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IS EDUCATION CONSUMPTION OR INVESTMENT? IMPLICATIONS FOR THE EFFECT OF SCHOOL COMPETITION

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ABSTRACT

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Abstract

Many observers have argued that giving parents freedom to choose schools would improve education (Friedman, 1955). We review the evidence, and find little indication that households systematically prefer higher value added schools. We show that this can be explained using a competitive labor market model that takes into account both student and employer choice. The setup implies that households will often rationally prefer schools with high absolute achievement rather than high value added. As a result, school choice can exacerbate inequality without improving opportunities for the most disadvantaged students.

1 Introduction

Friedman (1955) argued that giving parents more freedom to choose schools would improve education. His idea proved influential in part due to mounting evidence of problems with schools' productivity. For example, Hanushek (1986, 1997) showed that school systems can increase spending with little to show for it in terms of testing improvements.[1] Hoxby (2003) summarized the implications to argue that choice could have a major impact, leading the average student in the U.S. to score "at an advanced level where fewer than 10 percent of students now score."

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

[1]Hanushek's finding was for the U.S.; Pritchett (2003) presents 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.

However, a growing body of research suggests that the impact of choice on educational outcomes is mixed and often muted. To cite one example, results with voucher experiments suggest choice can have highly positive or negative effects on test scores (see Bettinger et al., 2017 and Abdulkadiroglu et al. 2018, respectively), and that they are most often modest (Epple et al., 2017). Considering analogous evidence, Beuermann and Jackson (2018) observe that given earlier predictions, "the lack of robust achievement effects of attending schools that parents prefer is something of a puzzle."

The purpose of this paper is to review research and show that this result is consistent with a competitive labor market model that takes into account both student and employer choice. The model is based upon three ingredients. First, education is an investment in human capital (Becker, 1964, Mincer, 1974). Hence, 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*. That is, individuals of a given skill level may receive higher wages if they match to more productive firms (e.g. Card et al., 2018). Hence, 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 schools produce. While most towns contain many schools, households often prefer those close to home (e.g. Abdulkadiroglu et al., 2017). Similarly, firms may opt to recruit at nearby schools (Weinstein 2017), or at those they expect to yield many candidates of the type they seek. Firms' concern for distance may also be endogenous to household preferences; for example, if high ability students live in a certain area and prefer a certain school, firms may in turn prefer to recruit there. While our setup focuses on labor markets, similar considerations arise in other venues in which human capital is valued, e.g. marriage markets or college admissions after high school.

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 the overall production of 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). Hence, a rational, income maximizing household 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, households prefer schools that produce good final outcomes—like those that place students into the best jobs. However, in some scenarios these may not be the schools with the greatest value added in terms of skill. In the second part of the paper we review a large empirical literature on school choice and show it is consistent with these results.[2] In particular, one can summarize a large part of this literature as showing that:

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 terms of skill.

In short the evidence is consistent with the hypothesis that schools supply a bundled commodity—they provide both skills *and* access to employers. As a result, choice alone is too crude a mechanism to ensure the effective provision of school services. Jurisdictions may need to consider more nuanced policies in order to enhance school performance and labor market outcomes.

This paper 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), and Abdulkadiroglu et al. (2017).

We also bring together work on labor and education, making the case that thinking of education as investment helps to understand school markets. Much work in labor economics focuses on estimating the returns to an additional year of schooling (Card, 2001; Lemieux, 2006). We focus instead on the return to attending different schools, and the implications this has on the effects of school competition. This relates to theoretical and empirical work on the returns to school identity, e.g. Hoekstra (2009), Saavedra (2009), Chetty et al. (2014b), MacLeod and Urquiola (2015), and 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 and Devereux, 2011; Autor, 2014; Chetty et al., 2014; and Chetty et al., 2017). We note that if schools help allocate students to jobs, 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 paper is organized as follows. Section 2 presents our model, and Section 3 discusses the empirical literature. Section 4 discusses implications and Section 5 concludes.

2 School Choice and the Labor Market

This section explores the implications of integrating employer choice with school choice. The development here is descriptive, with technical details and results relegated to the appendix.

[2]Due to space limitations we do not provide a comprehensive review of the literature on school competition, but rather focus on papers that address these two implications. We note that there are multiple recent reviews available. For instance, see Epple et al. (2017) on vouchers, Epple et al. (2016) on charter schools, and Urquiola (2016) on school competition generally. Earlier reviews include McEwan (2004), Rouse and Barrow (2009), and Bettinger (2011).

2.1 Setup

Suppose 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 can, in principle, serve all students in both districts. Students who cross the district boundary to attend school, however, must pay a cost C—the motivation being that households usually prefer schools close to home.[3] This cost can be set high enough so all parents use their home school. We will 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 will 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 will assume that $\rho_A > \rho_B$ and $v_B > v_A$. 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 important 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 U.S., or between low and high socioeconomic status students in many countries).[4] This implies that in terms of their skill levels, there are four types of graduates, $\{\alpha_H, \alpha_L\} \times \{A, B\}$:

$$\theta_{HB} > \theta_{HA} > \theta_{LB} > \theta_{LA}, \tag{2.1}$$

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 $\frac{1}{\gamma}$, where $\gamma \in [0, 1]$. Thus, γ measures the variation in firm quality. When $\gamma = 0$, all employers are equally productive.

[3] The literature provides ample evidence of such a preference. See for example Bayer et al. (2007), Gallego and Hernando (2009), Hastings et al. (2009), Abdulkadiroglu et al. (2017), Neilson (2017), and Walters (2018).

[4] 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:

$$w(\theta, \beta) = \beta\theta. \tag{2.2}$$

This equation illustrates that in the standard neo-classical 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. Hence, a rational student's school choice will depend on how he *believes* 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 these cases beliefs as to other agents' valuations will guide students' decisions.[5]

This might not be a major consideration 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.[6] As 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.[7] 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 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 and Avery (2013) describe college admissions officers' visits to high schools. They state that while there are about forty thousand high schools in the U.S., a college whose staff visits one hundred "is considered to be exceptionally dedicated and well-funded." Those they visit most are typically "feeder" schools known to produce many applicants. As stated, 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.[8]

[5]Browning et al. (2014).

[6]For example, the absence of search frictions produces this type of assortative result in terms of careers in Rosen (1981).

[7]Card et al. (2013) and Card et al. (2018) build upon Abowd et al. (1999) to demonstrate the empirical importance of firm matches for compensation (see also Card et al., 2014). Further, von Wachter and 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 or not 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 over time; see for example Acemoglu and Autor (2011) and Autor et al. (2008).

[8]These considerations are obviously related to geography. Since distance is a key driver of school choice, as long a there is residential sorting there will also be educational sorting along dimensions like ability or socioeconomic status. There is also a growing literature that shows the existence of significant labor market returns to location; see Moretti (2010) for a review. See also Davis and Dingel (2014) for theory and evidence.

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 its graduates are likely to face.

Henceforth 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.

2.2 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.

2.2.1 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 school B (the high value added school). Hence 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).[9] 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.

[9] Hoxby (2002) and others have argued 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 Hsieh and Urquiola (2003) point out that if school choice leads to sorting, these channels are empirically very hard to disentangle. In addition, McMillan (2005) shows that if schools' effort is endogenous to the type of student they attract (e.g. high or low income), it does not immediately follow that competition will put pressure on school A to improve.

This is a formal statement of Friedman's result (proofs and further details are in the appendix).[10] The intuition behind it is that given perfect matching, schools' ability to deliver skills and deliver jobs are perfectly aligned. In this case, households will choose schools as if skills were the only thing that mattered.

2.2.2 Case 2: Perfect information and capacity constraints

We continue to assume that information is perfect and symmetric, but now suppose that there are capacity constraints: each school can handle only half 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.[11] In this case we also simplify the analysis by supposing that $C = 0$ and $\rho_A + \rho_B = 1$ (the appendix 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 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 hence 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:

$$\gamma \geq 2\frac{v_B - v_A}{\alpha_H + v_A}. \tag{2.3}$$

In other words, as long as the variance in firm productivity (γ)—and hence in the returns to skill—is sufficiently large, then high ability students will prefer school A.[12] 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

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

[11] In many cities students can access "magnet" public schools if they score high enough on a test (e.g., Pop-Eleches and Urquiola, 2013; Abdulkadiroglu et al., 2014). Lotteries are also commonly used to determine access; for example by charter schools in the U.S. (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.

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

success, they are willing to trade off schools' performance in one dimension for the other.[13] 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 ($\alpha_H - \alpha_L > v_B - v_A$), 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 all low ability students choose school B, while their high ability counterparts choose A. As long as condition (2.3) 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 would get matched with the lowest productivity firm, which at this equilibrium has $\beta = 1$. This student's expected payoff at school B is $\left(1 - \frac{\gamma}{2}\right)(\alpha_L + v_B)$. Hence, under a random admission process, this student prefers school B to school A if and only if:

$$\gamma \leq 2\frac{v_B - v_A}{\alpha_L + v_B}. \tag{2.4}$$

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 random allocation if and only if:

$$2\frac{v_B - v_A}{\theta_{LB}} \geq \gamma \geq 2\frac{v_B - v_A}{\theta_{HA}}. \tag{2.5}$$

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.

2.2.3 Case 3: No capacity constraints, imperfect information

The final case is one without capacity constraints but with imperfect information. Specifically, we assume 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.

[13] This type of result is also possible in the model presented by MacLeod and 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 schools' ability to impart skills and deliver high earnings.

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 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 the appendix we show that this result depends in part upon having sufficiently high returns to skill (γ sufficiently high). 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 the appendix). The low skill workers left in school B have the worst job opportunities, since the most productive firms choose to recruit at school A. Hence, in this case increasing competition might lead to worse outcomes for students in less desirable areas, increasing inequality.

3 Evidence

The above model provides a way to organize the evidence on school choice, which we review in this section. We do not provide an exhaustive accounting of the research due to space constraints and the availability of recently published reviews.[14]

The essential finding from Section 2 is that, depending upon 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 upon the quality of the match they subsequently make in the labor market (or the marriage market, or later educational arenas like graduate school admissions). As a result, households are willing to trade off a school's ability to deliver: i) value added in terms of skills, and ii) 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. This is consistent with the existing empirical research. In particular in this section we review two findings that emerge from the literature:

1. There is clear evidence that households prefer schools that have higher levels of absolute achievement.

[14] See for example Epple et al. (2017) on vouchers, Epple et al. (2016) on charter schools, and Urquiola (2016) on competition more generally. For earlier review see also McEwan (2004), Rouse and Barrow (2009), and Bettinger (2011).

2. There is much less evidence that households systematically prefer schools with higher value added in the production of skill.

These matter because the importance of what actually drives parental choice has been noted by multiple authors over the years, e.g., Hanushek (1981), Rothstein (2006), and Abdulkadiroglu et al. (2017). The next subsections cover each of these findings, and a final one brings some implications together.

3.1 Households prefer schools with higher absolute achievement

Research has found clear evidence that households prefer schools that have higher levels of absolute achievement. For example, schools with high tests scores or graduation rates, or schools that successfully place students into the next educational stage (e.g., high schools that produce good college placements).

It is important to be clear that different measures of final achievement are typically correlated with each other, and with various measures of peer quality (e.g. parental income) and school resources (e.g. class sizes). Thus when we say that households prefer schools with higher achievement we refer to a whole vector of inputs and outputs the elements of which are typically positively correlated. In general, isolating a preference for any particular element of that vector is challenging.

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 and Weinstein (2008) provide a randomly selected subset of households in North Carolina with information on the absolute testing outcomes of schools 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 type of study considers whether families are willing to pay more for houses that allow their children to attend public schools with higher absolute 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, the United Kingdom, and the United States.[15]

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 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 China

[15] On Australia see Davidoff and Leigh (2008). On France see Fack and Grenet (2010). On the United Kingdom see Gibbons and Machin (2003), Cheshire and Sheppard (2004), Rosenthal (2006), and Gibbons and Machin (2008). On the U.S see Brasington and Haurin (2006) and Bayer et al. (2007), and also Figlio and Lucas (2004). For further discussion on this literature, see the review by Machin (2011).

(Hoekstra et al., 2018), New York City (Abdulkadiroglu et al., 2014 and Dobbie and Fryer, 2014), and Romania (Pop-Eleches and Urquiola, 2013).[16]

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 is allowed to respond. These settings can be informative about household preferences, even if somewhat indirectly. Theoretical models suggest that if households have preferences for attributes correlated with absolute achievement, then in these settings stratification will develop. For example, the rich or the highly able will tend to segregate into schools with similar individuals. To illustrate, Epple and Romano (1998) show this will be the outcome when families prefer good peers because of learning externalities. MacLeod and Urquiola (2015) present a similar result arising from informational concerns—students prefer to be pooled with high ability peers because this reveals they themselves are able. Consistent with these predictions, Hsieh and Urquiola (2006) suggest that the introduction of unrestricted vouchers in Chile led to substantial sorting by attributes such as household income. In addition, Valenzuela et al. (2013) show that Chile displays one of the highest levels of school level stratification in the OECD.[17] The patterns of stratification are less marked in the case of Sweden's nationwide voucher scheme, although they have become more so over time. For example, Bohlmark and Lindahl (2007) find little evidence that Swedish households used vouchers to segregate, but Bohlmark et al. (2015) find greater evidence evidence of such an effect.[18]

Finally a fifth type of study presents evidence of such stratification at higher educational levels. For instance, Hoxby (2009) shows that over several decades the U.S. college market developed a greater amount of sorting by SAT scores. Hoxby argues that decreasing transportation and information-related costs allowed students to exercise greater choice between colleges. This resulted in greater sorting such that, for example, the specific college a students attends has come to convey more precise information as to his or her SAT score. MacLeod et al. (2017) present evidence that a similar process is taking place in the country of Colombia, which also features a relatively *laissez-faire* university market.

3.2 Less evidence of a preference for value added in the production of skill

There is much less evidence that households systematically prefer schools with higher value added in the sense of causally raising skill levels. This is also seen from multiple approaches.

A first set of papers shows that when households are given vouchers enabling them to use private schools, the impact on their children's outcomes is sometimes positive and large,

[16] An analogous pattern also emerges for colleges in the U.S. (Avery et al., 2013).

[17] In addition, Mizala et al. (2007) suggest stratification is particularly extensive in the private sector. See also McEwan et al. (2008).

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

sometimes negative and large, and most often modest in magnitude. For example, a series of papers suggest Colombia's voucher program was highly beneficial to students (Angrist et al., 2002; Angrist et al., 2006; and Bettinger et al. 2010). In fact one recent study suggests that it more than paid for itself (Bettinger et al., 2017).[19] In stark contrast, Abdulkadiroglu et al. (2018) suggest that a voucher program in Louisiana substantially reduced students' achievement. A large number of studies lie in between these two, with the majority suggesting that vouchers have zero or modest effects (Epple et al., 2017). This also applies to charter schools, where some are found to substantially outperform public alternatives, and some to do worse (Epple et al., 2016). In addition, there is evidence that charter schools are more sought after by families for whom their causal effect is smaller (Abdulkadiroglu et al., 2016; Walters, 2018).

A second and rapidly growing literature compares students who just gain admission to selective schools with those who just miss doing so. This work mainly considers public school settings in which households exert effort to get their children into selective institutions. This effort can take the form of private tutoring in preparation for admissions exams, or of a willingness to have children travel further to attend such schools. These studies similarly produce mixed and modest findings. Some papers find positive effects of having access to a higher-ranked school (e.g. Hoekstra, 2009, Jackson, 2010, and Pop-Eleches and Urquiola, 2013). Some find negative effects for certain subgroups (e.g. Barrow et al., 2017; Beuermann and Jackson, 2018). In between some also point to zero, modest, or mixed effects (e.g. Park et al., 2008; Clark, 2010; Abdulkadiroglu et al., 2014; Ajayi, 2014; Bui et al., 2014; Dobbie and Fryer, 2014; Lucas and Mbiti, 2014).

A third set of studies considers the impact of information on value added, providing a useful counterpoint to the effect of information and housing valuations discussed in Section 3.1. For instance, Imberman and Lovenheim (2016) consider the release of information on value added on housing valuations in Los Angeles. This arguably provided new information, as schools' value added and absolute achievement have been shown to not be perfectly correlated in some markets.[20] Imberman and Lovenheim find that the information had little if any effect on housing valuations. Similarly, Mizala and Urquiola (2013) consider a Chilean program that publicly identified schools that outperformed peers with similar socioeconomic compositions, providing parents with a proxy for schools' value added. They find that the school market essentially did not react to such information: schools' market shares, prices, and socioeconomic composition were unaffected.

A fourth type of study analyzes parental preferences in school choice mechanisms, providing a useful contrast with literature reviewed above. Specifically, the question here is whether the schools parents request suggest that they prefer schools with higher value added, *over and above* their valuation of peer quality. Abdulkadiroglu et al. (2017) use data from New York City to suggest this is not the case; that is parents do not prefer schools with higher value added, once peer quality is controlled for. Related to this is also Rothstein (2006), who

[19]Illustrating that rigorous research does not always drive policy, the voucher program was terminated only a few years after its inception; the continued stream of papers are follow up studies on the original samples of voucher users.

[20]See for instance Abdulkadiroglu et al. (2014).

points out that if parents demand school value added, a school's peer group quality (i.e. its absolute achievement) will be correlated with its valued added in a housing market equilibrium. This induces an upward bias in cross-sectional peer effects estimates, particularly in markets with greater school choice. Rothstein however, 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.

Thus, consistent with the rational choice model in Section 2, parents and students do not appear to always rank schools based upon value added in skill production. These results are consistent with the hypothesis that education is not a simple consumption good, and that its investment components lead households to consider schools' ability to produce outcomes in other dimensions.

3.3 Other explanations

A key point that emerges from our model and from the evidence is that households may be relatively insensitive to (skill-related) value added measures. While we have put forth a hypothesis for why, there are other possibilities. One is that school value added as conventionally measured might not be relevant for labor market success. Recent work by Chetty et al. (2014a,b) suggests, however, that this is not the case. It uses administrative data including tax records to show that school and teacher value added does contribute to labor market outcomes (note that this is the maintained assumption in our formal example).[21]

Another possibility is that households may be unable to 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, or they may be unable to isolate these quantities—after all, this is challenging even for econometricians with access to a lot of data.[22] Our example shows that is not necessary; even if households understand/observe value added, they may still opt for lower value added schools. The crucial element is that some schools are more likely to put graduates in line for employment with high productivity firms. This in turn originates in the fact that employers seek high skill graduates, without regard for whether their skill originates in innate ability or value added.

4 Implications

Our simple model illustrates that in some sense what one has is a coordination problem. If high ability students were able to coordinate on a move, they would migrate to a higher value added school. But frictions of different types render this unlikely. A salient one emerges because there is likely to be persistence, for example, in the schools that firms recruit from. This might stem from proximity along geographical or other dimensions.[23] In either case,

[21] See also Chetty et al. (2011).

[22] See for instance the discussions in Rothstein (2017) and Chetty et al. (2017).

[23] Firms' attachment to specific locations may be persistent. For discussions of issues on the geographic location of economic activity see Moretti (2004).

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) American 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 hence to an increasing desire by students to enroll there. In short, school segregation is an equilibrium outcome that may be influenced by the job market itself.

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:[24]

> 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 depends upon the productivity of the firms 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) may be partially developed at school.

Analogous match effects can also 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/spouse quality, and Zimmerman (2016) shows that school selectivity can affect the probability that students end up on prestigious corporate boards. In addition, Arcidiacono and 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 U.S. there is evidence of increasing skill biased technical change (Autor et al., 2003; Autor et al., 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,

[24]See http://www.nytimes.com/2009/05/12/us/12bar.html

enhancing the role of the school sector in the intergenerational transmission of inequality.[25] Related, 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.[26]

Note that our theoretical results rely upon the hypothesis that students understand their skill and choose schools accordingly. However, Hoxby and Turner (2013) find that this is 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 hence 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 and 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 "pond" of potential employers or spouses or 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.

5 Conclusion

Friedman (1955) argued that introducing choice and competition would enhance education, an idea many have echoed (e.g., Chubb and Moe, 1990). 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 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 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.

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

[26] 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.

On the one hand, the argument we have made in this review is consistent with Banerjee's. 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 paper shows that all one needs are: i) the idea that education is partially an investment rather than just consumption, and ii) 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. We provide a further reason for concern on this front. In many cases schools may simply not be under intense competitive pressure to become better producers of skill, and this will tend to limit their readiness to create or take up innovations.

We highlight three areas for further research. First, to the extent that human capital can be viewed as an asset, then care must go into educational market design, just as regulation has turned out to be important in the case of financial markets. For example, work on how to best design competition and information policies such that they lead schools to improve their value added would be useful. Second, additional insights regarding the determinants of school choice (e.g. value added vs. absolute achievement) are relevant. Third, the nexus between education/schools and the labor market is one on which more could be usefully known. For example, knowledge in this area would further elucidate how interactions between the school and the labor market can contribute to the intergenerational transmission of inequality.

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A Model Details and Results

This section provides the details for the model and results discussed in Section 2. 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.[27] 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 corresponds to 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 its students.[28] 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 B 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. But 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.

[27] This can be a realistic assumption 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 see Pop-Eleches and Urquiola (2013) and Abdulkadiroglu et al. (2014); at the college level see Hoekstra (2009) and Riehl (2018).

[28] 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 for instance Chetty et al. (2014a).

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:

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

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 U.S., or between low and high socioeconomic status students in many countries).[29] Thus our setup has four student types $t \in \{H, L\} \times \{A, B\}$ with skill $\theta_{ks} = \alpha_k + v_s$ such that:

$$\theta_{HB} > \theta_{HA} > \theta_{LB} > \theta_{LA}, \tag{A.1}$$

where student type is indexed by:

$$t \in T = \{H, L\} \times \{A, B\}.$$

In short, 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 will be 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.[30]

To introduce elements of competition we assume that students can attend the school within their jurisdiction for free. If they enroll outside their jurisdiction, they must pay a cost C. For example, 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 will assume that a set of firms hire school 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 there is a return to skill that is greater at higher productivity firms. Formally, the expected wage paid to an individual hired by a firm of type β is:

$$w_{t\beta} = \beta\theta_t, \tag{A.2}$$

In words, all else equal firms prefer graduates with high innate ability, and all else equal they prefer graduates who benefited from high school value added. This is simply the ordering of skill levels.

Finally, we assume that the sequence of decisions is as follows:

[29] 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.

[30] See for instance Abdulkadiroglu et al. (2014).

1. Each student i chooses a school $s(i) \in \{A, B\}$. If he chooses the school outside his jurisdiction, 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 upon expectations. We assume throughout that both students and employers have correct expectations in equilibrium.

A.1 Full information case

As a benchmark, we begin with a full information case in which student ability is fully observed by all agents.[31] 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 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.

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 highest productivity firms: $\beta \in [1 + \gamma(1 - \rho_B), 1 + \gamma] = I^{\beta}_{HB}$.*

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 $\beta \in [1 - \gamma, 1 - \gamma\rho^A]$.*

[31] In general it is not the case that firms can observe everything about applicants. See MacLeod and Urquiola (2015) for a discussion.

In short, when there is perfect information employers prefer the graduates of schools with higher value added, although only the high ability 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, they know that it will be targeted by the highest productivity firms.[32] 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 2.2.1. We now show that the presence of perfect information is crucial to this result.

Consider the case in which schools are has a capacity of one, equal to the number of students in their district. In that case schools must have a method to select students when there is excess demand. One method is for schools to use selective admissions. When the education market is perfectly competitive then there is an equilibrium at which all the high ability students attend school B. The question is whether or not it is efficient.

Proposition 3. *Suppose schools are selective, and each have a capacity of* 1*, then when there the variation in firm productivity is sufficiently high there exists a competitive equilibrium at which all high ability students prefer school A over school B. More precisely:*

1. *When the number of high ability schools is less than the capacity of a single school ($\rho_A + \rho_B \leq 1$) and firm productivity variance satisfies $\gamma \geq \frac{v_B - v_A}{((\rho_A+\rho_B)\theta_{HA} - (1-\rho_A-\rho_B)(v_B - v_A))}$.*
2. *When the number of high ability students is more than the capacity of a single school ($\rho_A + \rho_B > 1$) and $\gamma \geq \frac{2(v_B - v_A)}{((\rho_A+\rho_B-1)v_B + v_A + \alpha_H(\rho_A+\rho_B))}$.*

Proof. Consider first the case $\rho_A + \rho_B \leq 1$ and suppose all high ability students choose to attend school A, which given selective admissions, that 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 recruit at school B (since $\theta_{LB} > \theta_{LA}$). Ex ante, high ability students do not know with which firm they will match, and hence their expected return from choosing School A is:

$$\left(1 + \gamma\left(1 - \frac{\rho_A + \rho_B}{2}\right)\right)\theta_{HA}$$

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

If a high ability student chooses school B she will be matched with the best firm available, and will get:

$$(1+\gamma(1-\rho_A-\rho_B))\theta_{HB}.$$

A high ability student will choose school A over school B if and only if:

$$\gamma \geq \frac{v_B - v_A}{((\rho_A+\rho_B)\,\theta_{HA} - (1-\rho_A-\rho_B)\,(v_B-v_A))}.$$

Suppose that now that $\rho_A+\rho_B>1$. In that case the payoff from school A is:

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

and the payoff from school B is:

$$(1+1-\gamma\,(\rho_A+\rho_B-1))\,/2\times\theta_{HB} = \left(1-\gamma\frac{(\rho_A+\rho_B-1)}{2}\right)\theta_{HB}.$$

In that case school A is preferred over school B by high ability individuals when:

$$\gamma \geq \frac{2\,(v_B-v_A)}{((\rho_A+\rho_B)\,(\alpha_H+v_B)-(v_B-v_A))} = \frac{2}{((\rho_A+\rho_B)\,(\alpha_H+v_B)\,/\,(v_B-v_A)-1)}$$

□

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 the high ability students.

Finally, note that charter schools use random assignment to mitigate the effects of sorting. This also may not work to direct demand towards 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 the high productivity firms recruit from school A, while the low productivity recruit from school B. For this to be an equilibrium we just need that the students do not wish to swap schools. For high ability students this requires that :

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

or:

$$\gamma \geq \frac{2(v_B-v_A)}{\alpha_H+v_A}. \tag{A.3}$$

In the case of the low quality ability students we need:

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

or:

$$\gamma \leq \frac{2(v_B-v_A)}{\alpha_L+v_B}. \tag{A.4}$$

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 later condition is our maintained assumption that the variation in skill is greater than the variation in value added, hence there are γ satisfying (A.3-A.4) for 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 admission 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 2.2.2.

A.2 Imperfect Information Case

In practice firms cannot perfectly observe workers' skill or ability.[33] Now suppose that employers can only observe the *average* skill of students at a school, and cannot disentangle value added from innate ability.[34] To explore this setting, we will 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:

$$\hat{\theta}^A \left(1 - \rho_A, \rho_A\right) > \hat{\theta}^B \left(1 - \rho_A, \rho_A\right). \tag{A.5}$$

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

$$\hat{w}\left(\beta, s\right) = \beta \hat{\theta}_s. \tag{A.6}$$

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

[33] This is the subject of the "employer learning" literature. See for instance Farber and Gibbons (1996) and Altonji and Pierret (2001).

[34] 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 for instance Rockoff et al. (2011) and 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.

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, then when $\hat{\theta}^A > \hat{\theta}^B$, 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 $\beta \in \left[\beta^A, 1 + \gamma\right]$ 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 $\hat{\beta}^B \left(n_L^A, n_H^A\right) = \hat{\beta}^A \left(n_L^A, n_H^A\right) - \gamma$.

Students' choice depends upon 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 $\gamma < 1$ then if the value added of school B is sufficiently high this term is negative, and hence in the absence of moving costs students would prefer school B.

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

Proposition 4. *Suppose 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*

$$C > D(\alpha_H, 1-\rho_A, \rho_A). \tag{A.7}$$

Then it is an equilibrium for students to chose 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 $D()$ 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 for v_B 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:*

$$D(\alpha_H, 1-\rho_A, \rho_A+\rho_B) > C > D(\alpha_L, 1-\rho_A, \rho_A+\rho_B), \tag{A.8}$$

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

Proof. Since $D()$ is increasing in α then we know there exists C satisfying (A.8). The allocation $\left\{n_H^A, n_L^A\right\} = \{\rho_A+\rho_B, 1-\rho_A\}$ corresponds to all high ability students going to school A, while low ability students stay at their respective schools. Now condition (A.8) 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. □

Thus 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 value added and the distribution of returns to skill satisfy:*

$$\gamma(\alpha_L + v_B) > v_B - v_A > 0, \tag{A.9}$$

then for costs C satisfying:

$$D(\alpha_L, \rho_A+\rho_B, 2-\rho_A-\rho_B) > C \geq 0, \tag{A.10}$$

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

Proof. Condition (A.9) implies that $D(\alpha_L, \rho_A + \rho_B, 2 - \rho_A - \rho_B) > 0$, and hence there exists costs that satisfy (A.10). This condition implies that all types prefer school A over school B, and hence all firms hire at school A. □

This result shows when the difference in value added is sufficiently small, then 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 the text. The result depends upon a number of 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, then employers will search for students at the schools that have the highest skill—the sum of innate ability and value added. Second, we have supposed 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 student 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 a number of 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 by colleges seeking the best applicants.

Thus, the combination of legacy "good" schools, combined with more competition and increased returns to skill can lead to more competition to enter into a legacy school, while *reducing* incentives to increase value added.