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Human Capital vs. Signaling is Empirically Unresolvable

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Human Capital vs. Signaling is Empirically Unresolvable

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Abstract

Economists offer two major explanations for the fact that we find causal labor market returns to education. The first is human capital accumulation: education improves ability. The second is signaling: education allows initially high-ability students to distinguish themselves. A major point of interest in the economics of education is relative contributions of signaling and human capital. Empirical evidence generally rejects pure human capital or pure signaling models. I argue that exclusions of the pure models effectively form the limits of what can be learned from empirical data about relative contribution. An education returns model with some non-zero contribution of both signaling and human capital cannot be empirically distinguished from another model with different non-zero contributions, making human capital vs. signaling a poor framing for understanding the return as a whole, and for policy decision-making.

Keywords: Human capital, signaling, identification, education

JEL: I23, I26, J24

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I. INTRODUCTION

A central question in the economics of education is the effect of education on earnings. A large part of the empirical work in the economics of education concerns estimates of the causal effect of education on earnings and the implications of that effect. A large part of the theoretical work in the economics of education concerns explanations of why that causal effect exists and is positive.

The two prevailing explanations are human capital and signaling. Human capital theory (Schultz, 1963; Becker, 1964) suggests that education has a positive causal effect on student ability, which in a competitive labor market translates into higher earnings. Those with education earn more because they learn.

Signaling theory (Spence, 1973) suggests that education does not improve student ability, but that education is used to identify workers who already had high levels of ability.[1]

Human capital and signaling are not mutually exclusive. Accordingly, there are multiple empirical studies, many of them discussed in later sections, that convincingly show both that human capital explains a non-zero portion of the returns to education, and that signaling explains a non-zero portion of the returns to education.

However, showing that both effects are non-zero does not provide information on which of the explanations should be given primacy, or to what degree each should be given weight. Since the introduction of signaling in the early 1970s, the weight of the evidence has been considered multiple times. Different authors make a case, using empirical observation, that one explanation should be preferred, but they do not agree on which explanation it is (Layard and Psacharopoulos, 1974; Weiss, 1995; Lange and Topel, 2006; Caplan, 2018).

The debate remains unsettled partly because of the well-acknowledged fact that signaling and human capital effects are very difficult to distinguish from each other empirically. In

[1]Throughout the paper I use the term signaling to also refer to the screening hypothesis (Arrow, 1973; Stiglitz, 1975; Wolpin, 1977), which is similar but differs in timing and some implications (Stiglitz and Weiss, 1994).

1986, in a study finding evidence of signaling effects, Lang & Kropp wrote "In fact, many members of the profession maintain (at least privately) that these hypotheses cannot be tested against each other and that the debate must therefore be relegated to the realm of ideology" (Lang and Kropp, 1986; Lange and Topel, 2006). Despite this concern, the attempt to provide evidence to inform the human capital vs. signaling debate continues.

In this paper, I attempt to validate the profession's concern. Evidence has been used to convincingly reject a model of education returns in which either human capital or signaling play *no* part. However, I claim that any model of education returns within those bounds, from a model that is almost entirely human capital to a model that is almost entirely signaling, is empirically undistinguishable from another model that assigns different weight to the two explanations.

I make this case by presenting signaling and human capital as both existing in empirical form as part of a returns-to-education model with mediating variables. Both explanations imply that education should improve earnings, and the distinction between them can be understood as emphasizing different mediating variables that explain *why* education improves earnings.

In this framework, I show in Section II the conditions necessary to identify the human capital or signaling shares of the return. I then argue in Section III that these conditions cannot be realistically met for three reasons: (Section III.i) There are too few observable mediating variables that can be assigned to *only one* of human capital or signaling, (Section III.ii) both theories place heavy emphasis on unobservable mediating variables which prevents falsification, and (Section III.iii) situations in which all these concerns can be overcome are too heterogeneous to be able to build a general model of education returns.

In effect, the argument comes down to this: the task of estimating the signaling and human capital shares of the return to education requires that researchers estimate how a non-experimentally derived causal effect is mediated. This is in itself a difficult, although not impossible, statistical feat, especially given that simply identifying one or two mediating

effects is not enough to estimate the shares. What pushes the task to effective impossibility is that it must be done in a context where the mediating variables of interest are unmeasurable, both theories are too loosely defined in empirical terms for nearly any proxies to be believable, and, when identifiable, the local average treatment effect is rarely of interest to answering the question.

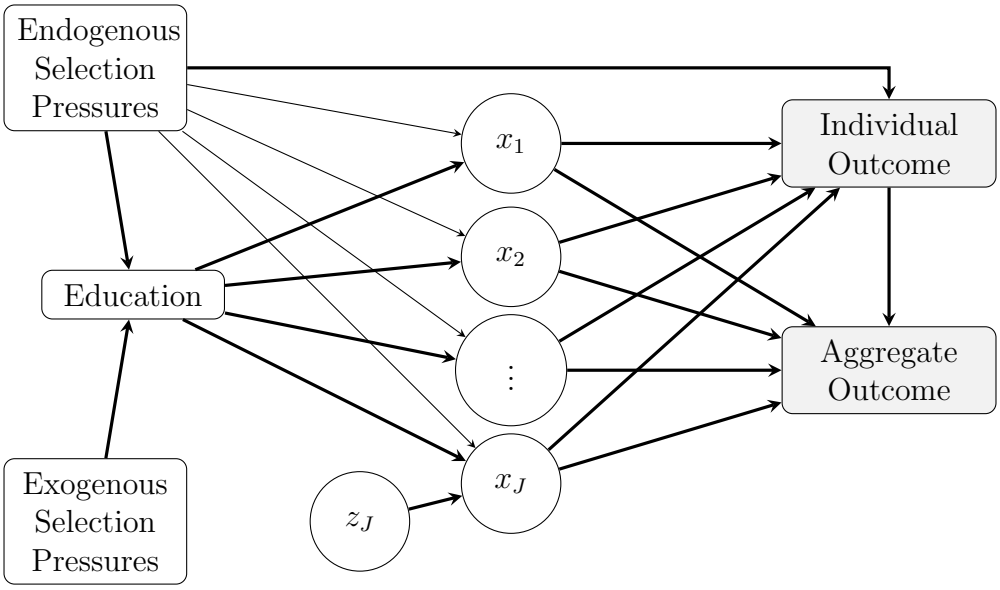
I argue, then, that while human capital and signaling are useful theoretical tools, and can be productively used to generate testable hypotheses, the actual testing of these hypotheses cannot usefully inform the theory, preventing the theory from being practically applicable in prediction or policy. This makes signaling and human capital a subpar approach to understanding education returns in the real world. I suggest in Section IV two alternatives: an atheoretical approach to understanding the returns to education within a mediating variables framework, and a theoretical framework that places at its center the concepts of the private and external returns to education. Section V concludes.

II. A MEDIATING-VARIABLES MODEL OF THE RETURNS TO EDUCATION

In this section I provide a general model of the returns to education. Figure 1 shows a directed acyclic graph that describes the basic relationship between education and various outcomes of interest (Pearl, 2009; Morgan and Winship, 2014).

In the model, variation in education is driven by both endogenous selection pressures (family background, ability) and exogenous selection pressures (compulsory education policy changes, experimental assignment). Education can be defined in the model at any given margin, such as "high school degree vs. bachelor's degree," "one more year of education vs. one less," or even something that simply changes the nature of education rather than the amount, such as "was placed with a great teacher rather than an average one" or "was exposed to advanced pedagogical methods vs. business as usual."

Figure 1: General Causal Model of the Effect of Education on the Labor Market



Education then does not affect outcomes of interest directly, but rather influences a host of mediating variables $x_1, ..., x_J$ that affect the outcomes of interest. The outcomes of interest can be measured at the individual level, such as labor market outcomes like the standard earnings at a certain age or over a lifetime (Card, 1999), but also unemployment, occupation held, measured productivity, or a particular age-earnings profile. Non-labor outcomes like marital status, health, or happiness (Oreopoulos and Salvanes, 2011; Heckman et al., forthcoming) or committing crime (Machin et al., 2011) can also be considered. Individual outcomes then build to affect aggregate outcomes such as productivity, economic growth, and inequality (Goldin and Katz, 2009) or the market conditions and wages for labor markets of more-educated and less-educated workers (Bedard, 2001; Moretti, 2004).

The mediating variables $x_1, ...x_J$ are defined broadly enough so as to intercept any direct effect that education might have on the outcomes of interest. These include things like cognitive skills (Ritchie and Tucker-Drob, 2018), non-cognitive and social skills (West et al., 2016), and job-specific skills (Van Der Velden and Bijlsma, 2016; Brunello and Rocco, 2017) of every variety, exposure to peers of certain qualities (Sacerdote, 2001), cultural socialization (Rivera, 2016), knowledge of one's extant abilities (Stinebrickner and Stinebrickner, 2014),

knowledge of the labor market (Botelho and Pinto, 2004), potential-employer beliefs about one's skills (Arcidiacono et al., 2010), or having a degree (Jaeger and Page, 1996; Belman and Heywood, 1997). Some of these mediating variables may have their own sources of exogenous variation (z_J).[2]

These mediating variables are key to identifying, empirically, the different explanations of the returns to education. With the exception of the selection explanation of educational premia (in which education is simply correlated with outcomes because both are determined by endogenous selection pressures), explanations of the returns to education assume that education has an effect on *something*, and then that something affects our outcomes of interest.

The human capital model assumes that education improves individual and aggregate outcomes because it improves the broadly defined job-relevant skills of the student, and these skills are rewarded in the labor market. In a pure human capital model, an empirical model that limited the mediating variables $x_1, ..., x_J$ solely to measures of skills would be sufficient to fully describe the effect of education if the measures were comprehensive enough. Signaling can similarly be defined using mediating variables; in a pure signaling model, $x_1, ..., x_J$ could be limited to measures of potential-employer beliefs about ability. Pure signaling or human capital models can be rejected by showing that these limited sets of mediating variables are insufficient.

Other explanations similarly fit the mediating-variables setting. If students use education to discover their own abilities, then "beliefs about one's own abilities" fits into $x_1, ..., x_J$. And if exposure to certain kinds of other students improves skills and socialization, or offers

[2]The presented model is general but is still by necessity a simplification, and there are several obvious variations. Depending on what is considered as an outcome, some outcomes may be considered mediating variables sometimes: for example, education may affect the occupation held which could affect labor market returns itself, but also individual productivity and thus returns through job match (Van Der Velden and Bijlsma, 2016) and aggregate productivity through production complementarities (Kremer, 1993). Mediating variables may also affect each other in some way, such as how having a degree can impact a potential employer's beliefs about a employee's skills. While not pictured, these complexities are generally understood and incorporated into the discussion of identification.

networking opportunities, then "exposure to students with quality ω" is a part of $x_1, ..., x_J$.

The use of this mediating-variables model is that it outlines what must actually be done to identify differing explanations of the education premium:

1. For some given explanation k of the education premium, translate k from a theoretical proposition into an empirical one.

    - Identify a subset of mediating variables $\chi_k \subseteq \{x_1, ..., x_J\}$ that can be said to be indicative of explanation k or a complement set χ_k^C that can be said to *not* be indicative of explanation k.
    - If the intent is to measure the *full* share of the education premium that is explained by k, then either χ_k or its complement set χ_k^C must be comprehensive lists of the mediating variables that are examples of k or not-k, respectively.

2. Estimate the part of the effect of education on the outcome of interest that occurs because of χ_k or χ_k^C.

    - Identify the effect of education on the outcome of interest while controlling for χ_k^C.[3]
    - Or, identify the effect of education on χ_k, and then, separately, the effect of χ_k on outcomes.

3. Conclude that the part of the return explained by χ_k, or the part of the return not explained by χ_k^C, is a k effect. If χ_k or χ_k^C is argued to be comprehensive, conclude that the estimate is *the* k effect.

[3]This is done either via the back-door approach by controlling fully for endogenous selection pressures, or instrumental variables by utilizing exogenous selection pressures (Pearl, 2009; Morgan and Winship, 2014). In some designs, direct control for χ_k^C is not required because the exogenous selection pressure identifies a local average treatment effect for which the link between education and χ_k^C should not occur, or variation in education is across a margin for which the link between education and χ_k^C should not occur, for example Pischke (2007).

The above approach can, and has, fruitfully led to useful information about how the effects of education are mediated. However, there are limitations to translating this empirical knowledge back into a theoretical understanding of education. Given that the human capital/signaling divide can be modeled as being in a mediating-variables setting already implies that distinguishing the two will be difficult, as mediation analysis is difficult even in randomized settings (Green et al., 2010), making following step 2 difficult.

Distinguishing signaling and human capital is harder still, however. Many of the above steps simply cannot be completed due to the formal structure of the human capital and signaling models. Step 1 requires that a list of measurable mediating variables be assigned to exactly one of these explanations, which human capital and signaling are too flexible to allow. Using the underlying latent variable "ability" that defines the signaling and human capital models would allow Step 1 and Step 3 to be completed, but ability is too abstractly defined to be measured. It is effectively impossible to use empirical results to actually develop a proper overall model of education, in which each mediating theoretical explanation of the return is given an appropriately-sized role and which can therefore be used to generate extrapolative policy analysis. I make this case in the next section.

III. DIFFICULTIES IN EXPLAINING THE RETURNS TO EDUCATION

The previous section outlined how explanations of the returns to education can be identified. In general, "a signaling effect" or "a human capital effect" can be found by selecting a set of mediating variables that can be convincingly labeled as being a clear empirical example of signaling or human capital, and isolating only the part of the effect of education that works through these variables.

However, in order to relate these results produced by this approach back to a theoretical explanation of the returns to education, we must be able to firmly establish which explanation

k these mediating variables are examples of. If the mediating variable can be plausibly considered an example of an alternate explanation not-k, or a mix of two explanations, then not much is learned about the underlying theory.

There are three reasons why empirical evidence can have only a limited effect on our understanding of human capital or signaling, which will be addressed in the following subsections. Section III.i shows that too few mediating variables can be plausibly assigned as examples of exactly one explanation. Section III.ii shows that the human capital and signaling models are both flexible enough in regards to the definitions of "ability" and "beliefs" that falsification is nearly impossible. Section III.iii shows that human capital and signaling effects are too heterogeneous to be able to accumulate results across contexts where the issues from Sections III.i and III.ii are avoided.

III.i. MULTIPLE EXPLANATIONS

The process of identifying effects aligned with different theoretical explanations in a mediating-variables framework requires that different mediating variables can be claimed by a given explanation. Otherwise, empirical results cannot be used to update scientific beliefs about those theories.

However, in the context of signaling and human capital, the list of mediating variables that can be considered the exclusive domain of one theory or the other is exceedingly small. As general concepts human capital and signaling are flexible enough that nearly any observed behavior can be predicted with some version of a human capital model and some version of a signaling model.

I use Arteaga (2018) as a basic illustration.[4] In this study, the author looks at a top economics and business program in Colombia that reduced its coursework requirements.

[4] Arteaga (2018) is used because it is also a useful example for several other discussions throughout the paper, and because the work itself is of high quality, so the issues that I point out are focused on the flexibility of the signaling and human capital models rather than flaws in the paper.

Graduates lacked a certain set of knowledge they would have otherwise had, but the population of students graduating from the program did not change immediately. So, the margin of education being examined (pre- and post-change in requirements) should affect earnings solely through the mediating variable "exposed to the set of knowledge taught in courses no longer required." Large observed effects of education on early career earnings through the mediator of choice are taken as evidence of human capital.

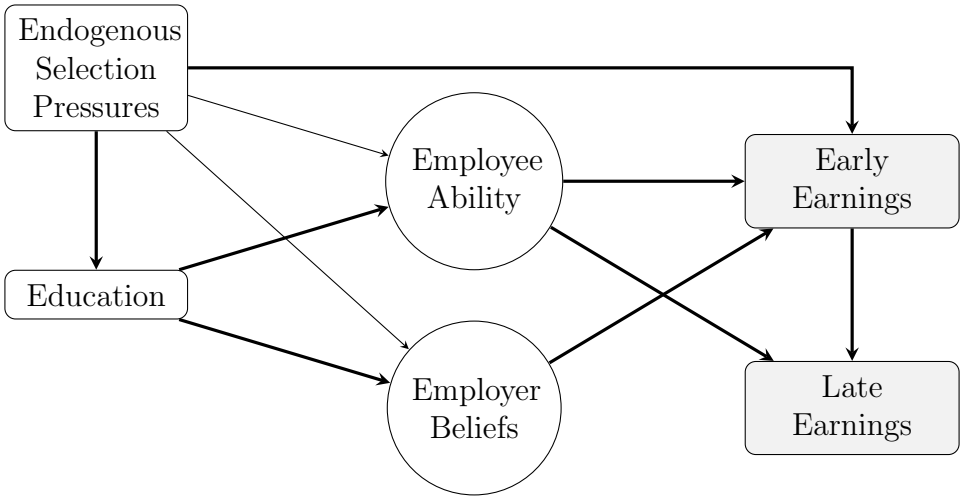
However, as outlined in the paper, top employers in the region commonly gave applicants written exams including questions about the knowledge no longer covered by coursework. Education could affect earnings through this mediator either because the knowledge acquired actually makes the students better workers (human capital) or because employers found that the knowledge had been in the past a good signal of desirable employee qualities,[5] and the results were more a consequence of employers either relying on an outdated signal, or finding that following the signal is still the best screening approach despite being weaker than it once was (signaling). Distinguishing the two explanations requires the researcher to know whether the material learned is actually productive, which is a high bar.

One could make a case that the effects in Arteaga (2018) are *better*-suited to human capital than to signaling. But viewing the effect as some unknown mix of the two, even if that mix is weighted towards human capital, severely limits the amount of inference about theory that can be drawn from the empirical results.

This same argument applies to any effect of education on outcomes that operates through skills that are learned in education but also visible to employers. Treating these effects as human-capital affiliated makes sense, but there are heavy requirements on the data to establish that signaling has no part to play in these results. And so, in evaluating the overall model of the returns to education, the entire portion of that return that operates

[5]To demonstrate the precise argument being made here, consider a student who learns Shakespeare in college, and then makes a Shakespeare reference during a job interview, impressing the interviewer and getting the job. This knowledge of Shakespeare is a skill acquired in education, and improved their earnings, even though it may have no effect on productivity.

Figure 2: Basic Employer Learning Model



through observable learned skills has an indeterminate theoretical explanation. If employer-observable learned skills are responsible for 10% of the return, for example, then we can be certain about the interpretation of no more than 90% of the return.

These sorts of interpretation issues apply to many of the observed phenomena that are used to inform our understanding of human capital and signaling. I will consider three here: employer learning, sheepskin effects, and the effect of education on aggregate productivity.

Employer learning refers to the ability of employers to learn employee productivity better through observation after hiring them than they could learn before hiring on the basis of imprecise signals. As the employer learns the employee's productivity, earnings should increasingly reflect actual productivity (Jovanovic, 1979; Farber and Gibbons, 1996; Altonji and Pierret, 2001).

Under the employer learning model, if the returns to education fade quickly, this is generally taken to be evidence in favor of signaling, and if the returns to education persist or grow, this is taken to be evidence against signaling. The employer learning model is shown in the mediating-variables framework in Figure 2.

The empirical literature on employer learning typically finds that the returns to education persist or grow over time, and that employer learning is too quick for unobserved ability to go unrewarded for long, a result given a human capital interpretation (Altonji and Pierret,

1997; Bauer and Haisken-Denew, 2001; Lange and Topel, 2006). Lange (2007) uses these results to place an upper bound on the contribution of signaling at no more than 45%, under the assumptions most generous to signaling.

Using evidence on employer learning to inform theory about human capital and signaling assumes both that rapid learning could not erase human capital effects and, importantly, that there is no way for signals to affect late earnings.

Arcidiacono et al. (2010) argue that higher levels of education allows underlying ability to be communicated to employers much more accurately than for lower levels, partially because there are many more signals that can be sent (club participation, test scores).[6] If part of educational signaling is in providing a highly refined and accurate signal, rather than broadly separating an educated person from a less-educated person, then we could observe short employer learning periods even if a large part of the return to education is signaling.

Standard interpretations of employer learning results assume that mistaken employer beliefs at the time of hiring cannot affect late earnings because employers will learn the true underlying ability. However, part of productivity in the workforce is firm-, industry-, or task-specific human capital that is acquired on the job rather than during education. In these cases, being assigned to a high-earning job early because of employer misperception allows the employee to gain specific human capital. Through experience, the misassigned employee improves their actual productivity beyond someone initially more skilled who simply failed to send the relevant signal. A similar phenomenon arises if sorting within firms into coworker groups occurs on the basis of education credentials and there are coworker spillovers (Bidner, 2014). Caplan (2018) cites this "foot-in-the-door" explanation in an argument against interpreting quick employer learning as evidence against signaling. We can take the observation that the returns to education persist combined with a short employer learning period to be consistent both with the human capital model and the signaling model.

[6]The Arcidiacono et al. (2010) empirical result that there is no employer learning for college graduates is disputed (Light and McGee, 2015). However, the use of the Arcidiacono study here does not rely on their empirical result.

Caplan (2018) focuses on a second empirical observation that is often taken as evidence in the human capital vs. signaling debate: sheepskin effects. The returns to education are much higher for years in which a degree is earned than in other years (Hungerford and Solon, 1987; Jaeger and Page, 1996; Belman and Heywood, 1997; Flores-Lagunes and Light, 2010). This is an empirical regularity that is observed globally, and I refer to it here as a sheepskin effect. In the mediating-variables framework, "holding a degree" is the mediating variable of interest, and the sheepskin effect argument assigns this mediating effect to signaling.[7]

Before considering the argument that sheepskin effects may not be entirely signaling, it is worth noting the contradiction between the employer learning and sheepskin literature. Both literatures frame, and sometimes explicitly refer to, their mediating effect of interest not as just *a* signaling effect, but as *the* signaling effect. These literatures cannot both be right. The generous 45% or preferred 10% maximum signaling share suggested by Lange (2007) in the employer learning literature is mutually exclusive with the conservative 50% or preferred 80% minimum signaling share suggested by Caplan (2018) relying on a review of the sheepskin effect literature. This tension can be resolved if these estimates are so noisy that they do in fact overlap, if neither effect makes up the entirety of the signaling effect, or if neither effect is exclusively the domain of signaling.

There are several explanations of observed sheepskin effects that do not rely on signaling. The first is that sheepskin effects simply reflect selection into graduation on the basis of prior observables. Sheepskin effects tend to persist after adjusting for selection pressures and prior observables (e.g. Frazis, 1993; Caplan, 2018), but one could make the argument that there are always other prior observables the researcher cannot account for.[8] The second is that sheepskin effects reflect selection into graduation on the basis of factors that could not be

[7] I refer here specifically to estimates that compare the returns to education between degree-granting and non-degree-granting years. Several of the arguments presented here that interpret sheepskin effects in human capital terms do not apply to natural experiments that estimate the return to holding a degree in other ways, like Tyler et al. (2000).

[8] The argument that there's always something else that could be controlled for is both always true and unsatisfying. I make the case in Section III.ii that the abstract nature of "ability" in both human capital and signaling theories invites and validates this particular unsatisfying argument.

known ahead of time; students learn of their own return to education through the process of education and drop out, ensuring that those with the lowest returns are seen terminating their education at non-degree years (Chiswick, 1973; Hungerford and Solon, 1987; Lange and Topel, 2006). The third is that the original argument that sheepskin effects cannot reflect human capital may be partially incorrect, and at least some small part of the sheepskin effect can be explained by students learning more valuable skills in the final year than in earlier years. This may be plausible in any context, like college, where curriculum becomes more specialized in later years.

I present another human capital-based explanation of sheepskin effects here. I take it as given that part of the return to education is that it provides a credential certifying student ability. However, this credential certifies not just prior ability but also skills learned in the process of education. Part of the return to the credential itself is because of human capital accumulation, and the signal cannot be sent unless valuable skills are actually learned. The fact that sheepskin effects persist after controlling for initial student ability measures lends plausibility to the idea that part of what is credentialed is learned in school.[9] This explanation relies on both signaling and human capital and cannot arise from pure signaling.

For a basic illustration, consider a mass of students of identical prior ability 1 facing four years of education, the fourth of which earns a degree. Identical prior ability ensures there can be no signaling or selection on prior ability. Every year t, each student i sees their ability increase through learning by $a_{it} \sim U[0,1]$, and the enrolled students in the bottom decile drop out because the university determines they have not learned enough and so gives them failing grades. Wages are equal to average ability within education group after graduation. The observed returns will produce a sheepskin effect derived purely from human

[9] In Arteaga (2018) above, if the subjects students were no longer required to learn were in fact productive skills, then that study provides an example of education as a credentialing process for accumulated skill rather than previously-existing skill. Using the same Arteaga (2018) result as an example of something that is presumably human capital potentially being signaling, and also as an example of something that is presumably signaling potentially being human capital, highlights the indeterminate interpretation that these theories lead to.

capital accumulation differences, with 28%, 31%, and 115% returns for the second, third, and degree year relative to the year before.[10]

I discuss one last area in which empirical results are commonly used to make inference about the relative importance of signaling and human capital: the impact of education on aggregate productivity and growth. This is also referred to (with some variation in concept) as the external or social benefits of education, or education spillover effects. Human capital implies that education will improve worker skill, while signaling does not. A result that higher levels of education improves productivity or leads to economic growth is taken as an example of human capital.

Unlike with employer learning and sheepskin effects, the empirical effect of interest is less settled here. Evidence on national growth generally ranges from the null to the optimistic (Topel, 1999; Lange and Topel, 2006; Goldin and Katz, 2009). Studies using within-country regional variation often find modest external economic benefits of education (Acemoglu and Angrist, 2000; Moretti, 2004), but these results too are inconsistent (Ciccone and Peri, 2006). There are studies of the underlying necessary mechanism here, too, finding improved productivity within firms on the basis of education (Battu et al., 2003; Crook et al., 2011).

Regardless of the exact impact of education on aggregate productivity levels, the standard interpretation of such an effect is that it would be an example of human capital accumulation. However, this assumes that the signaling function of education is nonproductive, which is untrue in any version of the signaling model in which the return to skill varies between occupations, for example shown theoretically in Hopkins (2012) or empirically in van der Meer (2011) and Van Der Velden and Bijlsma (2016). Here, the ability of the signaling model to sort workers to the right jobs unambiguously improves productivity. If worker ability is complementary with the skill of other workers (as in Kremer, 1993), the impact of this sorting will be heightened. Signaling may also be productive because it allows firms to

[10]These figures come from a basic simulation using 1,000,000 students, with log ability regressed on schooling level to estimate returns. No attempt is made here to mimic real dropout rates or return sizes.

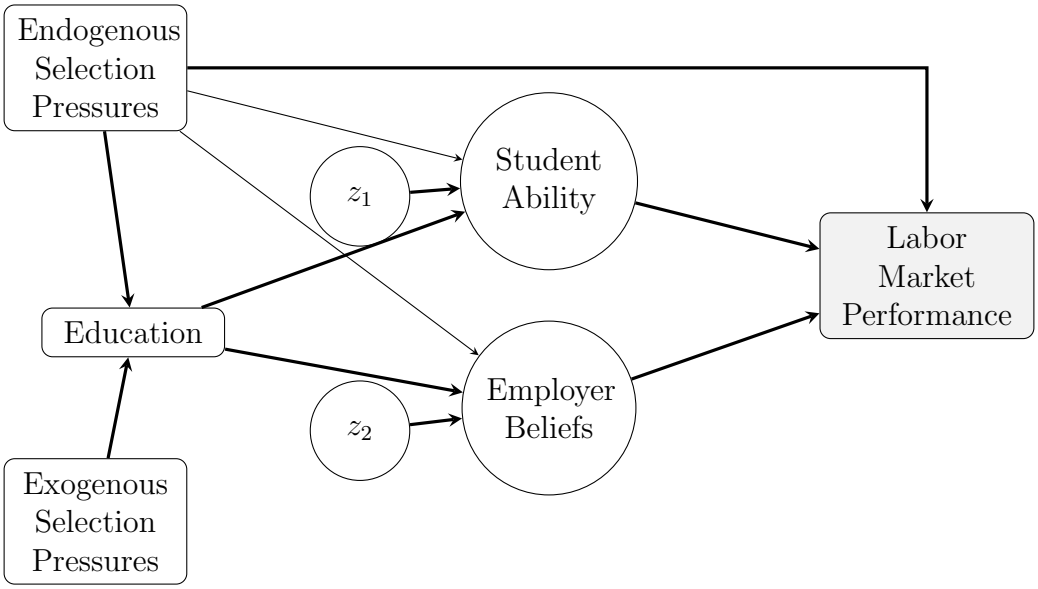
predict worker ability and thus equalize marginal products across firms (Wolpin, 1977).

These three effects: employer learning, sheepskin effects, and external returns, have made up the backbone of the literature separating human capital and signaling. However, these cannot actually be said with confidence to be pure empirical examples of either human capital or signaling. These effects cannot be cleanly assigned to just one explanation even though several simplifying assumptions have made the task easier. Monopsony, discrimination, or other frictions strain the relationship between productivity and earnings in unpredictable ways. Since empirical inference for both models relies on the ability to infer productivity from wages, the real difficulty in assigning mediating effects to explanations is even muddier than has been presented here.

While these empirical effects still may intuitively rest more with one explanation than the other, the important point is that they cannot be clearly assigned to being *entirely* one explanation or the other from theory alone. There is no clear way to break them down further such that the "human capital share" and the "signaling share" of each can be separated; such an attempt would face the same problems as trying to break down the return to education as a whole into a human capital share and a signaling share. Economists may agree that the employer learning literature is *more* supportive of human capital than of signaling, but without a clear way to estimate *how much*, this information is of limited value to determining the relative contributions of signaling and human capital.

Without being able to assign the mediating variable cleanly, the mediating-variable processes of identification outlined in Section II cannot be applied using them. Since these three empirical effects appear to make up a large portion of the return to education, a large portion of the return to education cannot be assigned to one explanation or another. The part of the return that *can* be clearly divided into signaling and human capital effects is minimal. The ability to produce theoretical inference from empirical results is limited.

Figure 3: Simple Theoretical Model of the Returns to Education



III.ii. ABILITY AND BELIEFS

Section III.i details the problems associated with assigning different observed mediators to human capital or signaling in order to identify the contribution of each, as in Figure 1. Perhaps it does not need to be so difficult. The empirical model that may be in the mind of some researchers as they consider the relative contributions of signaling and human capital may not be the complex Figure 1 but instead the simpler Figure 3 in which the assignment of each mediating effect is clear.

Under Figure 3, human capital and signaling effects can be cleanly defined by simply selecting appropriate proxies for Employee Ability or Employer Beliefs. This is effectively the same approach that is taken in Section II, but adds the identifying assumption that Employee Ability can be fully proxied by observable measures of ability such as test scores, or that Employer Beliefs can be fully proxied by some measure of employer beliefs, if available, or fully controlled by examining a situation where it would be difficult for employers to see variation in education.

This approach fails because both theories resist the use of proxies.

The problem grows from the fact that "ability" is broadly defined, both in the human

capital and signaling models. In these models, ability is not limited to intelligence, but rather is any quality that makes someone a more productive employee. Ability is necessarily multidimensional, and includes features that researchers do not have access to or are effectively unmeasurable.

The abstract nature of ability makes both signaling and human capital exceedingly difficult to falsify using proxies of ability. If measures of ability learned in school do mediate the returns to education, this is taken as evidence of human capital. But if this ability can be observed by employers, as in Arteaga (2018), it can be argued that these learned skills increase wages because they are signals and do not contribute to productivity. If measures of ability learned fail to mediate the returns to education, this is taken as evidence of signaling. But it can be argued simply that the wrong sort of ability has been measured. As long as the list of skills that employers actually value is not known or includes unmeasurable characteristics, both arguments always have the potential to be true.

We can consider the implications for human capital and signaling theories under empirical findings that should be disastrous for each. Finding that education has little impact on ability, for example, should be strong evidence against the human capital model. Similarly, finding that education significantly contributes to the development of ability should minimize the potential impact of signaling, as would findings that employer beliefs are not affected by education.

First, we consider the implications of findings that education has little impact on ability. Arum and Roksa (2011), for example, argue that recent cohorts of college students retain relatively little of the knowledge they are taught in class. Further, the literature on the psychology of learning finds that the ability for students to learn in class things that are far removed from what is actually studied is limited and (Barnett and Ceci, 2002; Ambrose et al., 2010; Sala et al., 2018). Let us take these empirical results as given, and consider the implications on theoretical understanding. Given this evidence, Caplan (2018) argues that it is effectively impossible that skills are heavily improved in college, and so the human capital

model is likely to apply little.

However, even if there is little evidence that education moves measured skills,[11] the human capital model is flexible enough to accommodate.

First, unless learning is literally zero, understanding whether learning is "large" or "small" requires actual measurement of the outcome of interest, not just measurement of skill. This places heavy data demands on this particular argument against human capital, and has been pointed out by several responses to Arum and Roksa (Pascarella et al., 2011; Haswell, 2012). Second, skills of labor-market interest could be close enough to what is directly taught in class that transfer across closely-linked domains occurs. Third, education could directly teach other skills - learning to turn something in on time, for example, does not appear in the "learning objectives" part of a syllabus and would not be included in a follow-up test of learning, but it does appear on the syllabus and is a skill practiced in school.

The argument that estimates of the effect of education on skills measure the wrong skills can be made regardless of how many abilities education may be shown not to affect. This frames human capital theory as being so flexible as to be unfalsifiable through the measurement of ability.

This unfalsifiable framing is scientifically frustrating but that does not make the core argument incorrect. There is evidence to support the idea that, if improvement in a given skill does not mediate the returns to education, education may still have an effect through other skills. Heckman et al. (2013) provide one example of this, in which the authors find that the Perry Preschool program had effects on student personality despite fading or null effects on achievement tests. Chetty et al. (2011), Carneiro and Ginja (2014), and Baker et al. (2015) provide similar evidence in other contexts. Chetty et al. (2014) find that the

[11] There is reason to doubt that the effects are zero - there is no shortage of studies that find effects of various educational interventions on test scores. This literature is not often brought up in the human capital vs. signaling debate because this debate is usually thought of in regards to amount of schooling rather than quality. However, the well-established ability to affect test scores at the margin implies a general ability of education to affect measurable ability, although an argument could be made that the effect is small with some definition of small.

assignment of different teachers affects adult labor market performance even though the effect of a given teacher on cognitive skills is generally recognized to decay much sooner than adulthood. This literature does not mean that a null finding of the effect of education on intermediating skills is non-informative, but it limits the extent to which theoretical inference can be drawn from empirical results.

One potential approach to restoring falsifiability via measured skill to the human capital model would be to find a set of variables representing measurable ability that fully mediate the effects of education. Hanushek (2016) finds that cognitive scores fully mediate the relationship between education and national growth. However, if this finding were to hold on individual data, it would contradict the standing evidence on individual returns via other skills.

The signaling model, like the human capital model, relies on a broad measure of ability, which can make the model flexible in the same way. Arteaga (2018) is an example of evidence that education clearly improves some measure of ability that mediates the returns to education. We can take this result for granted and consider the implications for the signaling model. As previously argued in regards to Arteaga (2018), very strict conditions must be placed on the visibility of that skill in order to ensure that the phenomenon cannot be explained using signaling, considerably narrowing the range of observations that would falsify signaling.

The broad measure of ability makes the signaling model flexible in another way. A common critique of the signaling model is that, if education is largely about signaling, then employers should be able to find far less expensive ways than education of identifying high-quality workers. Most employers have yet to find a way to do this. The standard response to this critique is that education does not just signal easy-to-measure things like intelligence, but a host of wider skills like conscientiousness and conformity (Caplan, 2018). This response mirrors the human capital-supporting argument that, if education does not improve measured skills, it may still improve other, unmeasurable skills. Like the argument

in favor of human capital, this defense of signaling frames it as flexible enough to avoid falsification on the basis of measured ability. For this reason, the Hanushek (2016) result, if it held at the individual level, would pose a challenge to the signaling model in addition to the human capital model.

The signaling model also relies on employer beliefs and inferences about student ability. Because these beliefs are about a broad concept of ability, they are both similarly broad and harder to measure.

The lack of data on employer beliefs means there are fewer example studies to refer to. However, we can imagine a study finding the result that, controlling for other qualities commonly visible to employers, learning a potential employee's education level has no effect on survey-measured employer beliefs about that employee. Formally this would be a refutation of the signaling model. However, even in this extreme case it could be argued that the beliefs being measured do not represent the actual impression that employers get of their employees, and that the wrong question was asked. This objection can be raised no matter how beliefs were elicited. It could also be argued that the other observed qualities were sufficient to signal employee quality, and that education was simply a poor *marginal* signal and remains a powerful signal overall.

III.iii. HETEROGENEITY

In the previous two sections I made the case that it is extremely difficult to cleanly identify the extent to which signaling or human capital explain the return to education. These problems can be overcome in serendipitous circumstances. For example, a natural experiment may push students across a particular margin of education in a way that is invisible to employers (as in Pischke, 2007), or change what employers believe about skill without changing the actual skill (as in Tyler et al., 2000). With the proper accumulation of evidence across multiple such circumstances, it still may be possible to construct a general model of education returns.

In this section I argue that a general model of the returns to education, in which the relative contributions of human capital and signaling are properly estimated, is unlikely to come from an accumulation of evidence from different contexts. The effects, even if plausibly estimated within any given study, are simply too heterogeneous to be aggregated with confidence. As a result, the local average treatment effects these studies uncover are of interest generally, but do not heavily inform the debate about the relative importance of signaling and human capital.

The return to education itself, like many causal effects in the social sciences, can be expected to be heterogeneous. Evidence on the return backs this up; the return differs across the margin of education studied (Jaeger and Page, 1996), across countries (Trostel et al., 2002), across demographics (Cunha and Heckman, 2007; Henderson et al., 2011), and across labor market conditions (Altonji et al., 2016). The literature on the returns to education has long had to confront the difficulties of attempting to make generalizable statements about the returns to education when the best evidence that addresses endogeneity is necessarily context-specific or produces a local average treatment effect (Card, 1999). This literature faces difficult problems even without the classification and inference issues faced by human capital and signaling, addressed in previous sections.

The heterogeneity in the overall return is the first problem for inference about human capital and signaling. Consider a study that uses an unusual source of variation allowing a signaling explanation to be excluded, and estimates a 6% annual return to education. Assuming that non-signaling and non-human capital explanations can be ignored, it could then be inferred that the human capital-derived return to education in this context is 6%.

But in order to put this in context with signaling, the size of the entire return must also be known. The unusual variation allowed the non-human-capital part of the education return to be excluded in estimation, but that does not the return is fully human capital in reality. If the overall return is 7%, then human capital explains much of the return. But if in this context the return is a very high 20%, then human capital explains a minority of the return.

In order to understand the relative contributions of signaling and human capital, it must be possible to simultaneously perform the two very difficult tasks of plausibly estimating the human capital (or signaling) effect size, *as well as* the overall effect of education (or the opposing effect).

In addition to heterogeneity in the overall return, the signaling and human capital shares of the return should similarly be heterogeneous, perhaps even moreso than the return itself.

There is, of course, variation in human capital effects that can be measured in a fairly straightforward way. Different students see different amounts of improvement in their measured ability following schooling on the basis of personal characteristics such as race (Fryer and Levitt, 2004) or different qualities of the education they are exposed to such as the teacher or school assigned (Deming, 2014; Chetty et al., 2014).

Ability improvements as a result of education can be measured more directly when students enter jobs where productivity can be measured. Chingos and Peterson (2011) find that a master's degree in education is uncorrelated with effectiveness as a teacher, even though it guarantees higher pay under many teacher payment agreements. Hussey (2012) finds that the personal returns to an MBA are not reflected in a causal improvement of productivity. Both results imply that the any selection-corrected returns to these degrees are signaling or some other non-human-capital explanation.

Acknowledging variation in human capital returns to education means that local effects, which are the only kind that can be plausibly estimated given the question at hand, are less applicable broadly. It would not be believable, for example, to take the Chingos and Peterson (2011) or Hussey (2012) results concerning particular degrees and apply them generally. These findings imply a 0% human capital share in these particular cases, which is inconsistent with broader findings that reject the 0% human capital share.

Signaling effects are heterogeneous as well. Theoretically, signaling effects should be more heterogeneous than human capital effects. Human capital effects should vary with the individual ability to acquire skills from education and the quality and format of that

education, all of which are likely to follow well-behaved and relatively tight distributions. Signaling effects, on the other hand, should vary with the skill level of other people sending the same signal and also with the sum total of all other information the employer has about the employee. Alternative available information is likely to vary widely across individuals and groups, and so the signaling effect should vary sharply too.

Consistent with the theoretical prediction, studies of signaling effects that examine heterogeneity in the effect tend to find it. Bedard (2001) finds gender differences, and Tyler et al. (2000) finds racial differences. Clark and Martorell (2014) is an exception, finding that high school degree signaling effects were uniformly zero across all groups studied. More broadly, sheepskin effects vary significantly across time, geography, and demographics (Belman and Heywood, 1991; Gibson, 2000; Belman and Heywood, 1997; Bitzan, 2009; Bol and Van De Werfhorst, 2011). While I have argued that sheepskin effects are not fully signaling, it is unlikely that major variation in sheepskin effects can be fully explained by heterogeneity in the human capital portion of the sheepskin effect.

Convincingly estimated human capital and signaling effects are rare and rely on convenient natural experiment designs, as in Tyler et al. (2000) or Clark and Martorell (2014), or unusual contexts where an explanation's share is a realistically-identifiable 0% or 100%, as in Chingos and Peterson (2011) or Hussey (2012). Relying on natural experiments in general is tenuous because these identify signaling and human capital at a particular, often unusual, margin. Since the signaling and human capital effects are highly heterogeneous across different margins, this approach cannot say much about the overall signaling or human capital share. Standard tests of human capital and signaling that can be easily estimated in many contexts, like employer learning or sheepskin effects, unfortunately cannot be cleanly assigned to only one explanation.

One potential way around this heterogeneity problem is to estimate the human capital and signaling shares is to model the problem structurally, so that the share can be estimated generally without needing natural experiments. Fang (2006), for example, uses a simplified

structural model in which the signaling and human capital shares are identified on the basis of the model and assumptions about the ability distribution. This approach may offer the most hope for plausible generalizability. However, a structural approach necessarily relies on selecting a particular structure by which human capital and signaling operate. In effect, this addresses the problem from Section III.i that both models are flexible enough to explain wide ranges of behavior by partly disallowing that flexibility. Creating variants of the signaling and human capital models rigid enough that they can actually be pinned down may be preferable to declaring the unresolvability of the issue, as this paper does. But the resulting versions of human capital and signaling will not match the flexible theoretical versions, and the differences may be important.

IV. RELATED QUESTIONS AND PATHS FORWARD

The goal of this paper is not to make the case that signaling and human capital are useless concepts. Signaling and human capital remain useful concepts for advancing a theoretical understanding of the returns to education, and they remain useful concepts for the generation of hypotheses that can be tested empirically. However, it is nearly impossible to use those empirical results to inform an underlying theoretical model of education returns.

Human capital and signaling are useful starting points for theorizing about education, but the model of interest should be framed in other ways. I suggest two approaches here, and fortunately both are already underway within the economics of education.

One approach is to be generally atheoretical. Understanding the variables that mediate the returns to education is a valuable goal in itself, and has important policy implications. There is no need to treat these results as proxies for unmeasurable theoretical concepts. There is already an extensive list of studies, many of them cited in this paper, that examine variables that mediate the returns to education without attempting to infer anything about

human capital or signaling.

The atheoretical approach appears to leave something out, in particular how certain theoretical concepts such as the broadly defined "ability" or "beliefs" almost surely play into the returns to education. However, the amorphousness of these terms may act to inhibit our empirical understanding. As outlined in Section III.ii, an emphasis on ability and beliefs rather than more precise terms that can be measured, "math test scores" for example, means that the connection between the theory and measurable reality is weak anyway. Theoretical ability and measurable ability may not be the same thing, but that simply means that we can neither test nor use claims made on the basis of theoretical ability. Forward-looking work like Cardoso et al. (2018) acknowledges the place of ability in the model of the returns to education, but focuses its implications on decompositions of the returns to education according to measurable factors.

Further, we have an example of a closely related literature that already takes this approach: the literature on the gender wage gap. Similar to the literature on the returns to education, the gender wage gap literature looks at the effect of a variable on earnings. It also takes an interest in the variables that mediate and explain that effect. However, those measurable mediating variables—things like occupation—are taken to be of direct interest (Blau and Kahn, 2017). There are still some theoretical constructs that cannot be measured directly, such as discrimination, but the literature does not attempt to frame itself entirely in this way. Further, although broadly-defined ability remains an important construct as it would in any model of earnings, the framing of the literature encourages disputes about theoretical concepts like discrimination in terms of measurable ability. For example, Fortin (2008) describes an explanation of apparently discriminatory behavior as being gender differences not in "ability" but in four measurable non-cognitive traits.

The second potential approach is to return to a theoretical framework but a different one. After all, having a general theoretical framework is useful and allows for predictive and policy analysis outside the bounds of what has already been observed. There may be

theoretical framings other than signaling and human capital that are more amenable to be informed by empirical data and are as relevant to policy, or moreso.

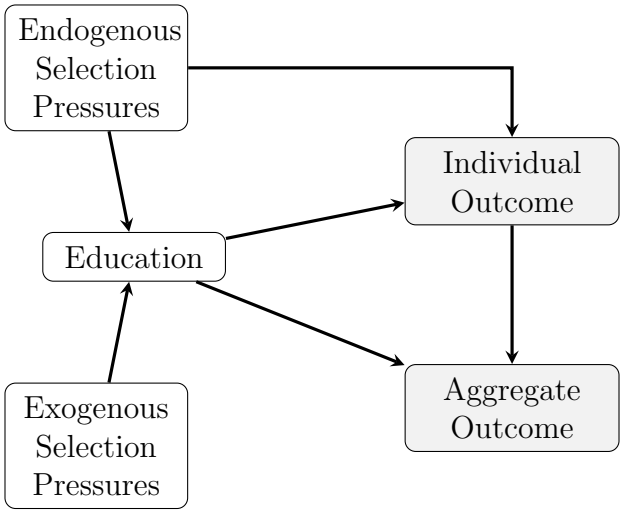
The use of signaling and human capital framework in the context of policy prescription has often focused on the question of how much education subsidy is justified. If education is mostly human capital, then external returns will be large and positive, and subsidy is justified. If education is mostly signaling, then external returns will be small, and education may have undesirable effects on income distribution (Stiglitz, 1975), so subsidy is unjustified or less justified.

However, this approach fails for two reasons. First, because the question of whether education is "mostly" signaling or human capital is empirically unresolvable. Second, even if the relative contributions of signaling and human capital could be estimated, these policy prescriptions do not actually follow. As discussed in Section III.i, education as signaling can improve productivity by leading to a more efficient use of talent. There are other ways in which education can improve productivity without building human capital, by geographically concentrating talent or through its existence as an industry. And, although the argument is more strained, it is possible for education to reduce productivity by building human capital if the skills attained allow graduates to enter industries that rest on rent-seeking or negative externalities.

I argue that the exact same policy question of interest can be answered more directly and accurately using a framing that is already in use and is more amenable to being informed by empirical data: the identification of private and external returns. The primary policy application of signaling vs. human capital terms effectively uses signaling and human capital as stand-ins for private and external returns anyway (Lange and Topel, 2006; Caplan, 2018). It makes more sense to simply study the question of actual policy interest, which is conveniently also more amenable to empirical analysis.

Private and external returns can be estimated in a model like Figure 1, focusing on the overall effect of education on individual and aggregate outcomes, rather than focusing on

Figure 4: The Returns to Education Without Mediating Variables



the mediating variables. This approach does not need to concern itself with assigning each mediating variable x_j to one explanation or another, avoiding effectively all of the issues raised by Sections III.i and III.ii.

Alternately, a private and external returns framework can be presented more simply by ignoring the mediating variables altogether, as in Figure 4. Here, the direct return to education is what matters, without regard to what explains that return, and instead considering the different (directly measurable) outputs that education affects, and whether those outputs are private or external.

Private vs. external returns is similar in many ways to human capital vs. signaling, but has more direct policy relevance, can be more easily connected to measurable variables in empirical data, and is more robust to noncompetitive labor markets where the link between ability and earnings is unclear. There are difficulties as well; current estimates of the external returns to education, such as estimates of the effect of education on growth, are inconsistent, and there is the question of how to determine which aggregate markets a given person's education applies to. But these are questions of a very different sort than in signaling and human capital, where difficulties arise from the imprecise nature of the question itself.

Conveniently there is already a basis of existing research to which the framework can

be applied; all existing research on the overall return to education applies directly to our understanding of the private return, and work on the effect of education on economic growth, productivity, and the wages of others applies directly to our understanding of the external return (and often is already referred to by that term, or the social return, or spillovers). As a means of organizing empirical data on the returns to education into theory, the private vs. external distinction may prove far more useful than human capital vs. signaling and offers a clear path forward.

V. CONCLUSION

The current theoretical view of the returns to education is that these returns can be explained using signaling and human capital accumulation. Empirical evidence rejects models of pure human capital or pure signaling. In this paper I make the case that empirical evidence can do little more to inform theory in this case. Signaling and human capital are both theoretically flexible enough that most observed behavior can be explained by either. The mediating effects that we use to empirically formalize human capital and signaling are rarely pure examples of either model. The flexible conception of ability prevents it from being proxied accurately enough to make precise theoretical inference. And, finally, the circumstances in which other problems can be overcome are too rare and unusual to use in service of a general understanding of the relative contribution of the two explanations.

The range of human-capital-and-signaling models that can be supported by the data is too wide to use the concepts of human capital and signaling to make predictions or policy prescriptions about education with a useful degree of precision. This casts doubt on the usefulness of this theoretical framing as applied to the real world.[12]

[12]As an aside, one cannot use the heavy degree of overlap between the two theories as a justification to prefer one and ignore the other. It is not uncommon to see results related to the returns to education explained in human capital terms unless the evidence is explicitly signaling-related. As such, one temptation might be to take the argument of this paper to mean that signaling is so empirically similar to human capital that it can be ignored and human capital assumed. But there is no basis other than chronology and gut

The literature already offers a means of organizing empirical results into a superior theoretical framework. Understanding the returns to education as being separable into private and external returns has in the past been seen as a restatement of the human capital vs. signaling debate. But the potential for signaling to produce productivity improvements and external returns means that the analogy is imperfect, and implies that the private/external distinction is actually more useful for making policy prescriptions and making sense of empirical data.

Human capital and signaling remain useful theoretical concepts, and the underlying explanation of education returns should naturally include both signaling and human capital. But any empirical tests of human capital or signaling-derived theories should not be automatically understood as having theoretical implications for the models they are derived from.

Transitioning to a basis of private and external returns offers a more fruitful path for understanding the returns to education. Crucially, it is a theoretical framing that actually allows the immense wealth of empirical evidence on the return to education to have a direct impact on our theoretical understanding. The two framings answer different questions—*how* does education affect outcomes as opposed to *why*—and so the distinction between the two is not trivial. But it appears that this particular *why* question, as interesting as it may be, is of limited use in application because it cannot be connected to empirical reality.

Because nearly all results can be explained using either signaling or human capital, the vast majority of empirical results are void of theoretical contribution to this particular *why* question. It is very strange that the economics of education, a highly empirical field, has settled on a theoretical framing that can learn little from the vast bulk of empirical work. On the other hand, any result that estimates the size of the effect of education on any outcome contributes to *how*. And, any study that atheoretically studies the mediators of the return

intuition for human capital to be the default model and signaling the alternative. Taking the overlap to mean that human capital could be ignored would be equally justified and equally wrong.

to education can contribute to a *why* question, just not one that relies on human capital and signaling as means of categorizing those mediators.

Following a debate on human capital and signaling that has lasted for nearly fifty years without approaching resolution, the field would do well to reorient, whether to my preferred theoretical framing or to something else. Applied economists should focus on addressing questions that can actually be answered.

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