Annual Review of Economics

Is Education Consumption or Investment? Implications for School Competition

W. Bentley MacLeod[1,2] and Miguel Urquiola[1,2]

[1]Department of Economics, Columbia University, New York, NY 10027, USA;
email: bentley.macleod@columbia.edu, msu2101@columbia.edu

[2]National Bureau of Economic Research, Cambridge, Massachusetts 02138, USA

Annu. Rev. Econ. 2019. 11:563–89

First published as a Review in Advance on May 28, 2019

The *Annual Review of Economics* is online at economics.annualreviews.org

https://doi.org/10.1146/annurev-economics-080218-030402

JEL codes: J3, J4, I2, L1

Keywords

school choice, competition, value added

Abstract

Milton Friedman argued that giving parents freedom to choose schools would improve education. His argument was simple and compelling because it extended results from markets for consumer goods to education. We review the evidence, which yields surprisingly mixed results on Friedman's prediction. A key reason is that households often seem to choose schools based on their absolute achievement rather than their value added. We show that this can be rational in a model based on three ingredients that economists have highlighted since Friedman worked on the issue. First, education is an investment into human capital. Second, labor markets can feature wage premia: Individuals of a given skill level may receive higher wages if they match to more productive firms. Third, distance influences school choice and the placements that schools produce. These factors imply that choice alone is too crude a mechanism to ensure the effective provision of schooling.

1. INTRODUCTION

Friedman (1955) argued that giving parents freedom to choose schools would improve education. His argument was simple and compelling because it extended results from markets for consumer goods to education. Empirical work has produced surprisingly mixed results on Friedman's prediction. For example, voucher experiments suggest that choice can have highly positive (Bettinger et al. 2017), highly negative (Abdulkadiroglu et al. 2018), or modest effects (Muralidharan & Sundararaman 2015). Considering analogous evidence, Beuermann & Jackson (2018, p. 1) observe that "the lack of robust achievement effects of attending schools that parents prefer is something of a puzzle."

This article reviews the evidence, pointing out that a key factor behind this puzzle is that households often seem to choose schools based on their absolute achievement rather than their value added, in other words, based on how good their students' skills are, as opposed to how good they are at improving their students' skills.

This review also offers an explanation for this behavior, one based on three ingredients that labor and education economists have highlighted since Friedman wrote on the issue. First, in large part, education is an investment into human capital (Becker 1964). Thus, households use schools to purchase an asset rather than a consumption good, and this asset is only assigned a value in subsequent arenas like labor markets. As a result, a student's school choice depends on her beliefs regarding how agents like employers will value her skills. Second, labor markets can feature wage premia: Individuals of a given skill level may receive higher wages if they match to more productive firms (e.g., Card et al. 2018). Thus, schools can provide two commodities that affect the value of human capital: skills and job match quality. Third, distance, broadly construed, influences school choice and the placements that schools produce. Households often prefer schools close to home (e.g., Abdulkadiroglu et al. 2017a), and firms may opt to recruit at schools that are nearby or will yield many promising candidates (e.g., Weinstein 2017). Furthermore, firms' concern for distance may be endogenous to household preferences; for example, if high-ability students prefer a certain school, then firms may prefer to recruit there. While we focus on labor markets, similar considerations arise in other venues in which human capital is valued, like marriage markets or college admissions.

We show that, under the appropriate conditions, school choice can enhance the school sector's performance. When labor markets feature no transaction costs, there is perfect assortative matching, with the most skilled workers going to the most productive firms. In this case, households care only about skill, and, subject to some assumptions, giving them greater choice raises overall skill. This is the case implicitly assumed by much of the school choice literature.

However, labor markets do feature transaction costs. For example, firms do not perfectly observe all potential employees' attributes, and they tend to recruit at a limited number of schools (MacLeod et al. 2017, Weinstein 2017). Thus, rational income-maximizing households may prefer schools that provide the best job placements rather than the most skills. In this case, increasing school choice may actually worsen the school sector's production of skill. In other words, for students making human capital investments, schools supply a bundled commodity: They provide skills and access to agents that matter later in life, like employers. Since households prefer schools that produce good final outcomes like jobs, in some scenarios they may not choose schools with the greatest value added in terms of skill. In short, choice alone is too crude a mechanism to ensure the effective provision of schooling, and policy makers may need to consider more nuanced interventions to enhance school performance and labor market outcomes.

This review relates to several areas of research. It is relevant to work attempting to determine what drives parental choice in educational markets. The importance of this question to understanding the effects of competition between schools has been noted by multiple authors over the years (e.g., Hanushek 1981, Rothstein 2006, Hastings et al. 2009, Abdulkadiroglu et al. 2017b).

We also bring together work on labor and education, making the case that thinking of education as investment helps us to understand school markets. Much work in labor economics focuses on estimating the returns to an additional year of schooling (Mincer 1974, Card 2001, Lemieux 2006). We focus instead on the return to attending different schools and the implications that this has on the effects of school competition. This relates to theoretical and empirical work on the returns to school identity (e.g., Dale & Krueger 2002, Hoekstra 2009, Saavedra 2009, Chetty et al. 2014b, MacLeod & Urquiola 2015, MacLeod et al. 2017).

In addition, our work helps to tie research on education and labor income inequality and its intergenerational transmission (e.g., Black & Devereux 2011; Autor 2014; Chetty et al. 2014c, 2017b). We note that, if schools help allocate students to jobs, then school markets can play an important role in determining the distribution of income. This role may grow if wage premia increase (Card et al. 2013), or if the school sector becomes increasingly stratified (Hoxby 2009).

The remainder of the review is organized as follows. Section 2 discusses the empirical literature, and Section 3 presents our model. Section 4 concludes.

2. EVIDENCE

This section presents an overview of research on the impact of competition and choice in school markets. This is a vast area of work that has grown rapidly, making a full review difficult to carry out in the present format. In light of this, we make two choices. First, we focus on only a subset of studies.[1] Second, we note that, especially as it pertains to the model that we present, much of this literature can be summarized in two key findings:

1. There is clear evidence that households prefer schools that have higher levels of absolute achievement.
2. There is much less evidence that households systematically prefer schools with higher value added in the production of skill (i.e., that this preference is strong enough to be the primary driver of school choice).

To be precise, consider individual i who attends school s in period 0 and obtains outcome w_{1is} in period 1. This outcome could be college placement after high school, starting wage after college, lifetime earnings, or marriage quality. Suppose that outcomes are a function of skill, θ:

$$w_{1is} = f(\theta_{1is}), \quad 1.$$

and that student i enters school s with skill θ_{0is} and leaves with skill θ_{1is}. When we ask whether students prefer schools with higher value added, we are asking whether they choose a school s over s' if $\theta_{1is} - \theta_{0is} > \theta_{1is'} - \theta_{0is'}$. When we ask whether they prefer schools with high absolute achievement, we are asking whether they choose a school s over s' if $w_{1is} > w_{1is'}$. In practice, measures of absolute achievement are usually strongly correlated with each other and with measures of peer quality. Thus one cannot easily isolate whether parents prefer a given school because of its absolute final outcomes or its peer quality.

[1]This choice additionally reflects the availability of recently published reviews, for example, the work of Epple et al. (2017) on vouchers, Epple et al. (2016) on charter schools, and Urquiola (2016) on competition more generally. For earlier reviews, see McEwan (2004), Rouse & Barrow (2009), and Bettinger (2011).

Note that, due to data availability considerations, educational research often focuses on test scores as a proxy for skills, θ. One question is whether test scores improve real outcomes like wages, as Equation 1 assumes. Chetty et al. (2011, 2014b) suggest that this is the case: They use administrative data including tax records to show that school and teacher value added measured using test scores do contribute to labor market outcomes.[2] Thus, it is reasonable for researchers to use test score value added as a measure of school quality. Our model asks if this always makes sense for parents too.

The next section discusses the evidence on the use of absolute achievement as a metric for school quality, followed by a section discussing the evidence on the use of school value added as a metric.

2.1. Households Prefer Schools with Higher Absolute Achievement

The evidence of a preference for schools with high absolute achievement emerges from multiple methodologies applied in diverse settings. A first type of study exploits information experiments. For instance, Hastings & Weinstein (2008) provide a randomly selected subset of households in North Carolina with information on the absolute testing outcomes of schools that they are eligible to apply for. They find that households that receive this information are more likely to request the higher-achievement schools for their children.

A second set of studies considers whether families are willing to pay more for houses that allow their children to attend public schools with higher achievement. For example, Black (1999) exploits boundary cutoffs in a way that essentially mimics a regression discontinuity design. The motivation is that differences in neighborhood quality (e.g., safety and other amenities like restaurants) are unlikely to change discontinuously at exactly the same boundaries that separate school enrollment catchment areas. Yet house prices rise discretely just as one crosses into the higher-achievement area. Broadly similar results emerge in cities in Australia, France, South Korea, the United Kingdom, and the United States.[3]

A third type of study analyzes households' preferences in school choice mechanisms. Specifically, these are settings in which parents are allowed to request different public schools for their children. The lists that parents submit tend to show a clear preference for schools with better absolute outcomes. This is seen, for example, with respect to high schools in Boston and New York City (Abdulkadiroglu et al. 2014, Dobbie & Fryer 2014), China (Hoekstra et al. 2018), the United Kingdom (Burgess et al. 2015), Romania (Pop-Eleches & Urquiola 2013), and Trinidad and Tobago (Jackson 2010).[4]

A fourth set of papers analyzes the impact of large-scale national voucher schemes, i.e., settings in which all households are allowed to freely choose schools, and the private sector can fully respond. Theoretical models suggest that, if households have preferences for attributes correlated with absolute achievement, then stratification will develop in such settings; for example, the rich or the able will segregate into schools. Epple & Romano (1998) show that this can be driven by a concern for peer effects, and MacLeod & Urquiola (2015) show that this can be driven by informational concerns—students prefer to be pooled with high-ability peers because this reveals

[2]For a review of evidence surrounding the impact of test scores and national income, see Hanushek & Woessmann (2010).

[3]For work on Australia, see Davidoff & Leigh (2008); for France, Fack & Grenet (2010); for South Korea, Moon (2018); for the United Kingdom, Gibbons & Machin (2003, 2008), Cheshire & Sheppard (2004), and Rosenthal (2006); and for the United States, Brasington & Haurin (2006), Bayer et al. (2007), and Figlio & Lucas (2004). For further discussion on this literature, see the review by Machin (2011).

[4]An analogous pattern emerges for colleges in the United States (Avery et al. 2013).

that they themselves are able. Consistent with these predictions, Hsieh & Urquiola (2006) suggest that the introduction of vouchers in Chile led to substantial sorting by attributes like household income.[5] One can see broadly similar patterns of choice leading to increased stratification in liberalized markets, including Sweden's school voucher system (Bohlmark & Lindahl 2007, Bohlmark et al. 2015) and the US (Hoxby 2009, 2016) and Colombian college sectors (MacLeod et al. 2017).[6]

2.2. Less Evidence that Households Systematically Choose Higher-Value-Added Schools

There is much less evidence that households systematically choose schools with higher value added in the sense of causally raising skill levels, i.e., schools with high $\theta_{1is} - \theta_{0is}$. A first set of studies focus on parental preferences per se and provide a useful contrast with the literature reviewed in the previous section. For example, Abdulkadiroglu et al. (2017b) use data from New York City to explore whether the schools that parents request suggest that they prefer schools with higher value added, over and above their valuation of peer quality (i.e., over and above absolute achievement). They find this not to be the case. Related to this, Rothstein (2006) points out that, if parents demand school value added, then a school's peer group quality will be correlated with its valued added in a housing market equilibrium. This should induce an upward bias in cross-sectional peer effect estimates, one that is stronger in markets with greater school choice. Rothstein (2006, p. 1334) finds "no evidence that the school-level association between student characteristics and outcomes is stronger in high-choice markets," suggesting that value added is not a primary determinant of parental choices.

A second set of papers show that, when households are given vouchers that greatly expand their access to private schools, the impact on their children's outcomes is sometimes positive and large, sometimes negative and large, and most often modest in magnitude. For example, a series of papers suggest that Colombia's voucher program significantly benefitted students, including by raising their test scores (Angrist et al. 2002, 2006; Bettinger et al. 2010). In fact, one recent follow-up study suggests that, at least for certain types of students, the vouchers more than paid for themselves in that they raised graduates' wages and thus also tax revenue (Bettinger et al. 2017).[7] In stark contrast, Abdulkadiroglu et al. (2018) suggest that a voucher program in Louisiana substantially reduced students' test scores. A large number of studies lie in between these two, with the majority suggesting that vouchers have modest effects in multiple dimensions (Epple et al. 2017). Similarly mixed results apply to charter schools, where some are found to substantially outperform public alternatives in terms of raising test scores, and some to do worse (Chabrier et al. 2016, Epple et al. 2016, Cohodes 2018). Consistent with the former possibility, Hanushek et al. (2007) find that parental decisions to exit charter schools in Texas are indeed correlated with value added.[8]

[5] In addition, Valenzuela et al. (2013) show that Chile displays one of the highest levels of school-level stratification in the Organisation for Economic Co-operation and Development (OECD). Furthermore, Mizala et al. (2007) suggest that stratification is particularly extensive in the private sector (see also McEwan et al. 2008).

[6] Voucher schemes in the United States are not nationwide, but rather tend to be relatively small and local. The United States nonetheless displays a large amount of choice between school districts (Tiebout 1956). Urquiola (2005) presents evidence that this type of choice also leads to stratification by socioeconomic characteristics, although Hoxby (2000) finds less evidence of such an effect.

[7] Bettinger et al. (2017) note that a caveat arises because the vouchers may have had unmeasured negative externalities.

[8] In addition, there is evidence that charter schools can be more sought after by families for whom their causal effect is smaller (Abdulkadiroglu et al. 2016, Walters 2018).

A third and rapidly growing literature studies students whose school choice sets are expanded not by vouchers but by gaining admission to selective schools with higher absolute achievement. This work mainly considers public school settings in which households exert (often substantial) effort to get their children into schools with clear cutoff scores that lend themselves to regression discontinuity analyses. These studies similarly produce mixed and often modest findings regarding the effect of greater access to educational options. Some papers find positive effects (e.g., Hoekstra 2009, Jackson 2010, Pop-Eleches & Urquiola 2013), and some find negative effects, at least for certain subgroups and along some dimensions (e.g., Barrow et al. 2017, Beuermann & Jackson 2018). In between, multiple studies point to modest effects (e.g., Park et al. 2008, Clark 2010, Abdulkadiroglu et al. 2014, Ajayi 2014, Bui et al. 2014, Dobbie & Fryer 2014, Lucas & Mbiti 2014).

A fourth set of studies considers the impact of information on testing value added, providing a useful counterpoint to the work on information and housing valuations discussed in Section 3.1. Imberman & Lovenheim (2016) consider the impact of the release of information on school value added on housing valuations in Los Angeles. This arguably provides the market with new data, as schools' value added and absolute achievement have been shown to not be perfectly correlated in some markets (see, for instance, Abdulkadiroglu et al. 2014). Imberman & Lovenheim find that the information had little if any effect on housing valuations. Similarly, Mizala & Urquiola (2013) consider a Chilean program that publicly identified schools that outperformed peers with similar socioeconomic compositions, providing parents with a proxy for school value added. They find that the school market essentially did not react to such information: Schools' market shares, prices, and socioeconomic composition were unaffected.

Finally, while studies show that (as reviewed above) generalized school choice can produce stratification, the evidence is less robust regarding whether it increases skills as measured by test scores. For example, in the United States, Hoxby (2000) finds that urban areas in which parents can choose among more districts have more productive schools, but Rothstein (2007) questions the robustness of the result. In Chile, Hsieh & Urquiola (2006) find that, while vouchers led to massive private growth and stratification, it is less clear that they increased average educational attainment. Indeed, if vouchers had fully succeeded, then Chile would have been done with educational reform. In fact, over the past decade—and despite some subsequent improvement in its international testing performance—Chile has been experimenting with extensive reforms to target vouchers, reduce sorting, and make school productivity more transparent such that it might drive parental choice.[9]

3. SCHOOL CHOICE AND THE LABOR MARKET

The key finding highlighted above is that households often seem to choose schools based on their absolute achievement rather than their value added. One interpretation might be that parents are irrational and/or have a taste for schools with low value added. This section shows, however, that integrating school choice with recent developments in labor economics implies that households that care about final outcomes should not always choose schools with higher value added. In some cases, favoring schools with higher absolute achievement will lead to better final outcomes, even when there are no explicit peer effects. We build a simple a model to illustrate this point. The text

[9]For recent work on Chile, see Feigenberg et al. (2014), Navarro-Palau (2017), Neilson (2017), and Aguirre (2018). Related to this, MacLeod & Urquiola (2015) note that the use of lotteries—as is done in American charter schools—may render value added more transparent and increase the likelihood that it drives school choice.

describes the model and its key results, while the technical details are relegated to the appendix (Section 5).

3.1. Setup

Suppose that there are two neighboring school districts, A and B, with the number of students in each normalized to 1. Each district operates a school indexed by $s \in \{A, B\}$. Each school uses a constant returns to scale technology and could, in principle, serve all students in both districts. Students who cross the district boundary to attend school must pay a cost C, the motivation being that households usually prefer schools close to home.[10] This cost can be set high enough that all parents use their home school. We parameterize increasing school choice by reductions in C, since these allow more households to cross the boundary to buy schooling.

Students have either high or low ability, $\alpha_k \in \{\alpha_H, \alpha_L\}$, where $\alpha_H > \alpha_L$. Each individual observes her ability, but it may or may not be observable to others. We let ρ_A and ρ_B stand for the fraction of high-ability students in the district denoted by the subscript. When they attend school s, individuals receive value added v_s. More precisely, let skill be equal to ability augmented by school value added:

$$\theta_{ks} = \alpha_k + v_s.$$

We assume that $\rho_A > \rho_B$ and $v_B > v_A$ (this is important and consistent with results suggesting that schools with better peer composition do not always have higher value added, as reviewed in Section 2). In other words, district A has a greater prevalence of high-ability children, but district B has a more productive school. We also make the assumption that

$$\alpha_H - \alpha_L > v_B - v_A.$$

In words, schools close only a fraction of the ability gap. This is reasonable given the evidence that schools do not easily equalize achievement between salient groups (e.g., between Blacks and Whites in the United States, or between low and high socioeconomic status students in many countries).[11] This implies that, in terms of their skill levels, there are four types of graduates, $\{\alpha_H, \alpha_L\} \times \{A, B\}$:

$$\theta_{HB} > \theta_{HA} > \theta_{LB} > \theta_{LA}, \qquad 2.$$

with high-ability students who went to school B being the most skilled.

On the labor market side, assume that the number of employers is equal to the number of graduates (mass of 2). We index these firms by their productivity:

$$\beta \in [1 - \gamma, 1 + \gamma],$$

which is uniformly distributed with density $1/\gamma$, where $\gamma \in [0, 1]$. Thus, γ measures the variation in firm quality. When $\gamma = 0$, all employers are equally productive.

---

[10]The literature provides ample evidence of such a preference (see, for example, Bayer et al. 2007, Gallego & Hernando 2009, Hastings et al. 2009, Burgess et al. 2015, Abdulkadiroglu et al. 2017a, Neilson 2017, Walters 2018).

[11]The point is that extremely successful schooling interventions might close such gaps, but the fact that there is concern regarding the intergenerational transmission of inequality suggests that such interventions are the exception rather than the rule.

We assume a perfectly competitive labor market, such that an individual with skill θ who works at firm β earns a wage

$$w(\theta, \beta) = \beta\theta. \quad 3.$$

In other words, there is complementarity, and individuals of a given skill level receive higher wages if they match to more productive firms. There is evidence supporting this important assumption. For instance, Card et al. (2013, 2018) build upon the work of Abowd et al. (1999) to demonstrate the empirical importance of firm matches for compensation.[12]

Equation 3 illustrates that, in the standard neoclassical framework (Becker 1964, Mincer 1974), education is an investment that creates an asset: human capital or skill, θ. The value of this asset is not determined by the student, but by the market. Thus, a rational student's school choice will depend on how he believes that employers will value his skills in the future. While our focus is on the labor market, a student may similarly consider how going to a given high school will affect his prospects in the marriage market or how he is viewed by college admissions officers. In all of these cases, beliefs as to other agents' valuations will guide students' decisions (Browning et al. 2014).

This might not be a major consideration—as regards the school market—if there were no labor market frictions. In that case, there would be perfect assortative matching of firms and graduates, with the highest θ individuals working for the highest β firms.[13] As a result, households would always prefer schools with higher value added. Much of the literature on school choice implicitly assumes this, perhaps because it conveniently implies that the only goal of education is skill acquisition, which in turn can be proxied using test scores.

However, a growing literature in labor economics suggests that matching is imperfect: An individual of a given skill level can be paid different amounts at different firms.[14] This suggests that the matching process is expensive: Prospective employers cannot screen every person in the market. We therefore assume that employers recruit at only one school (*A* or *B*). This assumption is consistent with the work of Weinstein (2017), who shows that recruitment costs lead firms to search mainly within local labor markets. Similar considerations arise when schools prepare students for subsequent educational markets. For example, Hoxby & Avery (2012) describe college admissions officers' visits to high schools. They state that, while there are approximately 40,000 high schools in the United States, a college whose staff visits one hundred "is considered to be exceptionally dedicated and well-funded" (Hoxby & Avery 2012, p. 7). Those they visit most are typically feeder schools known to produce many applicants, or schools with locations such that students from several high schools can attend the visit. As stated above, such preferences on the part of firms and schools may be endogenous to household preferences. For instance, if high-ability students are more likely to use a certain school, it may make sense for firms to recruit there.[15]

---

[12]More generally, earlier work in labor economics suggests that some firms pay higher wages for equally skilled workers. This work highlights mechanisms like efficiency wages and rent sharing (see, e.g., Krueger & Summers 1988, Van Reenen 1996).

[13]For example, the absence of search frictions produces this type of assortative matching with careers, as shown by Rosen (1981).

[14]As indicated above, Abowd et al. (1999) and Card et al. (2013, 2018) underline the empirical importance of firm matches (see also Card et al. 2014, Autor et al. 2017, Caldwell & Harmon 2019). Furthermore, von Wachter & Bender (2006) and Oreopoulos et al. (2012) provide evidence that careers matter by considering how the trajectories of otherwise identical individuals differ depending upon whether they got their job during a recession. More broadly, research shows that the labor market returns to schooling vary with educational level and have evolved in different ways (see, for example, Autor et al. 2008, Acemoglu & Autor 2011).

[15]These considerations are obviously related to geography. Since distance is a key driver of school choice, as long as there is residential sorting, there will also be educational sorting along dimensions like ability or

This implies that a rational, income-maximizing household will care not only about a school's value added, but also about the quality of employers that its graduates are likely to face. To reflect this, we consider the following sequence of choices:

1. Students observe their ability and then choose a school (paying a cost C if they use the one outside their district).
2. Students acquire human capital and graduate with skill $\theta_{ks} = \alpha_k + v_s$.
3. Employers choose one school from which to recruit employees. At this school, they can use interviews or other means to gather information on graduates.

By definition, a market is competitive if there is no coordination of choice. Thus, we suppose that students and firms make their choices independently.

3.2. Implications

We use the above setup to study three scenarios. These cases illustrate that, in our setup, both perfect information and the absence of capacity constraints are necessary for competition to enhance the production of skill. In particular, case 1 shows that, when both are present, increasing households' freedom to choose raises average school value added and thus provides precise conditions under which Friedman's (1955) hypothesis is correct. Cases 2 and 3 show that, when either is missing, competition can fail to produce excess demand at the higher-value-added school or can even lead to its exit.

3.2.1. Case 1: perfect information and no capacity constraints. The best conditions for competition arise when information is perfect and symmetric—skill is easily observable—and there are no capacity constraints. In this case, employers can identify the highest-skilled graduates at school B (the high-value-added school). Thus, the highest-productivity (β) firms recruit there and pick off these students, and in general, there is perfect matching. It is therefore optimal for all students to choose school B and for all firms to recruit there. In this case, greater school choice—reductions in C—will allow more district A students to use the higher-value-added school (and this might put pressure on school A to improve).[16] This is summarized as Result 1.

> **Result 1.** When information is symmetric, and schools have no capacity constraints, the labor market will feature perfect assortative matching. In this case, greater competition (lower C) raises average school value added, as more students switch from the low- to the high-productivity school.

This is a formal statement of Friedman's (1955) result (proofs and further details are in Section 5).[17] The intuition behind it is that, given perfect matching, a school's abilities to

socioeconomic status. Growing work suggests that there are significant labor market returns to location (for a review, see Moretti 2011; for theory and evidence, see Davis & Dingel 2014).

[16]Hoxby (2002) points out that choice can improve outcomes through both of these channels: transfers to school B and responses from school A. There is evidence of the latter channel being active (e.g., Chakrabarti 2008), although if school choice leads to sorting, then these channels are hard to disentangle (Hsieh & Urquiola 2003). In addition, McMillan (2005) shows that, if schools' effort is endogenous to the types of students that they attract, then it does not immediately follow that competition will put pressure on school A to improve. Gilraine et al. (2019) point out that the competitive effects of choice will depend on whether schools are horizontally or vertically differentiated.

[17]Note that, even in this environment, there are potential political economy concerns. Even though the perfectly competitive allocation is Pareto efficient, some students in district B earn lower incomes relative to the

deliver skills and to deliver jobs are perfectly aligned. In this case, households will choose schools as if skills were the only thing that mattered.

3.2.2. Case 2: perfect information and capacity constraints. We continue to assume that information is perfect and symmetric but suppose that there are capacity constraints: Each school can handle only half of the total population of students. The question is whether competition will produce excess demand for school B. Capacity constraints immediately raise the question of how seats at more desirable schools are rationed. We consider equilibria under two procedures commonly used in school choice schemes: selective admissions based on ability and lotteries.[18] In this case, we also simplify the analysis by supposing that $C = 0$ and $\rho_A + \rho_B = 1$ (Section 5 considers the more general case).

It is clear that one equilibrium is to have all students prefer school B, and for this school to only admit the high-ability students. However, suppose that all high-ability students prefer school A. In that case, all of the high-productivity firms with $\beta \in [1, 1+\gamma]$ will opt to recruit from school A. Ex ante, students do not know which firm will employ them, and thus their expected wage at school A is $\left(1 + \frac{\gamma}{2}\right)(\alpha_H + v_A)$. If one of the high-ability students considered using school B instead, she could predict being hired by the best firm recruiting at school B, thus receiving payoff $(\alpha_H + v_B)$. This person will decide against that option and remain at school A if and only if

$$\gamma \geq 2\frac{v_B - v_A}{\alpha_H + v_A}. \quad 4.$$

In other words, as long as the variance in firm productivity (γ) is sufficiently large (i.e., the variance in returns to skill is significant enough), high-ability students will prefer school A.[19] In short, in this scenario, even complete freedom to choose ($C = 0$) does not generate excess demand for the high-value-added school.

The intuition has two parts. First, households realize that, while schools impart skills, they also provide pathways to jobs. Because households' goal is ultimately labor market success, they are willing to trade off school performance in one dimension for the other.[20] Second, employers wish to hire skilled workers—they do not care about value added per se (recall $\theta_{ks} = \alpha_k + v_s$: employers desire high θ but do not care where it originates). In other words, firms want the best employees, and if ability can overwhelm value added ($\alpha_H - \alpha_L > v_B - v_A$), then they will not mind recruiting at a low-value-added school.

Could a similar equilibrium obtain under randomized admissions? To see that it could, suppose that all low-ability students choose school B, while their high-ability counterparts choose A. As

situation in which district A students are forced to accumulate lower skill. They would naturally oppose school choice.

[18]In many cities, students can access magnet public schools if they score high enough on a test (e.g., Pop-Eleches & Urquiola 2013, Abdulkadiroglu et al. 2014). Lotteries are also commonly used to determine access, for example, by charter schools in the United States (Epple et al. 2016). We do not consider prices as a rationing mechanism. The vast majority of school choice programs around the world do not use prices to ration slots (Epple et al. 2017). An exception is Chile's voucher program, which allowed private schools to charge add-ons for many years but is moving away from that practice.

[19]Note that, even if low-ability individuals were to prefer school A, the selective admissions policy precludes their admission.

[20]This type of result is also possible in the model presented by MacLeod & Urquiola (2015), although in that case, the result arises from information transmission rather than from the fact that the higher-productivity firms recruit in certain schools [MacLeod et al. (2017) present causal evidence that such informational channels are relevant]. In addition, Riehl et al. (2016) present empirical evidence consistent with the existence of tradeoffs in universities' ability to impart skills and deliver high earnings (for variation in other dimensions, see Beuermann & Jackson 2018, Kraft 2019).

long as the condition in Equation 4 is satisfied, high-ability students will prefer school A. Now consider the choice of a low-ability student. If accepted by school A, she would be the lone low-ability graduate there and would get matched with the lowest-productivity firm, which at this equilibrium has $\beta = 1$. This student's expected payoff at school B is $\left(1 - \frac{\gamma}{2}\right)(\alpha_L + v_B)$. Thus, under a random admissions process, this student prefers school B to school A if and only if

$$\gamma \leq 2\frac{v_B - v_A}{\alpha_L + v_B}. \qquad 5.$$

In other words, as long as the variance in firm productivity is sufficiently small, low-ability students will continue to prefer school B. To summarize, in this case, having each type of student self-select into one school (high ability into A and low ability into B) is an equilibrium under the random allocation if and only if

$$2\frac{v_B - v_A}{\theta_{LB}} \geq \gamma \geq 2\frac{v_B - v_A}{\theta_{HA}}. \qquad 6.$$

Our assumption that $\theta_{HA} > \theta_{LB}$ ensures that this condition is feasible. This is summarized as Result 2.

Result 2. When information is symmetric, but there are capacity constraints, there exist equilibria under which the high-value-added school experiences no excess demand. This reflects rational self-selection on the part of students and can happen even with perfect competition ($C = 0$) and under both selective and randomized admissions policies.

3.2.3. Case 3: no capacity constraints, imperfect information. The final case is one without capacity constraints but with imperfect information. Specifically, we assume that firms cannot observe the skill level of every individual in a school—they only observe the average level. In this scenario, suppose that the mean skill at school A when there is no competition (C is very high) is greater than at school B (this follows from our assumption that $\rho_A > \rho_B$). In that case, the most productive firms will hire at school A. As competition is increased (C is reduced), there will be a point at which the high-ability students self-select into school A (as in case 2 above), which in turn leads more high-productivity firms to recruit at this school. Finally, when there is perfect competition ($C = 0$), all students choose school A. Thus we have Result 3.

Result 3. Suppose that there is imperfect information in that firms must choose where to recruit based only on the expected skill of students. If school A is sufficiently positively selected (i.e., it begins with a sufficient number of high-quality students), then increasing competition (lowering C) may lead all students to prefer school A even though school B has higher value added.

Thus, under some conditions, allowing families freedom of choice may even lead to the higher-value-added school being essentially displaced from the market. In Section 5, we show that this result depends in part upon having sufficiently high returns to skill (γ sufficiently large). In particular, there are cases in which the combination of competition and sufficient returns to skill leads to school A being the desirable school, with only low-skill individuals using school B (Proposition 5 in Section 5). The low-skill workers left in school B have the worst job opportunities, since the most productive firms choose to recruit at school A. Thus, in this case, increasing competition might lead to worse outcomes for students in less desirable areas, increasing inequality.

To summarize, the essential finding from this section is that, depending on the context, increasing choice and competition may or may not enhance the production of skill. The key reason for this is that, in buying education, households invest in human capital, and the value of this asset depends on the quality of the match that they subsequently make in the labor market (or the marriage market, or later educational arenas like graduate school admissions). As a result, students are willing to trade off a school's ability to deliver (*a*) value added in terms of skill and (*b*) pathways to outcomes like good jobs.

In most cases this leads households to prefer schools that have high absolute levels of ability and final achievement—this is the outcome in all cases above. However, in some scenarios—cases 2 and 3—these are not the schools with higher value added. These results are consistent with the existing empirical evidence (Section 2).

3.3. Discussion

Our simple model illustrates that school choice entails a coordination problem. If high-ability students and firms were able to coordinate on a move, they would migrate to a higher-value-added school. However, a variety of frictions make such coordination unlikely. Firms may choose a school due to proximity along geographical or other dimensions.[21] In addition, if high-ability students prefer certain schools, then firms are also likely to recruit there, generating self-reinforcing dynamics. For example, Hoxby (2009) shows that (at the top end of selectivity) US colleges have become increasingly stratified—the specific college a student attends conveys more information about his SAT score than it did a few decades ago. Hoxby points out that this may be due to decreasing transportation and information-related costs. This is certainly possible, but it may additionally reflect increasingly strong reputational effects that lead the most productive firms to prefer recruiting at the most prestigious colleges and thus to an increasing desire by students to enroll there.

This also helps to explain why the benefits of incumbency seem to be so marked in education. Once a school or college establishes a reputation as a destination for certain types of recruiters, it will tend to display inertia, staying in that position. For example, in the law industry, certain schools are known for sending students into areas such as corporate law, clerkships, or public-interest law. Employers will have an incentive to return to those schools, and good students with an interest in these areas will have every incentive to enroll in them. This situation will tend to persist even if these schools do not produce the highest value added in terms of skills. This idea was captured by Antonin Scalia when he described the schools he preferred his clerks to have attended (see Liptak 2009):

> By and large, I'm going to be picking from the law schools that basically are the hardest to get into. They admit the best and the brightest, and they may not teach very well, but you can't make a sow's ear out of a silk purse. If they come in the best and the brightest, they're probably going to leave the best and the brightest, O.K.?

We also note that the economic literature has been producing increasing evidence regarding another key ingredient in our example: the possibility that matches matter, e.g., that equally skilled individuals can earn different wages depending on the productivity of the firms that they work for. This effect has been discussed for some time, particularly in the sociology literature. For example, books by Kahn (2011) and Rivera (2015) detail the process by which schools prepare students for elite jobs, and of course, the networks discussed by Granovetter (1973) are partially developed at school.

Analogous match effects can arise in arenas beyond the job market. Kaufmann et al. (2013) use regression discontinuities to show that admission to elite colleges in Chile improves partner and

[21] Firms' attachment to specific locations may be persistent (see Moretti 2004).

spouse quality, and Zimmerman (2016) shows that school selectivity can affect the probability that students end up on prestigious corporate boards. In addition, Arcidiacono & Lovenheim (2016) and Riehl (2018) present evidence of match effects at college, which may lead certain schools to specialize in the graduates of certain types of high schools.

In addition, in the United States, there is evidence of increasing skill-biased technical change (Autor et al. 2003, 2006). This could in part reflect an increase in the importance of the match component. If so, it would raise the value of schools that provide good matches, enhancing the role of the school sector in the intergenerational transmission of inequality.[22] Relatedly, MacLeod et al. (2017) show that the Colombian university system is stratified by ability, with students who attend more prestigious colleges experiencing an earnings advantage that grows with experience. This in turn generates a demand for prestige.[23]

Note that our theoretical results rely on the hypothesis that students understand their skill and choose schools accordingly. However, Hoxby & Turner (2013) find that this is often not the case for many well-qualified students from disadvantaged backgrounds. In our framework, this would imply that these students would end up with lower-quality employment matches and thus lower incomes. Finally, Result 3 implies that students from disadvantaged backgrounds who attend elite colleges should get an income boost. However, at the margin, if students from good backgrounds make optimal choices, then the effect of going to a different college for them should be small. This is exactly what Dale & Krueger (2002, 2014) find: Students with lower socioeconomic status get a significant income boost from attending an elite college, which is not the case for students from advantaged backgrounds.

In short, schools provide both value added in terms of skill and a pool of potential employers, spouses, colleges, etc. This can lead to equilibria with segregation of students into good and bad schools, with the feature that the bad schools may have higher value added.

Another possibility is that households may be unable to observe and/or understand the concept of value added or to process the information necessary to approximate it. That is, they may find it difficult to disentangle innate ability and value added—after all, this is challenging even for econometricians with access to a lot of data (for discussions, see, for instance, Chetty et al. 2017a, Rothstein 2017). While this is possible, our analysis shows that, even if households understand and observe value added, they may still rationally opt for lower-value-added schools.

Two elements are necessary for this to work. First, the variance in skill must be larger than the variance in value added; second, there must be significant variation in the return to skill across firms. If, additionally, employers seek high-skill graduates without regard for whether their skill originates in innate ability or value added, then one can get self-reinforcing equilibria where high-skill individuals and high-productivity firms coordinate on certain schools. Thus, the recent rises in returns to skill and college selectivity may be mutually reinforcing phenomena that have contributed to the overall increase in income inequality.

4. CONCLUSION

Friedman (1955) argued that introducing choice and competition would enhance education. His idea proved influential in part due to mounting evidence of problems with schools' productivity. For example, Hanushek (1997) shows that school systems can increase spending with little to show

[22]There is also much work in sociology highlighting the role that education plays in generating inequality (see Neckerman & Torche 2007).

[23]MacLeod et al. (2017) further find that the introduction of a national exit exam reduced the labor market return to college prestige. This suggests that improving the measurement of individual performance may be one way to reduce the self-enforcing nature of the link between school and occupational choice.

for it in terms of testing improvements.[24] Hoxby (2003, p. 289) summarizes the implications to argue that choice could have a major impact, leading the average student in the United States to score "at an advanced level where fewer than 10 percent of students now score."

In general, these observers did not feel a need to specify or formalize how this would happen. After all, in many areas of the economy, market liberalization produces better outcomes without the need for any specifics or detailed understanding of the sector in question. Banerjee (2007) provides a critique of this type of approach. Making explicit reference to education, he states that economists are sometimes too fond of one-stop solutions advertised as cure-alls. He explicitly singles out school vouchers and states:

> It is the same with all of these: incentives, vouchers.… We come to them…as a one-stop solution to the problems of education. To those who believe in [these, they are]…an abstraction, a metonymy for faith in the power of the market. They do not claim to know how exactly the market will achieve the promised miracle, but it will do it (indeed, for them this unpredictability is part of its appeal). (Banerjee 2007, p. 18)

Banerjee (2007, p. 18) calls instead for economists to "step into the machine"—to get into the details of a sector like education and understand how its performance might be improved.

On the one hand, the argument that we make in this review is consistent with Banerjee's (2007). Once one considers the characteristics of education, it is possible to see that introducing greater choice may not automatically produce better outcomes. In particular, this review shows that all one needs are (*a*) the idea that education is partially an investment rather than just consumption and (*b*) the notion that schools can contribute to delivering good job (or other types of) matches.

On the other hand, the model also raises caveats regarding Banerjee's (2007) general point. Many education economists have truly stepped into the machine, running randomized trials to identify ways to improve school value added, for instance. Pritchett (2009) points out, however, that there may be limited demand for the findings produced by randomized controlled trials. Our results suggest that one reason for this may be that, in many cases, schools are not under intense competitive pressure to become better producers of skill, and this will tend to limit their readiness to create or take up innovations identified in experiments.

Finally, exploring the complementarity between school choice and employer search may be a fruitful avenue for research. There is the technical question of how to measure complementarities that are known to play an important role in firm performance (e.g., Athey & Stern 1998, Caroli & van Reenen 2001, Bresnahan et al. 2002). In addition, a developing literature in spatial economics recognizes that location affects information flows and worker productivity (e.g., Moretti 2011). Davis & Dingel (2019) show that the costs of information exchange may be lower when firms locate close to each other, which gives rise to location-related complementarities. They show that this leads to agglomeration economies that can explain a number of the stylized facts about cities. In this review, we show that students' search for schools and firms' search for workers can also be complements, which may explain the segregation of students into schools by absolute achievement rather than value added. The importance of these complementarities is magnified when there are greater returns to skill, and thus our framework is consistent with the observation that colleges have become more selective in a period that has seen increasing returns to skill. In short,

[24]Hanushek's (1997) finding was for the United States; Gundlach et al. (2001) present analogous evidence of declining school productivity in other OECD countries. More recent studies measuring the causal impact of resources produce mixed results. For example, Jackson et al. (2016) and Lafortune et al. (2018) find that spending improves outcomes, while de Ree et al. (2018) find no impact.

integrating school choice into analyses of production complementarities in spatial economies has the potential to provide novel insights on growth and inequality.

5. APPENDIX: MODEL DETAILS AND RESULTS

This section provides the details for the model and results discussed in Section 3. The model considers three parties: students, schools, and employers. Each student lives in one of two jurisdictions, A or B, with the number of students in each normalized to 1. Each jurisdiction runs a school, indexed by $s \in \{A, B\}$. Students are indexed by $i \in I_s = [0, 1]$, where I_s denotes the set of students in jurisdiction s. Individuals are of either low or high ability, denoted by $\alpha \in \{\alpha_L, \alpha_H\}$, where $\alpha_H > \alpha_L > 0$. We assume that students can observe their own ability.[25] The fraction of high-ability students in each jurisdiction is given by ρ_s. In other words, students $i \in [0, 1 - \rho_s) \subset I_s$ are of low ability, and the rest are of high ability. The index identifies specific individuals that we need when discussing who chooses a particular school; however, the relationship between index and ability is unknown to the market.

Each school $s \in \{A, B\}$ provides value added v_s to all of its students.[26] The skill of an individual i who went to school s is thus given by $\alpha_i + v_s$, i.e., value added augments innate ability to produce skill. We assume that jurisdiction A has a higher proportion of high-ability students, $\rho_A > \rho_B$, but jurisdiction has the school with higher value added: $v_B > v_A > 0$. In practice, one might expect that school A would have more resources and perhaps thus have higher value added. However, research suggests that better-resourced schools are not always more productive, and we make these assumptions to show that the demand for school A is not necessarily driven by value added.

We also assume that schools close only a fraction of skills gaps, i.e., the difference in ability is greater than that in value added:

$$\alpha_{\mathrm{H}} - \alpha_{\mathrm{L}} > v_B - v_A.$$

This assumption is supported by the evidence that schools, even over several years, do not easily close achievement gaps between salient groups (e.g., between Blacks and Whites in the United States, or between low and high socioeconomic status students in many countries).[27] Thus, our setup has four student types $t \in T = \{H, L\} \times \{A, B\}$ with skill $\theta_{ks} = \alpha_k + v_s$ such that

$$\theta_{HB} > \theta_{HA} > \theta_{LB} > \theta_{LA}. \qquad 7.$$

To summarize, to make things interesting, we rig the model such that school B has higher value added but may produce graduates with lower absolute skill. The question is whether competition directs students to school B. We also note that there is empirical support that school rankings by absolute achievement do not always correspond to rankings by value added (see, e.g., Abdulkadiroglu et al. 2014).

[25]This can be realistic at higher educational levels. For instance, students applying to high school or college often have access to imperfect but numerous signals of their own ability. These can include standardized test results and grade point averages. For analyses that illustrate such settings at the high school level, the reader is referred to Pop-Eleches & Urquiola (2013) and Abdulkadiroglu et al. (2014); at the college level, the reader is referred to Hoekstra (2009) and Riehl (2018).

[26]Supposing that value added is constant across students is consistent with the literature, which does not find great evidence of heterogeneity in teacher and school effects (see, e.g., Chetty et al. 2014a).

[27]The point is that extremely successful schooling interventions might close such gaps, but the fact that there is concern regarding the intergenerational transmission of inequality suggests that such interventions are the exception rather than the rule.

To introduce elements of competition, we assume that students can attend the school within their jurisdiction for free. If they enroll outside their jurisdiction, then they must pay a cost C. This could capture the cost of travel or fees imposed by one jurisdiction on students from the other, as happens with state universities. A high enough C makes each school a monopoly within its jurisdiction. Thus, reductions in C correspond to increasing competition between schools.

We assume that a set of firms hires graduates. We index these firms by their productivity, β, which we suppose is uniformly distributed on Γ:

$$\beta \in [1-\gamma, 1+\gamma] = \Gamma,$$

with $\gamma \in [0, 1]$. Thus, γ measures the variation in firm quality. When $\gamma = 0$, all employers have the same productivity, while $\gamma = 1$ corresponds to the case in which the worst firm has productivity equal to zero, and the best firm's productivity equals two.

We suppose that there is a return to skill that is greater at higher-productivity firms. Formally, the expected wage paid to an individual of type t hired by a firm of type β is

$$w_{t\beta} = \beta\theta_t. \qquad 8.$$

In words, all else being equal, firms prefer graduates with higher innate ability, and all else being equal, they prefer graduates from schools with higher value added. Finally, we assume that the sequence of decisions is as follows:

1. Each student i chooses a school $s(i) \in \{A, B\}$. If he chooses the school outside his jurisdiction, then he pays a cost C.
2. Firm $\beta \in \Gamma$ chooses the school from which to recruit one employee, $s(\beta) \in \{A, B\}$.
3. Students and firms are matched, resulting in a match $\beta(i)$ and a wage

$$w_i = \beta(i)\left[\alpha_i + v_{s(i)}\right].$$

We assume that, once they recruit at a school, employers carry out interviews that ensure that the better firms are matched with the better students. Since employers choose schools after students do, students' school choice is dependent upon their expectations regarding future employment. This is important because it implies that the effect of increased competition will depend on expectations. We assume throughout that both students and employers have correct expectations in equilibrium.

5.1. Full Information Case

As a benchmark, we begin with a full information case in which student ability is fully observed by all agents.[28] Suppose that the moving cost C is set sufficiently high such that there is no movement between schools. Since school B has the highest value added, the best employers will recruit there and pick up all the high-ability individuals, $\{\alpha_H, B\}$, i.e., these firms will get the graduates with the highest skill levels. Next, employers will move to school A and offer jobs to the high-ability graduates from that school. Once all of the high-ability individuals are employed, the next firms will return to school B and hire the remaining students. Finally, the remaining students at school A will be hired. Proposition 1 summarizes this result.

[28] In general, it is not the case that firms can observe everything about applicants (for a discussion, see MacLeod & Urquiola 2015).

Proposition 1. Suppose that student ability is perfectly observable, and there is no competition between schools. Then the equilibrium employer match is given by:

1. The high-ability students at school B are matched to the highest-productivity firms: $\beta \in [1 + \gamma (1 - \rho_B), 1 + \gamma]$.
2. The high-ability students at school A are matched to the next tier of firms with productivity $\beta \in [1 + \gamma (1 - \rho_B - \rho_A), 1 + \gamma (1 - \rho_B)]$.
3. The low-ability students at school B are matched next to firms with productivity $\beta \in [1 - \gamma \rho_A, 1 + \gamma (1 - \rho_B - \rho_A)]$.
4. Finally, the low-ability students at school A are matched to firms with productivity $\beta \in [1 - \gamma, 1 - \gamma \rho^A]$.

In short, when there is perfect information, employers prefer the graduates of schools with higher value added, although only the high-ability students among them. This also implies that, if the number of high-ability students at school B is small, then the average wage of graduates from school A may exceed that of students from school B. Observe that perfect associative matching implies that all firms with $\beta \in [\beta_H, 1 + \gamma]$, where $\beta_H = 1 + \gamma (1 - \rho_B - \rho_A)$, are matched with the high-ability students.

Now, still in the full information setting, consider the effect of increasing competition by lowering C such that all students can choose schools. Consider first the high-innate-ability students. Since school B has higher value added, and since it contains some high-ability students, these students know that it will be targeted by the highest-productivity firms.[29] Thus, when costs C are low enough, all the high-ability students from jurisdiction A would cross over and attend school B. The same reasoning holds for the low-ability students. Thus, we have:

Proposition 2. For sufficiently low costs of exerting choice, C, the unique equilibrium entails all students going to school B and all employers choosing employees from school B.

This result is the fundamental motivation for implementing school choice. In this case, both students and employers prefer education as provided by the high-value-added school. Competition raises average school productivity and average wages. This implies Result 1 in Section 3.2.1. We show that the presence of perfect information is crucial to this result.

Consider the case in which schools have a capacity of 1—the number of students in their district. In that case, schools must have a method to select students when there is excess demand from neighboring school districts. One method is for schools to use selective admissions. When the education market is perfectly competitive, there is an equilibrium at which all the high-ability students attend school B. The question is whether it is an equilibrium.

Proposition 3. Suppose that schools are selective and each have a capacity of 1. If the number of high-ability students is less than 1, then there exists a competitive equilibrium at which all high-ability students prefer school A over school B if and only if

$$\gamma \left[\theta_{HB} \left(\frac{\rho_A + \rho_B}{2} \right) - (v_B - v_A) \left(1 - \frac{\rho_A + \rho_B}{2} \right) \right] \geq v_B - v_A.$$

Proof. Suppose that all high-ability students choose to attend school A, and that, given selective admissions, they are all accepted. This in turn implies that the firms with $\beta \in [1 + \gamma(1 - \rho_A - \rho_B), 1 + \gamma]$ recruit at school A, and the next group of firms recruits at school B (since $\theta_{LB} > \theta_{LA}$). Ex ante, high-ability students do not know with which firm they

[29]We further assume that students do not take into account any externalities generated by their choices.

will match, and thus their expected return from choosing school A is:

$$E\{w_{HA}\} = \left[1 + \gamma\left(1 - \frac{\rho_A + \rho_B}{2}\right)\right]\theta_{HA},$$

where w_{HA} is the realized wage received by high-ability graduates from school A. If a high-ability student chooses school B and will be matched with the best firm available, then, under the hypothesis that firms can observe ability when they interview at a school, the best student will be matched with the best firm, and we get

$$w_{HB} = [1 + \gamma(1 - \rho_A - \rho_B)]\theta_{HB}.$$

A high-ability student will choose school A over school B if and only if $w_{HA} \geq w_{HB}$, which implies the inequality in Proposition 3.

This result shows that, if the variance of the returns to skill (γ) is sufficiently large, then there can be a competitive equilibrium with school A having all of the high-ability students. The necessary condition for this to hold is that school A can admit all of the high-ability students. If this is not the case, then there will be some high-ability students at school B, which in turn implies under ex post perfect information that the best firms recruit at B, which in turn implies that the best students prefer B, leading to all the best students going to B.

Finally, note that charter schools use random assignment to mitigate the effects of sorting. This also may not work to direct demand toward school B. This is clear from a simple example. Suppose that $\rho_A + \rho_B = 1$, and all the high-ability students apply only to school A, while the low-ability students apply only to school B. In this case, students self-select into schools, and the random allocation system is not used. In addition, in this case, all of the high-productivity firms recruit from school A, while the low-productivity firms recruit from school B. For this to be an equilibrium, we only need the students not to wish to swap schools. For high-ability students, this requires that

$$(1 + \gamma/2)\,\theta_{HA} \geq \theta_{HB},$$

or

$$\gamma \geq \frac{2(v_B - v_A)}{\alpha_H + v_A}. \qquad 9.$$

In the case of the low-ability students, we need

$$(1 - \gamma/2)\,\theta_{LB} \geq \theta_{LA},$$

or

$$\gamma \leq \frac{2(v_B - v_A)}{\alpha_L + v_B}. \qquad 10.$$

There are γ that solve this if and only if

$$\frac{2(v_B - v_A)}{\alpha_L + v_B} \geq \frac{2(v_B - v_A)}{\alpha_A + v_A},$$

or

$$\alpha_H + v_A \geq \alpha_L + v_B.$$

This latter condition is our maintained assumption that the variation in skill is greater than the variation in value added, and thus there are γ satisfying Equations 9 and 10. In other words, there exists a competitive equilibrium with complete sorting of the high-ability students into the low-value-added school, despite the existence of a lottery admissions system. In particular, this result implies that school choice mechanisms cannot be guaranteed to reward the high-value-added school. Setting $\rho_A + \rho_B = 1$ implies Result 2 in Section 3.2.2.

5.2. Imperfect Information Case

In practice, firms cannot perfectly observe workers' skill or ability.[30] Now suppose that employers can only observe the average skill of students at a school and cannot disentangle value added from innate ability.[31] To explore this setting, we need to characterize the equilibrium allocation of students between schools. To do so, it is useful to let n_H^A and n_L^A denote the number of high- and low-ability students at school A. The corresponding number of students at school B is given by $n_H^B = \rho_A + \rho_B - n_H^A$ and $n_L^B = (1 - \rho_A - \rho_B) - n_L^A$. Let $n^s = n_H^s + n_L^s$ be the total number of students at each school

Given this, the average skill level of school A graduates is given by

$$\hat{\theta}^A \left(n_L^A, n_H^A\right) = \frac{n_H^A \alpha_H + n_L^A \alpha_L}{n^A} + v_A,$$

with $\hat{\theta}^B \left(n_L^B, n_H^B\right)$ analogously defined. Further supposing that the number of high-ability students in district A is sufficiently larger than in district B, we have

$$\hat{\theta}^A (1 - \rho_A, \rho_A) > \hat{\theta}^B (1 - \rho_A, \rho_A). \qquad 11.$$

We know that this is possible since $\theta_{HA} > \theta_{LB}$. In this case, when a firm β hires a student at school $s \in \{A, B\}$, it expects payoff

$$\hat{w} (\beta, s) = \beta \hat{\theta}_s. \qquad 12.$$

This reflects the case in which the firm can no longer cherry-pick the most able graduates.

The most productive firms will choose the school with the highest average skill, which in turn determines the average productivity of firms that recruit at school s, $\hat{\beta}_s$. Students will choose the school with the highest expected wage net of moving costs. Thus, if a student with ability α from jurisdiction $d \in \{A, B\}$ attends school $s \in \{A, B\}$, his payoff is

$$w (\alpha, d, s) = \hat{\beta}^s (\alpha + v_s) - \delta_{ds} C,$$

where $\delta_{ds} = 0$ if $d = s$ and 1 otherwise.

We can now define an equilibrium. An allocation of employers and students is an equilibrium if neither students nor firms can increase their payoff by switching schools. Let us begin by exploring equilibria for which $\hat{\theta}_A > \hat{\theta}_B$. Since students prefer to work for higher-productivity firms, when

[30] This is the subject of the employer learning literature (see, e.g., Farber & Gibbons 1996, Altonji & Pierret 2001).

[31] School value added is difficult for econometricians to isolate despite having access to large amounts of data. Similarly, teacher value added turns out to be difficult to predict, even using rich observable characteristics (see, e.g., Rockoff et al. 2011, Araujo et al. 2016). In contrast, and as reviewed in Section 2, parents seem to generally be aware of schools' absolute achievement and to prefer those with higher levels of achievement.

$\hat{\theta}^A > \hat{\theta}^B$, the top $n^A = n_H^A + n_L^A$ firms hire at school A and the rest at school B. Thus, without loss of generality, an equilibrium allocation in this case has firms $\beta \in [\beta^A, 1+\gamma]$ hiring at school A, where

$$\beta^A\left(n_L^A, n_H^A\right) = 1 + \gamma - \gamma n^A.$$

The average productivity of firms hiring at school A is therefore

$$\hat{\beta}^A\left(n_L^A, n_H^A\right) = \frac{1+\gamma+\beta^A\left(n_L^A, n_H^A\right)}{2} = 1 + \gamma\left(1 - \frac{n^A}{2}\right).$$

The equivalent expression for school B is $\hat{\beta}^B\left(n_L^A, n_H^A\right) = \left[\beta^A\left(n_L^A, n_H^A\right) + (1-\gamma)\right]/2 = 1 - \gamma n^A/2 = \hat{\beta}^A\left(n_L^A, n_H^A\right) - \gamma$.

Students' choice depends on two factors: the cost of moving, C, and the difference in payoffs. Given an allocation of students, define the utility from attending school A less the utility from attending school B by

$$\begin{aligned} D\left(\alpha, n_L^A, n_H^A\right) &= \hat{\beta}^A\left(n_L^A, n_H^A\right)(\alpha + v_A) - \hat{\beta}^B\left(n_L^A, n_H^A\right)(\alpha + v_B) \\ &= \gamma(\alpha + v_B) - \hat{\beta}^A\left(n_L^A, n_H^A\right)(v_B - v_A) \\ &= \gamma(\alpha + v_B) - \left[1 + \gamma\left(1 - \frac{n^A}{2}\right)\right](v_B - v_A) \\ &= \gamma\left[\alpha + v_A + \frac{n^A}{2}(v_B - v_A)\right] - (v_B - v_A). \end{aligned}$$

Given that value added at school B is higher than at school A, this term can only be positive when the diversity in the returns to skill, γ, is sufficiently high. In particular, if $\gamma < 1$ and the value added of school B is sufficiently high, then this term is negative, and thus, in the absence of moving costs, students would prefer school B.

When variation in value added is small relative to variation in ability, the fact that employers sort across schools can lead to equilibria where the lower-value-added school has the best students. To illustrate this, let us begin with the autarky case, where there is no mobility.

Proposition 4. Suppose that the average skill of students living in jurisdiction A is higher than that of students living in jurisdiction B, i.e., $[\hat{\theta}^A(1-\rho_A, \rho_A) > \hat{\theta}^B(1-\rho_B, \rho_B)]$. Suppose also that mobility costs satisfy

$$C > D(\alpha_H, 1-\rho_A, \rho_A). \qquad 13.$$

Then, it is an equilibrium for students to choose their local school and for the high-quality firms $\beta \in [1, 1+\gamma]$ to recruit employees at school A.

Proof. Consider the allocation at which all students attend their local school. By assumption, average skill is higher at school A, and therefore employers with $\beta \in [1, 1+\gamma]$ will choose school A, with the rest choosing school B. Since $C > D(\alpha_H, 1-\rho_A, \rho_A)$, this implies that the high-ability students at B prefer to stay at B. The monotonicity of $D(\cdot)$ with respect to α implies that low-ability students will not want to switch.

Now consider increasing competition by lowering costs C. Further suppose that $D(\alpha_H, 1-\rho_A, \rho_A) > 0$. This will hold when v_B is sufficiently small (but still greater than v_A). This implies that, when $C < D(\alpha_H, 1-\rho_A, \rho_A)$, high-ability students at school B strictly prefer school A. Once they move, the average skill at school A rises. This further reinforces the preference for school A. Thus, we have:

Proposition 5. Suppose that moving costs satisfy

$$D(\alpha_H, 1-\rho_A, \rho_A+\rho_B) > C > D(\alpha_L, 1-\rho_A, \rho_A+\rho_B); \qquad 14.$$

then, it is an equilibrium for all high-ability students to attend school A, while low-ability students attend their local school. Firms with $\beta \in [1+\gamma-\gamma(1+\rho_B), 1+\gamma]$ employ students from school A, while the remaining firms recruit at school B.

Proof. Since $D(\cdot)$ is increasing in α, we know there exists C satisfying Equation 14. The allocation $\{n_H^A, n_L^A\} = \{\rho_A+\rho_B, 1-\rho_A\}$ corresponds to all high-ability students going to school A, while low-ability students stay at their respective schools. Now the condition in Equation 14 implies that it is optimal for high-ability students to leave B to attend A, while low-ability students strictly prefer to stay at their local school.

This result provides conditions under which high-ability students prefer school A, even though school B has higher value added. We now show that competition does not solve this situation.

Proposition 6. Suppose that value added and the distribution of returns to skill satisfy

$$\gamma(\alpha_L+v_B) > v_B - v_A > 0; \qquad 15.$$

then, for costs C satisfying

$$D(\alpha_L, \rho_A+\rho_B, 2-\rho_A-\rho_B) > C \geq 0, \qquad 16.$$

it is an equilibrium for all students to choose school A.

Proof. The condition in Equation 15 implies that $D(\alpha_L, \rho_A+\rho_B, 2-\rho_A-\rho_B) > 0$, and thus there exist costs that satisfy Equation 16. This condition implies that all types prefer school A over school B, and thus all firms hire at school A.

This result shows that, when the difference in value added is sufficiently small, even in the presence of perfect competition ($C = 0$), there can be an equilibrium at which all students choose the school with lower value added. This implies Result 3 in Section 3.2.3. The result depends on several ingredients that can help us understand when we can expect competition to work. First and foremost is the assumption that employers use school identity to set wages. When this is true, employers will search for students at the schools that have the highest skill—the sum of innate ability and value added. Second, we suppose that there are increasing returns to skill—this means that there is a match component to compensation.

The consequence is that we get interlocking decisions. If students expect the best employers to recruit at school A, then students will prefer school A, even when school B is known to have higher value added. Moreover, the incentive to choose school A is highest for the high-ability students. The students of the lowest ability might prefer school B, while the better students prefer school A. Of course, these results can be reinforced if students have difficulty observing value added.

This provides several insights regarding the impact of choice. First, if the distribution of ability is relatively uniform, and schools are equally bad, then a new school with higher value added could enter. The problem is that if there exists a historically good school, where there is a high proportion of high-ability students, then increasing competition could in fact result in increased demand at this school even if its value added is lower. This is driven by high-ability students elsewhere who would like the chance to be matched to high-productivity firms. The analysis also applies to high school, where one replaces employers with colleges seeking the best applicants.

Thus, the combination of desirable selective schools and increased returns to skill can lead to greater demand for selective schools and reduced incentives for these to increase their value added.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

For useful comments, we are grateful to Evan Riehl, Juan Saavedra, and an anonymous reviewer. For excellent research assistance, we thank Sakshi Gupta. All remaining errors are our own.

LITERATURE CITED

Abdulkadiroglu A, Agarwal N, Pathak P. 2017a. The welfare effects of coordinated assignment: evidence from the New York City high school match. *Am. Econ. Rev.* 107:3635–89

Abdulkadiroglu A, Angrist J, Hull P, Pathak P. 2016. Charters without lotteries: testing takeovers in New Orleans and Boston. *Am. Econ. Rev.* 106:1878–920

Abdulkadiroglu A, Angrist J, Pathak P. 2014. The elite illusion: achievement effects at Boston and New York exam schools. *Econometrica* 82:137–96

Abdulkadiroglu A, Pathak P, Schellenberg J, Walters C. 2017b. *Do parents value school effectiveness?* Unpublished manuscript, Duke Univ., Durham, NC

Abdulkadiroglu A, Pathak P, Walters CR. 2018. Free to choose: Can school choice reduce student achievement? *Am. Econ. J. Appl. Econ.* 10:175–206

Abowd JM, Kramarz F, Margolis DN. 1999. High wage workers and high wage firms. *Econometrica* 67:251–333

Acemoglu D, Autor D. 2011. Skills, tasks and technologies: implications for employment and earnings. In *Handbook of Labor Economics*, Vol. 4, ed. O Ashenfelter, D Card, pp. 1043–171. Amsterdam: Elsevier

Aguirre J. 2018. *How can progressive vouchers help the poor benefit from school choice? Evidence from the Chilean voucher system*. Tech. Rep., Teach. Coll., Columbia Univ., New York

Ajayi K. 2014. *Does school quality improve student performance? New evidence from Ghana*. Unpublished manuscript, Boston Univ.

Altonji JG, Pierret CR. 2001. Employer learning and statistical discrimination. *Q. J. Econ.* 116:313–50

Angrist J, Bettinger E, Bloom E, Kremer M, King E. 2002. The effect of school vouchers on students: evidence from Colombia. *Am. Econ. Rev.* 92:1535–58

Angrist J, Bettinger E, Kremer M. 2006. Long-term consequences of secondary school vouchers: evidence from administrative records in Colombia. *Am. Econ. Rev.* 96(3):847–62

Araujo MC, Carneiro P, Cruz-Aguayo Y, Schady N. 2016. Teacher quality and learning outcomes in kindergarten. *Q. J. Econ.* 131:1415–53

Arcidiacono P, Lovenheim M. 2016. Affirmative action and the quality-fit tradeoff. *J. Econ. Lit.* 54:3–51

Athey S, Stern S. 1998. *An empirical framework for testing theories about complementarity in organizational design*. NBER Work. Pap. 6600

Autor D, Dorn D, Katz LF, Patterson C, Van Reenen J. 2017. *The fall of the labor share and the rise of superstar firms*. NBER Work. Pap. 23396

Autor D, Levy F, Murname RJ. 2003. The skill content of recent technological change: an empirical exploration. *Q. J. Econ.* 118:1279–334

Autor DH. 2014. Skills, education, and the rise of earnings inequality among the 'other 99 percent'. *Science* 344:843–51

Autor DH, Katz LF, Kearny MS. 2006. The polarization of the U.S. labor market. *Am. Econ. Rev.* 96:189–94

Autor DH, Katz LF, Kearny MS. 2008. Trends in U.S. wage inequality: revising the revisionists. *Rev. Econ. Stat.* 90:300–23

Avery CN, Glickman ME, Hoxby CM, Metrick A. 2013. A revealed preference ranking of US colleges and universities. *Q. J. Econ.* 128:425–67

Banerjee A. 2007. Inside the machine: toward a new development economics. *Boston Rev.* 32:12–18

Barrow L, Sartain L, de la Torre M. 2017. *The role of selective high schools in equalizing educational outcomes: using place-based affirmative action to estimate heterogeneous effect by neighborhood socioeconomic status*. Unpublished manuscript, Fed. Reserve Bank Chicago

Bayer P, Ferreira F, McMillan R. 2007. A unified framework for measuring preferences for schools and neighborhoods. *J. Political Econ.* 115:588–638

Becker G. 1964. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. Chicago: Univ. Chicago Press

Bettinger E. 2011. Educational vouchers in international contexts. In *Handbook of the Economics of Education*, Vol. 4, ed. E Hanushek, S Machin, L Woessmann, pp. 551–72. Amsterdam: Elsevier

Bettinger E, Kremer M, Kugler M, Medina C, Posso C, Saavedra JE. 2017. *Can educational voucher programs pay for themselves?* Unpublished manuscript, Harvard Univ., Cambridge, MA

Bettinger E, Kremer M, Saavedra JE. 2010. Are educational vouchers only redistributive? *Econ. J.* 120:F204–28

Beuermann DW, Jackson CK. 2018. *Do parents know best? The short and long-run effects of attending the schools that parents prefer*. NBER Work. Pap. 24920

Black S. 1999. Do better schools matter? Parental valuation of elementary education. *Q. J. Econ.* 114:577–99

Black S, Devereux P. 2011. Recent developments in intergenerational mobility. In *Handbook of Labor Economics*, Vol. 4, ed. O Ashenfelter, D Card, pp. 1487–541. Amsterdam: Elsevier

Bohlmark A, Holmlund H, Lindahl M. 2015. *School choice and segregation: evidence from Sweden*. Work. Pap. 2015:8, Inst. Eval. Labour Market Educ. Policy, Uppsala, Swed.

Bohlmark A, Lindahl M. 2007. *The impact of school choice on pupil achievement, segregation and costs: Swedish evidence*. Work. Pap. 2786, IZA, Bonn, Ger.

Brasington D, Haurin D. 2006. Educational outcomes and house values: a test of the value added approach. *J. Reg. Sci.* 46:245–68

Bresnahan TF, Brynjolfsson E, Hitt LM. 2002. Information technology, workplace organization, and the demand for skilled labor: firm-level evidence. *Q. J. Econ.* 117:339–76

Browning M, Chiappori PA, Weiss Y. 2014. *Economics of the Family*. Cambridge, UK: Cambridge Univ. Press

Bui SA, Craig SG, Imberman SA. 2014. Is gifted education a bright idea? Assessing the impact of gifted and talented programs on students. *Am. Econ. J. Econ. Policy* 6:30–62

Burgess S, Greaves E, Vignoles A, Wilson D. 2015. What parents want: school preferences and school choice. *Econ. J.* 125:1262–89

Caldwell S, Harmon N. 2019. *Outside options, bargaining, and wages: evidence from coworker networks*. Unpublished manuscript, Univ. Copenhagen

Card D. 2001. Estimating the return to schooling: progress on some persistent econometric problems. *Econometrica* 69:1127–60

Card D, Cardoso AR, Heining J, Kline P. 2018. Firms and labor market inequality: evidence and some theory. *J. Lab. Econ.* 36:84–111

Card D, Devicienti F, Maida A. 2014. Rent-sharing, holdup, and wages: evidence from matched panel data. *Rev. Econ. Stud.* 81:84–111

Card D, Heining J, Kline P. 2013. Workplace heterogeneity and the rise of West German wage inequality. *Q. J. Econ.* 128:967–1015

Caroli E, van Reenen J. 2001. Skill-biased organizational change? Evidence from a panel of British and French establishments. *Q. J. Econ.* 116:1449–92

Chabrier J, Cohodes S, Oreopoulos P. 2016. What can we learn from charter school lotteries? *J. Econ. Perspect.* 30:57–84

Chakrabarti R. 2008. Can increasing private school participation and monetary loss in a voucher program affect public school performance? Evidence from Milwaukee. *J. Public Econ.* 92:1371–93

Cheshire P, Sheppard S. 2004. Capitalising the value of free schools: the impact of supply characteristics and uncertainty. *Econ. J.* 114:F397–424

Chetty R, Friedman JN, Hilger N, Saez E, Schanzenbach DW, Yagan D. 2011. How does your kindergarten classroom affect your earnings? Evidence from Project STAR. *Q. J. Econ.* 126:1593–660

Chetty R, Friedman JN, Rockoff J. 2014a. Measuring the impacts of teachers I: evaluating bias in teacher value-added estimates. *Am. Econ. Rev.* 104:2593–632

Chetty R, Friedman JN, Rockoff J. 2014b. Measuring the impacts of teachers II: teacher value-added and student outcomes in adulthood. *Am. Econ. Rev.* 104:2633–79

Chetty R, Friedman JN, Rockoff J. 2017a. Measuring the impacts of teachers: reply. *Am. Econ. Rev.* 107:1685–717

Chetty R, Friedman JN, Saez E, Turner N, Yagan D. 2017b. *Mobility report cards: the role of colleges in intergenerational mobility*. Unpublished manuscript, Stanford Univ., Stanford, CA

Chetty R, Hendren N, Kline P, Saez E. 2014c. *Where is the land of opportunity? The geography of intergenerational mobility in the United States*. NBER Work. Pap. 19843

Clark D. 2010. Selective schools and academic achievement. *B.E. J. Econ. Anal. Policy* 10:1935-1682

Cohodes SR. 2018. Charter schools and the achievement gap. *The Future of Children*, Winter. **https://futureofchildren.princeton.edu/news/charter-schools-and-achievement-gap**

Dale SB, Krueger AB. 2002. Estimating the payoff to attending a more selective college: an application of selection on observables and unobservables. *Q. J. Econ.* 117:1491–527

Dale SB, Krueger AB. 2014. Estimating the effects of college characteristics over the career using administrative earnings data. *J. Hum. Resourc.* 49:323–58

Davidoff I, Leigh A. 2008. How much do public schools really cost? Estimating the relationship between house prices and school quality. *Econ. Record* 84:193–206

Davis DR, Dingel JI. 2014. *The comparative advantage of cities*. NBER Work. Pap. 20602

Davis DR, Dingel JI. 2019. A spatial knowledge economy. *Am. Econ. Rev.* 109:153–70

de Ree J, Muralidharan K, Pradhan M, Rogers H. 2018. Double for nothing? Experimental evidence on an unconditional teacher salary increase in Indonesia. *Q. J. Econ.* 133:993–1039

Dobbie W, Fryer R. 2014. The impact of attending a school with high-achieving peers: evidence from New York City exam schools. *Am. Econ. J. Appl. Econ.* 6:58–75

Epple D, Romano R, Urquiola M. 2017. School vouchers: a survey of the economics literature. *J. Econ. Lit.* 55:441–92

Epple D, Romano R, Zimmer R. 2016. Charter schools: a survey of research on their characteristics and effectiveness. In *Handbook of the Economics of Education*, Vol. 5, ed. E Hanushek, S Machin, L Woessmann, pp. 139–208. Amsterdam: Elsevier

Epple D, Romano RE. 1998. Competition between private and public schools, vouchers, and peer-group effects. *Am. Econ. Rev.* 88:33–62

Fack G, Grenet J. 2010. When do better schools raise housing prices? Evidence from Paris public and private schools. *J. Public Econ.* 94:59–77

Farber HS, Gibbons R. 1996. Learning and wage dynamics. *Q. J. Econ.* 111:1007–47

Feigenberg B, Rivkin S, Yan R. 2014. *Illusory gains from Chile's targeted school voucher experiment*. NBER Work. Pap. 23178

Figlio D, Lucas M. 2004. What's in a grade? School report cards and house prices. *Am. Econ. Rev.* 94:591–604

Friedman M. 1955. The role of government in education. In *Economics and the Public Interest*, ed. RA Solo, pp. 124–44. New Brunswick, NJ: Rutgers Univ. Press

Gallego F, Hernando A. 2009. *School choice in Chile: looking at the demand side*. Unpublished manuscript, Pontif. Univ. Catol. Chile, Santiago

Gibbons S, Machin S. 2003. Valuing English primary schools. *J. Urban Econ.* 53:197–219

Gibbons S, Machin S. 2008. Valuing school quality, better transport and lower crime: evidence from house prices. *Oxf. Rev. Econ. Policy* 24:99–119

Gilraine M, Petronijevic U, Singleton JD. 2019. *Horizontal differentiation and the policy effect of charter schools*. Unpublished manuscript, New York Univ.

Granovetter MS. 1973. The strength of weak ties. *Am. J. Sociol.* 78:1360–80

Gundlach E, Woessman L, Gmelin J. 2001. What parents want: school preferences and school choice. *Econ. J.* 471:C135–47

Hanushek E. 1981. Throwing money at schools. *J. Policy Anal. Manag.* 1:19–41

Hanushek E. 1997. The productivity collapse in schools. In *Developments in School Finance*, ed. W Fowler, pp. 183–95. Washington, DC: Natl. Cent. Educ. Stat.

Hanushek EA, Kain JF, Rivkin SG, Branch GF. 2007. Charter school quality and parental decision making with school choice. *J. Public Econ.* 91:823–48

Hanushek EA, Woessmann L. 2010. Education and economic growth. In *Economics of Education*, ed. DJ Brewer, PJ McEwan, pp. 60–67. Amsterdam: Elsevier

Hastings J, Kane T, Staiger D. 2009. *Heterogeneous preferences and the efficacy of public school choice*. Unpublished manuscript, Brown Univ., Providence, RI

Hastings J, Weinstein J. 2008. Information, school choice, and academic achievement: evidence from two experiments. *Q. J. Econ.* 123:1373–414

Hoekstra M. 2009. The effect of attending the flagship state university on earnings: a discontinuity-based approach. *Rev. Econ. Stat.* 91:717–24

Hoekstra M, Mouganie P, Wang Y. 2018. Peer quality and the academic benefits to attending better schools. *J. Labor Econ.* 36:841–84

Hoxby C. 2000. Does competition among public schools benefit students and taxpayers? *Am. Econ. Rev.* 90:1209–38

Hoxby C. 2002. How school choice affects the achievement of public school students. In *Choice with Equity*, ed. P Hill, pp. 141–78. Stanford, CA: Hoover Press

Hoxby C. 2009. The changing selectivity of American colleges. *J. Econ. Perspect.* 23:95–118

Hoxby C, Avery C. 2012. *The missing 'one-offs': the hidden supply of high-achieving, low income students*. NBER Work. Pap. 18586

Hoxby C, Turner S. 2013. *Expanding college opportunities for high-achieving, low-income students*. Work. Pap. 12-014, Stanford Inst. Econ. Policy Res., Stanford, CA

Hoxby CM. 2003. School choice and school productivity: Could school choice be a tide that lifts all boats? In *The Economics of School Choice*, ed. CM Hoxby, pp. 287–41. Chicago: Univ. Chicago Press

Hoxby CM. 2016. *The productivity of U.S. postsecondary institutions*. NBER Work. Pap. 13875

Hsieh CT, Urquiola M. 2003. *When schools compete, how do they compete? An assessment of Chile's nationwide school voucher program*. NBER Work. Pap. 10008

Hsieh CT, Urquiola M. 2006. The effects of generalized school choice on achievement and stratification: evidence from Chile's school voucher program. *J. Public Econ.* 90:1477–503

Imberman S, Lovenheim M. 2016. Does the market value value-added? Evidence from housing prices after a public release of school and teacher value-added. *J. Urban Econ.* 91:104–21

Jackson CK. 2010. Do students benefit from attending better schools? Evidence from rule based student assignments in Trinidad and Tobago. *Econ. J.* 120:1399–429

Jackson CK, Johnson RC, Persico C. 2016. The effects of school spending on educational and economic outcomes: evidence from school finance reforms. *Q. J. Econ.* 131:157–218

Kahn SR. 2011. *Privilege: The Making of an Adolescent Elite at St. Paul's School*. Princeton, NJ: Princeton Univ. Press

Kaufmann KM, Messner M, Solis A. 2013. *Returns to elite higher education in the marriage market: evidence from Chile*. Unpublished manuscript, Bocconi Univ., Milan, Italy

Kraft M. 2019. Teacher effects on complex cognitive skills and socio-emotional competencies. *J. Hum. Resourc.* 54:1–36

Krueger AB, Summers LH. 1988. Efficiency wages and the inter-industry wage structure. *Econometrica* 56:259–94

Lafortune J, Rothstein J, Schanzenbach D. 2018. School finance reform and the distribution of student achievement. *Am. Econ. J. Appl. Econ.* 10:1–26

Lemieux T. 2006. The "Mincer equation" thirty years after *Schooling, Experience, and Earnings*. In *Jacob Mincer, A Pioneer of Modern Labor Economics*, ed. S Grossbard, pp. 127–45. Berlin: Springer

Liptak A. 2009. On the bench and off, the eminently quotable Justice Scalia. *The New York Times*, May 11. **https://www.nytimes.com/2009/05/12/us/12bar.html**

Lucas A, Mbiti I. 2014. Effects of school quality on student achievement: discontinuity evidence from Kenya. *Am. Econ. J. Appl. Econ.* 6:234–63

Machin S. 2011. Houses and schools: valuation of school quality through the housing market. *Labor Econ.* 18:723–29

MacLeod WB, Riehl E, Saavedra JE, Urquiola M. 2017. The big sort: college reputation and labor market outcomes. *Am. Econ. J. Appl. Econ.* 9:223–61

MacLeod WB, Urquiola M. 2015. Reputation and school competition. *Am. Econ. Rev.* 105:3471–88

McEwan P. 2004. The potential impact of vouchers. *Peabody J. Educ.* 79:57–80

McEwan P, Urquiola M, Vegas E. 2008. School choice, stratification, and information on school performance. *Economia* 8:1–42

McMillan P. 2005. Competition, incentives, and public school productivity. *J. Public Econ.* 89:1131–54

Mincer J. 1974. *Schooling, Experience and Earnings*. New York: Columbia Univ. Press

Mizala A, Romaguera P, Urquiola M. 2007. Socioeconomic status or noise? Tradeoffs in the generation of school quality information. *J. Dev. Econ.* 84:61–75

Mizala A, Urquiola M. 2013. Parental choice and school markets: the impact of information on school effectiveness. *J. Dev. Econ.* 103:313–35

Moon TS. 2018. *Access to local amenity and housing prices*. Tech. Rep., Princeton Univ., Princeton, NJ

Moretti E. 2004. Workers' education, spillovers and productivity: evidence from plant-level production functions. *Am. Econ. Rev.* 94:656–90

Moretti E. 2011. Local labor markets. In *Handbook of Labor Economics*, Vol. 4B, ed. D Card, O Ashenfelter, pp. 1237–313. Amsterdam: Elsevier

Muralidharan K, Sundararaman V. 2015. The aggregate effect of school choice: evidence from a two-stage experiment in India. *Q. J. Econ.* 130:1011–66

Navarro-Palau P. 2017. Effects of differentiated school vouchers: evidence from a policy change and date of birth cutoffs. *Econ. Educ. Rev.* 58:86–107

Neckerman K, Torche F. 2007. Inequality: causes and consequences. *Annu. Rev. Sociol.* 33:263–83

Neilson C. 2017. *Targeted vouchers, competition among schools, and the academic achievement of poor students*. Unpublished manuscript, Princeton Univ., Princeton, NJ

Oreopoulos P, von Wachter T, Heisz A. 2012. The short- and long-term career effects of graduating in a recession. *Am. Econ. J. Appl. Econ.* 4:1–29

Park A, Shi X, Hsieh CT, An X. 2008. *Does school quality matter? Evidence from a natural experiment in rural China*. Unpublished manuscript, Univ. Chicago

Pop-Eleches C, Urquiola M. 2013. Going to a better school: effects and behavioral responses. *Am. Econ. Rev.* 103:1289–324

Pritchett L. 2009. The policy irrelevance of the economics of education: Is 'normative as positive' just useless, or is it worse? In *What Works in Development? Thinking Big and Thinking Small*, ed. J Cohen, W Easterly, pp. 130–64. Washington, DC: Brookings Inst. Press

Riehl E. 2018. *Fairness in college admission exams: from test score gaps to earnings inequality*. Unpublished manuscript, Cornell Univ., Ithaca, NY

Riehl E, Saavedra J, Urquiola M. 2016. *Learning and earning: college output, value added, and socioeconomic status*. Unpublished manuscript, Columbia Univ., New York

Rivera LA. 2015. *Pedigree: How Elite Students Get Elite Jobs*. Princeton, NJ: Princeton Univ. Press

Rockoff JE, Jacob BA, Kane TJ, Staiger DO. 2011. Can you recognize an effective teacher when you recruit one? *Educ. Finance Policy* 6:43–74

Rosen S. 1981. The economics of superstars. *Am. Econ. Rev.* 71:845–58

Rosenthal M. 2006. *Nicholas Miraculous: The Amazing Career of the Redoubtable Dr. Nicholas Murray Butler*. New York: Farrar Strauss Giroux

Rothstein J. 2006. Good principals or good peers: parental valuation of school characteristics, Tiebout equilibrium, and the incentive effects of competition among jurisdictions. *Am. Econ. Rev.* 96:1333–50

Rothstein J. 2007. Does competition among public schools benefit students and taxpayers? Comment. *Am. Econ. Rev.* 95:2026–37

Rothstein J. 2017. Measuring the impact of teachers: comment. *Am. Econ. Rev.* 107:1656–84

Rouse CE, Barrow L. 2009. School vouchers and student achievement: recent evidence and remaining questions. *Annu. Rev. Econ.* 1:17–42

Saavedra J. 2009. *The learning and early labor market effects of college quality: a regression discontinuity analysis*. Unpublished manuscript, Harvard Univ., Cambridge, MA

Tiebout C. 1956. A pure theory of local expenditures. *J. Political Econ.* 64:416–24

Urquiola M. 2005. Does school choice lead to sorting? Evidence from Tiebout variation. *Am. Econ. Rev.* 95:1310–26

Urquiola M. 2016. Competition among schools: traditional public and private schools. In *Handbook of the Economics of Education*, Vol. 5, ed. E Hanushek, S Machin, L Woessmann, pp. 209–37. Amsterdam: Elsevier

Valenzuela J, Bellei C, De Los Rios D. 2013. Socioeconomic school segregation in a market-oriented educational system: the case of Chile. *J. Educ. Policy* 29:217–41

Van Reenen J. 1996. The creation and capture of rents: wages and innovation in a panel of U.K. companies. *Q. J. Econ.* 111:195–226

von Wachter T, Bender S. 2006. In the right place at the wrong time: the role of firms and luck in young workers' careers. *Am. Econ. Rev.* 96:1679–705

Walters CR. 2018. The demand for effective charter schools. *J. Political Econ.* 126:2179–223

Weinstein R. 2017. *Geography and employer recruiting*. Tech. Rep. 11224, IZA, Bonn, Ger.

Zimmerman S. 2016. *Making the one percent: the role of elite universities and elite peers*. NBER Work. Pap. 22900

Annual Review of Economics

Volume 11, 2019

Contents

Symposium: Universal Basic Income

Indexes

Errata

An online log of corrections to *Annual Review of Economics* articles may be found at http://www.annualreviews.org/errata/economics