The GED is a "Mixed Signal": The Effect of Cognitive and non-Cognitive Skills on Human Capital and Labor Market Outcomes*

James J. Heckman† Jingjing Hsse‡ Yona Rubinstein§

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"A Short Version"¶

Abstract

Using the GED program, this paper studies the effect of non-cognitive skills on the accumulation of human capital and on labor market outcomes. GED recipients, currently one half of all high school dropouts, *do not* quit school due to deficiencies in cognitive abilities or because of income constraints. Moreover, on average, GED recipients' hourly wages exceed those of ordinary high school dropouts and fall below those of ordinary high school graduates. However, controlling for AFQT scores and completed years of schooling, GED recipients' wages fall below the wages of

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†University of Chicago and the American Bar Foundation. E-mail: jjh@uchicago.edu

‡University of Chicago. E-mail: klmjihse@lily.src.uchicago.edu

§Tel-Aviv University. E-mail: yonar@post.tau.ac.il, y-rubinstein@uchicago.edu

¶The complete version is available upon request.

high school dropouts. We attempt to determine the unobserved characteristics that cause GED recipients to earn less than ordinary high school dropouts do. GEDs exhibit more developed cognitive skills, but they exhibit deficient non-cognitive skills. Both cognitive and non-cognitive skills, such as self-discipline and persistence, affect educational attainment and labor market outcomes. Since the GED exam tests cognitive skills, it "selects" high school dropouts with a mixed quality of skills: they are bright but lack perseverance and self-discipline. We find that GEDs' wages do not increase upon acquisition of the degree. Hence, we find no treatment effect for the GED. Our results suggest that: (a) both cognitive and non-cognitive skills affect educational attainment, (b) labor markets price out both cognitive and non-cognitive skills and (c) the wages of GED recipients reflect the mixed quality of their skills. JEL:C31

1 Introduction

The General Educational Development (hereafter GED) program is a second chance program that administers a battery of cognitive tests to self-selected high school dropouts to determine whether or not they are the academic equivalents of high school graduates. The GED was introduced in 1942 by the examination staff of the United States Armed Forces Institute in order to assist World War II veterans in "re-adjusting to civilian life and in pursuing higher educational and vocational goals."[1]

The fraction of high school credentials issued via the GED testing program rose sharply over the last three decades. By the late 1990s, almost one of five high school diplomas was gained by passing the GED battery exam. This is well reflected in the share of GED holders in the population.

In 1975, thirty years after the GED was first introduced, one of seven high school dropouts aged 19 to 24 earned a high school equivalency diploma by the GED exam, and these GED holders accounted for only one of twenty of all high school certificates

[1]Malizio, Andrew G. and Douglas R. Whitney, *Who takes the GED Tests? A National Survey of Spring 1980 Examinees.* Washington, DC: American Council of Education, 1981.

awarded. In 1998, one of two high school dropouts was a GED recipient, and these recipients accounted for one of five high school graduates

The US Census considers the GED recipients to be high school graduates. Using this classification, it appears that high school dropout rates declined over the last three decades. Viewing GED recipients as high school dropouts reveals an altogether different picture - the share of those who chose to drop out of high school in the late 1990s' was higher than in the early 1960s!

This study addresses two main questions: First, why do GED recipients drop out of school and how well do labor markets treat this growing group? Second, what is the role of *both* cognitive and non-cognitive abilities in determining educational attainments and life time earnings of high school dropouts?

Several recent studies have addressed the question of how well labor markets treat GED recipients. They find that GED recipients earn less than high school graduates but more than other high school dropouts. Yet, the source of the difference in wage rates and earnings between GED recipients and other dropouts is not well established.

A large body of subsequent research summarized in Boesel, Alsalam and Smith (1998) confirms these findings. Cameron and Heckman show that the wage gap between GED recipients and other high school dropouts is due to the higher cognitive abilities of the GED recipients and the greater amount of education attained before GEDs dropout. Tyler, Murnane and Willett (2000) argue that acquisition of a GED *improves* labor market outcomes of high school dropouts - net of human capital effects - by serving as a valuable *signal* to the labor markets.[2]

We argue that the GED is a *"mixed signal."* Most studies evaluating the GED program[3], as well as most discussions of ability bias in the estimated return to education, treat omitted "abilities" as a composition of traits which can be aggregate to one factor, often proxy by cognitive tests. We argue that this missing framework cannot explain

[2]Tyler, Murnane and Willett report that GED signal increase earnings of white young dropouts by 10% to 19%.

[3]David Boesel, Nabeel Absalem and Thomas Smith (1998) present a comprehensive review of evidence on the GED program.

either (i) why the GED recipients drop out of school, or (ii) the labor market outcomes of GED recipients.

Both cognitive and non-cognitive abilities, such as self-discipline, persistence and perseverance are valued in the labor markets and both type of skills affect the non-monetary costs of acquiring human capital. As a consequence of these first two points, cognitive and non-cognitive abilities jointly determine the accumulation of human capital in the form of education, training and experience. Dropping out of high school is due to a lack of non-cognitive skills, cognitive skills, or both. Since the GED exam is a cognitive task, it selects high school dropouts with a mixed quality of skills. They are brighter than other dropouts but lack perseverance and self discipline. Their endowments of noncognitive skills are lower. Our econometric tests show that GED recipient wages reflect a different composition of skills determined prior to receiving of the GED title, rather than a GED "treatment effect."

Using the National Longitudinal Survey of Youth (NLSY) and the Panel Study of Income Dynamics (PSID) we find that:

- The GED exam is successful in psychometrically equating GED test takers with ordinary high school graduates who do not go on to college. Recipients are as smart as ordinary high school graduates who do not go on to college, where cognitive ability is measured by an average of cognitive components of the Armed Forces Qualifying Test (AFQT) or by the first principle component ("g"). By these same measures, GED recipients are smarter than other high school dropouts who do not obtain a GED. The pattern is the same for all other groups. The choice of the GED recipients to quit school cannot be explained by cognitive abilities or income constraints.

- In unadjusted cross sectional comparisons, GED recipients earn hourly wage rates and annual earnings substantially less than those of high school graduates and earn slightly more than other high school dropouts. Accounting for GEDs higher years of schooling, or for their higher AFQT, GED recipients earn *less* than other high school

dropouts, and have lower hourly wages. These results are statistically significant.

- Controlling for fixed effects, we find no evidence of a permanent effect of GED certification on wages for high school dropouts who take the GED after age 17. For instance, we find the white males GED recipients earn approximately 8 percent less than other high school dropouts with the same years of schooling and AFQT scores. This is true before and after the acquisition of the GED degree.

- The labor force participation and employment rates of GED recipients are lower than those of other dropouts. Their turnover rates are higher too. This is true both before and after the acquisition of a GED degree.

- The story for white females is slightly different. Girls who drop out for reasons other than pregnancy are like teenage boys who drop out. As for teenage mothers, GED recipients earn the same as other high school dropouts once AFQT and years of schooling are accounted for.

Some unmeasured factors account for the relatively poor performance of GED recipients compared to that of other dropouts. Our study points to the role of *non-cognitive* abilities.

It is common knowledge outside of academic journals that motivation, tenacity, trustworthiness and perseverance are important traits for success. Even in the Bible, as he cast Adam and Eve out of the Garden of Eden, God explained that the knowledge they gained from partaking of the forbidden fruit will not be sufficient to secure the good life: "In the sweat of your face shall you eat bread." [Genesis 3: 17] Forbearance is equally important.

This insight has not become any less significant over time. Thomas Edison wrote that "genius is 1% inspiration and 99% perspiration." Similarly, many parents are cognizant of the importance of these noncognitive traits. An example of this concern is the enduring popularity of stories like "The Tortoise and The Hare" and "The Little Engine That Could."

It is surprising that academic discussions of skill and skill formation almost exclusively focus on measures of cognitive ability and ignore noncognitive skills. The early literature on human capital (Gary Becker) contrasted cognitive ability models of earnings with human capital models, ignoring noncognitive traits entirely. The signalling literature (Michael Spence) emphasized that education was a signal of a one dimensional ability, usually interpreted as a cognitive skill. Most discussions of ability bias in the estimated return to education treat omitted ability as cognitive ability and attempt to proxy the missing ability by cognitive tests.

Most assessments of school reforms stress the gain from reforms as measured by the ability of students to perform on a standardized achievement test. Widespread use of standardized achievement and ability tests for admissions and educational evaluation are premised on the belief that the skills that can be tested are essential for success in schooling, a central premise of the educational testing movement since its inception.

Much of the neglect of noncognitive skills in analyses of earnings, schooling and other lifetime outcomes is due to the lack of any reliable method of measuring them. Self reported measures of persistence, self esteem, optimism, time preference and the like are now being collected, and some studies estimate the effect of these measures on earnings and schooling outcomes. These studies shed new light on the importance of noncognitive skills.[4] Yet they are not without controversy. For example, *ex post* assessments of self esteem may be as much the consequence as the cause of the measures being investigated.

We avoid these problems by using evidence from the GED testing program in the United States to demonstrate the quantitative importance of noncognitive skills in determining earnings and educational attainments. First, we identify a noncognitive factor that accounts for the unexplained GEDs decision to drop out of school. Then, we show that this factor play an important role in explaining the poor labor market outcomes of

[4]Studies by Samuel Bowles and Herbert Gintis (1976), Rick Edwards (1976) and Roger Klein, Richard Spady and Andrew Weiss (1991) demonstrate that job stability and dependability are traits more valued by employers (ascertained by supervisor ratings and surveys of employers) **than cognitive ability (?)**, although they present no direct evidence on wages and educational attainment. Perseverance, dependability and consistency are the most important predictors of grades in school (Bowles and Gintis).

GED recipients. Finally, we show that this factor is correlated with behavioral outcomes.

Using the NLSY we find that white male GED recipients show that:

- GED recipients have the highest level of participation in (almost) every category of illicit (illegal) activity compared to other high school dropouts. Their crime participation rate is also higher than that of high school graduates and those with more than 12 years of schooling. This is true even when the outcomes are not adjusted for differences in AFQT and educational attainment. It is also true when we exclude persons who acquire the GED in prison, or all persons who have been in prison.[5] The same applies for white females, excluding teenage mothers, who are much less likely to get the GED in prison. GED recipients are more likely to participate in illegal drug use, drug selling, fighting in school, vandalism, shoplifting, theft, robberies, and school absenteeism than are other dropouts.[6]

- The statistical correlation between AFQT scores and an index of participation in illicit activity is significantly negative in the population at large. Individuals with higher AFQT scores are less likely to participate in illicit behavior. Yet, this relationship does not hold within education groups. The correlation between AFQT scores and our index among all high school dropouts and among high school graduates (with 12 years of schooling) is positive and statistically significant. It is especially strong for all dropouts, suggesting that among high school dropouts, the higher the AFQT score, the more likely is participation in illicit activity.

- This trade-off is entirely consistent with the view that both cognitive and noncognitive traits play important roles in determining graduation from high school.

The GED is a *"mixed signal"*: dropouts who take the GED are as "smart" as ordinary high school graduates, yet they have lower levels of noncognitive skills than other high

[5] In order to avoid a spurious causal relationship arising from prisoners and hence people with a greater participation in crime acquiring the GED.

[6] Excluding GED recipients, the rate of illegal and delinquent behavior decreases monotonically as education levels rise.

school dropouts.

- Both traits determined educational attainments. Non-cognitive traits play an important role in explaining the dropping out phenomenon in the US.

- Labor markets outcomes of GED recipients reflect a composition of traits formed prior to receiving of the GED title, rather than a GED "treatment effect."

Our finding challenges the conventional human capital literature and signalling literature that assume a single skill. It also demonstrates the folly of a psychometrically-oriented educational evaluation policy that assumes that cognitive skills are all that matter. Inadvertently, a test has been created that separates out bright but nonpersistent and undisciplined dropouts from other dropouts. It is, then, no surprise that GED recipients are the ones who drop out of school, fail to complete college (Stephen Cameron and James Heckman) and who fail to persist in the military (Janice Laurence). GED recipients are generally "wiseguys," who lack the ability to think ahead, persist in tasks, or adapt to their environments. The labor market performance of the GED recipients compared to both high school dropouts of the same ability and high school graduates demonstrates the importance of noncognitive skills in economic life.

The plan of this paper is as follows. We start in Section 2 with some basic facts about schooling attainments, the school dropout phenomenon, and the GED over the last three decades. In Section 3, we introduce the microdata and some basic facts on GEDs based on the NLSY panel data. The question why GED-holders drop out of school is addressed in Section 4 and Section 5. Section 6 and Section 7 provide a first glance at the labor market outcomes of GED-holders. In Section 8, we present the statistical framework. In Section 9 we estimate the effect of GED diploma and the effect of noncognitive factors on the wages of high school dropouts. Section 10 presents evidence on the behavioral outcomes of GED holders. We focus especially on the comparison between the outcomes of GED holders and the outcomes of other high school dropouts and ordinary high school graduates. In Section 11 we provide a simple theoretical explanation for our results. In section 12 we present evidence from other studies. Section 13 and section 14 provides detailed critique

on the use of inter-states variation in GED passing standards for estimating the effect of a GED degree on labor market outcomes. We conclude in Section 15.

2 The GED program and Aggregate Educational Attainments

In this section, we present new evidence on the evolution of the GED program over the past three decades. We also address the implications for the evolution of educational attainment in the US over this period of time. The US Census considers the GED recipients to be high school graduates. Using microdata from the Current Population Survey (hereafter: CPS), the October supplement, and aggregate data from the Digest of Educational Statistics, we are able to separate the GED subgroup from ordinary high school graduates.[7]

Two important facts emerge: First, in the late 1990s the share of General Educational Development (GED) credentials issued each year as a fraction of total high school credentials was more than twice higher then in the early 1970s. Second: including GED recipients in the high school dropout group reverses the time trend on high school dropouts. Instead of decreasing by approximately one third, from 15 percent in early 1970s to 11 percent in the-late 1990s, dropout rates actually increased. At the late 1990s, drop out figures in the USA are the highest since the early 1960.

Figure 1 shows the General Educational Development (GED) credentials issued as fraction of total high school graduates of public and private schools. As figure 1 makes clear, over the past three decades, the GED program became a major road for graduation. At the early 1970s less than 10 percent of high school diplomas were issued via the GED program. Three decades later, by the late 1990s, almost one of five high school graduates earned her/his degree by taking the "second chance" program.

Data on drop out rates suggest that the GED program serves as a "first chance" program (rather than a "second chance"). Figure 2 shows high school drop out rates over

[7]Source: http://nces.ed.gov/pubs2001/digest/

the last three decades under two different classifications: (i) the dropout rates according to the US Census classification, (for young American 16 to 24 years of age), and (ii) the dropout rates when high school dropouts with a GED degree are included in the high school dropouts category (a percent of 17-year-old population).

According to the US Census classification, the percent of high school dropouts among persons 16 to 24 years of age reached during the late 1990s the lowest level since data are available. A totally different picture emerges when GED holders are included in the high school dropout category. In 1971, the share of those who graduated from public or private high schools was approximately 75 percent of the population of 17 years of age.

It is common knowledge that children do not start school at the same age. In this case, the ratio, one minus the share of those who graduated from public or private high schools (for instance 25 percent in 1971) is a lower bound for the dropping out rate among the 17 years old cohort. Three decades later, by the late 1990s, it was slightly higher than 30 percentage points. This is the highest dropping out rate in the USA since early 1960s.[8]

The change in the aggregate figures might reflect changes in the composition of the socioeconomic and ethnic characteristics of the average young American rather than a change in the educational attainments of young Americans. For this reason we repeat this exercise, this time using the CPS data set (October supplement), which enable us to separate the GED subgroup from ordinary high school graduates, by race and gender groups. Due to lack of large samples we look at the sub-group of persons, 18 to 24 years of age. The CPS sample data display similar results to the aggregate data. This holds both for males and females, as well as by race.

For instance, (a) the share of GED holders among young cohorts (18-24 years old) of white males increased sharply from approximately three percent in 1975 to twelve percent in 1998; (b) including GED recipients in the high school dropout group reverses the time trend on high school dropouts. Instead of decreasing from twelve percent in 1975 to eight

[8] Assuming that the heterogeneity in the age children first attend school has not shrinked over the last decades. Using the NLSY and the Panel of Income Dynamics (PSID) we actually find that increasing variation at the age children first attend school as we move to younger cohorts.

percent in 1998, dropout rates actually increase from fifteen percent in 1975 to twenty percent in 1998.

Figure 3.a presents the share of GED graduates among young whites (aged 18-24) by gender. Both females and males exhibit the same trend. Among younger cohorts, GED graduates constituted a five times higher proportion in the late 1990's than they did in the mid-1970's. Moreover, half of this jump took place in the mid 1990s - from 1993 to 1996. Figure 3.b highlights the key role that GED graduates have on the evolution of high school graduation rates. Among both males and females, GED graduates constituted a five times higher share of new graduates (ordinary and certified) in the mid-1990's as they did in 1975. In 1975, one of twenty measured graduate white males attained the degree by taking the GED exam. In 1998 (and 1996) one of five measured graduate white males was a GED graduate.

The same pattern holds for women. Figures 4.a and 4.b present the change in the share of high school dropouts among young whites over the last three decades. In 1975, fifteen percent of all white males age 18-24 did not complete high school in the usual way. Among them, one in five obtained a GED. High school dropouts (not including GEDs) constituted fifteen percent of white males aged 18-24. Twenty years later (1996), it would seem that fewer are dropping out of high school than ever before. The share of high school dropouts among white males aged 18-24 declined by half - from fifteen percent in 1975 to eight percent in 1998. Introducing GED graduates back into the high school dropout group totally reverses the picture. The share of dropouts increased from fifteen percent in 1975 to more than twenty percent in the-mid 1990s. According to both aggregate data (Figure 2) as well as the microdata (Figures 4.a and 4.b), by the late-1990s, one of two high school dropouts is a GED holder.

We propose that GED graduates exhibit unobserved skills higher than those of high school dropouts but lower than those of dropouts who do not obtain GEDs. If so, then classifying GED graduates as high school graduates reduces the average quality of both measured graduates and dropouts. We also suspect that this classification explains part of the increase in the graduate/dropout wage gap over the 1980's and the1990's. Who

are the GED recipients? We address the question in the following sections.

3 The micro data and some basic facts

This paper analyzes educational attainments and labor market outcomes of high school dropouts who certified as high school graduates by the GED program. Our data are drawn from the 1979-1994 waves of the NLSY (the military sub-sample and the non-black, non-Hispanic disadvantaged samples are excluded).

The NLSY collected detailed information on school attendance including data indicating a possession of a GED degree by year and month. In addition, the NLSY panel data contains a detailed description of labor market outcomes with a rich set of demographic characteristics. The data set also includes direct measures of cognitive performance - the Armed Forces Qualification Test (hereafter AFQT) and self-reported 22 indicators of illegal and delinquent behavior. The AFQT is age adjusted.[9] The NLSY data allow us to avoid the bias inherent in studies using cross-section because it is longitudinal, and measures family background, cognitive abilities and behavioral outcomes (starting as early as age 14), education and training and labor market outcomes over the sample period. Confining the analysis on educational attainments to young persons between 13 and 15 at the beginning of the sample allows us to study the role of cognitive abilities as well as income constraints in explaining the dropping out phenomenon.

We group respondents into five education categories: high school dropouts, GED graduates, high school graduates, respondents with some college, and college graduates. High school dropouts include those with less than 12 years of schooling by 1994. GED recipients include those who dropped out of high school and were classified later, by 1994, as high school graduates by the GED. High school graduates include those who completed 12 years of schooling by 1994, and did not drop out of high school. We classify individuals with more than 12 years of schooling but less than 16 (excluding GED recipients) are classified as having some college. We define those with 16 years of schooling or more in

[9] Further information about the AFQT is given in Appendix A.1.

1994 as college graduates. Table 1 presents basic facts on high school dropouts, GED holders and high school graduates in our sample, by race and gender.[10]

GED-holders complete more years of schooling than other dropouts yet less than ordinary high school graduates. This is also true when we include their post high school studies. The mean wages follow a similar pattern: GED-holders earn more than other high school dropouts but less than ordinary high school graduates. These findings agree with other studies. However, three facts should be pointed out: (i) GED-holders (males) are not likely to work more than other HSDs, (ii) they serve in jail more than other dropouts, and (iii) almost half of all female who drop out gave birth to live children sometime between the ages of 15 and 19. These facts should be taken into account when studying the effect of the GED program on the labor market outcomes of high school dropouts. Finally, we find that GED-holders, on average, work a couple of years before getting their GED diploma. We will use that for studying the effect of the GED program on the labor market outcomes of high school dropouts.

[10]Table 1A (appendix) defines the basic variables we use in our study and presents their sample means.

Chapter II: Why Do GED-holders Drop Out?

Disparities in family income and cognitive ability are the conventional explanations for the posterior differences in educational attainment and labor market outcomes. In this section we examine the relative contributions of cognitive ability and family income constraints to the initial decision of GED-holders - currently one half of all high school dropouts - to quit school.

Cameron and Heckman (1993) present considerable evidence that GED recipients' cognitive skills and family background differ from those of ordinary high school graduates. This section presents simple mean-difference and univariate distributional comparisons among high school dropouts (HSDs), GED-certified (GEDs) and high school graduates (HSGs). We address the question in the title by focusing on the comparison between GEDs and high school graduates who choose not to obtain further education.

Two main results emerge from this section: First, GED-recipients do not drop out of school because of deficiencies in cognitive abilities. GED recipients possess similar cognitive abilities as high school graduates with 12 years of schooling. Second, we find no evidence that GED-recipients do drop out of school because of income constraints.

GEDs are more likely to be raised in a single-parent family than ordinary high school graduates. In fact the share of GEDs coming from a single-parent family is as high as their share of other high school dropouts. The fact that GED holders are more likely to be part of a single parent household implies that the gap between the resources per capita of GEDs and high school dropouts may be smaller than the family income gap. Indeed we find that the income per-capita of GED-holders is as high as that of high school graduates.

These findings challenge the conventional reliance on cognitive skills and income constraints in accounting for high school attrition and the poor labor market outcomes of high school dropouts. Non-cognitive skills may lie at the heart of this phenomenon.

4 Cognitive abilities

Table 2.a displays the average age-adjusted Armed Forces Qualification Test (AFQT) scores of all individuals in the National Longitudinal Survey of Youth (NLSY) broken down by educational category, gender, and race. The first panel of Table 2.a makes clear that high school graduates have statistically significantly higher mean test scores than GED recipients, who, in turn, have higher mean test scores than high school dropouts.

However, AFQT scores may be affected by the individual level of schooling at the time of the testing. To control for this effect we present in the second panel of Table 2.a the mean AFQT scores for a sub-sample of individuals who were 15-16 years of age in 1980 when the test was administered. For this sub-group, subsequent graduation from high school has no effect on test scores, while years of schooling have little effect, at least in the comparison between ordinary high school graduates and those who will eventually become GED recipients.[11] These results hold for males and females, as well as for blacks, Hispanics, and whites. As panel B shows the mean AFQT score of white high school graduates is 44 percent higher than the mean AFQT scores of their GED counterparts.

According to the Current Population Survey (CPS), more than one half of white high school graduates, 25 to 29 years old in 1998 did not seek to obtain higher education. The benefits of a college education may have an important role in the decision to graduate from high school. However, the considerable share of high school graduates who do not go on to obtain further education suggests that a high school diploma has other valuable attributes in addition to being a prerequisite for future education and its returns. If this is so, a comparison between high school dropouts and high school graduates who do not obtain further education may provide us with a fresh insight into the reasons for high school attrition. Indeed, a comparison between GED recipients and high school graduates with only 12 years of schooling provides a very different conclusion. We illustrate it using some figures and tables. Figure 2.a shows the distributions of age-adjusted AFQT scores for white male GED recipients versus ordinary high school graduates with 12 years of

[11] Les than X percent of all GED holders drop out school at the 14 or less years of age.

schooling.

As Figure 5.a makes clear, the GED exam is quite successful in psychometrically equating white GED holders with ordinary high school graduates who do not obtain further education. The pattern is the same for black males, as well as for black and white females.[12] Table 2.b agrees with the figure. It presents the mean AFQT scores for 15-16 years-old individuals broken down into high school dropouts, GED holders and high school graduates with 12 years of schooling.[13] We find no significant difference between the mean AFQT scores of white GED recipients and the mean AFQT scores of high school graduates who did not obtain further education by their early 30s. Note that this is not true for the comparison between other high school dropouts and ordinary high school graduates. We find that the mean AFQT scores of high school graduates with 12 years of schooling is significantly higher than the mean AFQT scores of high school dropouts who do not purchase a GED degree. This is also true for blacks. On average, GED recipients are as smart as ordinary high school graduates who do not go on to college, where cognitive ability is measured by an average of cognitive components of the AFQT. By this same measure, GED recipients are smarter than other high school dropouts who do not obtain a GED. These evidence makes it quite clear that GED holders did not drop out of school due to lack of cognitive ability.

5 Family background

Yet, cognitive ability is but one possible source of variation in schooling decisions. Liquidity constraints, time preferences and non-cognitive abilities may systematically affect educational attainment too. A conventional explanation for the disparity in educational attainment is the difference in the family resources required to finance a college education (see e.g. Hauser (1993) and Kane (1994)).

[12] The results for **Hispanics** are quite similar, yet not as strong as the results for **Blacks**. Since the fraction of recent immigrants among Hispanic is higher than among the rest we focus on the first two sub-groups.

[13] In 1994, when these individuals are 33-34 years of age.

Cameron and Heckman (2001) challenged this view by making an important distinction between the effect of family income on early education and the effect of family resources on further education. They found that family income plays an important role in earlier schooling decisions, namely on high school completion, but not directly on college attendance of high school graduates.

Given the importance of disparity in family resources in explanations of the decision to drop out of school, next we compare the family income of GED recipients with the family income of ordinary high school graduates with twelve years of schooling.

Using the NLSY we calculate the average family income of high school dropouts, GED holders and ordinary high school graduates with no further education. Since family income may vary over the childhood, its effect on offsprings' outcomes may vary with their age. Thus, we restrict our sample to include only observations for those whose family income is available for the age range before most high school dropouts left school.

Table 2.c displays the family income and the income per capita for youth ages 14-17 in 1979. Panel A reveals that high school dropouts are more likely to come from families with lower earnings than do GED holders, who, in turn, have lower family income than the high school graduates who do not obtain further education.

The family income gaps are in agreement with the differences in parental education. The parents of high school graduates posses higher level of schooling than the parents of GED holders do. Yet, as Table 2.d shows, the gap between the years of schooling completed by the parents of high school graduates who with further education and the parents of GED-holders is substantially smaller than the difference between GED holders and all high school graduates (0.4, 1.1). Note that the family income gaps are above and beyond the gap in parental education, evaluated at labor market prices. The share of GED holders who grew up in a single parent family may explain part of it.

GED holders are more likely to come from single parent families than do ordinary high school graduates (See Table 2.e). This holds for Blacks, Hispanics, and Whites. For instance, the share of GED holders living in a single parent family at 14 years of age is as high (or even higher) as the share of high school dropouts (for Whites and Hispanics). The

substantial differences in the family structure of GED holders and ordinary high school graduates is presumably the reason why the gap between the family income of GED holders and high school graduates is above and beyond what their parents' education predicts.

However the fact that GED holders are more likely to be part of a single parent household implies that the gap between the resources per capita of GEDs and high school dropouts may be smaller than the gap in their family income. The second column in each panel of Table 2.c shows that income per-capita. Correcting for the size of the family we do find no significant difference between the income per-capita of GED holders and ordinary high school graduates. For instance, the gap between the average annual family income of white high school graduates with 12 years of schooling and the average annual family income of GED holders is \$6500 (in 2000 dollars), which is approximately 14 percent of the average annual family income of GED holders. The gap between the average income per-capita of these groups is approximately \$735, only 5 percent of the average income per capita of GED holders. Yet, note that this does not hold for other high school dropouts. High school graduates who do not obtain further education grow up in families with higher monetary resources per family member than high school dropouts do.

It is well established that children living with both parents have better educational outcomes than those who are growing in a single parent family. The evidence on the channels through which family structure affects the offspring's outcomes is still in question (See Solon, 1999).

Our results indicate that the role of family structure in the formation of other, non-cognitive skills may be important, but that it does not significantly affect the cognitive characteristics of the children. However, since family structure is the only observed difference between GED holders and ordinary high school graduates, the key to understanding the reasons for attrition lie therein.

Chapter III: How well does the labor market treat GEDs?

People possess many heterogeneous skills, some of which can be priced immediately upon labor market entry because they can be easily identified. Other kinds of skills may be distinguished by the market over time. The GED program may affect individuals' wages either by improving the endowments of both kinds of skills or by serving as a signal for the less apparent ones. The relative wages of the GED recipients may reflect a different composition of skills rather than being as a direct outcome of a GED degree.

In this section, we use the NLSY panel data to address two questions: (i) what is the causal effect of a GED degree on the labor market outcomes of GED holders, (ii) what are the cognitive and non-cognitive differences, evaluated at labor market prices, between GED recipients and other high school dropouts.

In his seminal work on the investment on human capital of the life cycle, Ben-Porath (1968) shows that the price of labor does not affect the allocation of time between working and investing in human capital.[14] Yet, facing an expected increase in the price of labor, a few periods from present, agents will re-allocate their time such that they will work less at the current wages and more in the higher wages.

Following economic theory, if the possession of a GED degree affects the wage offers that GED-holders face, then we should expect GED-holders to work less during the periods before they acquire the GED degree, and more after (relative to their counterparts).

We address the questions of interest using two strategies. First, we examine the effect of a GED degree on the wages of GED holders using data on wages. Second, we analyze the issue indirectly, employing the intuition emerging from the Ben-Porath model.

Since the second line of approach is somewhat intuitive, we'll describe it briefly as we present the data. We preview our analysis by looking at the hourly mean wages of high school dropouts, GED holders and high school graduates, conditional on observable characteristics we associate with human capital, ignoring unobserved heterogeneity.

[14] This is known as the "Ben-Porath neutrality".

6 The labor market outcomes of GED holders - a first glance

Table 3 shows the means hourly wages of GED holders and other high school dropouts workers relative to the mean hourly wages of ordinary high school graduates, using a sub-sample of HSDs, GED holders and HSGs white males. In unadjusted cross sectional comparisons, GEDs earn hourly wage rates substantially less than those of high school graduates and earn slightly more than other high school dropouts. Conditional on experience and annual hours worked, OLS estimators show that a GED recipient earns approximately 17 percent less than an ordinary high school graduate does, and 9 percent more than a high school dropout does (Column I). This results agree with the findings in previous studies.

The GED exam is successful in psychometrically equating GED test takers with ordinary high school graduates who do not go on to college. Recipients are as smart as ordinary high school graduates who do not go on to college, where cognitive ability is measured by an average of cognitive components of the AFQT. By these same measures, GED recipients are smarter than other high school dropouts who do not obtain a GED.

Accounting for the differences in cognitive abilities - as measured by the AFQT score - we find no significant difference between the mean hourly wages of high school dropouts and GED holders. AFQT scores play a key role in reversing the wage order between GED recipients and HSDs. However, AFQT exerts almost no effect on the wage gap between GED recipients and high school graduates. Both GED holders and other high school dropouts workers earn on average approximately 17 percent less than the average hourly wages of high school graduates with the same AFQT scores. (See Column II). While cognitive abilities explain much of the GED-HSD wage gap, they explain very little of the wage gap between GED recipients and high school graduates.

GED holders have slightly more years of schooling than other dropouts. Accounting for their higher years of schooling, and their higher AFQT scores the initial wage order is *reversed*: we find that GED holders earn approximately 8 percent *less* than other

high school dropouts. Note that by conditioning out the difference in years of schooling completed and cognitive abilities, we find no significant difference between the wages of other high school dropouts and ordinary high school graduates.

Why do GED holders, who choose to work, earn less than their high school dropouts counterparts do? We preview the study of the wages of GED-holders with a brief look at the employment of GED-holders, relative to other high school dropouts.

7 Employment

This section presents evidence on the effect of GED degree on the labor supply of GED-holders. Two main findings emerge from the comparison of GED-holders with other high school dropouts' employment, before and after the treatment. First, we find no evidence that the GED degree affects the labor supply of white males or white females. This holds when labor supply is measured either by annual work hours, employment status or unemployment status. Second, white males GED holders are more likely to supply less labor than high school dropouts with the same observable characteristics; They work less hours per year, they are more likely not to work, and more likely to report being unemployed. Finally, the employment outcomes of GED-holders who gained their degree early on in their life are worse than the outcomes of GED-holders who certified at an older age.

The dependent variable is either the annual worked hours, or binary variables indicating the employment status. The vector of regressors includes age adjusted AFQT score, years of schooling completed, years since left school, region of residence, local unemployment rate, cohort of birth and other observable characteristics.

7.1 Results for white males

Figure 7.a, Figure 7.b and Figure 7.c show the mean difference between the annual worked hours of GED-holders and other high school dropouts, by the number of years since graduation, separately for GED holders who gained a GED degree at (i) 18-19 years of

age, (ii) 20-22 years of age and (iii) 23-25 years of age.

We find that: (a) GED-holders work, on average, less than their high school dropouts counterparts. This is true for the period *before* and *after* the acquisition of the GED degree, (b) The employment gap is larger for GED-holder who acquire their degree at 18-19 years of age than for GED-holders who certified at an older age. For instance, the mean annual worked hours of GED-holders who certified at the age of 18-19 years of age is 400 hours less than the mean annual work hours of high school dropouts. It is also true for GED-holders who gained their degree at 20 to 22 years of age. However, we find no significant difference between the mean annual worked hours of GED-holders who graduated at 23 to 25 years of age (or later) and other high school dropouts. It is worth noticing that the largest gap between annual worked hours of GED-holders and other high school graduates is during the year the GED degree was purchased. For instance, a GED-holder who purchased the GED degree at 21 years of age works approximately 400 hours less than his high school dropout counterpart during the years before and after the acquisition of the GED degree, and 600 hours less than a high school dropout with the same observed characteristics at the year of graduation. Cameron and Heckman (1993) report that GED-takers spend on average 20 hours studying for the exam. Hence, it seems that the decline in annual worked hours (200 hours) cannot be explained by re-allocation of time between market working and studying to the GED exam.

Figure 7.d, Figure 7.e and Figure 7.f present the change in the annual work hours of GED-holders before and after they were certified, conditional out individuals' fixed effects. Controlling for unobserved invariant heterogeneity two main results emerge from these figures: First, as all three figures make clear, the GED has no positive effect on the annual worked hours of GED recipients. In fact, we find that GED-holders who acquired their degree at 23-25 years of age actually work less hours while possessing a GED degree then before. Second, GED-holders work significantly less at the year they acquire the GED diploma.

GED-holders work after the acquisition of the GED degree more they had worked at the year they purchased it. Yet, this is also true for the years before they had acquired

the GED degree. For example, for GED-holders, who purchased the diploma at 18-19 years of age, we find no change in the annual worked hours before during and after the treatment.

Finally we look at the likelihood of being employed. Figure 7.g, and Figure 7.h show the likelihood of GED-holders to be employed. Two main results emerge from these figures: First, GED-holders are less likely to be employed than high school dropouts with the same observable characteristics. Second, We find, no long-run effect of the GED degree on the likelihood of a GED recipient to be employed. Third, as for the short-run, we find that GED-holders are more likely to purchase the GED degree while they are not working.

7.2 Results for white females

We repeat the above exercise for white females. Figure 7.i, Figure 7.j and Figure 7.k show the mean difference between the annual worked hours of GED-holders and other high school dropouts, by number of years since graduation, separately for GED holders who gained a GED degree at (i) 18-19 years of age, (ii) 20-22 years of age and (iii) 23-25 years of age. As for white males, we find no evidence the GED degree affects the labor supply of white males or white females. Yet, unlike males, we find no significant difference in the mean annual worked hours between GED-holders and other high school dropouts. It is worth noticing that, as for males, GED holders work less at the year they purchase the GED than during the years before or after. As for males, this dip is larger than the average time a GED taker spend studying for the GED exam. Not surprisingly we find no significant difference between the likelihood of GED-holders and other high school dropouts to be working. This is true before and as well as after the acquisition of the GED degree.

8 Measurement framework

8.1 The Statistical Model:

- Let $Y_{i,t}$ be the log hourly wage of individual i at time t (or any other outcome of interest). For the sake of simplicity, let us assume, for each person i, two potential outcomes corresponding to a treatment and a control state. [15]Let $Y_{HSD,i,t}$ denote the wage of person i at time t if not treated, and $Y_{GED,i,t}$ log hourly wage of person i at time t if treated. Let $D_{i,t} = 1$ denote the possession of a GED degree by time t. Hence, the log hourly wage of person i at time t is:

$$Y_{i,t} = D_{i,t} Y_{GED,i,t} + (1 - D_{i,t}) Y_{HSD,i,t} \tag{1}$$

  Equation (1) is Quandt's (1972) switching outcomes model**,** as well as the Roy model of income distribution (Roy 1951; Heckman and Honore 2000).

- Ignoring other covariates (or assuming that these have already been conditioned out), potential outcomes are determined by the treatment state. Following Mincer's (1974) semilog specification of the earnings equation, we assume, that log wages take the form:[16]

$$\begin{aligned} Y_{GED,i,t} &= \gamma_{i,g,k} + U_{GED,i,t} \qquad i = 1, ..., I;\ t = 1, ..., T \\ Y_{HSD,i,t} &= U_{HSD,i,t} \qquad i = 1, ..., I;\ t = 1, ..., T \end{aligned} \tag{2}$$

  where T is the length of the panel and I is the number of subjects in it. $\gamma_{i,g,t}$ measures the effect associated with the receipt of a GED diploma at age g, k years later on person i'**s** wages. If the effect is common for all persons (conditional on X) then $\gamma_{i,g,k} = \gamma_{g,k}$ for all i. If there is no depreciation in the effect of a GED degree on a person's wages then $\gamma_{i,g,k} = \gamma_{i,g}$. If the effect of the receipt of the GED

[15]We can generalize it to the case of more then two potential outcomes. See Heckman and Vytlical (2000) for the multi-outcome extension.

[16]For simplicity we suppress explicit notation for the dependence on the covariates $X_{i,t}$, which consists of person's i personal characteristics and labor market variables at time t.

diploma on wages does not vary with the age when the GED diploma was acquired then $\gamma_{i,g,k} = \gamma_k$.

- $U_{i,t}$ is a composite of unobserved invariant abilities, pre-determined before the acquisition of the GED degree, and person-specific random wage shocks:

$$\begin{aligned} U_{GED,i,t} &= \theta_{GED,i} + \varepsilon_{i,t} \\ U_{HSD,i,t} &= \theta_{HSD,i} + \varepsilon_{i,t} \end{aligned}$$

where θ_i is the vector of non-time varying unobserved variables that influence wages. $\varepsilon_{i,t}$ represents person-specific series of shocks:

$$\varepsilon_{i,t} = D_{i,t}\Delta\varepsilon_{GED,i} + \nu_{i,t}$$

where $\Delta\varepsilon_{GED,i}$ is the difference between the average person-specific wage shock before and after the acquisition of the GED degree. $\nu_{i,t}$ represents person-specific *i.i.d.* wage shocks. $E(\nu_{i,t}) = 0$. If person-specific wage shocks are not correlated with the acquisition of the GED degree then $E(\Delta\varepsilon_{GED,i}) = 0$. We allow the non-random sample of GED recipients to have a distribution of invariant unobserved skills different from other dropouts. Hence, we decompose $U_{i,t}$ into the variation *between* and *within* groups:

$$U_{i,t} = \theta_{HSD} + D_i\Delta\theta_{GED} + \Delta\theta_i + \nu_{i,t} + D_{i,t}\Delta\varepsilon_{GED,i}$$

where (i) θ_{HSD} is high school dropouts' intercept, (ii) D_i is a dummy variable which equals 1 iff $\sum D_{i,t} > 0$, (iii) $\Delta\theta_{GED}$ is the difference between GED holders' and other high school dropouts' intercepts, and (iv) $\Delta\theta_i = \theta_i - (\theta_{HSD} + D_i\Delta\theta_{GED})$ is the fixed effects variation within groups.

- Substituting these expressions into Equation (1) the earnings function can be written - ignoring non-employment at this stage - as:

$$Y_{i,t} = D_{i,t}\left(\gamma_{g,k} + \Delta\gamma_{GED,g,k} + \Delta\gamma_{i,g,k}\right) + \theta_{HSD} + D_i\Delta\theta_{GED} + \Delta\theta_i + \nu_{i,t} + D_{i,t}\Delta\varepsilon_{GED,i} \tag{3}$$

where $\gamma_{g,k}$ is the return to a random sample of the high school dropouts population. $\Delta\gamma_{GED,g,k}$ and $\Delta\gamma_{i,g,k}$, decompose the difference between person i's return and the common effect into the variation *between* and *within* groups. $\Delta\gamma_{GED,g,k}$ is a "sorting gain" that arises from a purposive selection, based on individual comparative advantage, into the GED program:

$$\Delta\gamma_{GED,g,k} = E\left(\gamma_{i,g,k} - \gamma_{g,k} \mid D_{i,t} = 1\right) = \left(\gamma_{GED,g,k} - \gamma_{g,k}\right)$$

which is the difference between the average gain among GED holders and the common effect in the population. $\Delta\gamma_{i,g,k}$ is the difference between person i's effect and the average effect among GED holders $\Delta\gamma_{i,g,k} = \left(\gamma_{i,g,k} - \gamma_{GED,g,k}\right)$. If the only source of heterogeneity are the between groups differences, then $\Delta\gamma_{i,g,k} = 0$. $\Delta\theta_{GED}$ is a "sorting gain" generated by the effect of invariant unobserved skills on the decision to participate in the GED program.

- As was already pointed out by Carneiro, Heckman and Vytlacil (2001), the parameters of interest should be determined by the economic question. If the expected return to a random sample of the dropouts population is the economic question, then, $\gamma_{g,k}$ the *average treatment effect* (ATE), is the parameter of interest. If the causal effect of a GED degree on GED holders' wages is the question addressed, then $\gamma_{GED,g,k} = \gamma_{g,k} + \Delta\gamma_{GED,g,k}$, *the average treatment effect on the treated* ($ATET$), is the parameter of interest.

- This paper addresses two questions concerning labor market outcomes. First, what is the causal effect of a GED degree on the GED holders' wages - i.e. the average treatment effect on the treated ($ATET$). Second, what are the unobserved cognitive and non-cognitive differences - evaluated at labor market prices ($\Delta\theta_i$) - between GED recipients and other high school dropouts.

- As such, the parameters of interest are (i) $\gamma_{GED,g,k}$, (ii) $\Delta\theta_{GED}$.

8.2 Identification issues

- We can write the OLS estimator of the causal effect of a GED degree on the mean outcomes of high school dropouts as the following weighted average:

$$\begin{aligned} E\left(\gamma_{g,k}^{OLS}\right) &= \frac{cov\left(D_{i,t}, Y_{i,t} \mid \cdot\right)}{var\left(D_{i,t}\right)} \\ &= \frac{E\left[\left(Y_{i,t} - \bar{Y}\right) D_{i,t} \mid \cdot, D_{i,t} = 1\right] P}{P\left(1-P\right)} + \frac{E\left[\left(Y_{i,t} - \bar{Y}\right) D_{i,t} \mid \cdot, D_{i,t} = 0\right] \left(1-P\right)}{P\left(1-P\right)} \\ &= \frac{E\left[\left(Y_{i,t} - \bar{Y}\right) \mid \cdot, D_{i,t} = 1\right]}{\left(1-P\right)} \end{aligned} \tag{4}$$

  where $P = \Pr\left[D_{i,t} = 1\right]$. By substituting Equation (3) into Equation (4) we receive that the OLS estimator equals to:

$$E\left(\gamma_{g,k}^{OLS}\right) = \gamma_{g,k} + \Delta\gamma_{GED,g,k} + \Delta\theta_{GED} + \Delta\varepsilon_{GED,i} \tag{5}$$

  Assuming that (i) GED-holders are a random sample of the high school dropout population ($\Delta\theta_{GED} = 0$) and that (ii) the time GED holders choose to take the battery of exams is not correlated with their wages $\Delta\varepsilon_{GED} = E\left(\Delta\varepsilon_{GED,i}\right) = 0$, then the OLS generates an unbiased estimate of the $ATET$.

8.2.1 Selection on absolute and comparative advantage:

- As Equation (3) makes clear, the fact that GED degrees are not randomly assigned to high school dropouts introduces three potential econometric problems: (i) selection based on comparative advantage, (ii) selection based on absolute advantage, and (iii) the effect of person-specific wage shocks on the timing of treatment.

- The first two are the standard cross-section selection problem.

  - If agents know, or can (partially) predict the individual ex-post effect γ_i, then the choice of participation in the program is correlated with unobserved heterogeneity in the return to a GED degree - $\Pr\left(D = 1 \mid X_i, \gamma_i\right) \neq \Pr\left(D = 1 \mid X_i\right)$. If so, the average effect of a GED degree on the wages of GED holders overstates the expected effect of a GED degree on a random sample of the dropouts

population:

$$P.1: \ \Delta\gamma_{GED,g,k} > 0$$

– Moreover, if a person's absolute advantage in labor market activities - i.e. the fixed effects θ_i - is (negatively) correlated with the cost associated with an acquisition of a GED degree, then $\Pr(D = 1 \mid X, \theta) \neq \Pr(D = 1 \mid X)$. In this case $D_{i,t}$ is correlated with $\Delta\theta_i$:

$$P.2: \ \Delta\theta_{GED} > 0$$

– The third econometric problem is the endogeneity of the timing. If the timing of the receipt is affected by person-specific wage shocks, for instance, if agents are more likely to take the GED exam when their wages are lower than they expect them to be, then $D_{i,t}$ is (may be) correlated with $\Delta\varepsilon_{GED,i}$. If so, person-specific wage shocks are *not* randomly distributed before treatment and after treatment:

$$P.3: \ E(\Delta\varepsilon_{GED,i}) \neq 0$$

8.2.2 Non-employment:

- Working decisions introduce additional econometric problems. First, if the choice to work is correlated with the effect of a GED degree on person i's wages, then the average effect of a GED degree (on GEDs workers) is a biased estimator of the average treatment effect on GED holders:

$$P.4: E\left(\Delta\gamma_{GED,g,k,i} \mid Y_i > 0\right) \neq E\left(\Delta\gamma_{GED,g,k,i}\right)$$

- Second, if workers are not randomly drawn from their educational groups then the difference between the fixed effects of GED holders and other high school dropouts is a bias estimate of the average unobserved skills gap between GED recipients and other high school dropouts:

$$P.5: E(\Delta\theta_i \mid Y > 0) \neq E(\Delta\theta_i)$$

Finally, if a person-specific wage-shocks affect working decisions as well as the timing the GED exam is taken then:

$$P.6 : E\left(\Delta\varepsilon_{GED,i} \mid Y > 0\right) \neq 0$$

8.3 Identification strategy

- We identify the parameters of interest - $\gamma_{GED,g,k}$ and $\Delta\theta_{GED}$ - by comparing the wages of GED recipients before and after acquisition of the GED degree with wages of other high school dropouts.

- We control for selection on unobserved non-time varying variables by differentiate out individual fixed effects:

$$\left(Y_{i,t} - Y_i\right) = \left(D_{i,t} - \bar{D}_{i,t}\right)\delta_{GED,g,k} + \left(D_{i,t} - \bar{D}_{i,t}\right)\Delta\gamma_{i,g,k} + \nu_{i,t} + \left(D_{i,t} - \bar{D}_{i,t}\right)\Delta\varepsilon_{GED,i} \tag{6}$$

  where Y_i is the average wage of person i. $\bar{D}_{i,t}$ is the fraction of time that person i holds a GED degree while observed (by the econometrician) working. Note that for those who hold a GED degree throughout the period, $\left(D_{i,t} - \bar{D}_{i,t}\right) = 0$.

- $\delta_{GED,g,k}$ is the average effect of a GED degree on GED holders' wages, for whom we observe positive wages *before* and *after* the receipt of the diploma $\left(0 < \bar{D}_{i,t} < 1\right)$. Hence the fixed effect estimator of the $ATET$ is[17]:

$$E\left(\gamma_{g,k}^{FE}\right) = \delta_{GED,g,k} + \Delta\varepsilon_{GED} = \gamma_{GED,g,k} + \Delta\gamma_{GED,g,k} + \Delta\varepsilon_{GED} \tag{7}$$

  where $\Delta\gamma_{GED,g,k} = \delta_{g,k} - \gamma_{GED,g,k}$ and $\Delta\varepsilon_{GED} = E\left(\Delta\varepsilon_{GED,i}\right)$

8.3.1 Identifying assumptions:

- We do not observe wages before and after treatment for a sub-sample of the GED-holders who had acquired the GED degree at early age. If the effect of a GED degree

[17] Assuming, for the sake of simplicity, that $E\left(\Delta\varepsilon_{GED,i} \mid \left(D_{i,t} - \bar{D}_{i,t}\right) \neq 0\right) = E\left(\Delta\varepsilon_{GED,i}\right)$.

does not vary with the age the GED diploma was acquired then $\delta_{GED,g,k} = \gamma_{GED,g,k}$ $\left(\Delta\gamma_{GED,g,k} = 0\right)$.

- Yet, the effect of a GED degree on wages may vary with the age the degree was acquired. We find it hard to argue that a GED degree acquired at 18 to 20 years age has the equivalent effect as the same diploma acquired ten years later. In this case the fixed effect estimate is biased. However, the difference between the effect of a GED degree acquired at 18 years of age and a degree received one year later might be negligible.

- Following this argument, the first identifying assumption we impose is that the sample GED-holders can be split into G age groups such that (i) each sub-group includes individuals with positive wages before and after the treatment and that (ii) the effect of a GED degree on wages do not vary with age it was acquired within them:

$$\gamma_{GED,g,G,k} = \gamma_{GED,G,k} \tag{A.1}$$

- Timing is also of considerable importance. The age at which GED-holders acquired the degree is determined by observed and unobserved personal characteristics as well as by random shocks. Since our data contains more than one cohort of GED holders, we find it fair to assume that the average timing projected using observed invariant characteristics is not correlated with individual wage shocks:[18]

$$\hat{D}_{i,t} = E\left(D_{i,t} \mid X_i,\, \nu_{i,t},\, \Delta\varepsilon_{GED,i}\right) = E\left(D_{i,t} \mid X_i\right) \tag{A.2}$$

- Substituting $(A.1)$ and $(A.2)$ into Equation (6) the fixed effects estimator provides an unbiased estimate of the $ATET$:

$$\frac{\partial E\left(Y_{i,t} - Y_i \mid \cdot\right)}{\partial \hat{D}_{i,t}} = \delta_{GED,g,k} = \gamma_{GED,G,k} = \gamma_{GED,g,G,k}$$

[18] Yet it is correlated with the actual timing:

9 How well do the labor markets treat GED-holders? A closer look.

9.1 Main Findings:

Unambiguous results emerge from the specifications presented in this section. The main results are: (i) controlling for experience, hours worked, cognitive abilities measured by AFQT scores, and years of schooling completed, GED recipients earn *less* than other high school dropouts do; moreover, (ii) the GED exerts no treatment effect. These results hold both for white males as well as for white females, excluding teenage mothers.

We start with a detailed description of the results for white males. In the next sub-section, we present the results for white females .

The dependent variable in all these specifications is the log hourly real wage.[19] The $X_{i,t}$ vector includes potential experience (age, minus 7, minus years of schooling completed), annual worked hours (in logarithms), years of schooling completed, training cohort of birth and local unemployment rate.[20]

9.2 Findings for white males

Table 4.a and Table 4.b present several specifications, based on equation (6) using a sub-sample of high school dropouts (HSDs) and GED-holders. Each table contains two panels. The rows in the first panel present the change in the mean hourly wages of high school dropouts *after* they (a) gain a GED degree (first row), (b) accumulate additional years of schooling[21], and (c) participate in training programs, conditional on unobserved invariant heterogeneity. In the second panel we decompose the variation in the individuals' fixed effects into (i) the variation due to differences in the AFQT scores, (ii) years of schooling completed before dropping out from school, and (iii) permanent differences

[19] We estimated the same specifications using log weekly wages. We find no significant difference between the results obtained using log weekly wages and log hourly wages.

[20] Further details are available at each table and in the appendix.

[21] The actual change in years of schooling completed after dropping out from high school.

between eventual GED-holders and other high school dropouts, with the same AFQT scores and years of schooling completed.

The first number in Column (i), 0.023 (sd : 0.032) is the average change (percentage points) in the mean wages of high school dropouts, after certified as high school graduates by the GED program, unconditional on additional years of schooling or training. The first number in the second panel of Column (i), 0.055 (0.039) is the permanent differences between eventual GED-holders and other high school dropouts, unconditional on AFQT scores or years of schooling completed.

Similarly to the OLS results (Table 3) we do find that GED-holders earn more than other high school dropouts (see the $F-test$ at the bottom of the table). Yet, this is due to permanent differences between the mean wages of GED-holders and other high school dropouts, when we do not control for differences in AFQT scores and years of schooling completed.

In Columns (ii) and (iii) we introduce AFQT scores and years of schooling completed as regressors in the fixed effects decomposition. In doing so, we find that the initial wage order is *reversed*: GED recipients earn approximately 10 percent *less* than do other high school dropouts, with the same AFQT scores and years of schooling before dropping out. In Columns (iv) and (v) we allow years of schooling accumulate after dropping out from school and participation in training programs to affect the relative wages of GED-holders. As these columns make clear, the relative wages of GED recipients do not change upon receipt of the GED diploma. (The point estimator in Column (v) is 0.013 with s.d. of (0.032)). As in the previous specifications, we find that the permanent wages of GED-holders trail by approximately 10 percent below the average wages of other high school dropouts, controlling for AFQT scores and years of schooling completed.

These results lead us to the following questions: (i) do our findings hold also for females and/or minorities? If so, (ii) what is the *latent dimension* in the individuals' human capital that causes GED recipients to earn less than other high school dropouts with the same cognitive abilities do?

9.3 Is it a jail phenomenon?

High school dropouts are more likely than average to commit crimes and/or to spend time in jail. Convicts can obtain GED credentials while spending time in jail. Hence, the share of convicts and ex-convicts among GED recipients may exceed the share of convicts and ex-convicts among other HSDs. We concluded the previous section by asking the following question: "What is the *latent dimension* causing GED recipients to earn less than other high school dropouts do?" One might argue that GEDs' inferior labor market performance reflects a "jail premium" rather than an unobserved skills phenomenon. Is the latent dimension a "jail premium"? Figure 9 presents the share of white males who spent time in jail by education category. Almost one in five white male GED recipients spent some time in jail, compared with nearly one in ten white, male HSDs. Among white, male GED recipients who spent time in jail, one in four obtained the credential while in jail. Because a non-negligible portion of our GED sample obtained their credentials in jail, we go on to examine the "jail premium" hypothesis. We address this question in two ways. In this sub-section, we repeat the above estimations, restricting our sample to those respondents whom we never observe in jail. In the next section we study the GED effect for white females. In doing so, we also control for the jail premium, since the rate of crime is negligible among women.

As for the white male sample, we exclude those observed in jail at least one survey. Since causality may run from labor market outcomes to criminal activity, excluding those who eventually serve in jail from the sample, even during the periods before first time observed in jail, may introduce bias. For this reason we, first, exclude males survey in jail, yet only after the first time (in the NLSY data) in jail. By doing so, we lose 13 persons out of 426.

We also repeat the exercise described previously for a sub-sample of white males never observed in jail. Table 4.b reports the results. As Table 4.b makes clear, the relative wages of GED-holders do not reflect a "jail phenomenon". We find that the GED title has no effect on the real hourly wages of GED-holders. Moreover, we find that GED-holders earn on average, before and after acquisition of a GED degree, 10 percent *less* than other high

dropouts, conditional on AFQT scores and years of schooling completed.

Hence, excluding convicts and ex-convicts, when we control for cognitive skills and education, the GED's fixed effect still switches from positive to negative. Therefore, we cannot explain the "switching signs" phenomenon as a jail premium.

9.4 Timing, and the GED effect over the life cycle

So far we ignored the wage dynamics of GED-recipients. The causal effect of a GED degree on the wages of high school dropouts - as we emphasize in the statistical framework - may vary over time. This is especially relevant if the GED degree serves mainly as a signal. The GED degree might affect wages of GED-holders for short time even if eventually it will not affect their wages later on. Yet, this is not the only reason why we should study the dynamics of the wages of GED-holders. If the time in which GED-holders take the GED is endogenous to their labor market outcomes - as the employment data suggest - the fixed effects estimator might overstates the effect of GED diploma on wages of GED-holders. As Equation (7) makes clear, if GED-recipients choose to take the GED test during the "bad times" - i.e., when their outcomes fall below what they had expected them to be - then comparing the wages of GED recipients before and after acquiring the GED degree with wages of other high school dropouts overstates the "true" casual effect of GED degree.

Figure 8 shows the mean difference between the log hourly wages of GED-holders and the log hourly wages of other high school dropouts, by the number of years since graduation. We find that GED-holders earn on average less than their high school dropouts counterparts. This is true for the period *before* and especially *after* the acquisition of the GED degree, yet it does not exhibit a monotonic pattern. As Figure 8 makes clear, the wage gap is especially large in the year before and the year after the acquisition of the GED degree. This is also true 3 years after acquiring the GED degree (and later on). We find smaller differences during the years before the acquisition of the GED degree. These facts, in addition to the employment figures, suggest that high school dropouts who eventually certified as GED-recipients take the GED exam when their labor market

outcomes are especially low.

Does the acquisition of the GED degree affect the wages of high school dropouts at the "short-run"? At first glance it might seem that it does. According to Figure 8, the mean wages of GED-holders increases during the second year after their graduation. Yet, a closer look reveals that their wages during the 2nd year after graduating do not exceed their means wages before taking the GED exam, and that they actually never earn more than high school dropouts with the same observed characteristics. Needles to say that the GED "effect" does not last for a long time. As Figure 8 shows, the mean wages of GED-holders fall back to be approximately 10 percents less than the mean wages of their high school dropouts counterparts.

9.5 Findings for white females

In aggregate, we find that the wages of white, female GEDs do not differ significantly from those of other white, female high school dropouts with the same observable characteristics. We find no evidence for either a treatment effect or for a persistent unexplained wage gap between the two categories. However, when we exclude teenage mothers, we find very similar results for white females as we found for white males. Among teenage mothers, GED recipients earn more than other dropouts do; however, this earnings differential exists both before and after receipt of the GED diploma. In Table 5.a, Table 5.b and Table 5.c, we present several specifications, based on equation (6) , using a sub-sample of high school dropouts and GED recipients only.

On average, GED-holders earn approximately 10 percent more than other high school dropouts. Yet, this is true both before and after acquisition of the GED title. As for white males, controlling for difference in years of schooling and AFQT scores, we find no change in the hourly wages of GED-holders upon the receipt of the GED degree. Unlike white males, we find no permanent difference in the wages of GED-holders and other high school dropouts with the similar years of schooling and AFQT scores.

9.5.1 Teen pregnancy and teen birth

Our results for females differ slightly from our results for males. Among males, when we control for AFQT scores, GEDs earn significantly less than other HSDs do. We do not find the same result for females. At first glance we might suspect that the findings obtained for male reflects a general phenomenon. However, females may drop out of school for different reasons than men do. We should consider the possibility that women drop out of school as a result of *teen pregnancy and teen birth*.[22] In 1998, 5.1% of women aged 15 to 19 years (3.5% for white Non-Hispanic) gave birth to live children.[23]. These statistics suggest that a non-negligible share of female dropouts are teenage mothers. Among the 337 white females whom we consider in Table 5.a, 137 gave birth sometime between the ages of 15 and 19. This paper does not aim to study the teen birth phenomenon. Yet it would be wrong to assume that males and females drop out of school from the same reasons. If teen mothers drop out of school for reasons other than cognitive and non-cognitive deficiencies, then the unobserved traits of this particular group may differ significantly from those of other dropouts. Given the large share of teenage mothers in our sample, we opt to study this sub-group separately. In Tables 5.b and 5.c, we disaggregate the female population into teenage mothers and other dropouts. Using Table 5.b, we can compare the GED's effects on female dropouts without children to the GED's effects on males. This exercise allows us to examine the robustness of our results for males.

9.5.2 White females, excluding teenage mothers:

In Table 5.b, we report the regression results for white females, excluding teenage mothers. Controlling for individual's fixed effect we find that: (i) wages of GED recipients do not vary with acquisition of the GED degree, (ii) GED recipients earn, before and after they gain a GED degree, approximately 10% less, than do other dropouts with the same AFQT

[22]We do not argue for argue for a causal interpretation between the teen pregnancy and dropping out of high school. However, we can not rule it out.

[23]Source: National Center for Health Statistics. National Vital Statistics Reports, Volume 48, Number 6, April 24, 2000

scores, years of schooling completed and training.

9.5.3 Teenage mothers exclusively:

In Table 5.c, we present regression results for a sub-sample of teenage mothers. Controlling for time-invariant heterogeneity, we find that GED recipients earn 18 percent more than other dropouts do, but we cannot attribute their higher wages to the acquisition of the GED diploma. In Columns (ii) and (iii), we introduce the AFQT scores. We find that we cannot explain the GED-HSD wage gap with differences in cognitive abilities. In Columns (iv) and (v), we introduce years of schooling and training. Both significantly affect log wages. While years of schooling affect wages only when we overlook invariant heterogeneity, job training exerts the same effect in both specifications. Note that the effect of additional training is associated with the *persistent* GED-HSD wage gap (Column v). This may suggests that among teenagers mothers - GED recipients have higher non-cognitive skills than other dropouts - and these are correlated with the accumulation of training.

9.6 Self-selection and the GED effect

See the complete version

9.7 What have we learned?

When we exclude teenage mothers, female GEDs exhibit many of the same traits as their male counterparts do. In neither group does the acquisition of the GED credential affect wages relative to other HSDs. Both male and female GEDs earn more than do other dropouts of the same race and sex. However, both male and female GEDs earn substantially less than do other high school dropouts with the same cognitive skills. This pattern does not hold for teenage mothers who dropped out of school. Among this sub-group, GED recipients earn more than other dropouts do, but not because of higher cognitive skills. In fact, we find that white, teenage mother GEDs earn more than other

white, teenage mother dropouts do, because they invest more in their human capital. This investment is not correlated with the acquisition of the GED degree.

10 Who are the GED recipients? A first glance at the latent dimension

GED recipients *do not* drop out of school because of deficiencies in cognitive abilities or because of income constraints. Moreover, years later they earn less, and are more likely to be unemployed, than other high school dropouts with similar cognitive abilities. Why do labor markets treat GED-holders worse than other high school dropouts?

This study points out to the role of skills other than cognitive. In this section, we take advantage of self-reported illegal and delinquent behavior from the NLSY (surveyed only once, in 1980). This survey contains 20 yes/no questions regarding illegal and delinquent behavior.

Table 6 presents, for both white males and females, age-adjusted self-reported illegal and delinquent behavior by education category. There is some suggestion that white male GED recipients show the highest level of participation in (almost) every category of illegal activity, compared to other high school dropouts. This is true even when the outcomes are not adjusted for differences in AFQT and educational attainment. It is also true when we drop persons who acquire the GED in prison, or all persons who have been in prison, to avoid a spurious causal relationship arising from prisoners and hence people with a greater participation in crime acquiring the GED. The average ILA score of GED-holders is 0.18 - i.e., 18 percent higher than the score of the benchmark person in the population sample - while the average score of HSDs (white males) is 0.11 and the average ILA score of ordinary high school graduates is 0.05.

The same applies for white females, excluding teenage mothers, who are much less likely to get the GED in prison. For instance, the share of GED-holders who report smoking pot during the last year is 27 percent higher than the average share in the population sample (age adjusted). GED recipients are more likely to participate in illegal drug use, drug selling, fighting in school, vandalism, shoplifting, theft, robberies, and

school absenteeism than are other dropouts.[24]

This fact raises some questions as to whether a one-dimension model of human capital is the appropriate framework to understanding why young Americans choose to drop out of high school.

10.1 GEDs' labor market activity

This section examines the labor market activities of GEDs. Experience is a primary means by which labor market participants accumulate human capital. In Table 8, we present means and standard deviations for a variety of labor market-related variables, including accumulated working experience, by education group. We observe non-negligible differences among dropouts, GEDs, and graduates. The oldest cohort in our sample was 36 years old in 1994. While high schools graduates average 12 years of experience by the age of 33, both dropouts and GEDs average have less than 10 years of work experience by the same age. The differences in their actual experience may be misleading, since dropouts and GEDs have had more time available for investment outside school than HSGs have. In row (4) we present a measure Time Wasted (TW), which illustrates this point. We calculate Time Wasted as the gap between potential experience and actual experience. The differences are striking: while a 33 year-old HSG "wastes" 3 years on average, an average GED graduate wastes twice as much (6.5 years), and an average HSD wastes 7.7 years. In other words, both HSDs and GEDs waste third of the years after dropping out of high school; during these years they neither work nor study. Figure 10.a and (10.b) illustrates the pattern of wasting time over the years. In general, time wasted decreases with cognitive skills (AFQT), though not for GED graduates. We associate lack of personality skills with instability. Personality skills may affect labor market outcomes through job turnover. People change jobs for two reasons: (i) voluntary leave for a better job, or (ii) layoffs ("bad news"). Table 8 reports the results. Dropouts, GED graduates, and college graduates all tend to change jobs more than high school graduates

[24]Excluding GED recipients, the rate of illegal and delinquent behavior decreases montonically as education levels rise.

not completing college. An average GED graduate works at 1.81 different jobs per year, whereas an average high school graduate works only 1.55 jobs/yr. A GED graduate changes occupations 1.3 times per year. High school dropouts do so 1.25 times, and high school graduates only 1.01. This order also holds for the number of times individuals move between different industries.

11 Interpretation: a simple two-dimensional "model"

So far we established that: (i) GED holders do not drop out from school due to income constraints or cognitive deficiencies, (ii) they do earn more than other high school dropouts, yet (iii) controlling for cognitive abilities – as measured by AFQT scores and educational attainments - they actually earn less than other high school dropouts. In addition, we find that they are more likely to be involved in illicit activities than persons from any other education category.

What is the appropriate framework to analyze the labor market outcomes and educational attainments of young Americans?

We found that both cognitive and noncognitive traits are valuable assets at the labor markets as well as in the production of human capital. Moreover, our findings suggests that the fact that individuals posses different composition of such skills is crucial for understanding both educational and labor market outcomes. In other words, not all "smart" people have better noncognitive traits than the cognitively less able people. In fact a substantial part of them posses less. This is the reason why "smart" kids, like the GED-holders, who do not face income constraints, drop out from school. This is also the reason why GED-holders earn less than other dropouts with the same years of schooling completed, when we control for differences in cognitive abilities. Apparently, the inputs - either by *nature* or *nurture* - which generate one type of traits do not "guaranty" having the others.

This section provides a simple exposition of our argument and it's implications in the context of the educational attainments and the labor market outcomes of GED-holders

and other high school dropouts. Employed with the very basic tools any undergraduate economist should posses, the analysis of optimal production using *isoquants curves* and *budget constraints*, we show that we are able to explain what one factor model fails to fit. In addition, our analysis provides us with testable implications we would take to the data.

Educational attainment are a complex process. Cognitive abilities, knowledge, motivation, discipline and many other skills and traits serve as "inputs" in the underlying educational production function. For the sake of simplicity, yet without losing generality, let us assume that we can aggregate the variety of traits individuals employ while studying at school into cognitive and noncognitive traits.

In the two-input case there is a convenient way to depict production relations known as the *isoquant*. Consider Figure 12.a where we illustrate two axes representing a person endowments of cognitive (vertical axes) and non-cognitive (horizontal axes) traits. The isoqaunt S^0 is the set of all possible combinations of minimum cognitive and noncognitive traits that together enable any person in our economy to achieve S_0 years of schooling. For instance, as Figure 12.a depicts, both person i and person j who posses different levels of cognitive and noncognitive traits are able to achieve the same educational attainments - as measured by years of schooling completed.

Assuming that cognitive and noncognitive traits substitute and complement each other, the isoquants have a convex shape as in Figure 12.a. Persons possessing more than at least one trait should be able to produce at least as much as those who posses less, as in Figure 12.b. More of both inputs generates better educational attainments.

This is also true at the labor markets. Persons' wages reflect both skills. Individuals with different endowments may earn the same as person i and person j in Figure 12.c do.

So far, we just apply Econ 200 to illustrate the production of human capital and labor market goods (wages) as functions of person traits. Figure 12.d fits the market productivity of GED holders and other high school dropouts with the data on their cognitive and noncognitive traits - as measured by AFQT scores and by illicit activities.

GED holders are, on the one hand, "smarter" than other dropouts ($C_{GED} > C_{HSD}$),

yet, on the other, they posses less of noncognitive traits ($NC_{GED} > NC_{HSD}$). If GED holders earn higher wages than other dropouts do, then the *Technical Rate of Substitution* of cognitive for noncognitive skills should be such that the isowages curve of GED holders – i.e. the curve GED holders lay on - is higher than the isowages curve of the other high school dropouts ($W^1 > W^0$).

Figure 12.e combines both outcomes in the same two-dimensional space. W_{GED} and W_{HSD} are the isowages of GED-holders and of other high school dropouts respectively. Note that the initial endowments of cognitive and noncognitive traits are not the only inputs we use at the labor markets. Skills and knowledge acquired in school are also valuable at the labor markets. We incorporate the third dimension - schooling - in the two-dimensional space, by studying the labor market outcomes of agents with the same years of schooling "constraint".

The isoschooling curve S^0 is the set of all possible combinations of cognitive and noncognitive traits that are sufficient in order to achieve S_0 years of schooling. If GED holders earn more than other high school dropouts, with the same years of schooling completed, then it must be that the *Technical Rate of Substitution* (hereafter: TRS) of cognitive traits for noncognitive traits at the labor markets is higher then the TRS at school.

What should be the market wages of GED holders, relative to the wages of other high school dropouts with the same years of schooling, once we control for their higher AFQT scores? Figure 12.f depicts the answer. GED-holders posses higher cognitive skills. The cognitive traits gap equals to $C_{GED} > C_{HSD}$. By subtracting the cognitive gap, evaluated in labor market prices, from the wage of GED-holders (W^0_{GED}), we receive an adjusted isowages curve for GED-holders (W^1_{GED}). Note that this isowage curve shows all possible combinations of cognitive and noncognitive traits that are sufficient for earning the wage of a person with same cognitive skills as high school dropouts and the level of noncognitive traits as GED-holders posses.

Since HSD posses higher noncognitive traits than GED-holders do, it is clear that they should earn higher wages than GED-holders, once years of schooling and AFQT scores

are taken into account. This prediction, needless to say, fits our estimators perfectly.

So far we fitted our empirical findings with a simple framework of a two-dimensional skills model. However, if this is the correct framework, cognitive and noncognitive traits are substitutes in the production of educational attainments. In other words, we should find that among individuals with the same educational attainment, as goes without saying, the smarter you are the less noncognitive abilities you posses. We face this challenge in the next section.

11.1 The correlation between cognitive skills and behavioral problems

The correlation between cognitive and non-cognitive skills is the focus of much work in sociology and psychology. While most of these studies examine to what extent individuals with better cognitive abilities have better social talent, we raise the question whether cognitive and noncognitive skills substitute each other in educational attainments, labor markets and in other social activities.

Table 7 presents a set of OLS estimates age-adjusted AFQT scores regressed on an index of participation in illicit activity (ILA).

The correlation between AFQT scores and an index of participation in illicit activity is statistically significantly negative in the population at large. Individuals with higher AFQT scores are less likely to participate in illicit behavior. The normalized regression coefficient of AFQT scores on an index of illicit activity (ILA) in the population sample is $-0.114\,(0.031)$, indicating for positive correlation between cognitive and noncognitive abilities unconditional on educational attainments.

Yet this relationship does not hold within education groups. The normalized regression coefficients of AFQT scores on an index of illicit activity (ILA) among all high school dropouts and among high school graduates (with 12 years of schooling) are 0.205 (0.069) and 0.109 (0.050) respectively. In other words, among persons with the same educational outcomes we find negative correlation between their AFQT scores and their social per-

formance. The smarter they are the more likely they are to participate in illicit activity. It is especially strong for all dropouts, suggesting that among high school dropouts, the higher the AFQT score, the more likely is the participation in illicit activity. This trade-off is entirely consistent with the view that both cognitive and non-cognitive traits play an important roles in determining graduation from high school.

12 Evidence from other studies

Our evidence on the importance of perseverance and social skills is consistent with studies by Weiss (1988) and by Klein, Spady and Weiss (1991). They attribute the premium accorded to high school graduates, compared to high school dropouts in semiskilled and skilled occupations, to the higher levels of job stability (lower quit rates) and dependability (lower absenteeism) of high school graduates, and not to a greater productivity in final output. Bowles and Gintis (1976) present an array of evidence suggesting that employers in low-skill markets value docility, dependability and persistence more than they value cognitive skills. Bowles and Gintis (1998) emphasize that personality and other "affective" traits reduce the costs of both labor turnover of contract enforcement. Persons with high levels of self-discipline require less supervision and reduce monitoring costs. Dunifon and Duncan (1998, 1999) demonstrate that a variety of behavioral and attitudinal characteristics measured while persons are young substantially affect earnings 25 years later. Edwards (1976) shows that blue collar supervisors value dependability and consistency more than they value cognitive ability or independent thought. Meyer (1976) finds that high school teachers award grades according to the same set of values. Bowles, Gintis and Meyer (1975) show that perseverance, dependability, and consistency are the most important predictors of grades; creativity and independence are strong *negative* predictors of grade achievement. Hogan and Hogan (1989) document the importance of personality traits in predicting successful employment. They report that personality characteristics are only weakly correlated with ability measures. Their evidence is consistent with the evidence reported in Cawley et al (1999) and Heckman et al (1999) that personality traits

are only loosely correlated with background and ability measures. What evidence we have suggests a weak positive relationship between cognitive and non-cognitive skills. Family background variables do not accurately predict personality traits. The studies of performance in the military summarized in Trent and Laurence (1993) distinguish "can do" knowledge from "will do" in determining success in the military.[25] Non-cognitive "affective" characteristics determine actual performance and have predictive power independent of the cognitive characteristics which strongly affect "can do" measures.

[25]The distinction is between performance on cognitive tasks under stress-free conditions and performance under stress in combat-like or real-world situations. Interestingly, there appears to be a negative correlation between cognitive and non-cognitive skills in combat situations.

Chapter V: The use of inter-states variation in GED passing standards for estimating the effect of a GED degree on labor market outcomes - a critique.

The difference between states in what constitutes a passing test score on the GED exams has been mistakenly viewed as a "natural experimental" for estimating the effect of a GED degree on labor market outcomes. Recent studies compare the mean earnings of GED-takers with the same low GED test scores, but with different GED status depending on the state of residence.

Assuming no systematic differences between the unobservable characteristics of the treatment and the comparison groups, conditional on the mean wage gap among persons who achieved high test scores, the mean wage gap among GED-takers with low test scores is being used as an estimate for the effect of a GED degree on the earnings of low skilled high school dropouts.

This chapter provides economic theory and data which contradicts the difference-in-difference identifying assumptions. Using a simple model in which test scores reflect both persons' abilities as well as the effort they spend cramming for the exam, we show that the difference between states in what constitutes a passing test score on the GED exams does not provide as with a "natural experiment". The effort GED-takers choose to spend cramming for the exam is determined by the state's threshold. The variation in states' passing standards presumably control for the selection into the GED program. However it introduces another type of selectivity bias caused by the option people have with respect to the choice of how much effort to spend.

Using data on the wages of high school dropouts and high school graduates in the treatment and the comparison states we show that the dif-in-dif estimator overestimates the effect of a GED degree on the earnings of low skilled dropouts. In fact, we find similar "GED treatment effect" for high school dropouts who *do not* posses a GED degree as Tyler, Murnane and Willet (2000) find for GED-holders using the inter-state variation in the passing standards and the dif-in-dif estimator.

13 The Differences-in-Differences Estimator using Differential State GED Passing Standards

13.1 The experiment

- GED passing standards vary across states. For the sake of simplicity, let us assume two sets of states: (i) low passing standards (hereafter: LS), (ii) high passing standards (hereafter: HS). Let $Z_i = 1$ if person i is an LS resident. Assuming there exists a test score range that is above the threshold of the LS states and below the passing threshold of the HS states, then we may find individuals with the same test scores but with different GED certification statuses.

- At first glance it may appear as if the states' variation in the GED passing standards provide us with a perfect experiment. Tyler, Murnane and Willet (2000) use the differential state GED passing standards and individuals' GED test scores for estimating "the signaling effects of the GED on earnings of dropouts who would choose to obtain the GED and are at the margin of passing."

- They compare the high-low test score wage ratios in LS states with the high-low test scores ratios in HS states.

13.2 The empirical critique

13.2.1 The statistical model:

If the rate of return to skills associated with cognitive achievement is lower in the treated states than in the non-treated states than the dif-in-dif estimator overstates the GED effect.

To make it clear, let's assume that there are no systematic differences between the two sub-groups of states except a (potential) difference in the rate of return to cognitive skills (β). We further assume that we have only two type of high school dropouts: (i) HSDs who achieved low GED test scores and (ii) HSDs who achieved high GED test scores. Let

$H_i = 1$ if person i belongs to the high scored group and $H_i = 0$ if she does not.[26] Given this assumptions the statistical model can be re-written as:

$$\begin{array}{rclcrcl} Y_{i,j,L} & = & \alpha_j & + & & + \gamma \cdot Z_i & + \varepsilon_{i,j,L} \\ Y_{i,j,H} & = & \alpha_j & + & \beta_j H_{i,j,H} & + \gamma & + \varepsilon_{i,j,H} \end{array} \tag{8}$$

where Z_i is a dummy variable which equals one if person i is a LS residence. $\beta_j$stands for the return to cognitive skills in state j. γ is the net GED treatment effect. $\varepsilon_{i,j,L}$ and $\varepsilon_{i,j,H}$ represent a person-specific $i.i.d.$ wage shocks. $E(\varepsilon_{i,j,L}) = E(\varepsilon_{i,j,H}) = 0$.

The mean wages, by group, at the low passing standards' states are:

$$\begin{aligned} Y_{L,L} &= \alpha_L + \gamma \\ Y_{H,L} &= \alpha_L + \beta_L + \gamma \end{aligned} \tag{9}$$

where the mean wages at the high passing standards' states are:

$$\begin{aligned} Y_{L,H} &= \alpha_H \\ Y_{H,H} &= \alpha_H + \beta_H + \gamma \end{aligned} \tag{10}$$

The difference-in-difference estimator of the GED treatment effect equals to:

$$DID = (Y_{L,L} - Y_{L,H}) - (Y_{H,L} - Y_{H,H}) = (Y_{H,H} - Y_{L,H}) - (Y_{H,L} - Y_{L,L}) \tag{11}$$

By substituting Equation (9) and Equation (10) into Equation (11) we receive that the difference-in-difference estimator equals to:

$$DID = \gamma + (\beta_H - \beta_L) \tag{12}$$

As Equation (12) makes clear, the $DID > \gamma$ if $(\beta_H - \beta_L) > 0$.

13.2.2 The data:

Figure 11 shows the difference between the high school premium (HSG/HSD ratios) in the HS states and the LS states $(\beta_H - \beta_L)$. We use NY and FL for the HS states and

[26] This normalization - i.e., the test scores in both states reflect the same level of human capital - is a very strong assumption we discuss in details in the next section.

TX for *LS* states. Two points emerge from this figure. First, the price gap in 1995, the year Tyler, Murnane and Willet use for estimating the treatment effect, is very similar to the GED effect in TMW's dif-in-dif. Second, it has the same time pattern as in TMW's Figure II. Hence, conditional on the skill gap price in these states the dif-in-dif estimate for the treatment effect is approximately 0.

Moreover, the passing score standards policy may be affected by the return to skills. In states where the return to skills is low, the information about individuals' skills has lower value too. Therefore, we would expect states with lower returns to skills to be more likely to adopt lower standards than other states do. The evidence illustrated in Figure 1 suggests that this may be the case.

For this reason we should be very careful in using differential state GED passing standards as an instrument.

14 The variation in states' passing standards and the use of test scores to proxy skills

Preparing for and taking an exam are experiences that all of us have faced and many still remember quite vividly. For most of us, the time immediately preceding an important examination is a stressful period of intense study. Presumably this is the reason why outside academic circles people assume that test scores reflect not only the knowledge, abilities, and skills acquired long before an exam, but also the short-run effort spent cramming immediately before it. Both cognitive as well as non-cognitive abilities like perseverance, diligence and self-discipline, play an important role in determining the knowledge and skills we already posses, as well as the effort we choose to spend cramming for each "D-day." Yet the effort we spend depends not only on our abilities and skills but also on how hard the particular exam's standards are. This is especially evident in "pass-fail" exams. Indeed, higher passing standards may even increase the attrition rates of the learning institution. Consequently we would expect those who choose to take the exam to expend more effort than they would under a regimen of lower expectations of performance. The

intuition is quite trivial. For any given level of skill, raising the plank for a passing grade necessitates a greater expenditure of effort by the optimizing student until the marginal benefit equals to the marginal dis-utility of studying

We believe this logic holds for the GED exam. We expect that GED-takers in states with higher passing standards will spend more effort than their counterparts in the low-standard states. If this is true, then the test scores in the high-threshold states reflect a higher effort-to-skill ratio than the comparable scores in the low-standard states. However, if short-run effort has little effect (or no effect) on a person's skills, then the GED test scores overstate the skills of individuals in the high-threshold relative to their counterparts in the low-standards ones. This is especially relevant for the comparison between individuals who are at the margin of passing the test. This is less of a problem for the comparison between individuals whom their abilities are high enough to put them far above the threshold. Tyler, Murnane and Willet (2000) employ the difference-in-difference estimator in order to obtain the GED treatment effect on the earnings of low skilled individuals. They compare earnings of individuals with low test scores in the low-standard states (LS) who obtained a GED diploma with the earnings of individuals with the same test scores in the high-threshold states (HS) but who have not received a GED degree. Tyler, Murnane and Willet (TMW) use the difference between the average earnings of high test scores people in low-standard states and the average earnings of their counterparts in the high-standard states to control for unobserved differences among low-skilled individuals. TMW were well aware of the effect of passing standards on personal behavior. Using their own words "If the different passing standards influence individual behavior in systematic ways, then this assumption [treatment and comparison groups are balanced on unobservable characteristics] may be violated." Nonetheless, they take for granted that the average effort gap among persons with high test scores is the same as this gap among those with low test scores, confusing the effect of passing standards on the non-random sample of GED-takers and the effect of the test's thresholds on the short-run effort people spent cramming immediately before the exam. TMW assume that attrition is negatively correlated with productivity-enhancing traits such as persistence, self-confidence, and mo-

tivation. If so, they claim, "this type of selection would result in an overestimate of the mean earnings of potential GED-holders in comparison group states."

The effect of passing standards on the ability of non-random sample of GED takers is trivial. However, TMW do not explain why people in the high standard states posses different skills than their counterparts in the low standard states, conditional on their test scores, in a model without short-run effort. Like TMW we do believe that passing standards affects selection into the GED program. However, unlike TMW we do make a clear distinction between the effect of economic incentives (passing standards) on the *composition* of unobserved traits of GED-takers and its effect on the short-run effort GED-takers *choose* to spend cramming for the test. We argue that the different passing standards affect the effort test-takers spend cramming *conditional* on their cognitive and non-cognitive abilities. The *selection problem* in this case is the *choice* of effort. Following our previous discussion, the assumption of TMW that the treatment and the comparison groups are balanced on unobserved characteristics is violated. Test score do not reflect the same composition of skills and effort for persons at the margin who face different passing standards. Following our argument, GED-takers with low test scores in the LS posses higher abilities and traits than their counterparts at the HS states. The difference is smaller among high able persons. The selection of effort violates the dif-in-dif identifying assumptions. This type of selection, in a paraphrase to TMW own words, would result in an overestimate of the mean earnings of low-skilled GED-holders in the treatment group states. TMW conclude that "The net effect [of selection] would be a downward bias in the estimated effect of the GED on earning." In the following sub-section we present a simple model which shows the opposite. The net effect of the choice of effort would be a upward bias in the estimated effect of the GED on earning.

14.1 The model

The production function:

Following the short discussion above, let **us** assume that person i's test score on exam j reflects both (i) her abilities (A_i) as well as (ii) the effort ($e_{i,j}$) she spend cramming for

the j test:

$$T_{i,j} = T\left(A_i, e_{i,j}\right) \tag{13}$$

where $T_{i,j}$ is persons i's test score in test j.

We assume that (i) person i''s abilities and skills are valued in the labor markets and that (ii) the short-run effort has no effect on person i's abilities or labor market outcomes. For the sake of simplicity, let's assume that:

1. test scores is the product of person i's abilities and the effort she spends:

$$T_{i,j} = A_i^{b_1} e_{i,j}^{b_2} + \nu_{i,j} \tag{14}$$

   In other words, we assume agents must spend at least some effort in order to produce positive test score (for instance - attending the test). $\nu_{i,j}$ is a stochastic random shock with mean 0:

$$\nu_{i,j} \sim N\left(0, \sigma^2\right)$$

2. person i''s log wages are a linear function of his abilities:

$$Y_i = \beta_1 A_i + \beta_2 X_i + \mu_i \tag{15}$$

   where X_i is a vector of characteristics and skills, which affect individual wages. μ_i is a mean 0 individual specific shock.

The GED test is a binary outcome test - i.e., pass-fail test. An individual gains a GED degree ($D_i = 1$) if and only if his test score equals or exceeds the state's threshold $\left(T^*_{S,i,j}\right)$:

$$D_i = 1 \, if \, T_{i,j} \geq T^*_{S,i,j}$$

The probability to gain a GED degree is given by:

$$\Pr\left(\nu_{i,j} \geq T^*_{S,i,j} - A_i^{b_1} e_{i,j}^{b_2}\right) = \Phi\left(\frac{A_i^{b_1} e_{i,j}^{b_2} - T^*_{S,i,j}}{\sigma}\right)$$

where $\Phi\left(\bullet\right)$ is the CDF of $(\bullet)$.

Preferences and expected utility:

The GED diploma does not include any information other than the information that person i is a GED-certified. Neither information about the GED test scores nor information on GED-takers who did not succeed is not available to the public. For these reasons we find it fair to assume that the only source of utility to GED-takers is generated from the possession of a GED degree.

$$U\left(D_i\right)=\left\{\begin{array}{c} 0\,if\,D_i=0 \\ U\left(D_i=1\right)\,if\,D_i=1 \end{array}\right\} \tag{16}$$

Effort is costly. We assume that the did-utility generated by effort is a linear function of the time spend in cramming to the exam. The expected utility for a GED-taker, conditional on her/his abilities, is:[27]

$$EU\left(D_i\right)=U\left(D_i=1\right)\cdot\Pr\left(D_i=1\right)+cov\left(U\left(D_i=1\right),\Pr\left(D_i=1\right)\right)-c\cdot e_{i,j}$$

where $-c\cdot e_{i,j}$ is the dis-utility person **i** obtains from spending $e_{i,j}$ units of effort cramming for the j test.

The optimal effort: the case of a risk-neutral person:

For the sake of simplicity, let us start with the optimal effort for the case of risk-neutral agents. An individual maximizes his expected utility by choosing the level of effort which equalize the expected marginal utility from effort with its marginal dis-utility (cost):

$$\frac{\partial EU_i}{\partial e_{i,j}}:=U_{D,e}=U\left(D_i=1\right)\cdot\frac{b_2}{\sigma}e^{b_2-1}\cdot A_i^{b_1}\cdot\phi\left(Z\right)\geq\frac{\partial U_i\left(C\right)}{\partial e_{i,j}}=c=U_{C,e} \tag{17}$$

where $U_{D,e}$ equals to the marginal benefit from effort and $U_{C,e}$ stands for the marginal cost (dis-utility) from effort. $Z=\frac{A_i^{b_1}e_{i,j}^{b_2}-T_{S,i,j}^{*}}{\sigma}$ and $\phi\left(Z\right)$ is the PDF.

The benefit obtained from the marginal unit of effort is the product of the utility gained from the possession of a GED degree ($U\left(D_i=1\right)$) the productivity of effort in generating higher test scores $\left(\frac{b_2}{\sigma}\right)$, person's ability A_i and the probability density function of Z. As Equation (17) makes clear, all agents who attend the test invest positive effort $\left(e^{*}>0\right)$. The F.O.C. also shows that agents must have certain level of abilities (relative to the test threshold) in order to take the exam. Since the dis-utility from effort is assumed

[27] Assuming individuals' abilties may affect the dis-utility from effort.

to be linear, the likelihood to meet the test's threshold - given the optimal effort - should be more than fair, as the second order conditions indicate:[28]

$$\frac{\partial^2 EU_i}{\partial^2 e_{i,j}} :\Longrightarrow \phi^{'}(Z) < -(1-b_2)\,\phi(Z)\,\frac{\sigma}{b_2} e^{-b_2} A_i^{-b_1} < 0 \tag{18}$$

which means that $Z^* > 0$.

- Figure 11.*a* illustrates this result. Point A and point B satisfy the F.O.C. Yet, it is quite clear that point B is the optimal level of effort. The optimal effort is given by the gap between the PDF under optimal effort and the PDF with no effort (See Figure 11.*b*)

As for the effect of parson's abilities on the optimal level of effort - the higher persons ability is the smaller the marginal benefit from effort is[29]:

$$\frac{\partial U_{D,e}}{\partial A} = b_1 A_i^{b_1-1} \cdot U(D_i = 1) \cdot \frac{b_2}{\sigma} e^{b_2-1} \cdot \phi^{'}(Z) \tag{19}$$

Figure 11.*c* shows the effect of person's ability on effort

Since we do not allow for negative effort (we assume that individuals do not choose the wrong answer in purpose), persons with high abilities, relative to the test threshold, may end up spending (almost) no effort at all. In other words, high ability persons will spend no effort but attending the test. (See Figure 11.*d*).

The effect of the test threshold on the effort test-takers spend cramming is tricky. For the high able individuals, for whom $\phi^{'}(Z \mid e = 0) < 0$, the higher the threshold the higher the effort:

$$\frac{\partial U_{D,e} \mid Z \mid e = 0 > 0}{\partial T^*} = -U(D_i = 1) \cdot \frac{b_2}{\sigma} e^{b_2-1} \cdot A_i^{b_1-1} \cdot \phi^{'}(Z) > 0$$

The marginal benefit increases with the test threshold. For this reason they will invest more.

[28] Note that we assume CRS in the production of test scores. Therefore: $0 < b1, b_2 < 1$

[29] By high ability relative to the test threshold we mean that their probability to meet the test standards spending no effort is greater than $1/2$ $\left(\frac{b_1 A_i - T^*_{S,i,j}}{\sigma} > 0\right)$.

As for the less able persons $(Z \mid e = 0 < 0)$. At first glance it might seem ambiguous. Yet, since the optimal level of Z is such that $Z^* > 0$ for all A and T^*, the higher the threshold the higher the effort spend:

$$\frac{\partial U_{D,e} \mid Z \mid e = 0 < 0}{\partial T^*} = -U(D_i = 1) \cdot \frac{b_2}{\sigma} e^{b_2 - 1} \cdot A_i^{b_1 - 1} \cdot \phi'(Z^*) > 0$$

Although $\phi'(Z < 0) > 0$, the marginal PDF, for those who chose to take the exam is always negative $\phi'(Z^* > 0) < 0$.

14.2 Implications:

TMW aim at estimating the effect of a GED degree, net of human capital effects, on the earnings of low skilled workers, by comparing the wages of individuals with low GED test scores in the low passing standards states, who posses a GED degree, with the earnings of their counterparts in the high passing standards states who do not have a GED degree. They use the gap between the wages of individuals with high GED test scores in the low and high passing standard to control for passing-standards fixed effects. Substituting Equation (15)into (11) we receive that the dif-in-dif estimator is:

$$\begin{aligned} DID &= (a_H E(\Delta A \mid T = L) + \Delta a_L E(A \mid T = L, Z = 1) + \delta_L LS + \gamma GED) \quad (20) \\ &- \\ &(a_H E(\Delta A \mid T = H) + \Delta a_L E(A \mid T = H, Z = 1) + \delta_H LS) \end{aligned}$$

where a_H is the price of skills in the high standards states, ΔA is the gap between the average skills of persons with low test scores in low and high standards states and γ is the effect of a GED degree on low skilled workers. δ_L is the low passing standard states effect on the relative wages of low GED test scores. Implicitly they employ three identifying assumptions.

- $\delta_L = \delta_H$

- $\beta_L = \beta_H \Longrightarrow \Delta\beta_L = 0$

- $E(\Delta A \mid T = L) = E(\Delta A \mid T = H)$

The first two we discussed in the previous section. In this section we focus on the third one. The third assumption is inconsistent with the behavior of a rational risk-neutral or risk average agent. Following the previous sub-section, we expect those at the margin to invest more effort the higher the state threshold. This does not hold for the case of highly able agents. If so:

$$E(\Delta A \mid T = L) > E(\Delta A \mid T = H) \approx 0$$

As Equation (11) the DID estimator overstate the GED treatment effect. This is also true when the price of skilled do not vary between states:

$$DID = \beta_H E(\Delta A \mid T = L) + \gamma \tag{21}$$

Interpreting DID at the causal effect of the GED on the earnings of GED-holders rests on an assumption that, conditional on GED test scores, the treatment and the comparison groups are balanced on unobservable characteristics that affect earnings. This is not a valid assumption, when effort spent cramming to the exam is an available input. As Equation (20) makes clear, in this case, the DD overestimate the effect of a GED degree on person's' earnings.

15 Conclusions

This paper evaluates the labor market outcomes of GEDs to assess the importance of cognitive and noncognitive skills. We base our argument on two cornerstones. First, both cognitive skills as well as non-cognitive skills (self-discipline and persistence) contribute substantially to the formation of human capital and job skills. Second, the GED program screens only cognitive skills. The GED program selects individuals with higher cognitive skills than those of ordinary high school dropouts, however, these individuals lack positive non-cognitive skills. Their lack of perseverance and social skills led them to dropout in the first place. We do not find that GEDs' wages increase upon acquisition of the degree. Hence, we conclude that the GED exerts no treatment effect. Using the NLSY for white males and females only, (results for other ethnic groups are being compiled) we focus on the GEDs' endowments and their labor market outcomes. We argue that the GED recipients are characterized by a mixed bag of endowments. Their AFQT scores are as high as those of high school graduates. Moreover, their parents' education levels and family incomes do not explain why they dropped out. Nevertheless, one in three GEDs comes from a single parent family, a higher rate than from any other education category. GEDs also tend to participate in criminal activities and other deviant behaviors, as measured by an index of participation in illicit activity (ILA), more than do individuals from any other education group. This relationship holds for both males and females, and even for individuals who never spent time in jail. As for labor market outcomes, we show that GED participation rates are similar to dropout participation rates. GEDs spend 1/3 of their time neither working nor studying. Conditional on age and hours worked, GEDs exhibit higher wages than high school dropouts do, but lower than ordinary high school graduates do. Controlling for cognitive skills measured by AFQT, GED recipients earn as much as other HSDs do. Introducing years of schooling completed, the initial rank reverses. GEDs' wages trail behind both graduate wages and dropout wages. Moreover, we find that wages of GED recipients do not increase with acquisition of the GED degree.

On the basis of this evidence we claim that the GED program *per se* has little or

no effect on high school dropouts' labor market outcomes. Our control function tests reveal this information. Moreover, we find evidence that labor markets price out not only cognitive skills, but also non-cognitive skills. Part of what appears to be a return to education does not reflect the price of knowledge but rather the price of unobserved skills correlated with educational attainment.

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16 Appendix

See the complete version