect of CEO quality with a monotonically increasing effect. The estimated effect of the upper quartile of ability is statistically significantly different from zero for both quality estimates.

Clearly the effect of CEOs' quality is non-linear and it increases sharply with quality. It is natural and interesting to compare this pattern of non-linear effect with that of the effect of teachers' value added but we did not find studies that provide such evidence.

Since the middle school system in Israel (grades 7-9) shares the same model of CEOs as that of primary schools, we replicated the analysis presented above with the data for middle schools. We relied on quality I as the measure of CEO quality because the sample of schools is much smaller than the primary schools sample: only 15 schools had changed their CEO from 2002-2003 to 2004-2005 and during the two periods, 13 different CEOs were the CEOs of these schools. Using the students' level data, the estimated effect of quality I for middle schools is presented in Table 9. The point estimates are negative in the first three columns but change sign when a school fixed effect is added to the regression as a control. The estimated effect is 0.048, very close to the respective estimate based on the sample of primary schools (0.040, se=0.016) but much less precisely estimated (se=0.055), probably due to the much smaller sample of schools, 15 versus 82.

[15] For example, Angrist and Lavy (1999).

## 7. Identifying Mechanisms of Effect of CEOs' Quality

The results reported above show that schools exhibit higher achievement when they have a higher quality CEO. In this section, we explore several potential mechanisms through which CEOs' quality may affect their students' academic achievement. We use a rich set of school practices and outcomes based on responses to questionnaires of primary school principals, teachers and students.[16] We focus on items that relate to the classroom and school environment (student questionnaire), on school activities and programs in the area of improving school climate and students' norms and on school resources (principal questionnaire), school procedures and teachers' on and off the job training (teacher questionnaire). To obtain a more general picture of the possible mechanisms and to gain statistical power, we also group outcomes into eight categories. We analyse each category by creating a category-specific average effect. This allows us to control for the potential problem of over-rejection of the null hypothesis due to multiple inference. Because different outcomes have different data scales, simply averaging the estimators for the treatment effect is not likely to produce a meaningful statistic. To address this concern, we follow the summary-index approach per Kling et al. (2007). The average effect of multiple outcomes is the average of z-scores of each outcome variable. This summary index is a special case of the z-score and is identical to the mean effect size of treatment if there is no missing value.[17] In general, the sign of the summary index reveals information on the direction of the aggregate impact of a class of outcomes, and the more the summary index deviates from zero, the stronger is the implied aggregate effect.

We are aware, of course, that we are not able to measure all the relevant mechanisms, and we cannot rule out the possibility that other mechanisms are in place, but the analysis presented in this section provides important insights regarding some possible mediating factors that drive the positive

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[16] See H. Jerome Freiberg (1999) and J. Barry Fraser (1998) for recent reviews of the educational research literature about the validity of students' and teachers' assessments of the classroom environment and their associations with students' achievements.

[17] In the regression specification this approach yields standardized estimators as follows: the treatment effects for $K$ outcomes are aggregated and reflected in a single standard normal statistic,

$$\tau = \frac{1}{K}\sum_{k}\frac{\boldsymbol{\beta}_{1\mathrm{k}}}{\sigma_{k_C}}, \quad k = 1, \dots, K$$

where $\boldsymbol{\beta}_{1k}$ indicates the average treatment effect for outcome $k$ and $\sigma_{k_C}$ denotes the standard deviation of the $k^{\mathrm{th}}$ control outcome. Having included the covariates, the $K$ average treatment effects ($\boldsymbol{\beta_1}$) and sample variances can be easily acquired through a linear regression. By doing so, the above equation can be thought of as a point estimator representing a collection of standardized treatment effects. However, this paper also takes into account the covariance of effects and therefore adapt a seemingly uncorrelated regression (O'Brien 1984, Kling et al. 2007):

$$\mathbf{Y} = \boldsymbol{I_K} \otimes (\boldsymbol{T} \quad \boldsymbol{X})\boldsymbol{\beta} + \boldsymbol{\upsilon}$$

where $\boldsymbol{T}$ is the treatment indicator(s), and $\boldsymbol{X}$ consists of controlled regressors as well as a constant term.

effect of the school CEO on students' achievements.[18] Our hypothesis is that if the effects of the CEO quality are partially being driven by a particular mediating factor, observing a significant effect of the CEO quality on this factor provides some evidence for the validity of this hypothesis.[19] We use in this section quality I as our measure of CEO quality because its estimation is based on sample that is twice as large as the one use to estimate quality II (497 schools versus 226 schools) and it allows for estimating within-school effects.

***School Priorities, Working Procedures and Resources***: In Table 10 we present evidence about three potential channels for the effect of CEO quality, priority setting by schools and working procedures, school resources and students' time allocated to homework. Three items in the teacher's questionnaire ("school has clearly defined priorities", "teachers are involved in setting school priorities", and "school has clearly defined working procedures") reflect management practices that can affect the allocation and use of school resources and therefore be conducive or harmful to learning and achievement. Clearly the scope, responsibilities and management directives of CEO can affect these school factors by the frequent interaction with school principals and teachers. In panel A we present treatment effect estimates for these outcomes, the mean of which are very high, over 5 in a scale of 1-6. The within school estimates show that a higher CEO quality improves only the first outcome, which reflects student-teacher relationship, but not the others. Panel B of Table 10 provides evidence on the impact of the CEO's quality on school resources, including outcomes that are less likely to be affected by the CEO, such as class size and instruction budget per class. These school inputs are determined by national or regional educational authorities and the CEO should not be able to influence them. Indeed, we find no significant effect on these inputs. We also find no significant effects of superintend quality on instruction time on different subjects and on the time students allocate to homework. These results are presented in Panel C.

***School climate programs and outcomes***: From two items in the school principal questionnaire we define an indicator of whether, in the current year, the school assessed the school climate and norms, and whether it had interventions aiming at improving norms, values, and discipline of students. In panel A of Table 11 we report estimates from regressions when each of these two indicators is the dependent variable. We use three different specifications identical to the three specifications used in Table 6.

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[18] A further limitation is that we cannot identify the causal effect of the mechanisms on outcomes because the former are numerous and we have only one potential instrument.

[19] Lavy and Schlosser (2011) show in online Appendix Table 5 that all indicators of the quality of the classroom environment, as described by the students, are highly correlated with students' academic performances even after controlling for school fixed effects and students' background characteristics. For example, they report that lower levels of classroom disruption and violence, better inter-student relationships, and a higher quality of interaction between teachers and students are all positively associated with students' test scores. Though they do not provide a causal interpretation to these correlations, their results suggest that students' assessments of their classroom environment have a high informational content and that these mechanisms, as pointed out in the educational literature, might play an important role in student's learning process.

Seventy-one percent of the schools in the sample had in the current year an assessment of discipline, violence and norms in school and 29 percent of schools had interventions targeted at improving these aspects of the school environment. CEOs' quality has a positive and statistically significant effect on both of these outcomes. The average effect shows similar positive outcomes.

In panel B of Table 11 we present estimates of the effect of CEOs' quality on classroom and school violence. This analysis is based on the following items from the student's questionnaire: (1) "There are many fights among students in my classroom."; (2) "This year I was involved in many fights" (3) "Sometimes I'm scared to go to school because there are violent students." The estimates reported in panel B columns 2–4 of Table 11 suggest that a higher CEO quality significantly lowers the level of violence in school. This effect is evident in each of the three items and also in their average effect. For example, the estimate for the effect of CEO quality on students' reports regarding the level of violence in the classroom is −0.035 (se = 0.018). The average effect of these three items is more precise than the estimates for the individual items. The average estimate is −0.033 (se = 0.012). Overall, these results suggest that having a higher quality CEO improves the safety climate in school by lowering the incidence of fights, increasing the safety of students, and lowering their anxiety about attending school.

Three items in the student's questionnaire ("When I have a problem at school there is always someone I can turn to (from the teaching staff)", "I feel well-adjusted socially in my class," and "I am satisfied in school") reflect school environment and climate, in particular the relationships between students and teachers and the quality of inter-student relationships. These factors can be conducive or harmful to learning and achievement. Being well-adjusted and accepted socially among classroom peers may improve a student's self-confidence, self-image, motivation, and other non-cognitive attributes that might be essential for effective learning.[20] In panel C we present treatment effect estimates for these outcomes, the means of which are very high, over 5 in a scale of 1-6. The within school estimates show that a higher CEO quality improves only the first outcome, which reflects student-teacher relationships, but not the others. The estimates of the social and school satisfaction are positive but they are small and not statistically different from zero, and so is the average effect.

***Scholastic Programs and Teachers Training***: In Table 12 we present evidence on three additional potential channels for the effect of CEO's quality: school scholastic programs in Hebrew, math and English, and two forms of teachers' training in each of these three subjects, in service on the job training and external courses. The subject specific programs include additional instructional resources for a given subject or improvements to teaching methods and practices. The effect of CEO quality is positive and significant in English but not in programs for the other two subjects.

[20] Table A3 provides further evidence on the relationship between school climate and violence, and students' scores. As the evidence cannot be interpreted as causal, the large and statistical within school conditional correlations with students' scores provide additional support for school climate and violence as a mechanism through which superintendents affect students' outcomes.

The effect of CEO quality on teachers' training outside of schools is practically zero, as seen by the estimated effect on external training in each of the three subjects. The estimated effect of on the job training is positive and significant, in math it is positive but not precisely measured, and in English it is negative but not different from zero. The average effect is positive but imprecise, suggesting that the overall effect is negligible but the effect on the composition of the in school training is meaningful. Angrist and Lavy (2001) estimated a large effect of such in school training on students' test scores.

***Changing School's Principal***: In Table 13 we present evidence on another important channel for the effect of CEO quality, changing the school principal. About 15 percent of the schools change their principal every year, implying that the mean duration of a school principal is 6-7 years. In columns 1-3 we present estimates of the effect of an indicator of change in the school CEO on the probability of a school changing its principal. This likelihood is lower by about 6 percent in the year a new CEO steps in, and it is 9 percent higher the following year. When both the contemporaneous and one year lagged effect are included jointly the estimates change marginally, though the pattern is the same. In columns 4-9 we present the estimates for each year separately. Most interesting are the results for the academic year 2004-2005, because we can estimate the contemporaneous effect and the one and two-year lag effects. The pattern that emerges is striking: the likelihood of a change in school principal in a new CEO's first year is lower by 7.6 percent; higher by 14 percent in the second year, and zero in the third year. These estimates clearly suggest that a change in school management is associated with the engagement of a new CEO. It is of course possible that the other mechanisms discussed above operate through the principal rather than through other channels. However, since all the mechanisms are endogenous, including the change of school principal, we cannot study the interlinkages between them.

## 8. Concluding Remarks

This is the first paper that measures the causal effect of the quality of management-supervision in public education. The structure of the education system in Israel, as in many other countries, includes a CEO who is the CEO of a group of about 15 schools over which she/he has extensive responsibility and authority. We exploit quasi-random turnover of CEOs'over time to measure their quality in terms of test score gains in English, Hebrew and math in primary schools in Israel. This turnover is largely dictated by a routine in the system to rotate CEOs across schools every 3-5 years, and by other naturally occurring events such as retirement of CEOs. We show that geographical considerations largely determine which schools are included in a CEO's cluster of schools. We further demonstrate that the turnover of CEOs is unrelated to schools or students' potential outcomes. We measure CEOs' quality similarly to recent measures of teachers' quality, including controls for school level lagged outcomes. We construct two alternative quality measures: the first based on the common academic achievement level of all schools that share the same CEO, the second based on the common growth in academic achievement shared by all schools that were assigned to the same new CEO. We then show that both

measures of CEOs' quality are uncorrelated with the probability that CEOs' experience turnover of schools.

We estimate that CEO quality has positive and significant effects on primary students' test scores in math, Hebrew, and English. Based on the first quality measure, one standard deviation improvement in CEO quality increases test scores by about 0.04 standard deviations in the test score distribution. The effect is similar for students from lower and higher socio-economic backgrounds, it is highly non-linear, increasing sharply for CEOs in the highest quartile of the quality distribution, and larger but not statistically significantly so for female CEOs. We obtain similar results when using the second measure of quality. We explore several mechanisms for these effects and find that CEOs with higher quality are associated with more focused school priorities and more clearly defined working procedures, but no effect on school resources – as funding is determined centrally at the Ministry of Education, and no effect on teachers' on the job and external training. Schools with higher quality CEOs are more likely to address school climate, violence and bullying, and implement interventions that lead to lower violence in school and higher social school satisfaction among students. It is interesting to note that this channel of effect of reducing violence and bullying in school is consistent with the strong discipline 'no excuse' philosophy of charter schools (Dobbie and Fryer 2013, Angrist, Pathak and Walters 2013) which also was effective in improving school outcomes when implemented in non-charter public schools (Fryer 2014).

Two additional remarks point to the relevance of our findings for public policy. First we note that the effect size of CEO's quality is particularly cost effective, because an increase in the quality of one manager can improve the outcomes of thousands of students. Therefore, investing in the quality of these CEOs of schools is very compelling resource wise, relative to investment in other school inputs, for example teacher quality. Secondly, about 70 percent of all CEOs are women, very different to the relative scarcity of women in leadership roles in other public sector management roles, and in the private sector. Our findings suggest that the quality of women as CEOs does not fall short of that of men in the same position, raising the policy concern of why there are so few women in leadership roles even in the public sector, and how allocative efficiency can be improved in this regard in the labor market.

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**Table 1: Number of Schools and Number of CEOs**

| | Year | | | |
|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 |
| **A. All CEOs** | | | | |
| Number of CEOs | 54 | 56 | 57 | 54 |
| Number of Schools | 810 | 807 | 803 | 797 |
| Number of Schools per CEO | 16.1 | 15.5 | 15.1 | 15.9 |
| | (4.92) | (5.67) | (5.52) | (6.10) |
| Male Sample | | | | |
| Number of CEOs | 14 | 15 | 13 | 10 |
| Number of Schools | 163 | 163 | 150 | 108 |
| Number of Schools per CEO | 13.9 | 12.9 | 13.6 | 13.5 |
| | (4.43) | (5.11) | (4.72) | (4.20) |
| Female Sample | | | | |
| Number of CEOs | 40 | 41 | 44 | 44 |
| Number of Schools | 647 | 644 | 653 | 689 |
| Number of Schools per CEO | 16.9 | 16.4 | 15.5 | 16.4 |
| | (4.90) | (5.64) | (5.71) | (6.38) |
| **B. Superintendents with Turnover of Schools** | | | | |
| Number of CEOs | - | 35 | 21 | 26 |
| Number of Schools | - | 563 | 309 | 448 |
| Number of Schools per CEO | - | 16.7 | 15.8 | 18.4 |
| | | (5.24) | (3.95) | (5.35) |
| **C. Superintendents with Net Turnover of Schools > 0** | | | | |
| Number of CEOs | - | 15 | 9 | 11 |
| Number of Schools | - | 277 | 135 | 234 |
| Number of Schools per CEO | - | 18.9 | 16.0 | 22.1 |
| | | (4.03) | (3.64) | (4.48) |
| **D. Superintendents with Net Turnover of Schools < 0** | | | | |
| Number of CEOs | - | 18 | 10 | 11 |
| Number of Schools | - | 238 | 142 | 135 |
| Number of Schools per CEO | - | 14.1 | 15.0 | 14.3 |
| | | (4.76) | (4.22) | (3.69) |
| **E. Final Analysis Sample of CEOs** | | | | |
| Number of CEOs | 27 | 29 | 29 | 26 |
| Number of Schools | 428 | 461 | 461 | 445 |
| Number of Schools per CEO | 16.7 | 16.6 | 16.7 | 18.0 |
| | (5.40) | (5.24) | (4.75) | (5.72) |
| **F. Retirement of Veteran CEOs and Introduction of New CEOs** | | | | |
| Number of New CEOs | 8 | 6 | 5 | 4 |
| Number of Schools per New CEO | 13.1 | 12.5 | 11.5 | 13.9 |
| | (6.53) | (6.72) | (6.94) | (7.36) |
| Number of Retiring CEOד (at year's end) | 4 | 4 | 7 | - |
| Number of Schools per Retiring CEO | 13.6 | 12.3 | 13.7 | - |
| | (3.69) | (6.00) | (5.91) | |
| Average number of New CEOs' Schools from Retired CEOs | - | 2.5 | 5.6 | 12.0 |
| | - | (3.02) | (4.83) | (7.57) |

*Notes:* Standard deviations are presented in parenthesis. The sample includes all schools in the jewish non-religious primary school system.

**Table 2: Regressions for Estimating CEOs' Quality, Method I**

| | Period 0: 2002-2003 | | Period 1: 2004-2005 | |
|---|---|---|---|---|
| | Mean (SD) | Regression Coefficient | Mean (SD) | Regression Coefficient |
| | (1) | (2) | (3) | (4) |
| **School Average Characteristics** | | | | |
| Male | 0.508 | -0.130 | 0.504 | -0.106 |
| | (0.500) | (0.013) | (0.500) | (0.012) |
| Number of Siblings | 2.115 | -0.050 | 2.114 | -0.049 |
| | (1.194) | (0.004) | (1.204) | (0.006) |
| Immigrant | 0.147 | -0.093 | 0.118 | -0.219 |
| | (0.354) | (0.083) | (0.322) | (0.120) |
| Father's Education | 12.625 | 0.033 | 12.613 | 0.026 |
| | (3.542) | (0.002) | (3.641) | (0.003) |
| Mother's Education | 12.968 | 0.048 | 12.965 | 0.035 |
| | (3.067) | (0.003) | (3.271) | (0.003) |
| Ethnicity - Asia Africa | 0.146 | -0.031 | 0.096 | -0.045 |
| | (0.353) | (0.013) | (0.295) | (0.019) |
| Ethnicity - Europe America | 0.159 | 0.063 | 0.154 | 0.082 |
| | (0.365) | (0.016) | (0.361) | (0.014) |
| Ethnicity - Ethiopia | 0.019 | -0.223 | 0.017 | -0.130 |
| | (0.137) | (0.074) | (0.130) | (0.045) |
| Ethnicity - Former USSR | 0.109 | 0.011 | 0.086 | 0.252 |
| | (0.312) | (0.099) | (0.281) | (0.125) |
| Ethnicity - Other | 0.032 | 0.101 | 0.027 | 0.239 |
| | (0.176) | (0.088) | (0.163) | (0.126) |
| Number of classes in the school | 15.757 | 0.001 | 15.846 | 0.001 |
| | (3.837) | (0.009) | (3.983) | (0.009) |
| Number of students in the school | 461.931 | 0.000 | 458.217 | 0.000 |
| | (144.421) | (0.000) | (147.471) | (0.000) |
| **School Average Lagged Z-Score** | | | | |
| 1991 4th Grade Math | 0.017 | 0.013 | 0.018 | -0.008 |
| | (0.876) | (0.031) | (0.863) | (0.031) |
| 1991 4th Grade Verbal | 0.002 | 0.018 | 0.009 | 0.048 |
| | (0.864) | (0.030) | (0.852) | (0.034) |
| 1991 5th Grade Math | 0.028 | -0.044 | 0.029 | 0.003 |
| | (0.882) | (0.023) | (0.876) | (0.023) |
| 1991 5th Grade Verbal | 0.005 | 0.041 | 0.009 | 0.013 |
| | (0.869) | (0.027) | (0.860) | (0.029) |
| Year FE | - | Yes | - | Yes |
| Subject FE | - | Yes | - | Yes |
| District FE | - | Yes | - | Yes |
| Superintendent FE | - | Yes | - | Yes |
| Number of Students | 32,805 | 32,805 | 31,174 | 31,174 |
| Number of Schools | 497 | 497 | 497 | 497 |
| Number of Superintendents | 47 | 47 | 47 | 47 |

*Notes*: In columns (1) and (3) standard devaitions are presented in parenthesis. In columns (2) and (4) standard errors in parenthesis are clustered at the superintendent level. Schools characteristics include number of classes, number of students and the number of schools under the school's superintendent. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. Test scores are standardized with 0 mean and unit sd.

**Table 3: Regressions for Estimating CEO's Quality, Method II**

| | Mean (SD) | Regression Coefficient |
|---|---|---|
| | (1) | (2) |
| **School Characteristics** | | |
| Δ Male | 0.001 | -0.019 |
| | (0.105) | (0.189) |
| Δ Number of Siblings | -0.034 | 0.026 |
| | (0.380) | (0.081) |
| Δ Immigrant | -0.031 | 0.236 |
| | (0.078) | (2.618) |
| Δ Father's Education | -0.037 | 0.048 |
| | (0.872) | (0.027) |
| Δ Mother's Education | -0.024 | -0.082 |
| | (0.716) | (0.041) |
| Δ Ethnicity - Asia Africa | -0.052 | -3.287 |
| | (0.072) | (13.185) |
| Δ Ethnicity - Europe America | -0.013 | -3.244 |
| | (0.089) | (13.122) |
| Δ Ethnicity - Ethiopia | -0.002 | -2.939 |
| | (0.021) | (13.266) |
| Δ Ethnicity - Former USSR | -0.027 | -3.169 |
| | (0.071) | (13.702) |
| Δ Ethnicity - Other | -0.004 | -4.088 |
| | (0.034) | (13.627) |
| Δ Number of classes in the school | -0.416 | 0.021 |
| | (2.364) | (0.018) |
| Δ Number of students in the school | -13.633 | 0.000 |
| | (67.449) | (0.001) |
| **School Average Lagged Z-Score** | | |
| 1991 4th Grade Math | -0.113 | -0.012 |
| | (0.900) | (0.041) |
| 1991 4th Grade Verbal | -0.079 | 0.036 |
| | (0.936) | (0.047) |
| 1991 5th Grade Math | -0.130 | 0.007 |
| | (0.907) | (0.037) |
| 1991 5th Grade Verbal | -0.077 | -0.041 |
| | (0.939) | (0.038) |
| Year FE | - | Yes |
| Subject FE | - | Yes |
| District FE | - | Yes |
| Superintendent FE | - | Yes |
| Number of Students (Period 1) | 13,605 | 13,605 |
| Number of Schools | 226 | 226 |
| Number of Superintendents | 44 | 44 |

*Notes*: In column (1) standard devaitions are presented in parenthesis. In column (2) standard errors in parenthesis are clustered at the superintendent level. Schools characteristics include number of classes, number of students and the number of schools under the school's superintendent. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. Test scores are standardized with 0 mean and unit sd.

**Table 4: Balancing Tests on Probability of Schools Changing CEO and on CEOs' Quality**

| | Changing Superintndent | | | Superintndent Quality | |
|---|---|---|---|---|---|
| | Mean of Schools that did not change CEO | Mean of Schools that did change CEO | Probability of Changing CEO | Method I | Method II |
| | (1) | (2) | (3) | (4) | (5) |
| **A. Student and School Characteristics** | | | | | |
| Male | 0.506 | 0.502 | -0.004 | 0.009* | 0.009 |
| | (0.500) | (0.500) | (0.004) | (0.005) | (0.006) |
| Number of siblings | 2.115 | 2.127 | 0.013 | 0.008 | 0.032 |
| | (1.199) | (1.164) | (0.035) | (0.031) | (0.092) |
| Immigrant | 0.133 | 0.139 | 0.006 | -0.007 | 0.004 |
| | (0.339) | (0.346) | (0.010) | (0.017) | (0.012) |
| Mother's years of education | 12.966 | 13.033 | 0.067 | 0.153 | -0.262 |
| | (3.168) | (3.184) | (0.114) | (0.179) | (0.224) |
| Father's years of education | 12.619 | 12.680 | 0.061 | 0.202 | -0.301 |
| | (3.591) | (3.654) | (0.129) | (0.223) | (0.233) |
| Ethnicity - Israel | 0.576 | 0.587 | 0.011 | 0.036* | -0.027 |
| | (0.494) | (0.492) | (0.013) | (0.020) | (0.022) |
| Ethnicity - Asia Africa | 0.122 | 0.114 | -0.007 | -0.006 | 0.006 |
| | (0.327) | (0.318) | (0.005) | (0.009) | (0.007) |
| Ethnicity - Europe America | 0.157 | 0.154 | -0.003 | -0.020* | 0.000 |
| | (0.363) | (0.361) | (0.006) | (0.006) | (0.014) |
| Ethnicity - Ethiopia | 0.018 | 0.010 | -0.009* | -0.002 | 0.018* |
| | (0.134) | (0.097) | (0.003) | (0.003) | (0.006) |
| Ethnicity - Former USSR | 0.098 | 0.099 | 0.001 | 0.000 | 0.007 |
| | (0.297) | (0.299) | (0.010) | (0.014) | (0.015) |
| Ethnicity - Other | 0.030 | 0.036 | 0.007 | -0.008 | -0.004 |
| | (0.170) | (0.187) | (0.003) | (0.008) | (0.004) |
| School's Number of Students | 460.121 | 451.097 | -9.022 | -24.821* | 29.176 |
| | (145.927) | (152.871) | (13.432) | (14.677) | (19.242) |
| School's Number of Classes | 15.800 | 15.668 | -0.132 | -0.638 | 0.714 |
| | (3.909) | (4.185) | (0.357) | (0.423) | (0.537) |
| **B. Tests' Z-scores 2002-2005** | | | | | |
| Math | -0.001 | 0.010 | 0.011 | 0.002 | 0.052 |
| | (1.004) | (0.986) | (0.025) | (0.017) | (0.077) |
| Hebrew | 0.006 | -0.005 | -0.011 | -0.035 | -0.009 |
| | (0.998) | (0.998) | (0.026) | (0.041) | (0.053) |
| English | -0.002 | 0.011 | 0.013 | -0.028 | 0.000 |
| | (0.999) | (1.005) | (0.034) | (0.074) | (0.089) |
| **C. Correlation Between Previous and Current School's CEO Quality Based on Method II** | | | | | |
| | | | $SI(VA)_{t+1} = -0.153 + 0.0916 * SI(VA)_t$ | | |
| | | | (0.197) (0.222) | | |
| | | | $R^2 = 0.005$ | | |
| Number of Schools | 497 | 222 | 719 | 301 | 82 |
| Number of CEOs | 47 | 55 | 67 | 30 | 29 |

Notes: In columns (1)-(2) standard deviations are presented in parenthesis. In column (3) standard errors in parenthesis are adjusted for school level clustering. In columns (4)-(6) standard errors in parenthesis are adjusted for CEO level clustering. All regressions include district dummies. In Panel C standard errors in parenthesis are adjusted for superintendnet level clustering. Number of schools and CEOs refer to Panels A-B. All schools are in the jewish non-religious primary school system. CEOs VA are standardized with 0 mean and unit sd. * indicates significant level at 10% or lower.

**Table 5: Distribution of the Change of CEO's Quality Within Schools, Method I**

| | Mean Change | SD | Min | Median | Max | Schools |
|---|---|---|---|---|---|---|
| | (1) | (2) | (4) | (5) | (6) | (7) |
| Full Sample | 0.091 | 1.341 | -3.467 | 0.228 | 2.213 | 82 |
| | (0.154) | | | | | |
| Female CEOs Subsample | 0.383 | 1.342 | -3.467 | 0.572 | 2.213 | 64 |
| | (0.177) | | | | | |

Notes: Robust standard errors are presented in parenthesis. All schools are in the jewish non-religious primary school system. The sample includes stacked math, hebrew and english tests scores. CEOs Quality is standardized with 0 mean and unit sd.

**Table 6: The Effect of CEO's Quality on Tests Z-Scores**

| | Quality Method I | | | | Quality Method II | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **A. Full Sample** | | | | | | | |
| Schools' Sample Regressions | -0.002 | -0.002 | -0.010 | 0.038 | 0.037 | 0.037 | 0.058 |
| | (0.026) | (0.026) | (0.017) | (0.019) | (0.041) | (0.041) | (0.030) |
| Students' Sample Regressions | 0.003 | 0.003 | -0.013 | 0.040 | 0.035 | 0.035 | 0.051 |
| | (0.025) | (0.025) | (0.018) | (0.016) | (0.041) | (0.041) | (0.032) |
| **B. Female CEOs Sample** | | | | | | | |
| Schools' Sample Regressions | 0.010 | 0.010 | -0.007 | 0.048 | 0.035 | 0.035 | 0.061 |
| | (0.029) | (0.029) | (0.020) | (0.022) | (0.043) | (0.043) | (0.032) |
| Students' Sample Regressions | 0.019 | 0.019 | -0.007 | 0.053 | 0.034 | 0.034 | 0.053 |
| | (0.028) | (0.028) | (0.019) | (0.011) | (0.043) | (0.043) | (0.034) |
| **C. Full Sample - By Parental Education (Student Level)** | | | | | | | |
| Below Median Father's Years of Schooling | -0.016 | -0.016 | -0.023 | 0.047 | 0.046 | 0.046 | 0.050 |
| | (0.024) | (0.024) | (0.029) | (0.027) | (0.042) | (0.042) | (0.036) |
| Above Median Father's Years of Schooling | 0.010 | 0.010 | 0.001 | 0.031 | 0.066 | 0.066 | 0.060 |
| | (0.023) | (0.023) | (0.017) | (0.012) | (0.028) | (0.028) | (0.028) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Subject FE | No | Yes | Yes | Yes | No | Yes | Yes |
| Schools' and Students' Characteristics | No | No | Yes | Yes | No | No | Yes |
| School FE | No | No | No | Yes | No | No | No |
| Number of Students | 10,249 | 10,249 | 10,190 | 10,190 | 39,915 | 39,915 | 39,852 |
| Number of Schools | 82 | 82 | 82 | 82 | 301 | 301 | 301 |
| Number of CEOs | 29 | 29 | 29 | 29 | 30 | 30 | 30 |

Notes: Standard errors in parenthesis are clustered at the CEO-by-year level. Schools characteristics include number of classes, number of students and the number of schools included in a CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. Test scores and CEOs Quality are standardized with 0 mean and unit sd.

**Table 7: The Effect of CEO's Quality on Tests Z-Scores**

| | Bayes Corrected Estimates | | Two-Step Bootstrapped Standard Errors | |
|---|---|---|---|---|
| | Method I | Method II | Method I | Method II |
| | (1) | (2) | (3) | (4) |
| **A. Full Sample** | | | | |
| Students' Sample Regressions | 0.038 | 0.050 | 0.040 | 0.051 |
| | (0.017) | (0.034) | (0.015) | (0.018) |
| **B. Female CEOs Sample** | | | | |
| Students' Sample Regressions | 0.053 | 0.052 | 0.053 | 0.053 |
| | (0.012) | (0.036) | (0.017) | (0.018) |
| **C. Full Sample - By Parental Education (Student Level)** | | | | |
| Below Median Father's Years of Schooling | 0.043 | 0.049 | 0.047 | 0.050 |
| | (0.029) | (0.038) | (0.022) | (0.019) |
| Above Median Father's Years of Schooling | 0.032 | 0.063 | 0.031 | 0.060 |
| | (0.013) | (0.029) | (0.020) | (0.018) |
| Year FE | Yes | Yes | Yes | Yes |
| Subject FE | Yes | Yes | Yes | Yes |
| Schools' and Students' Characteristics | Yes | Yes | Yes | Yes |
| School FE | Yes | No | Yes | No |
| Number of Students | 10,190 | 39,852 | 10,190 | 39,852 |
| Number of Schools | 82 | 301 | 82 | 301 |
| Number of CEOs | 29 | 30 | 29 | 30 |

Notes: Standard errors used to calculate bayes estimates at the VA estimation regression are clustered at the CEO level. Standard errors in columns (1)-(2) are clustered at the CEO-by-year level. Standard errors in columns (3)-(4) bootstrapped using the following two-step procedure: First, for each school in each period, we draw a random sample of students with replacement (In methodI we draw a random sample of schools with replacement). The VA estimation regression is estimated on this random sample, and the corresponding VA estimates are obtained. The second stage regression is then estimated on a random sample of students with replacement. This process is repeated a 1,000 times, and the bootstrap standard errors are computed using the sample of these 1,000 second-stage coefficient estimates. Schools characteristics include number of classes, number of students and the number of schools under the school's CEO. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. Test scores and CEOs Quality are standardized with 0 mean and unit sd.

**Table 8: Non Linear Effects of CEO's Quality**

| | Quality Method I | Quality Method II |
|---|---|---|
| | (1) | (2) |
| **A. Median** | | |
| Above Median VA | 0.065 | 0.082 |
| | (0.036) | (0.036) |
| **B. Quartiles** | | |
| 2nd VA Quartile | 0.031 | 0.080 |
| | (0.038) | (0.051) |
| 3rd VA Quartile | 0.055 | 0.099 |
| | (0.039) | (0.056) |
| 4th VA Quartile | 0.130 | 0.135 |
| | (0.045) | (0.057) |
| Year FE | Yes | Yes |
| Subject FE | Yes | Yes |
| Schools' and Students' Characteristics | Yes | Yes |
| School FE | Yes | No |
| Number of Students | 10,190 | 39,852 |
| Number of Schools | 82 | 301 |
| Number of CEOs | 29 | 30 |

Notes: Standard errors in parenthesis are clustered at the CEO-by-year level. Schools characteristics include number of classes, number of students and the number of schools included in the CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. Test scores and CEOs VA are standardized with 0 mean and unit sd.

**Table 9: The Effect of CEO's Quality I on Tests Scores - Middle Schools Sample**

| | Specification | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **A. Full Sample** | | | | |
| Students' Sample Regressions | -0.073 | -0.073 | -0.046 | 0.048 |
| | (0.096) | (0.096) | (0.040) | (0.055) |
| Above Median VA | -0.118 | -0.118 | 0.046 | 0.193 |
| | (0.081) | (0.081) | (0.065) | (0.037) |
| **C. By Parental Education** | | | | |
| Below Median Father's Years of Schooling | -0.020 | -0.020 | -0.019 | 0.041 |
| | (0.101) | (0.101) | (0.051) | (0.051) |
| Above Median Father's Years of Schooling | -0.142 | -0.142 | -0.080 | 0.027 |
| | (0.088) | (0.088) | (0.042) | (0.080) |
| Year FE | Yes | Yes | Yes | Yes |
| Subject FE | No | Yes | Yes | Yes |
| Schools' and Students' Characteristics | No | No | Yes | Yes |
| School FE | No | No | No | Yes |
| Number of Students | 5,172 | 5,172 | 5,169 | 5,169 |
| Number of Schools | 15 | 15 | 15 | 15 |
| Number of CEOs | 13 | 13 | 13 | 13 |

Notes: Standard errors in parenthesis are clustered at the CEO-by-year level. Schools characteristics include number of classes, number of students and the number of schools included in a CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious middle school system. Sample includes stacked math, hebrew and english tests scores. Test scores and CEOs Quality are standardized with 0 mean and unit sd.

**Table 10: The Effect of CEO's Quality on Working Procedures and School Resources**

| | Mean | Specification | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **A. School's Priorities and Working Procedures (Rank 1-6)** | | | | |
| Clearly Defined Priorities | 5.419 | 0.231 | 0.199 | 0.230 |
| | (0.462) | (0.122) | (0.101) | (0.103) |
| Teachers Involved in Setting School Priorities | 4.657 | 0.095 | 0.107 | 0.330 |
| | (0.635) | (0.076) | (0.085) | (0.173) |
| Clearly Defined Working Procedures | 5.461 | 0.179 | 0.149 | 0.102 |
| | (0.494) | (0.140) | (0.122) | (0.121) |
| *Average Effect* | 5.229 | 0.159 | 0.145 | 0.144 |
| | (0.456) | (0.101) | (0.087) | (0.115) |
| **B. School's Resources (Weekly Instruction Hours)** | | | | |
| Instruction Budget per Class | 44.981 | -0.048 | -0.090 | -0.015 |
| | (6.364) | (0.131) | (0.055) | (0.055) |
| Length of the School Week | 33.931 | -0.057 | -0.024 | -0.082 |
| | (3.062) | (0.124) | (0.061) | (0.047) |
| Instruction Hours of Math, Science and English | 14.186 | -0.012 | -0.017 | -0.038 |
| | (1.937) | (0.135) | (0.098) | (0.088) |
| *Average Effect* | 31.032 | -0.039 | -0.044 | -0.045 |
| | (3.397) | (0.125) | (0.057) | (0.046) |
| Year FE | | Yes | Yes | Yes |
| Student and School Characteristics | | No | Yes | Yes |
| School FE | | No | No | Yes |
| Number of Schools | 82 | 82 | 82 | 82 |
| Number of CEOs | 29 | 29 | 29 | 29 |

Notes: In column (1) standard deviations are presented in parenthesis. In columns (2)-(5) standard errors in parenthesis are adjusted for supintendent level clustering. An average effect is an equally weighted average of the rest of its panel's questions' values in column (1), and z-scores in columns (2)-(4). Panel A is drawn from principals' survey data and non-index variables originally take value of 0 or 1, with the exception of Use of Ministry Tools for Internal Evaluation which is a summary index of use of ministry tools questions. Panel B is drawn from teachers' survey data and non-index variables are originally on a scale of 1-6. Panel C is drawn from administrative data on school funding. Schools characteristics include number of classes, number of students and the number of schools included in the CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. CEOs Quality is standardized with 0 mean and unit sd. Outcomes and students' characteristics are school means. The dependent variable is a standardized transformation (mean zero, unit standard deviation) of the raw variable.

**Table 11: The Effect of CEO's Quality on School Environment and Climate**

| | Mean | Specification | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **A. School Climate and Norms Indicators (0/1)** | | | | |
| School Evaluates its Environment, Climate and Discipline | 0.707 | 0.267 | 0.264 | 0.250 |
| | (0.456) | (0.070) | (0.093) | (0.074) |
| Interventions Related to School Environment and Discipline | 0.291 | 0.097 | 0.335 | 0.493 |
| | (0.456) | (0.075) | (0.099) | (0.224) |
| *Average Effect* | 0.549 | 0.203 | 0.253 | 0.262 |
| | (0.385) | (0.054) | (0.070) | (0.077) |
| **B. Violence in School based on Students' Assessment (Rank 1-6)** | | | | |
| "There are many fights among students in my classroom" | 3.593 | -0.040 | -0.042 | -0.035 |
| | (1.497) | (0.023) | (0.022) | (0.018) |
| "This year I was involved in many fights" | 1.941 | 0.014 | 0.006 | -0.034 |
| | (1.389) | (0.021) | (0.016) | (0.016) |
| "Sometimes I'm scared to go to school because there are violent students" | 1.938 | -0.012 | 0.002 | -0.024 |
| | (1.483) | (0.019) | (0.013) | (0.012) |
| *Average Effect* | 2.492 | -0.013 | -0.012 | -0.033 |
| | (1.031) | (0.014) | (0.010) | (0.012) |
| **C. Students' Satisfcation (Rank 1-6)** | | | | |
| "There's someone in the teaching staff I can turn to" | 5.091 | 0.012 | 0.007 | 0.036 |
| | (1.324) | (0.017) | (0.016) | (0.008) |
| "I am staisfied in school" | 5.252 | 0.003 | 0.010 | 0.011 |
| | (1.147) | (0.019) | (0.017) | (0.017) |
| "I'm socially staisfied in school" | 5.246 | -0.001 | -0.002 | 0.004 |
| | (1.195) | (0.009) | (0.009) | (0.013) |
| *Average Effect* | 5.193 | 0.005 | 0.006 | 0.019 |
| | (0.926) | (0.017) | (0.016) | (0.014) |
| Year FE | | Yes | Yes | Yes |
| Student and School Characteriscs | | No | Yes | Yes |
| School FE | | No | No | Yes |
| Number of Schools | 82 | 82 | 82 | 82 |
| Number of CEOs | 29 | 29 | 29 | 29 |

Notes: In column (1) standard deviations are presented in parenthesis. In columns (2)-(5) standard errors in parenthesis are adjusted for superintendent level clustering. An average effect is an equally weighted average of the rest of its panel's questions' values in column (1), and z-scores in columns (2)-(4) Panel A is drawn from principals' survey data, outcomes and students' characteristics are school means and non-index variables originally take value of 0 or 1. Panels B and C are drawn from students' survey data, outcomes and students' characteristics are individual level data and non-index variables are on a scale of 1-6. Schools characteristics include number of classes, number of students and the number of schools included in the superintendent's cluster. Student and school characteristics also include share of boys in the class in the violence related dependent variables. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Superintendents Quality is standardized with 0 mean and unit sd. The dependent variable is a standardized transformation (mean zero, unit standard deviation) of the raw variable.

**Table 12: The Effect of CEO's Quality on School Scholastic Programs and Teachers' In and Out of School Training**

| | Mean | Specification | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **A. School has an Academic Program (0/1) in:** | | | | |
| Hebrew | 0.333 | -0.123 | 0.047 | 0.274 |
| | (0.473) | (0.104) | (0.129) | (0.294) |
| Math | 0.265 | -0.220 | -0.063 | -0.116 |
| | (0.443) | (0.098) | (0.111) | (0.432) |
| English | 0.222 | -0.116 | -0.116 | 0.472 |
| | (0.418) | (0.100) | (0.147) | (0.297) |
| *Average Effect* | 0.274 | -0.153 | -0.044 | 0.210 |
| | (0.363) | (0.085) | (0.094) | (0.294) |
| **B. Teachers Receive Out of School Training (0/1) in:** | | | | |
| Hebrew | 0.465 | 0.030 | 0.087 | 0.043 |
| | (0.201) | (0.078) | (0.092) | (0.149) |
| Math | 0.372 | 0.096 | 0.096 | 0.021 |
| | (0.191) | (0.062) | (0.092) | (0.106) |
| English | 0.183 | 0.099 | -0.022 | 0.035 |
| | (0.259) | (0.150) | (0.113) | (0.083) |
| *Average Effect* | 0.342 | 0.075 | 0.064 | 0.050 |
| | (0.134) | (0.053) | (0.055) | (0.077) |
| **C. Teachers Receive In-School Training (0/1) in:** | | | | |
| Hebrew | 0.507 | 0.037 | 0.064 | 0.313 |
| | (0.259) | (0.084) | (0.079) | (0.120) |
| Math | 0.380 | 0.033 | 0.117 | 0.192 |
| | (0.259) | (0.079) | (0.104) | (0.122) |
| English | 0.188 | -0.044 | -0.172 | -0.151 |
| | (0.347) | (0.080) | (0.078) | (0.102) |
| *Average Effect* | 0.358 | -0.008 | -0.005 | 0.024 |
| | (0.162) | (0.014) | (0.016) | (0.020) |
| Year FE | | Yes | Yes | Yes |
| Student and School Characteristics | | No | Yes | Yes |
| School FE | | No | No | Yes |
| Number of Schools | 82 | 82 | 82 | 82 |
| Number of CEOs | 29 | 29 | 29 | 29 |
| Number of Teachers | 2,236 | 2,236 | 2,236 | 2,236 |

Notes: In column (1) standard deviations are presented in parenthesis. In columns (2)-(5) standard errors in parenthesis are adjusted for supintendent level clustering. An average effect is an equally weighted average of the rest of its panel's questions' values in column (1), and z-scores in columns (2)-(4) Both panels are drawn from teachers' survey data and non-index variables originally take value of 0 or 1. Schools characteristics include number of classes, number of students and the number of schools included in the CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. CEOs Qualityis standardized with 0 mean and unit sd. Outcomes and students' characteristics are school means. The dependent variable is a standardized transformation (mean zero, unit standard deviation) of the raw variable.

**Table 13: The Effect of Change of CEO's on Change of School Principal**

| Years Since Change of CEO | Full Sample Period | | | 2002-2003 | 2003-2004 | | 2004-2005 | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| First Year | -0.044 | | -0.061 | 0.001 | -0.049 | | -0.076 | | |
| | (0.021) | | (0.028) | (0.033) | (0.055) | | (0.032) | | |
| Second Year | | 0.091 | 0.081 | | | 0.062 | | 0.139 | |
| | | (0.028) | (0.028) | | | (0.035) | | (0.050) | |
| Third Year | | | | | | | | | 0.007 |
| | | | | | | | | | (0.033) |
| Share of Schools Changing CEO | 0.15 | 0.15 | 0.15 | 0.15 | 0.17 | 0.17 | 0.14 | 0.14 | 0.14 |
| Number of Schools | 738 | 721 | 721 | 723 | 721 | 714 | 716 | 708 | 701 |

Notes: The sample includes schools that changed CEO once or less throughout the sample period (~90% of all schools). Standard errors are presented in parenthesis. All schools are in the jewish non-religious primary school system. In column 4 the change of school principal is between 2002-2003. In columns 5-6 the change in school principal is between 2003-2004. In columns 7-9 the change in school principal is between 2004-2005.

**Table A1: The Effect of CEO's Quality on Tests Z-Scores**

| | Quality Method I | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **A. Full Sample** | | | | |
| Schools' Sample Regressions | -0.003 | -0.003 | -0.012 | 0.036 |
| | (0.025) | (0.025) | (0.016) | (0.020) |
| Students' Sample Regressions | 0.002 | 0.002 | -0.012 | 0.041 |
| | (0.025) | (0.025) | (0.017) | (0.016) |
| **B. Female CEOs Sample** | | | | |
| Schools' Sample Regressions | 0.009 | 0.009 | -0.009 | 0.049 |
| | (0.028) | (0.028) | (0.019) | (0.022) |
| Students' Sample Regressions | 0.019 | 0.019 | -0.006 | 0.058 |
| | (0.028) | (0.028) | (0.019) | (0.011) |
| **C. Full Sample - By Parental Education (Student Level)** | | | | |
| Below Median Father's Years of Schooling | -0.017 | -0.017 | -0.021 | 0.055 |
| | (0.024) | (0.024) | (0.028) | (0.026) |
| Above Median Father's Years of Schooling | 0.010 | 0.010 | 0.002 | 0.028 |
| | (0.024) | (0.024) | (0.018) | (0.012) |
| Year FE | Yes | Yes | Yes | Yes |
| Subject FE | No | Yes | Yes | Yes |
| Schools' and Students' Characteristics | No | No | Yes | Yes |
| School FE | No | No | No | Yes |
| Number of Students | 9,295 | 9,295 | 9,236 | 9,236 |
| Number of Schools | 75 | 75 | 75 | 75 |
| Number of CEOs | 29 | 29 | 29 | 29 |

Notes: Standard errors in parenthesis are clustered at the CEO-by-year level. Schools characteristics include number of classes, number of students and the number of schools included in a CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. Test scores and CEOs Quality are standardized with 0 mean and unit sd. The sample excludes the 15 schools that were reassigned as a single-school or two-schools cluster and their reassignment showed no explicit spatial logic. 7 of these schools overlapped with the 82 schools in the analysis provided in Table 6.

**Table A2: The Effect of CEO Quality on Tests Z-Scores**

| | Quality Method I | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **A. Full Sample** | | | | |
| Schools' Sample Regressions | 0.007 | 0.007 | 0.017 | 0.049 |
| | (0.025) | (0.025) | (0.021) | (0.021) |
| Students' Sample Regressions | 0.012 | 0.012 | 0.011 | 0.062 |
| | (0.025) | (0.025) | (0.017) | (0.010) |
| **B. Female CEOs Sample** | | | | |
| Schools' Sample Regressions | 0.016 | 0.016 | 0.022 | 0.045 |
| | (0.029) | (0.029) | (0.028) | (0.023) |
| Students' Sample Regressions | 0.026 | 0.026 | 0.019 | 0.067 |
| | (0.029) | (0.029) | (0.022) | (0.010) |
| **C. Full Sample - By Parental Education (Student Level)** | | | | |
| Below Median Father's Years of Schooling | -0.004 | -0.004 | -0.001 | 0.079 |
| | (0.024) | (0.025) | (0.029) | (0.018) |
| Above Median Father's Years of Schooling | 0.025 | 0.025 | 0.031 | 0.053 |
| | (0.024) | (0.024) | (0.017) | (0.011) |
| Year FE | Yes | Yes | Yes | Yes |
| Subject FE | No | Yes | Yes | Yes |
| Schools' and Students' Characteristics | No | No | Yes | Yes |
| School FE | No | No | No | Yes |
| Number of Students | 8,222 | 8,222 | 8,164 | 8,164 |
| Number of Schools | 66 | 66 | 66 | 66 |
| Number of CEOs | 23 | 23 | 23 | 23 |

Notes: Standard errors in parenthesis are clustered at the CEO-by-year level. Schools characteristics include number of classes, number of students and the number of schools included in a CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. Test scores and CEOs Quality are standardized with 0 mean and unit sd. The sample excludes the 40 schools that were reassigned as a single-school or two-schools cluster. 16 of these schools overlapped with the 82 schools in the analysis provided in Table 6.

**Table A3: The Effect of CEO's Quality on School Resources and Students' Time Allocation**

| | Mean | Specification | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **A. School Resources** | | | | |
| Class Size | 28.044 | -0.438 | -0.118 | -0.065 |
| | (3.796) | (0.424) | (0.077) | (0.069) |
| Instruction Budget per Class | 45.017 | -0.302 | -0.543 | -0.122 |
| | (6.373) | (0.942) | (0.356) | (0.352) |
| Length of the School Week | 33.930 | -0.192 | -0.061 | -0.255 |
| | (3.073) | (0.445) | (0.191) | (0.149) |
| Instruction Hours of Math | 6.157 | 0.019 | 0.038 | -0.097 |
| | (0.784) | (0.071) | (0.070) | (0.137) |
| Instruction Hours of Science | 4.000 | -0.007 | -0.042 | -0.056 |
| | (1.295) | (0.168) | (0.117) | (0.117) |
| Instruction Hours of English | 4.051 | -0.024 | 0.005 | 0.066 |
| | (0.741) | (0.077) | (0.064) | (0.097) |
| Instruction Hours of Hebrew | 5.998 | 0.019 | 0.059 | 0.125 |
| | (1.320) | (0.105) | (0.116) | (0.109) |
| Instruction Hours of Math, Science, English and Hebrew | 20.207 | 0.006 | 0.060 | 0.038 |
| | (2.462) | (0.329) | (0.219) | (0.239) |
| **B. Students' Time Allocated to Homework** | | | | |
| Math | 2.960 | 0.010 | 0.014 | -0.029 |
| | (1.563) | (0.033) | (0.026) | (0.023) |
| English | 2.763 | -0.037 | -0.030 | -0.010 |
| | (1.622) | (0.044) | (0.036) | (0.030) |
| Hebrew | 2.264 | 0.036 | 0.057 | -0.012 |
| | (1.521) | (0.032) | (0.024) | (0.031) |
| Total | 8.002 | 0.011 | 0.045 | -0.055 |
| | (3.957) | (0.093) | (0.062) | (0.071) |
| Year FE | | Yes | Yes | Yes |
| Student and School Characteriscs | | No | Yes | Yes |
| School FE | | No | No | Yes |
| Number of Schools | 70 | 70 | 70 | 70 |
| Number of CEOs | 27 | 27 | 27 | 27 |

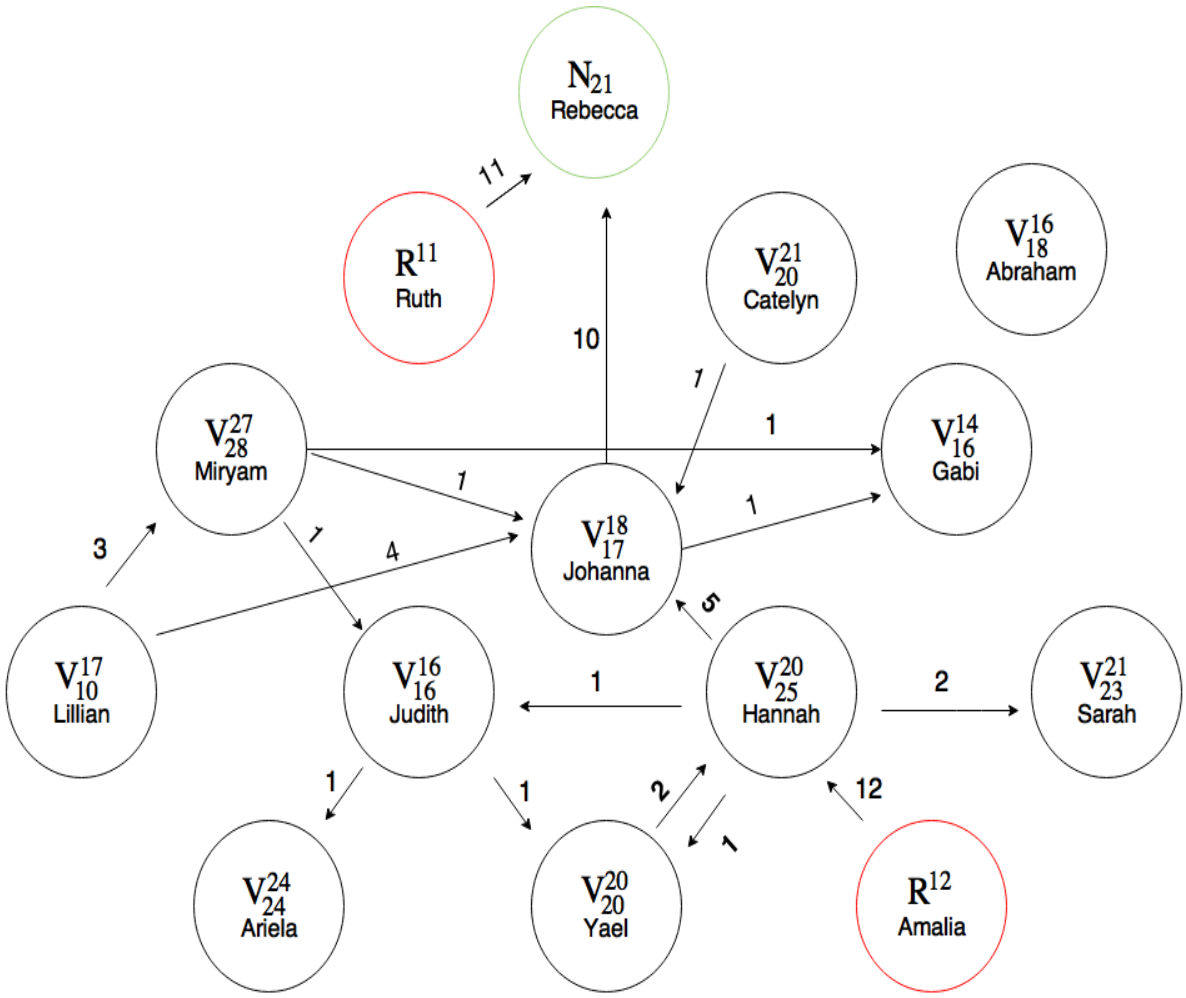
Notes: In column (1) standard deviations are presented in parenthesis. In columns (2)-(5) standard errors in parenthesis are adjusted for CEO level clustering. An average effect is an equally weighted average of the rest of its panel's questions' values in column (1), and z-scores in columns (2)-(4). Schools characteristics include number of classes, number of students and the number of schools included in the CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. All schools are in the jewish non-religious primary school system. CEOs Quality is standardized with 0 mean and unit sd. Number of schools and CEOs for panel B are 82 and 28 accordingly.

**Table A4: Violence and School Climate Regressions**

| | Specification | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| **A. Violence Index** | | | | | |
| Schools' Sample Regressions | -0.301 | -0.301 | -0.263 | -0.237 | -0.226 |
| | (0.018) | (0.018) | (0.017) | (0.015) | (0.005) |
| Students' Sample Regressions | -0.708 | -0.708 | -0.529 | -0.302 | -0.278 |
| | (0.101) | (0.101) | (0.112) | (0.140) | (0.050) |
| **B. School Climate Index** | | | | | |
| Schools' Sample Regressions | -0.016 | -0.016 | 0.009 | 0.070 | 0.023 |
| | (0.032) | (0.032) | (0.029) | (0.047) | (0.011) |
| Students' Sample Regressions | -0.017 | -0.017 | 0.005 | 0.086 | 0.020 |
| | (0.033) | (0.033) | (0.030) | (0.043) | (0.012) |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Subject FE | No | Yes | Yes | Yes | Yes |
| Schools' and Students' Characteristics | No | No | Yes | Yes | Yes |
| School FE | No | No | No | Yes | Yes |
| Number of Schools | 82 | 82 | 82 | 82 | 719 |
| Number of Students - Violence Index | 9,010 | 9,010 | 8,960 | 8,960 | 79,653 |
| Number of Students - School Climate Index | 10,249 | 10,249 | 10,190 | 10,190 | 90,264 |

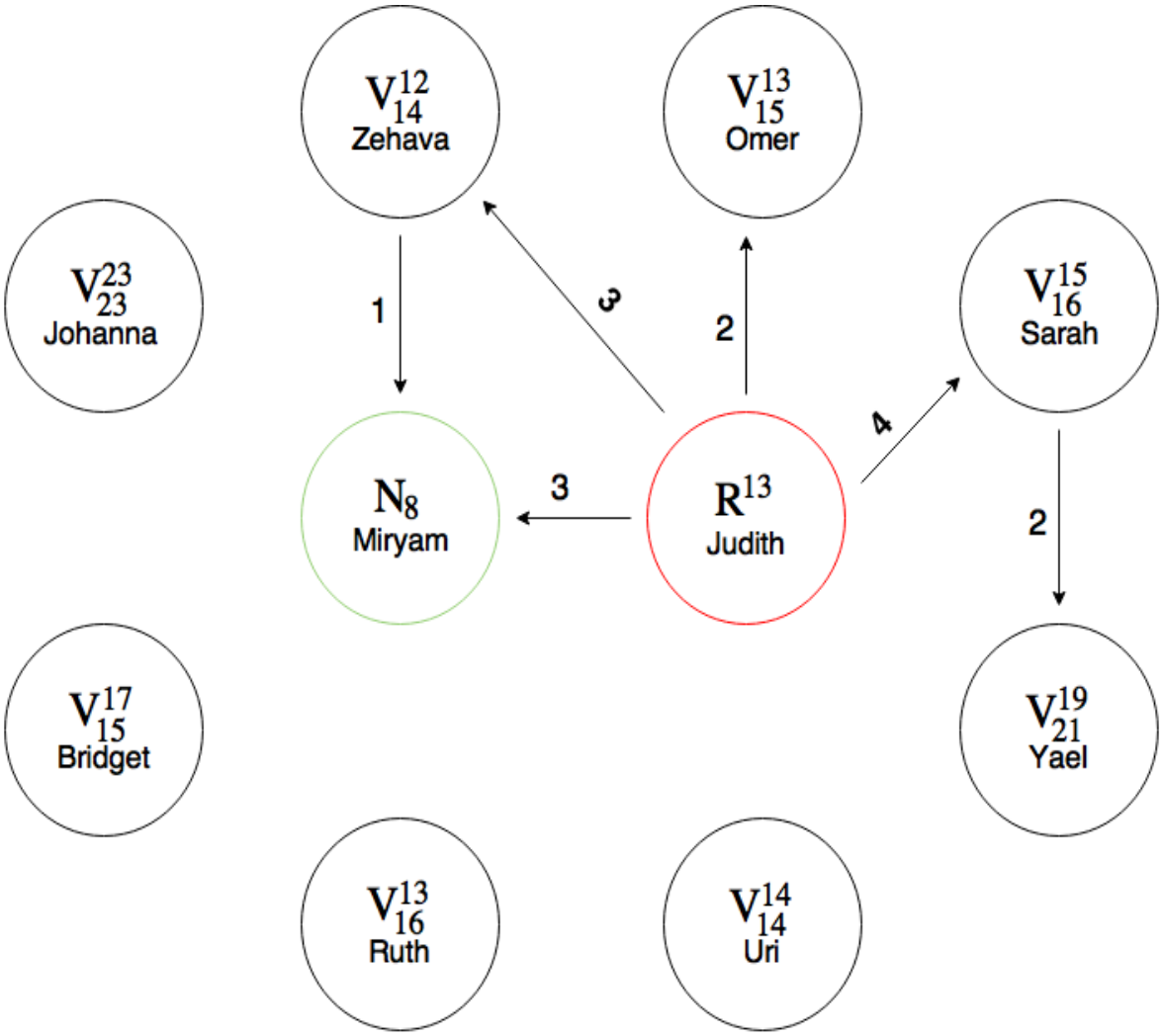
Notes: Standard errors in parenthesis are clustered at the school level. In Columns (1)-(4) the sample of 82 schools are the schools included in Table 11. Column (5) includes all schools. Schools characteristics include number of classes, number of students and the number of schools included in a CEO's cluster. Students' characteristics include gender, ethnic origin, parents' education, number of siblings and immigrant status. Dependent variable is tests scores in al specifications. All schools are in the jewish non-religious primary school system. Sample includes stacked math, hebrew and english tests scores. School climate and violence indices are the averages of the questions presented in panels A and B accordingly of table 11. The violence index regressions include only students who answered the relevant questions in the student surveys. The school climate regressions include all students, as the questions are from the principal survey and are on asked in the school level. Test scores and violence amd school climate indices are standardized with 0 mean and unit sd.

**Figure 1: CEOs' Turnover: Central District 2004-05**



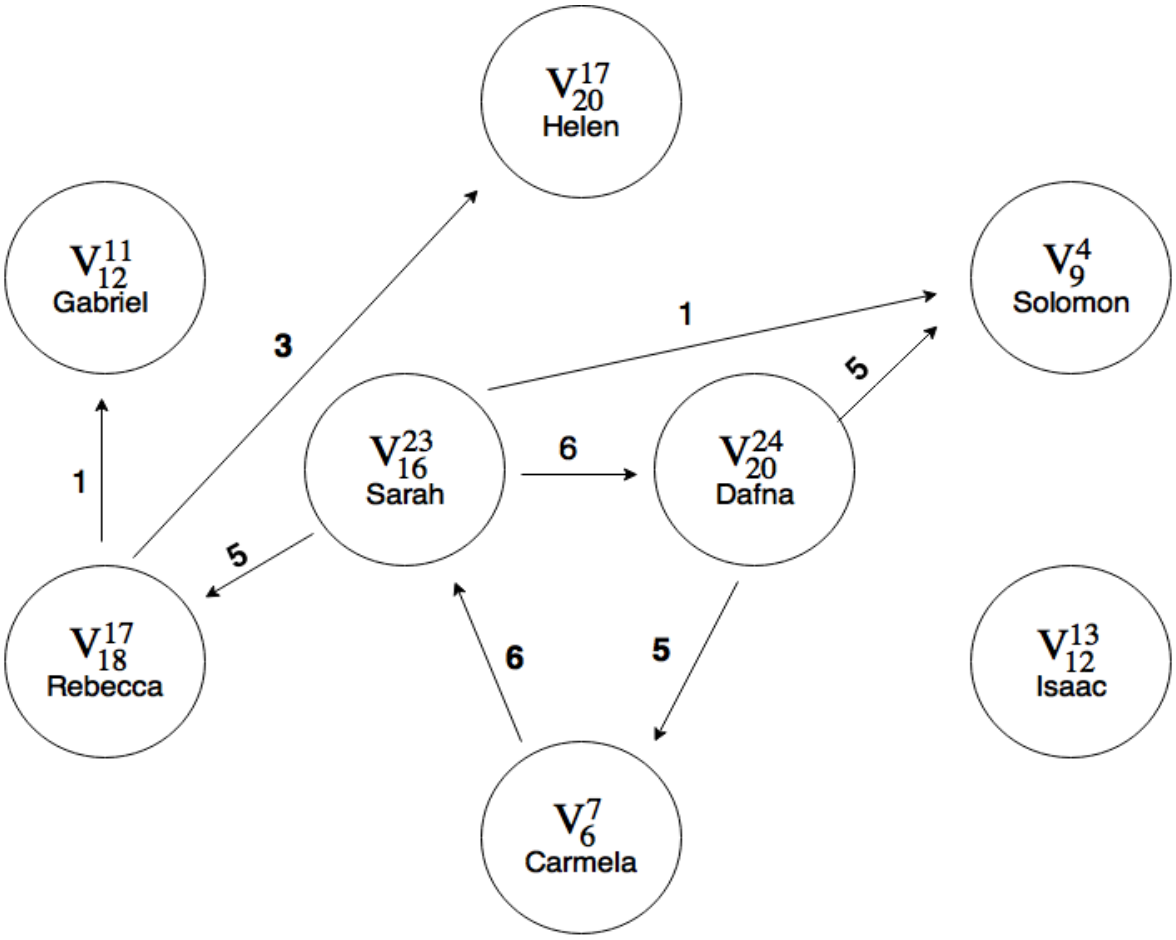

Notes: One of Miryam's 2005 schools is new. Two of Abraham's 2005 schools are new. One of Johanna's 2004 schools closed at the end of the year. One of Ariela's 2004 schools closed at the end of the year.

**Figure 2: CEOs' Turnover: South District 2002-03**




Notes: Miryam had one middle school in 2002 and 4 middle schools in 2003. Uri had 2 middle schools in both years. One of Sarah's 2002 schools closed at the end of the year. Bridget had one middle school in 2002 and one of her 2002 schools closed at the end of the year. Ruth had 5 middle schools in 2002 and 8 middle schools in 2003.

**Figure 3: Chart of CEOs' Schools Turnover in Haifa District 2003 - 2004**




Notes: One of Sarah's 2003 schools closed at the end of the year. Isaac had 6 middle schools in 2003 and 5 middle schools in 2004. Solomon had one Arabic school in 2003 and none in 2004.

Figure 4: Distribution of Superintendents' Number of Schools

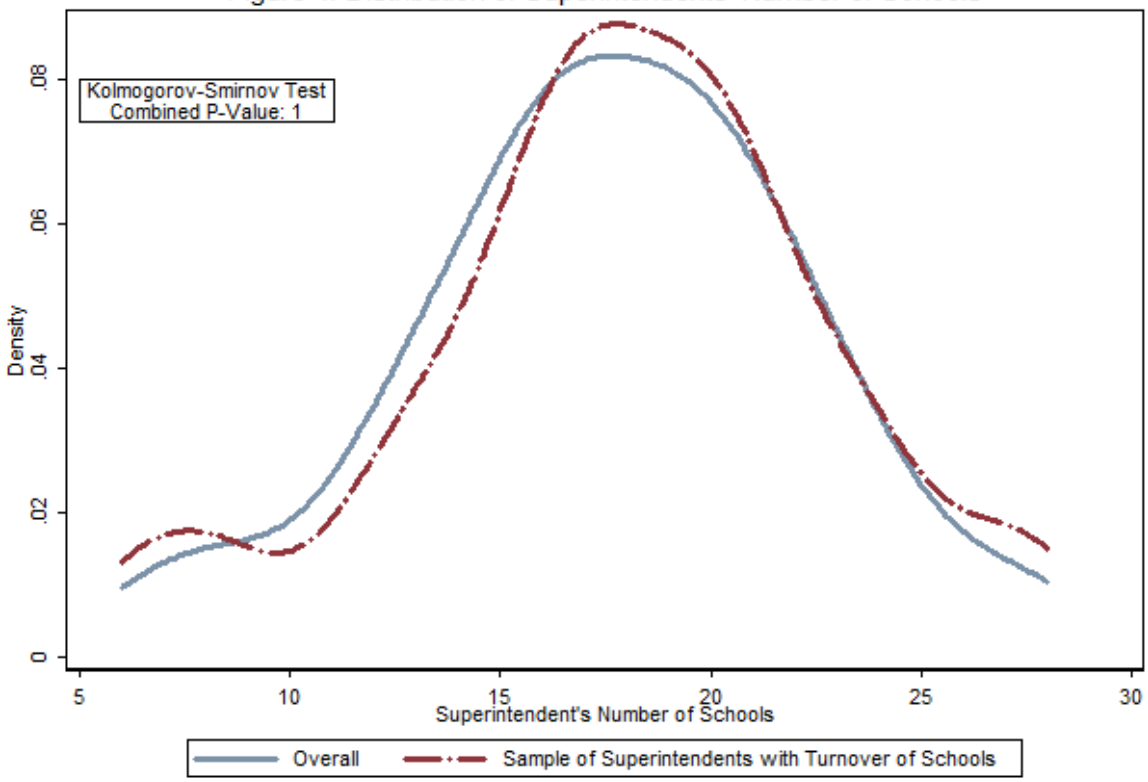
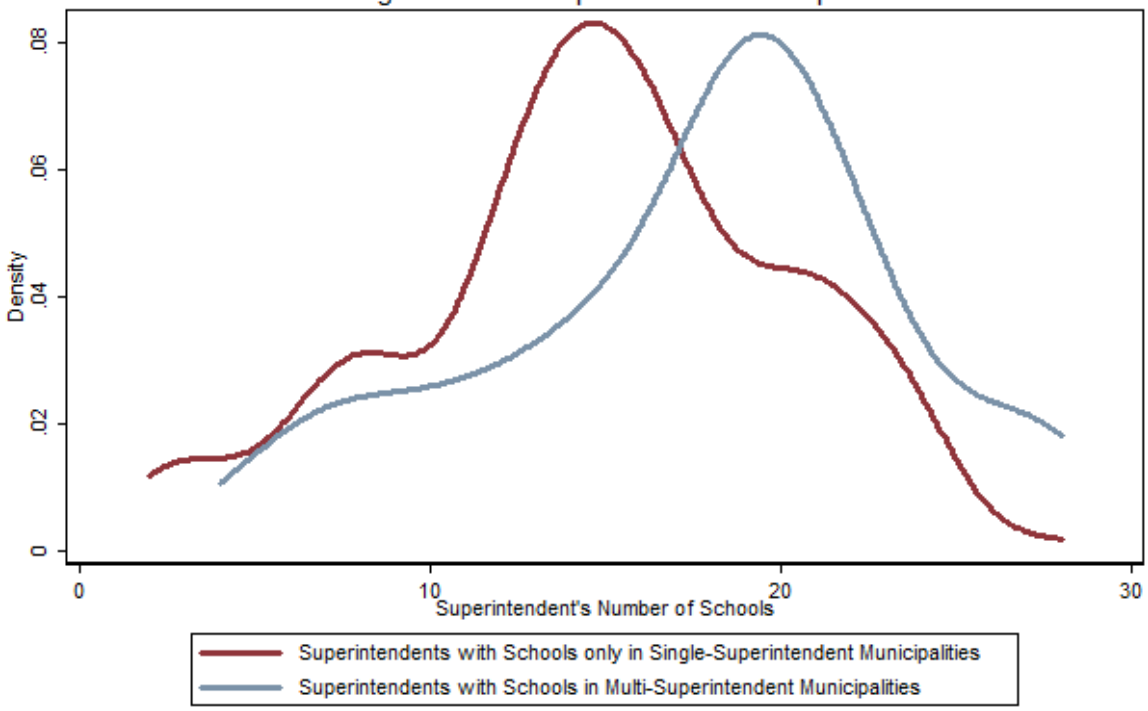


Figure 5: Distribution of Superintendents' Number of Schools in Single and Multi-Superintendent Municipalities




Number of Superintendents X Year with Schools only in Single-Superintendent Municipalities: 179
Number of Superintendents X Year with Schools in Multi-Superintendent Municipalities: 51

Figure 6: Distribution of Superintendents Quality I by Period

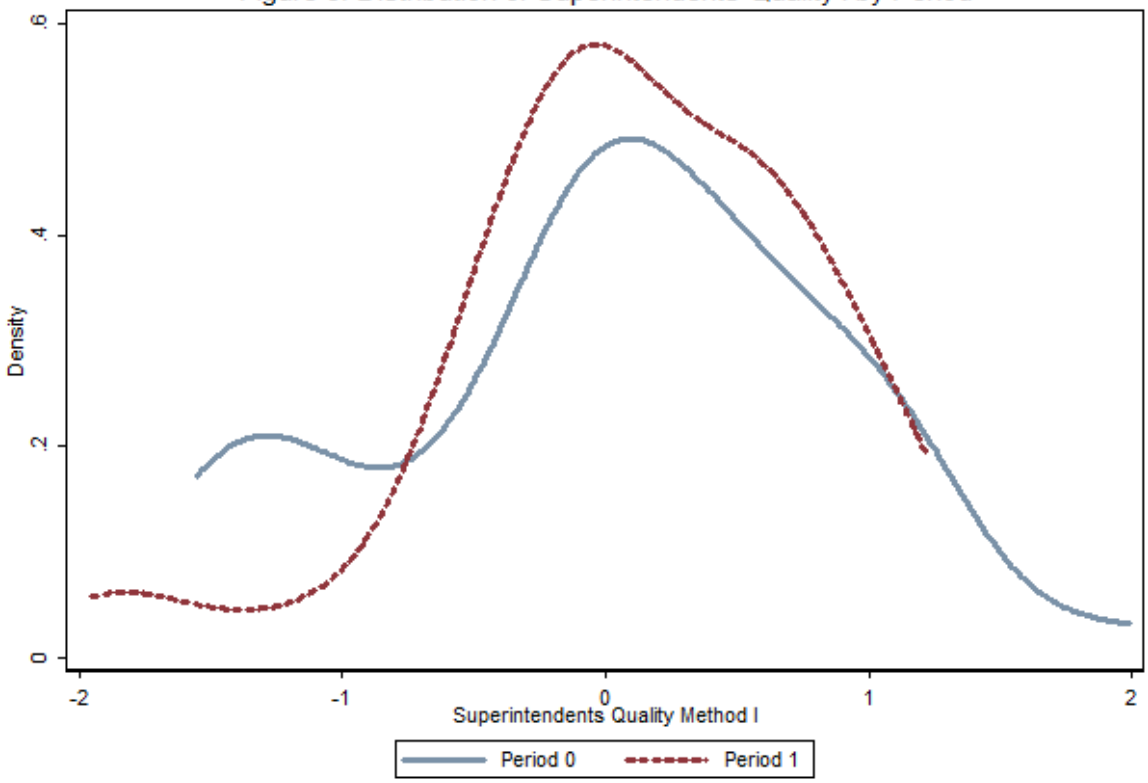


Figure 7: Distribution of Superintendents Quality I
with Different Controls for Lagged Test Scores

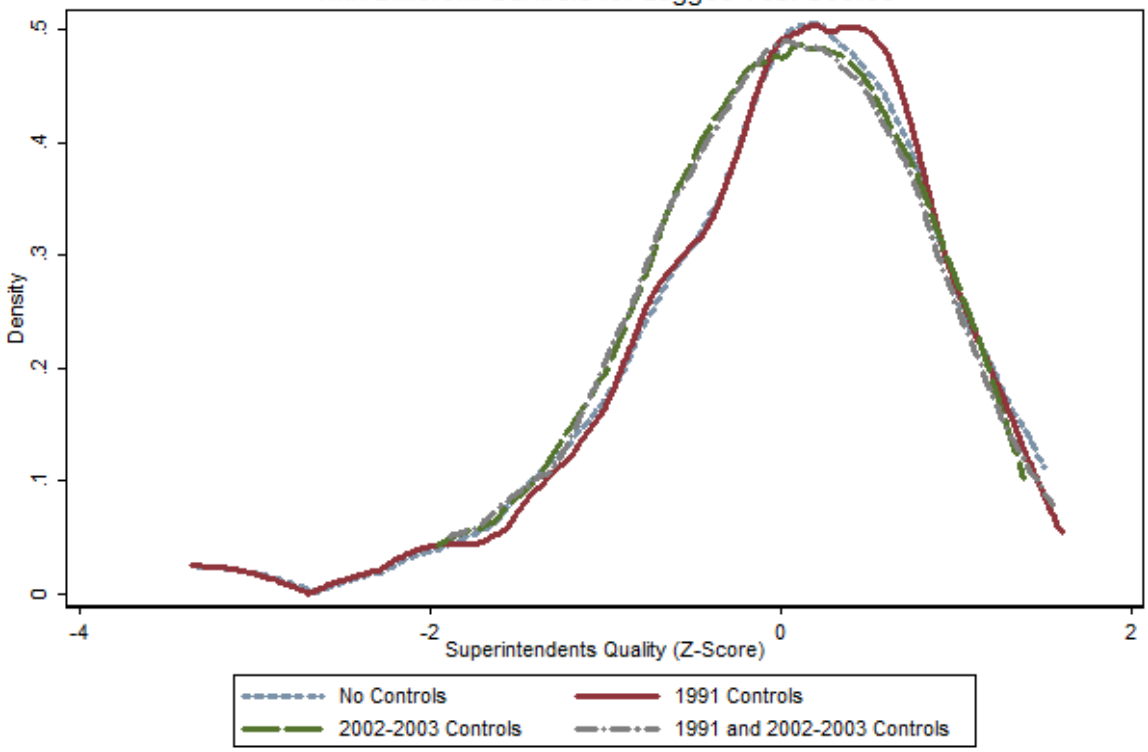
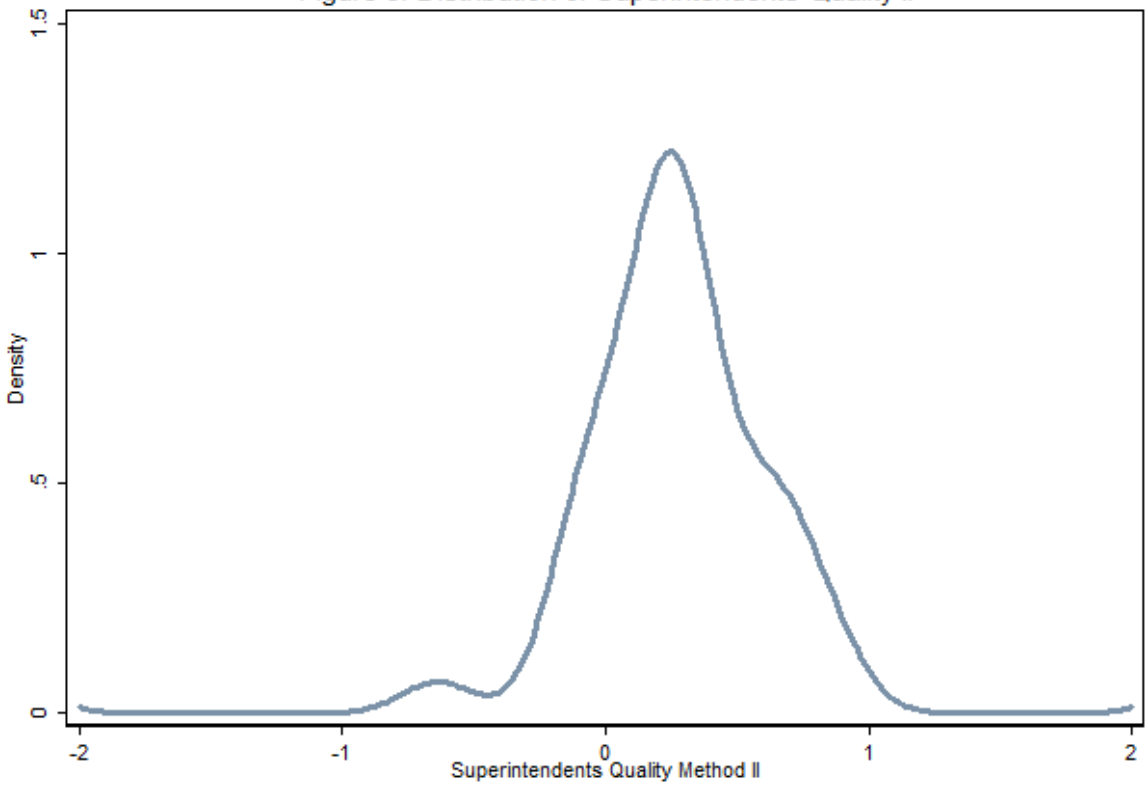
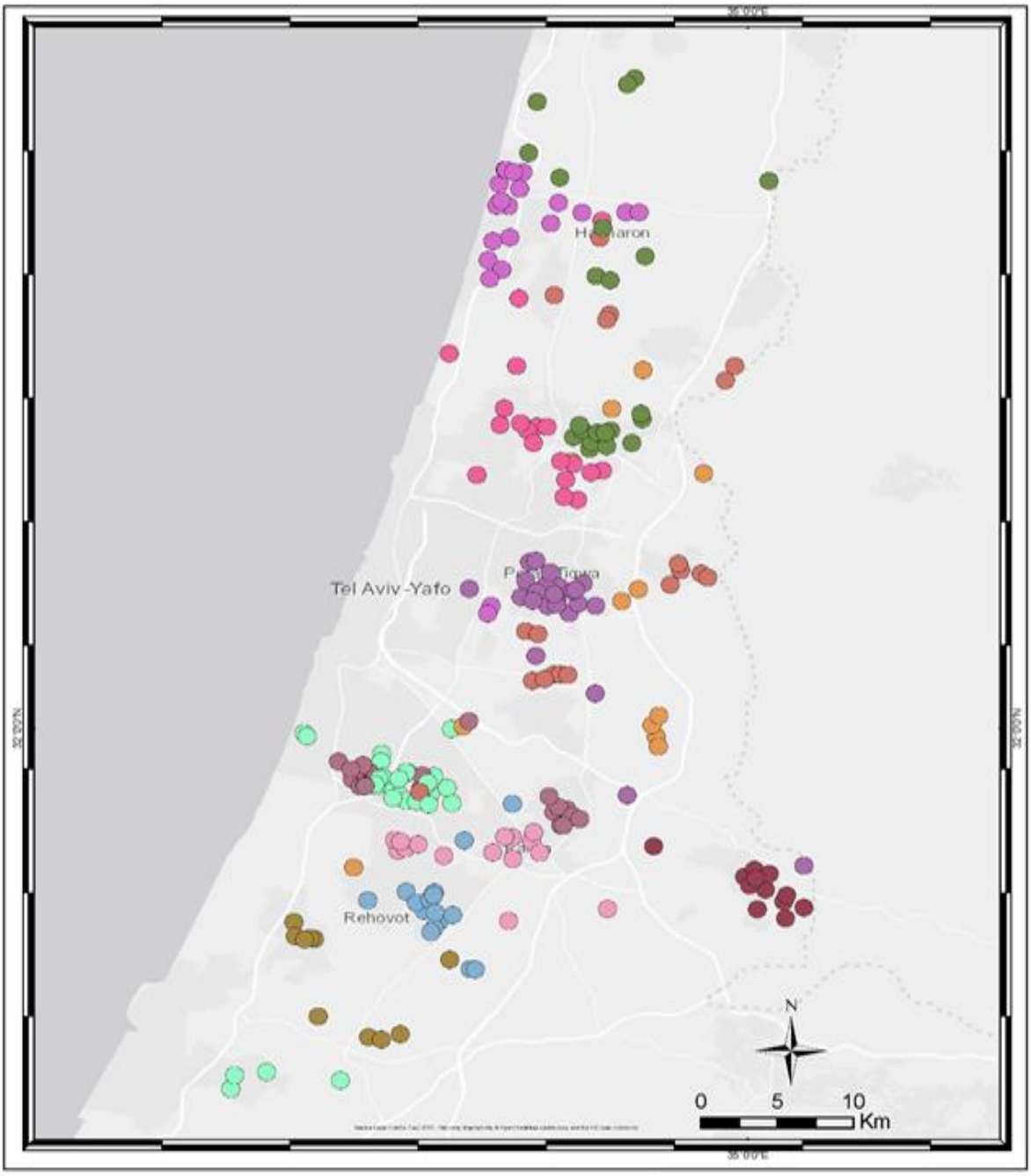



Figure 8: Distribution of Superintendents Quality II



**Map 1: Central District 2005**



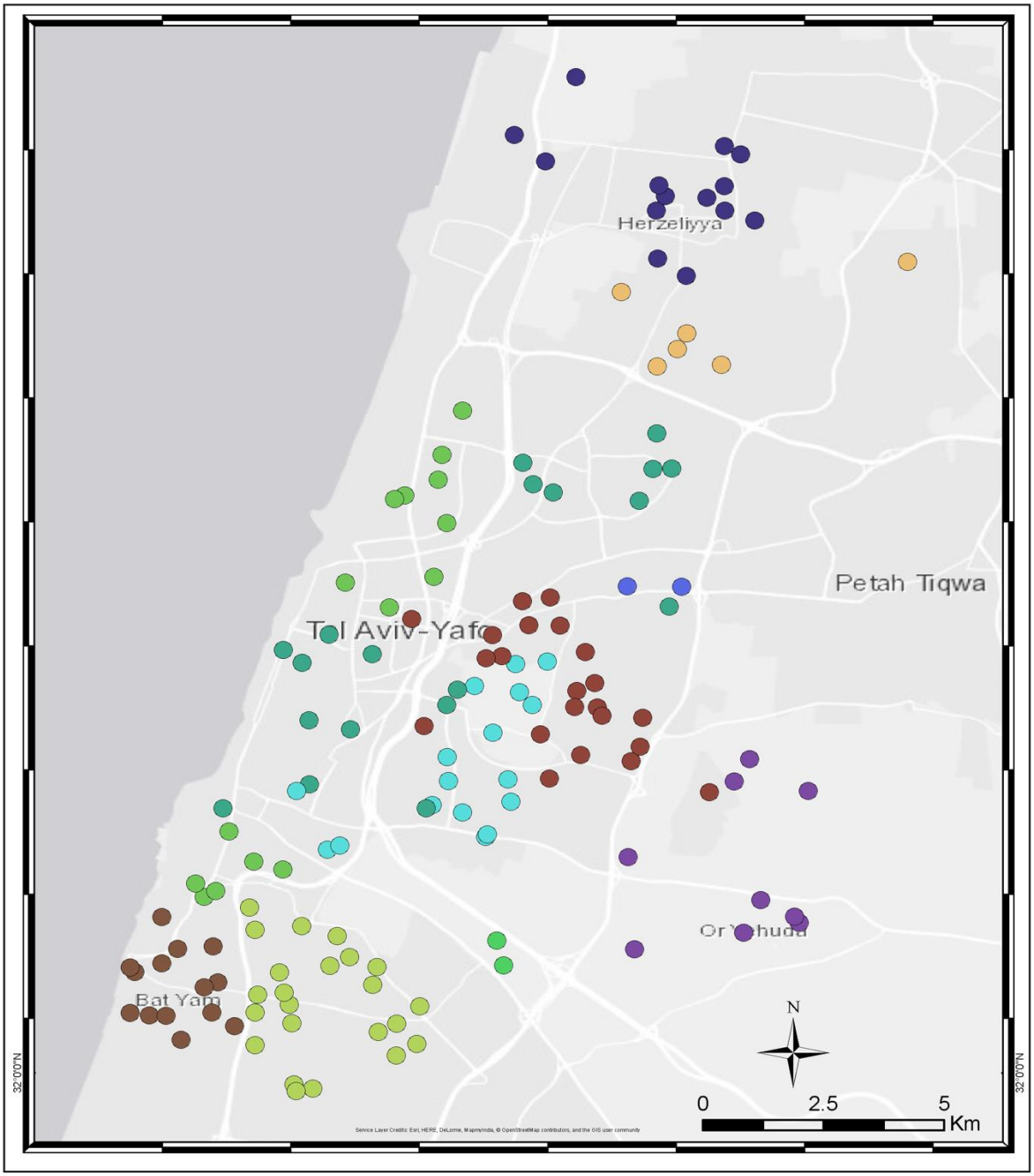

**Superintendents of 2005**

***Center (Merckaz) District***

**Legend**
**Superintendent (Schools Count)**

| | | |
|---|---|---|
| | 29 (16) | 49 (20) |
| 11 (14) | 31 (16) | 60 (28) |
| 14 (23) | 32 (12) | 62 (21) |
| 19 (22) | 44 (24) | 74 (10) |
| | | 76 (20) |

**Map 2: Tel Aviv District 2005**



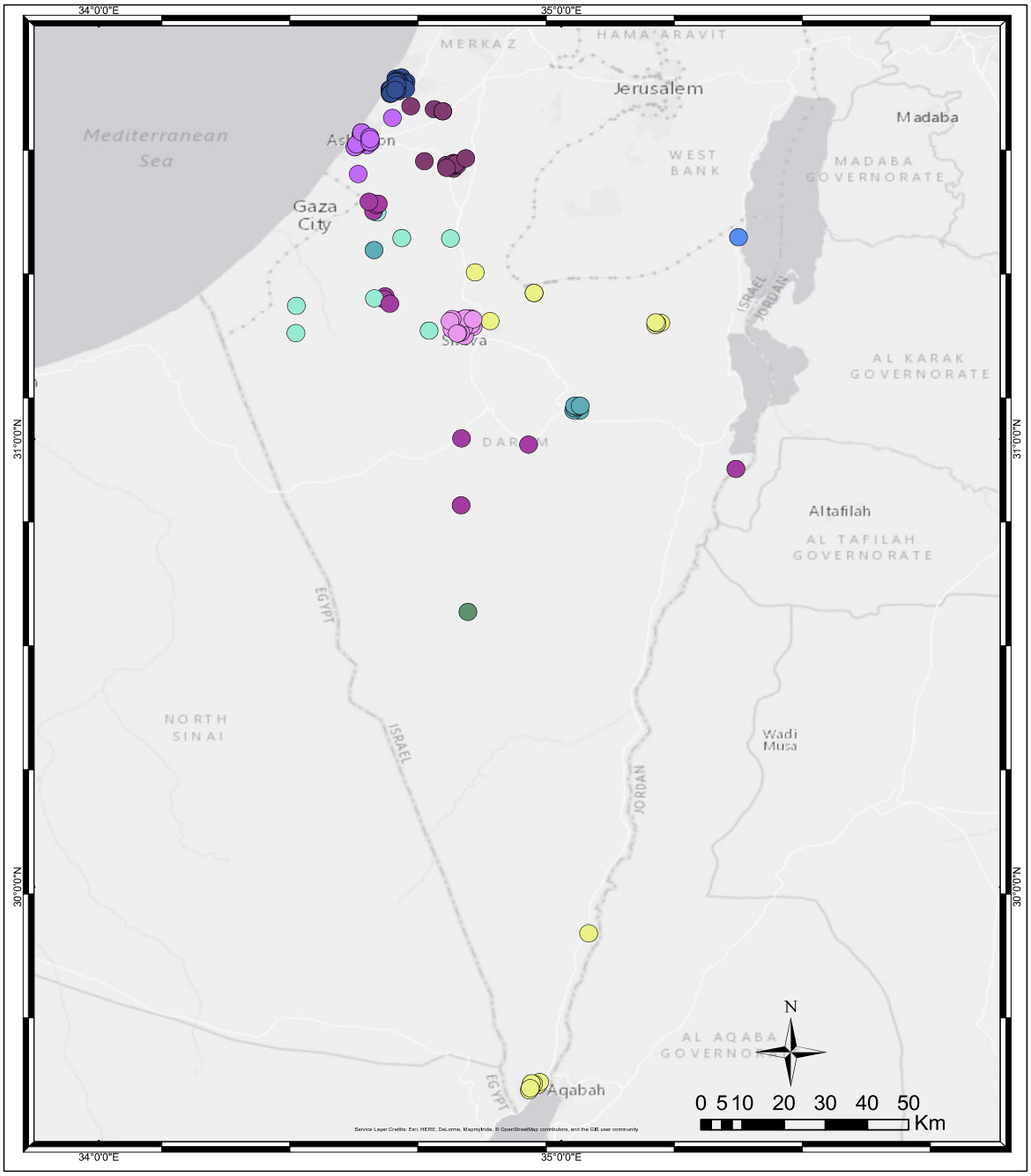

# Superintendents of 2005

***Tel Aviv District***

**Legend**
**Superintendent (Schools Count)**

| | | |
|---|---|---|
| 9 (9) | 45 (2) | 69 (2) |
| 30 (6) | 47 (15) | 70 (22) |
| 33 (23) | 63 (14) | 75 (19) |
| 43 (14) | 66 (17) | |

## Map 3: South District 2005



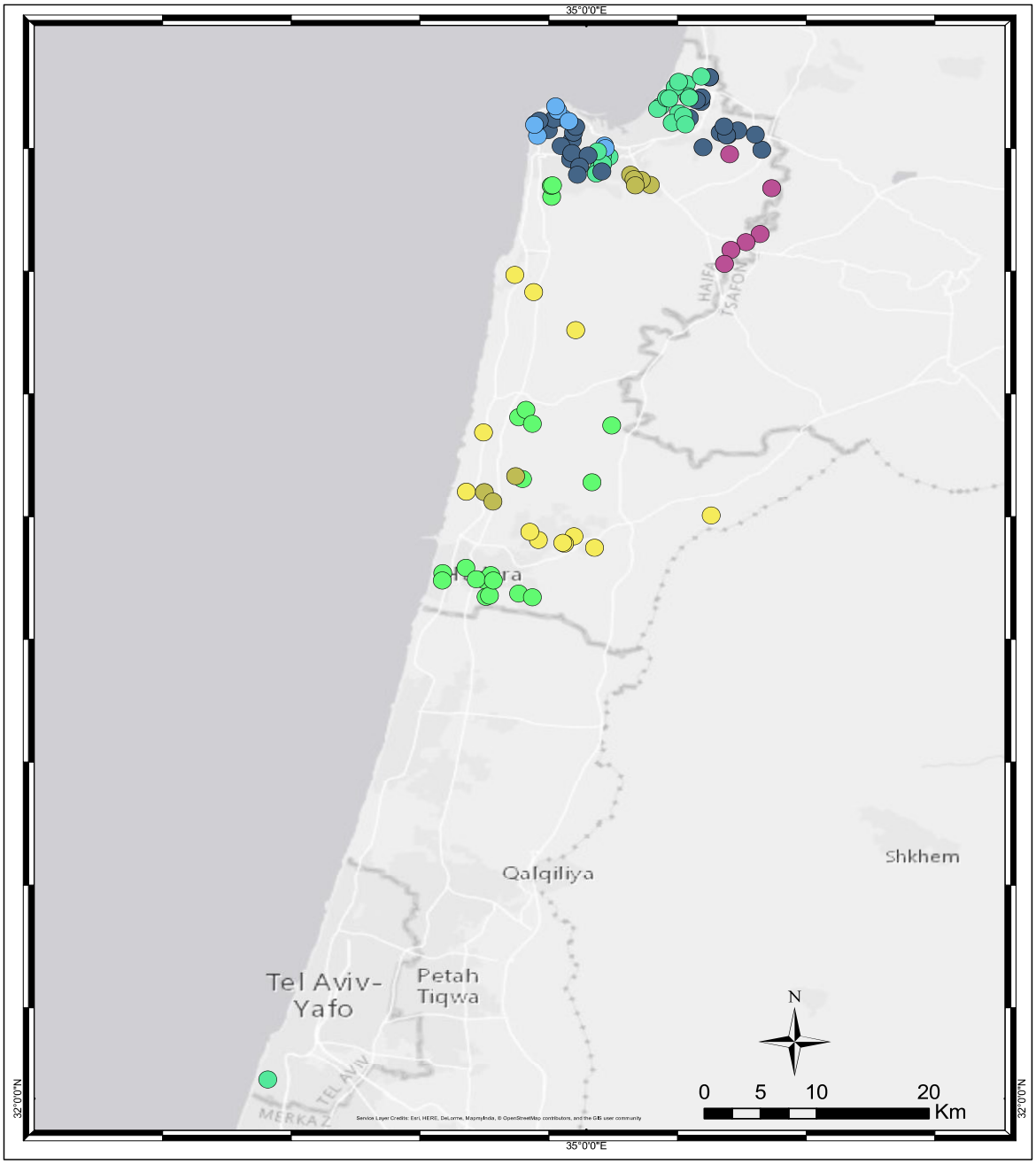

# Superintendents of 2005

## *South District*

**Legend**
**Superintendent (Schools Count)**

| | | |
|---|---|---|
| 7 (22) | 17 (16) | 52 (15) |
| 8 (18) | 26 (28) | 58 (7) |
| 16 (1) | 36 (8) | 67 (12) |
| | | 68 (1) |

## Map 4: Haifa District 2005



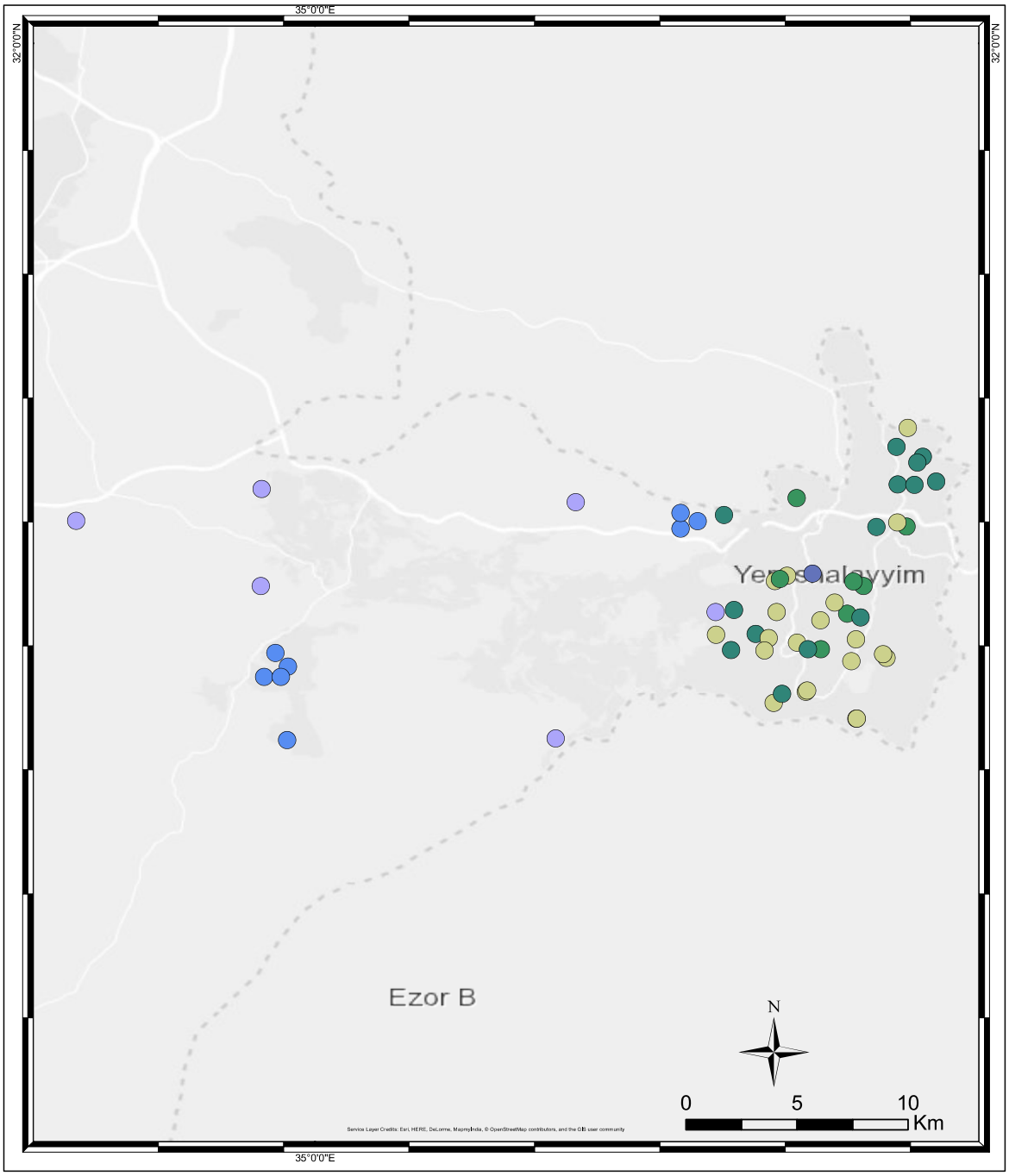

# Superintendents of 2005

## *Haifa District*

**Legend**
**Superintendent (Schools Count)**

- 3 (12)
- 40 (9)
- 42 (27)
- 46 (8)
- 50 (20)
- 55 (21)
- 65 (6)

## Map 5: Jerusalem District 2005



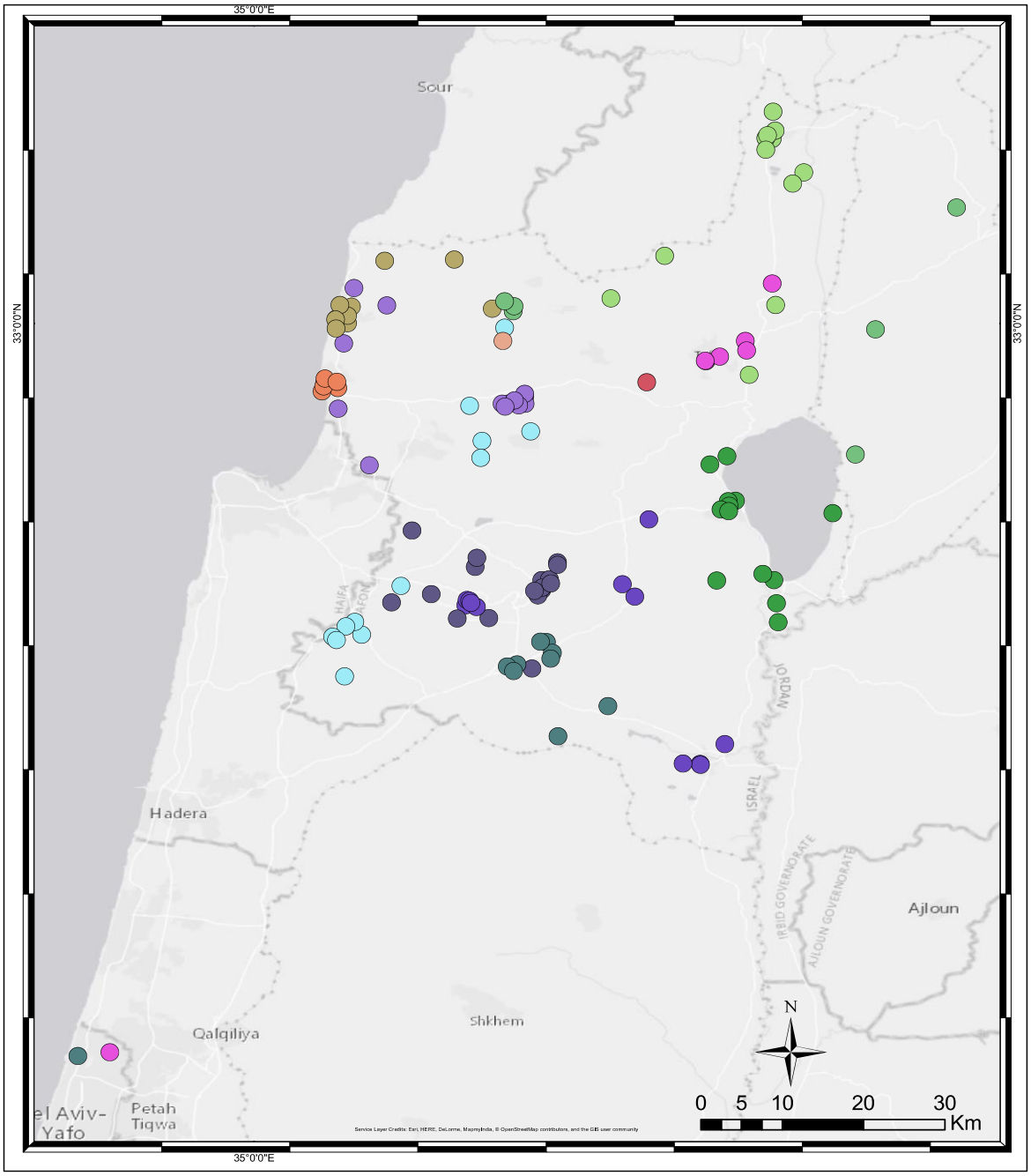

# Superintendents of 2005

## *Jerusalem District*

**Legend**
**Superintendent (Schools Count)**

- 4 (1)
- 21 (1)
- 39 (19)
- 5 (14)
- 34 (6)
- 48 (7)
- 68 (8)

## Map 6: North District 2005




# Superintendents of 2005

*North District*

**Legend**
**Superintendent (Schools Count)**

| | | |
|---|---|---|
| 12 (6) | 22 (13) | 38 (10) |
| 15 (6) | 24 (13) | 54 (7) |
| 18 (10) | 27 (12) | 61 (12) |
| 20 (17) | 28 (1) | 71 (12) |
| | | 72 (1) |