School-Level Budgetary Autonomy and Its Impact on Student Achievement*

I examine a school principals allocation decisions under centralized control and budgetary autonomy. The model shows that universal assignment of autonomy may increase the achievement gap between high and low performing schools by allowing schools with easy to educate students to perform better while increasing the incentive to shirk in schools with difcult to educate students. The results highlight the importance of principal quality and intrinsic motivation. Effective principals who care about student achievement have increased ability to improve student learning in poorly performing schools. Given expanding autonomy, this provides support for policies creating pathways to principalship for quality leaders.

Keywords: Education; K 12; Test Scores; Education Expenditures

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I. Introduction

School administrators are key agents in the daily operation of schools. One of the critical functions they perform is the management of a school's budget. Prior research has shown that time spent managing the budget significantly impacts student achievement (Horng, Klasik, and Loeb 2009). The amount of leeway principals have to make budgetary allocations, however, varies greatly across schools and districts. It is often claimed that public school principals do not have sufficient autonomy to make decisions in the best interest of the students they serve. This can, some believe, explain why public schools have been found to perform worse than private schools (Evans and Schwab 1995; Rouse 1998) and charter schools (Hoxby and Rockoff 2004; Hoxby 2004; Hoxby, Kang, and Murarka 2009). It might also explain why decades of research finds only small educational returns to allocating more resources to the public school sector (Hanushek 2003).

In response to these concerns, education policies are increasingly focused on giving more budgetary authority to principals with the hope of directing resources to their most efficient use. Many school districts in the U.S. that have implemented autonomy programs, including: Cincinnati, Milwaukee, Houston, Seattle, Oakland, Boston, Chicago, Portland, Minneapolis, St. Paul, Prince Williams County (Virginia), Okaloosa (Florida), and Hawaii.[1] The majority of these districts pursue a district-wide approach that increases the autonomy of all schools. Houston, Seattle, Chicago, Portland, Minneapolis, Prince William County, Okaloosa, and Hawaii have all increased autonomy district-wide. An autonomy program in New York City schools, called the Empowerment Schools Program, provides a clear representation of an autonomy program which in-

1. The first school district to implement autonomy was a district in Edmonton, Canada in 1976. The district maintained control of standard setting, but the individual principals made operating decisions. This reform provided a template for several of the U.S. reforms. (Ouchi 2006)

creased the budgetary autonomy of principals and allowed principals to select into the program. This paper examines how the increased freedom to allocate funds coupled with performance incentives for the principal impacts students' test scores. I develop a model of principal decision making to delineate the changing incentives created by budgetary autonomy and illustrate how characteristics of the principal and the students impact the program's effectiveness.

II. Literature review

There is a broad body of research that examines the alternative organizational structures of public institutions and characterizes them by their degree of decentralized decision-making. Inherent in these analyses is an investigation of how agents use private information or behave in self-interested ways that produce suboptimal outcomes. I focus on research that applies these results to the structure of education.

Bishop and Wöβmann (2004) present a simple theoretical model that addresses the importance of institutions in the production of education quality. They aptly direct attention to the fact that, 'it is the institutions of the education system that allocate the rights of decision-making in the system and determine the incentives faced by the actors.'[2] They assume a priori that autonomy has two effects: 1) it increases the informational content of decisions and, as a result, improves the efficiency of resource allocations and 2) it increases the latitude for an educational agent to divert funds from quality producing uses. Bishop and Wöβmann suggest that school-level autonomy on standard setting and testing would lead to the inefficient diversion effect dominating the efficiency achieving information effect. Increased control of process and personnel decisions, however, would lead to the opposite. The model developed in this

2. Bishop and Wöβmann (2004), p. 18.

paper builds on these insights, but does not impose an assumption on which effect will dominate.

The implementation of decentralized decision-making programs varies widely. Some programs devolve decision-making authority from the district level to smaller groups of schools. For example, in 1969 the New York City Schools' Chancellor reorganized the district's elementary and middle schools into 32 community school districts (CSDs).[3] More prevalent, however, are programs that aim to move decision-making authority to the school-level. Within public schools, charter schools provide the maximum amount of school-level autonomy. In addition, there are programs that increase the autonomy of individual schools while the district retains some decision-making control. Many of these programs are classified under the terms Site-Based Management (SBM) or Site-Based Budgeting (SBB).

The specifics of these programs vary greatly. The intended decision-makers are either principals, teachers, and/or parents. Some SBM/SBB programs require schools to set up site-based councils composed of all three types of decision makers. Decentralized decision-making programs, also, differ widely in the scope of autonomy conferred on the decision-maker. For example, some programs grant only budgetary autonomy, while others provide schools the ability to alter the length of the school day, institute different curriculum, or change the textbooks.

Relatively few studies examining school-level autonomy programs, such as SBM/SBB programs, focus on measuring the impact of such programs on student outcomes or resource allocations. Among the studies that analyze programs granting school-level budgetary autonomy, there are two that focus on student outcomes, i.e. Stiefel et al. (2003) and Loeb and Strunk (2007). Stiefel et

3. The history of this reform is discussed briefly in Stiefel et al. (2003), p. 407. High schools remained under centralized control.

al. examines a site-based management program in New York City schools that increased budgetary autonomy. The program was introduced in 1996 under the name Performance Driven Budgeting (PDB). PDB combined budgetary autonomy with performance incentives. Schools that expressed interest and were approved by their CSD superintendent joined the program. They find that the program increased school-level math and English scores in Grade 4 by approximately 0.056 and 0.059 of a standard deviation, respectively. A similar result holds for Grade 5 English scores (0.057). The impact on Grade 5 math scores is not statistically significant.

Loeb and Strunk (2007) examine the impact of autonomy on National Assessment of Educational Progress (NAEP) test scores at the state level, in particular on the percent passing at the Basic Level and the percent passing at the Proficient Level. Their paper does not focus on a particular initiative, but instead traces a general decentralization trend occurring between 1993 and 2000. They use principal's self-reported level of autonomy on the NCES Schools and Staffing Survey. Loeb and Strunk look specifically at the interaction between accountability and a principal's level of budgetary control. They present evidence that principal autonomy is more successful under systems of stronger accountability. Principal control of spending has a statistically significant and negative impact on both percent passing at the Basic and Proficient levels. When principal autonomy, however, is interacted with accountability, the impact is positive and significant.

Since autonomous public schools are intermediate between traditional public schools and charter schools, studies analyzing the impact of charter school attendance on student outcomes provide evidence of the impacts broader autonomy may present. There is now some convincing evidence that charter schools can improve educational outcomes (Hoxby and Rockoff 2004; Hoxby, Kang, Murarka

2009; Angrist et al. 2009). These studies identify the impact of charter school attendance on student test scores by using lotteries in oversubscribed schools. These schools are oversubscribed because parents' demand for them is high. The reduced sample that results, therefore, does not tell us the implications of charter schools for the wider population. This sample identifies effects for students entering better charter schools, i.e. the charter schools most strongly demanded by parents. Clark (2009) uses a regression discontinuity design that does not hinge on lotteries to identify the impact of grant-maintained schools in the UK, a program equivalent to U.S. charter schools, on students' test scores. He finds that grant-maintained schools produce relatively large improvements in student achievement.

Beyond studies that address the impact of autonomous decision making in public schools, there is a growing body of research that analyzes the role of the principal in the production of education (see e.g. Blank 1987; Horng, Kalorgrides, and Loeb 2009; Branch, Hanushek, and Rivkin 2009). While it is difficult to draw general results from this literature, some studies have found that principals that spend time on "organizational management" are associated with better school outcomes (Horng, Klasik, and Loeb 2009). Since organizational management is a category that includes managing the school budget, this provides some support for pursuing a better understanding of the effects of budgetary autonomy.

III. Program specifics

The program used to motivate the model of autonomy in this paper is the Autonomy Zone/Empowerment Schools Program implemented in New York City public schools (NYCPS). Although the practice of increasing autonomy for schools is neither new nor solely practiced in NYCPS, focusing the specifi-

cation on these schools provides a clearly defined program to study.

The Autonomy Zone program began in 2004-2005 school year, as a pilot with 29 schools . The pilot program lasted for two years, with 19 additional schools entering the program in the second year. The Autonomy Zone program was 'designed to give principals a greater degree of autonomy and flexibility in decision-making in exchange for greater accountability regarding student achievement.'[4] By the district's assessment the program was successful and, as a result, the program was expanded under the Empowerment Schools Program (Empowerment Network).[5] In 2006-2007 and 2007-2008, an additional 216[6] and 246[7] schools , respectively, joined the program.

Throughout the evolution of this program, the key component has been increased budgetary and decision-making autonomy for the principals who participate. The principal alone has the ability to apply to join the program. Once the principal decides to apply, he/she submits a contract including performance goals to the district. Following these submissions, the district must approve the participation of the school. The program affected school-level decision making through three channels: 1) increasing the total budget, 2) increasing control of the budget (including the vendors the school can contract with), and 3) performance incentives.

The total budget increased due to the district reallocating monies from the district budget to the school and awarding performance incentives in the form of budgetary increases. Schools gained greater control of their budgets because these new funds as well as previously restricted funds were now discretionary.

4. Autonomy Zone FAQ, 17

5. Empowerment Schools Brochure.

6. The NYCDOE website officially reports 332 schools participated in the first year of the Empowerment Schools program. My count is less than this because I do not include charter schools. Charter schools joined the program to collaborate with public schools about program choices.

7. In 2008, 30 schools joined the program and 11 participating schools returned to district control.

Schools on average gained control of approximately $250,000 more in discretionary funds; or approximately $326 per student.[8] 60% was in the form of additional funds and 40% was newly unrestricted funds that were previously restricted portions of the school's budget. As a percentage of a school's total budget , this increased control of the budget by 2.5%. Schools, of course, allocated these funds in diverse ways. The following shows how two schools chose to use their funds. In School A, with 384 students and $122,000 in additional discretionary spending, they

> implemented new [e]xtra [c]urricular [a]ctivities, including Yearbook and Choir, [p]artially [f]unded two coaches to provide professional development to teachers to increase instruction quality, and allocated money toward parent outreach programs.

In School B, with 1,383 students and $228,000 in additional discretionary spending, they

> hired: 1 new teacher and 1 new paraprofessional, started a drama program, and focused on professional development for math teachers to increase the quality of math instruction received by students.

While the increase in per student funding and the school's unrestricted budget is moderate, the greatest expansion in a principal's budgetary autonomy followed from an increased procurement cap and the ability to purchase inputs from non-contracted vendors. The program doubled the procurement cap for expenditures without district approval from $2,500 to $5,000. Schools gained the ability to buy services from vendors not contracted with the district for up to $25,000.

8. The per student increase was determined by dividing $250,000 by the average number of students in a school (766).

The budgetary reward was tied to improvement in student achievement. 'Schools that receive an A on their progress reports and +(well-developed) or π (proficient) on their quality review will be eligible for rewards and recognitions, including extra funding.'[9] The grade a school receives on their Progress Report Card is determined in part by an increase in student achievement above the previous year. All schools in the district receive a Progress Report Card, but only autonomous schools are eligible for a budgetary reward as a result. The budgetary reward is received in the year following the school's performance. This characteristic of the program, therefore, not only increased the level of discretionary funds, but also strengthened the alignment between the principal's incentives and student achievement.

For a school to earn an A on their Progress Report, the raw score they are assigned must increase by a specified amount over last year's raw score. The size of this required improvement is dependent on the current percentile rank of the school in terms of student achievement and the composition of the student body. In this way, the district is attempting to not unduly penalize schools that, for instance, already have a high percentile rank and are not likely to make large gains, as well as schools with more difficult to educate student populations. These required gains are aligned with the conditions required to achieve Adequate Yearly Progress . A school's score on the Progress Report Card is comprised of ratings of the school environment (15%), student performance on standardized exams (25%), and "student progress" (60%).

The model simplifies this setting by modeling the budgetary rewards as tied directly to the average gains in standardized test scores. Since this accounts for 60% of the Progress Report Score in middle and elementary schools, this simplification should still provide a reasonable approximation of the incentives

9. Autonomy Zone FAQ.

faced by a principal.

Finally, principals also agreed to sharper personal incentives tied to the school's performance on the Progress Report. Principals who failed to meet the expected gains in scores faced consequences as a result. The possible consequences ranged from district interventions to leadership changes and school closure. 'The accountability agreements lay out sanctions – including removal – that can be levied against principals who fail to perform.'[10] The district meted out punishments particularly for schools in the program that receive a grade of D or F on their progress report or a grade of C in three consecutive years. The consequences of poor performance may also be in the form of decreased professional status leading to less desirable career advancement. Conversely, meeting the expected gains may allow principals to signal their ability and result in more rapid promotion.[11]

IV. Theoretical framework

In this section, I develop a model of principal decision making in a public school. By varying the latitude a principal has to control expenditure allocations, I illustrate the effects of autonomy in public schools.

Consider a model in which the principal of the school is the sole decision maker. The principal seeks to maximize her own utility. All school principals share the same underlying, increasing, twice differentiable, and concave utility function $U(w, R, Q, C(e))$, parameterized by principal characteristics. Public school principals are motivated by a combination of pecuniary and non-pecuniary benefits. They care directly about the wage they earn w, a generalized concept of economic rents R, the quality of education Q, and the cost of

10. Let Principals Lead, New York Times, July 14, 2006, accessed through Lexis Nexis.
11. See Cullen and Mazzeo (2007) for an analysis of internal principal labor markets.

their effort $C(e)$.

It is assumed throughout that the wage rate w is high enough that the principal's participation constraint never binds. This simplifying assumption allows the analysis to focus on how principals allocate their available resources and the subsequent impact on student achievement.

Principals differ along two dimensions: personal characteristics and the student composition of the schools they serve. Personal characteristics include their effectiveness k and their tastes for rents and quality. The student populations of each school are composed of two types of students $i = 1, 2$. Each student type is typified by two parameters: the variance of their test scores σ_i and their test-taking effectiveness I_i. I define type 1 students as high effectiveness and type 2 students as low effectiveness. Each school is composed of n_1 type 1 students and n_2 type 2 students. The number of each type n_i is fixed within a school. Therefore, the total number of students served by a school is $N = n_1 + n_2$.

An individual student's score is determined by the following Cobb-Douglas production function

$$s_{ij}(x_i, e_i) = kI_i e_i^{\beta} x_i^{\alpha} + \epsilon_{ij} \quad for \quad \alpha, \beta > 0, i = 1, 2 \quad and \quad j = 1, ..., n_i \qquad (1)$$

where x_i and e_i denote per student expenditures and principal effort directed toward type i, respectively. The form of Equation **??** has the desirable feature that expenditures and effort are complementary. Principals effort can be thought of as a principals time spent developing programs, providing instructional support, managing the staff and budget, and/or performing other administrative functions, such as discipline. The production function is assumed to exhibit nonincreasing returns to scale in inputs, $\alpha + \beta \leq 1$. To capture the differing test-taking ability of student types, the student-level effectiveness parameter (I) varies across types. I_i captures both a types endowed ability and their stock of

prior knowledge that contributes to test-taking ability. Since type 1's are the high effectiveness type, $I_1 > I_2$. The randomness of an individual students test score is captured by ϵ_{ij} where

$$\epsilon_{ij} \sim N(0, \sigma_i) \quad i = 1, 2. \tag{2}$$

ϵ_{ij} captures random individual performance and unobserved variation in test-taking ability within types. The random component can also reflect variation in test precision. The principal knows the distribution of the error terms, but cannot affect the distributions.

The quality of education is measured as the gain in average test scores above the exogenous target level score set by the district. Therefore, school quality is measured as

$$Q = (\sum_{i=1}^{2} \sum_{j=1}^{n_i} s_{ij})/N - \bar{G} \tag{3}$$

where $\bar{G}$ represents the target score.

The random component of student test scores causes the principal to face uncertainty tied to a school's average test scores. To account for risk bearing, principals have constant absolute risk-averse (CARA) preferences represented by a negative exponential utility function of the following generic form

$$U(w, R, Q, C(e)) = -exp(-\eta[w + \phi R + \theta Q - C(e)]) \tag{4}$$

where $\eta > 0$ is the constant coefficient of absolute risk aversion, ϕ is the strength of the principal's preference for rents, and θ is the strength of the principal's preference for quality. Since the principal knows only the distribution of potential gains, the principal maximizes her expected utility. Maximizing expected utility is equivalent to maximizing the principal's certainty equivalent. Due to

the specification of the utility function and the normal distribution of the errors, the resulting certainty equivalent is of a simple, additive form. The certainty equivalent is the minimum/nonrandom level of utility the principal would accept rather than facing an uncertain payoff as a result of testing performance randomness. The certainty equivalent will be less than expected utility given the uncertainty. Given that wages enter as an additive constant and the participation constraint does not bind, the principals utility maximization can be reduced to maximizing

$$E[U(R,Q,C(e)) = -exp(-\eta[\phi R + \theta Q - C(e)])]. \tag{5}$$

IV.A District Control

In most districts, expenditures are largely controlled by the district. To illustrate this status quo, I assume the district mandates all expenditure decisions and no rents can arise. The principal maintains the ability to select her preferred levels of targeted efforts given the mandated expenditure allocations. These effort allocations are not observable to the district. I assume that the district cares about maximizing educational quality, but requires expenditure equalization across types due to equity concerns. Quality maximization subject to the equity constraint then implies a balanced budget with $x_1 = x_2 = Z$ and $n_1 x_1 + n_2 x_2 = NZ$, where Z is an exogenous amount of per pupil funding. Given these fixed allocations, the principal then proceeds to set targeted effort levels that maximize her utility. Since the centralized setting leaves the principal with zero rents, the principals utility function reduces to

$$U_c(Q,P) = -exp[-\eta(\theta Q - C(e))] \tag{6}$$

where C(e) is the disutility of her effort vector $e(e_1, e_2)$. The effort cost function is defined as

$$C(e) = n_1 e_1 + n_2 e_2. \tag{7}$$

Although exerting effort is privately costly for the principal, increased effort increases the productivity of expenditures and benefits the principal through her preference for quality. The principal therefore maximizes the following certainty equivalent when the school is centralized

$$\theta(\sum_{i=1}^{2} \frac{n_i}{N} k I_i e_i^{\beta} Z^{\alpha} - \bar{G}) - C(e) - \frac{1}{2N^2}\eta\theta^2(n_1\sigma_1^2 + n_2\sigma_2^2) \tag{8}$$

by choosing her targeted efforts . Her choice of effort does not impact the uncertainty costs she faces, which are given by the last term in Equation **??**.

IV.B Autonomy

The principal can choose to select autonomy to gain control of the assignment of expenditures in her school. If the principal selects autonomy, then her utility function is given by

$$U_A(R, Q, C(e)) = -exp[-\eta(\phi R + \theta Q - C(e))]. \tag{9}$$

As in the district control setting, the principal still cares about the quality of education measured by Q and faces the same cost of effort function ($C(e)$). The principal is not subject to the equity or balanced budget constraints imposed by the district. This allows principals the opportunity to consume some of the budget as generalized rents (R). The concept of generalized rents captures the ability of the principal to allocate their budget in ways that do not produce student test scores. For instance, a principal may have a preference for music education and therefore spend more funds hiring music teachers, buying instru-

ments, and/or relevant course material. By definition, these are not allocated in a way that increases student test scores, and therefore, do not impact school quality. Under autonomy, the principal is given a budgetary reward (B) for gains in test-scores in addition to the standard funding NZ. The reward is dependent upon the size of the gain in scores and flows directly into the rents she enjoys. Further, the reward is assumed to be

$$B(Q) = cQ \tag{10}$$

where c is a coefficient set by the district that monetizes school quality (Q). The reward is not received by the principal until the scores have been realized. The principal is therefore constrained by the following budget constraint

$$n_1 x_1 + n_2 x_2 \leq NZ. \tag{11}$$

This implies that the total budgetary reward is consumed. The principal's generalized rents (R) are the total current budget funds not assigned to the production of students test scores. Under autonomy, the principal maximizes the following certainty equivalent

$$\phi(NZ - \sum_{i=1}^{2} n_i x_i) + (c+\theta)(\sum_{i=1}^{2}[\frac{n_i}{N} k I_i e_i^{\beta} x_i^{\alpha}] - \bar{G}) - C(e) - \frac{1}{2N^2}\eta(c+\theta)^2(n_1\sigma_1^2 + n_2\sigma_2^2) \tag{12}$$

by choosing efforts and expenditures subject to Constraint **??**. As with district control, the principal's allocation decisions do not impact the uncertainty costs they bear. The uncertainty costs under autonomy, the last term of Equation **??**, will exceed those under centralized control due to the increased weight placed on them by the budgetary reward.

IV.C Selection

Principals were given the freedom to select autonomy or remain under district control. A principal will choose autonomy if the maximized value of her certainty equivalent under autonomy (V^{A*}) exceeds the maximized value of her certainty equivalent under district control (V^{C*}). The full effect of the autonomy program will therefore include the selection and the allocation of resources effects.

Target test scores are set by the district to encourage schools to perform at their optimum. Each school's target reflects the student population and the previous test score. To capture this attribute of the program, the target test score is equivalent to the maximized value of the average test score under centralized control. Since all schools were operating under centralized control prior to the introduction of the program, this is a reasonable estimate of the target score the district would set.

Schools select autonomy if

$$\phi R^{A*} + (c+\theta)(S^{A*} - S^{C*}) - C(e^{A*}) - UC^{A} > -C(e^{C*}) - UC^{C}. \qquad (13)$$

There are two types of schools that become autonomous; those that consume some generalized rents and those that do not. Since $UC^{A} > UC^{C}$, not all schools will select the program. For instance, schools that optimally consume no rents and have very small test score gains may find it optimal to not select into the program. The succeeding section discusses these difference between these schools.

IV.C.1 Autonomy: Rents or no rents?

Under autonomy schools have the option of consuming generalized rents or directing expenditures toward student learning. The following condition determines whether a school will choose to exhaust their budget to improve student test scores

$$\lambda = -\phi + [(c+\theta)k\beta^{\beta}(n_1 I_1^{\frac{1}{1-\alpha-\beta}} + n_2 I_2^{\frac{1}{1-\alpha-\beta}})^{(1-\alpha-\beta)}/N^{(2-\alpha-\beta)}]^{\frac{1}{1-\beta}} > 0. \quad (14)$$

Condition **??** yields a few direct implications. First, this condition highlights the tradeoff between generalized rent consumption and the expected test score gains. If a principal does not care about rents $\phi = 0$, then the principal will spend all of the budget and no generalized rents will be consumed. Assuming $\phi > 0$ for at least some schools in the district, **??** illustrates that better principals, smaller schools, and schools with relatively more type 1 students are less likely to consume rents. Smaller schools are less likely to consume rents because each student has a larger marginal impact on their average score. I use the term better in reference to principals that are more effective, more career-oriented, and more concerned with school quality, i.e. principals with higher values of k and θ. The empirically relevant case is for type 2 students to be a majority. Condition **??** further suggests that the larger the majority of type 2s the more likely it is that a school will be induced to consume generalized rents. This is because it is more costly to increase scores for weaker students.

Empirical evidence on principal sorting within a district has shown that principal experience and credentials, two components of effectiveness, are inversely related to school size and the proportion of type 2 students (Branch, Hanushek, and Rivkin (2009) and Horng, Kalogrides, and Loeb (2010)). This suggests that the parameters that push a principal toward consuming rents are

positively correlated. As a result, **??** illustrates that given autonomy, the already high performing schools are more likely to exhaust their budgets on test performance improvement than the low performing schools.

To simplify the succeeding discussion of results, I define two groups of schools based on condition **??**. Group 1 is characterized by high effectiveness principals, relatively more high effectiveness students, and small school size. Group 1 schools optimally choose not to consume any generalized rents. Group 2, therefore, is composed of schools with low effectiveness principals, more low test-effectiveness students, and a large school size. For the remaining analysis, I address the empirically relevant case where type 1 students are the smaller student group, i.e. $\frac{n_1}{n_2} < 1$.

IV.C.2 The selection decision for non-rent consuming schools

. For group 1 schools, their selection condition reduces to a comparison of expected average test scores under each regime and the increased uncertainty cost. Group 1 schools face this simplified condition because they optimally choose to consume no rents. The selection condition for group 1 schools can be written as

$$(1-\beta)(c+\theta)(S^{A,1*} - S^{C*}) - \beta c S^{C*} > c(2\theta + c)\frac{1}{2N^2}\eta(n_1\sigma_1^2 + n_2\sigma_2^2) \quad (15)$$

where $S^{A,1*}$ and S^{C*} are a schools expected average test score given group 1 autonomy and centralized control, respectively. Due to the increased flexibility granted under autonomy and the sharper incentives (and the budgetary exhaustion), the schools average test score will necessarily be higher than under centralized control. Since a principal still faces the added impact of the uncertainty cost and a principal's effort costs are lower under centralized control ($-\beta c S^{C*}$), the gains in average test scores must be large enough to cover the

increased cost. The impact of each parameter on a group 1 principal's propensity to select autonomy is summarized in Table **??**. Table **??** tracks the role of each parameter in the tradeoffs the principal faces. Column 1 reports the impact on the test score difference. The value of the test score difference is $(c+\theta)(S^{A,1*} - S^{C*})$.

Column 2 reports the parameters impact on the cost of effort difference $(-\beta c S^{C*})$. I examine the negative of this difference so that a plus sign means autonomy is more likely to be selected. Column 3 reports the difference in the uncertainty costs between regimes. These costs are weighted by the relevant taste parameters. This difference is expressed on the right hand side of **??**.

The group 1 schools with the highest propensity to select autonomy will have low values of risk aversion. A principals risk aversion interacts with the uncertainty costs they face and uncertainty costs will always be greater under autonomy. A principals preference for rents does not impact their propensity to select autonomy conditional on a school being in group 1. A principal's effectiveness (k) increases the likelihood she will join the autonomy program. All other parameters have an indeterminate effects on selection. As Table **??** shows this is the result of the countervailing incentives created by their impact on test scores and the uncertainty costs.

TABLE I: Characteristic effects on autonomy decision: Non-rent consuming schools

	Value of test score	-Cost of effort	-Uncertainty cost	Propensity to select autonomy	Average score impact
Risk aversion, η	no effect	no effect	-	-	no effect
Principal effectiveness, k	+	-	no effect	+	+
Taste for rents, ϕ	no effect	no effect	no effect	no effect	no effect
Taste for quality, θ	+	-	-	indeterminate	+
School size, N	-	+	+	indeterminate	+
Type ratio, n_1/n_2[1]	+	-	+/no effect[2]	indeterminate	+

Notes: The table indicates the overall impact of each parameter on components of the autonomy decision, the overall decision, and the impact on test scores conditional on autonomy being selected. For group 1 schools, the principal compares three factors across regimes to make their decision: (1) the value of the difference between student achievement, (2) the difference between effort costs, and (3) the difference in uncertainty costs. A + indicates that increasing the parameter positively effects that component. All impacts, including test score impacts, are made in comparison to the status quo, centralized control. For instance, the effect of taste for quality on the cost of effort difference comes from signing the comparative static $\partial(C(e^{A,1*}) - C(e^{C*}))/\partial\theta$.

1. It is assumed that $n_1/n_2 < 1$.

2. This result hinges on the assumption that the standard deviation of type 1 student's test scores is less than or equal to that of type 2 students. If the standard deviation of the type's test scores are symmetric, then the ratio of student's has no effect.

IV.C.3 The selection decision for rent consuming schools

. In group 2 schools, a principal chooses to consume generalized rents from the current budget. Group 2 schools, again, are characterized as having low principal effectiveness, large numbers of students, and a strong majority of the lower test-effectiveness type. These schools' selection decision can be reduced to the following tradeoffs

$$\phi(NZ-(c+\theta)S^{A,2*})+(1-\beta)(c+\theta)(S^{A,2*}-S^{C*})-c\beta S^{C*} > c(2\theta+c)\frac{1}{2N^2}\eta(n_1\sigma_1^2+n_2\sigma_2^2). \tag{16}$$

The individual components of a group 2 principal's selection decision are: rents, the value of test scores, cost of effort, and uncertainty cost. The relative uncertainty costs group 2 schools face are the same as those faced by group 1 schools. Group 2 schools, however, tend to be larger. The uncertainty costs, therefore, are likely lower for these schools. This makes it more likely that a group 2 schools would select autonomy.

For group 2 schools, the impact of all characteristics except risk aversion on the propensity to select autonomy is indeterminate. The results are summarized in Table **??**. The indeterminacy is the result of the increased tradeoffs that are available. Under autonomy with rents, the principal can choose to consume a little generalized rents and still increase test scores or they can choose to consume a larger amount of rents to the detriment of test scores. The increased flexibility allows the principal to use characteristics other than risk aversion to support either goal.

TABLE II: Characteristic effects on autonomy decision: Rent consuming schools

	Rents	Value of test score	-Cost of effort	-Uncertainty cost	Propensity to select autonomy	Average score impact
Risk aversion, η	no effect	no effect	no effect	-	-	no effect
Principal effectiveness, k	-	indeterminate	+	no effect	indeterminate	indeterminate
Taste for rents, ϕ	+	-	no effect	no effect	indeterminate	-
Taste for quality, θ	-	indeterminate	+	-	indeterminate	indeterminate
School size, N	+	indeterminate	indeterminate	-	indeterminate	indeterminate
Type ratio, n_1/n_2[1]	+	indeterminate	indeterminate	+/no effect[2]	indeterminate	indeterminate

Notes: The table indicates the overall impact of each parameter on components of the autonomy decision, the overall decision, and the impact on test scores conditional on autonomy being selected. For group 1 schools, the principal compares three factors across regimes to make their decision: (1) the value of the difference between student achievement, (2) the difference between effort costs, and (3) the difference in uncertainty costs. A + indicates that increasing the parameter positively effects that component. All impacts, including test score impacts, are made in comparison to the status quo, centralized control. For instance, the effect of taste for quality on the cost of effort difference comes from signing the comparative static $\partial(C(e^{A,1*}) - C(e^{C*}))/\partial\theta$.

1. It is assumed that $n_1/n_2 < 1$.

2. This result hinges on the assumption that the standard deviation of type 1 student's test scores is less than or equal to that of type 2 students. If the standard deviation of the type's test scores are symmetric, then the ratio of student's has no effect.

IV.D The Impact of Autonomy on Test Scores

A central intention of this research is to understand how autonomy impacts student performance. I begin by examining the impact on school-level test scores. For group 1 schools, expected average test scores necessarily increase given autonomy, $S^{A,1*} > S^{C*}$. For group 1 schools who select autonomy, the expected average test scores must increase by a sufficient margin to cover uncertainty costs and increased sensitivity to the target score. The following comparative statics results suggest how these gains are impacted by principal and student characteristics. Increases in all characteristics except risk aversion increase the expected average score for group 1 principals who choose autonomy. Autonomy simply allows the principal to more effectively incorporate characteristics into their allocation decisions . Therefore, in comparison to centralized control increasing the value of student and principal characteristics has a larger, positive impact on student test scores. These results are summarized in Table II.

The expected average score impacts for group 2 schools' characteristics are more complex relative to those for group 1 due to the increased tradeoffs. Test score impacts depend largely on the relationship between the budgetary reward, a principal's taste for student performance (θ), the value of the output elasticity of expenditures, and the gains from the complementarity of expenditures and efforts that are possible under autonomy. If $\phi Z^{\frac{1-\alpha-\beta}{1-\beta}} < \alpha(c+\theta)$, then a school's average test score under autonomy will be greater than its scores given centralized control. This is a sufficient condition for test score improvement, but it highlights some of the important tradeoffs occurring for the principal. The output elasticity of expenditures has a direct effect by raising the marginal impact of assigning funds to test score improvement and an indirect effect through the complementarity of efforts and expenditures. The complementarity is evident in

the power governing the impact of per-student expenditure. When α is low, i.e. when expenditures do not matter much for student outcomes, this condition is less likely to hold. A small β, or when efforts don't matter much, will also cause this condition to be less likely to hold. Therefore, if the principal's choices cannot affect average scores very much the incentives put in place by autonomy will push them to consume generalized rents at the expense of student test scores. If a district pursues universal assignment of autonomy this will increase the gap between high and low performing schools.

Similar to group 1 schools, a principals risk aversion has no impact on student test scores. Increases in ϕ will decrease any potential average score gains and increase the magnitude of potential average score decreases. All other characteristics have indeterminate effects of test scores.

Autonomy allows the principal to better utilize their own preferences and characteristics, as well as the characteristics of the student body they serve. This can benefit students when the incentives are such that student achievement is valued more highly than generalized rents. If, however, the incentives tied to test scores are not sufficiently strong the principal may choose to use the latitude for their personal benefit. In other words, how the principal values their own gains relative to those of students greatly impacts the success of such a program.

Schools that have smaller student populations, more effective principals, and principals who care more about their students will be likely to select autonomy without consuming generalized rents. Group 1 schools will always improve the expected school-level test score and the test score expected for the more able student type. Therefore, it is likely that schools that already have high-levels of student achievement will further improve their test-scores. In schools with large student populations and/or more difficult to educate student bodies, this model points out the importance of a principal's intrinsic values for student

achievement and rents. Principals who care about students have the potential to improve student achievement. The success of such programs depends on how well districts understand the impact of student and principal characteristics.

V. Conclusion

The model focuses on the importance of budgetary allocation in schools, particularly in situations where the school principal has significant control of their budget. Horng, Klasik, and Loeb (2009) found that principals that spend time on "organizational management" are associated with better school outcomes. By focusing on the role of the principal in both program selection and assignment of school resources, this model highlights factors that will impact student achievement. The model shows that universal assignment of autonomy has the potential to increase the student achievement gap between high and low performing schools by allowing schools with predominately easy to educate students to perform better while increasing the incentive to shirk in schools with difficult to educate students. The results also highlight the importance of principal quality and intrinsic motivation. Under autonomy, effective principals who care about student achievement have increased ability to improve student learning in poorly performing schools. Given expanding school-level autonomy, the analysis provides support for policies that provide better pathways to principalship for quality leaders.

Additionally the model helps to focus attention on the importance of selection for empirical investigation and identifies a potentially useful strategy to deal with it. A possible area to search for instrumental variables may be to utilize a proxy for their level of risk aversion. Future research should focus on estimating the causual impact of autonomy on student achievement.

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