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HEIGHT AS A PROXY FOR COGNITIVE AND NON-COGNITIVE ABILITY

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ABSTRACT

Taller workers receive a substantial wage premium. Studies extending back to the middle of the last century attribute the premium to non-cognitive abilities, which are associated with stature and rewarded in the labor market. More recent research argues that cognitive abilities explain the stature-wage relationship. This paper reconciles the competing views by recognizing that net nutrition, a major determinant of adult height, is integral to our cognitive and non-cognitive development. Using data from Britain's National Childhood Development Study (NCDS), we show that taller children have higher average cognitive and non-cognitive test scores, and that each aptitude accounts for a substantial and roughly equal portion of the stature premium. Together these abilities explain why taller people have higher wages.

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I. Introduction

Why do taller workers earn notably more than their shorter counterparts, even in industrialized countries? Height may increase individual productivity via its positive association with strength and endurance; however, most non-agricultural jobs are sedentary, and thus place relatively little value on these characteristics. Alternatively, stature may reflect other characteristics that are rewarded in the labor market. The most popular view in this vein attributes the premium to non-cognitive abilities (Stogdill, 1948; Baker and Redding, 1962; Adams, 1980; Judge and Cable, 2004; Persico, Postlewaite, and Silverman, 2004). On the other hand, more recent research argues that cognitive abilities explain the stature-wage relationship (Case and Paxson, 2008; Heineck, 2009).

This paper tests the competing hypotheses. Using data from the British National Childhood Development Study (NCDS), we examine the extent to which cognitive and non-cognitive abilities separately contribute to the stature-wage relationship. We find that taller children score higher on cognitive and non-cognitive assessments, and that each aptitude separately explains a substantial and roughly equal portion of the relationship. We also show that controlling for cognitive and non-cognitive abilities causes the stature premium to vanish.

It is well documented that stature is associated with personal and economic success. As early as 98 A.D., Roman historian Tacitus argued that stature represented achievement. Later scholars echoed this view, such as prominent 19^{th} century physician, Julien-Joseph Virey, who added that taller populations were also more motivated and industrious (Hall, 2006). Recent empirical evidence corroborates these claims. In western countries, an increase in a man's stature from the 25^{th} to the 75^{th} percentile of the height distribution—an increase of approximately 4 to 5 inches—is associated with a 9 to 15 percent increase in earnings (Judge and Cable, 2004; Persico, Postlwaite, and Silverman; 2004; Heineck, 2005; Case and Paxson, 2008; Hubler, 2009). This return is roughly as large as completing an additional 1 to 2 years of schooling.

The more popular (or traditional) view attributes the stature premium to a positive correlation between height and non-cognitive ability. This correlation is thought to work through various environmental pathways. For example, Persico, Postlewaite and Silverman (2004) argue that some individuals associate stature with physical ability. Taller workers, they reason, are stronger and quicker, and thus should excel in sports. This rational encourages these individuals to pressure taller classmates to participate in athletic activities. As a result, taller individuals are more inclined to engage in sports, and accumulate the productive non-cognitive abilities (social skills) attributed with participating in athletics, such as team work, discipline, confidence, and leadership. Including social participation controls in the earnings equation modestly reduces the estimated stature coefficient, from 0.023 to 0.018[1]. The height premium remains substantial and statistically significant at the 5 percent level. However, these results may understate the extent to which non-cognitive ability contributes to the height-wage relationship because the traditional view associates at least ten non-cognitive abilities with stature[2].

Case and Paxson (2008) recently challenged this view, suggesting that cognitive, rather than non-cognitive abilities, explain the stature premium. They attribute the height-cognition relationship to a biological pathway: insulin-like growth factors. These channels, they argue, stimulate simultaneous neural and physical growth, and also develop neurological regions that manage cognitive capacity. Their empirical evidence indicates that the height premium is largely, but not entirely, due to cognitive ability. Including cognitive test scores in the earnings equation reduces the estimated stature coefficient approximately 45 percent, from 0.023 to 0.013 for men and 0.019 to 0.011 for women. However, the stature-wage relationship for men remains economically and statistically significant at the 5 percent level, suggesting that other characteristics, such as non-cognitive abilities, may play an important, independent role in the relationship.

[1] The standard earnings equation is wages regressed on stature.

[2] These characteristics are authority, communication, confidence, courtesy, discipline, ethical conduct, motivation, optimism persuasion, sociability. Persico, Postlwaite and Silverman (2004) did not include these measures in their analysis due to data limitations.

This paper makes two contributions to the literature. First, we show that taller children are more cognitively able and socially adept. Using data from the NCDS, we find that a one standard deviation increase in stature at age 7 (approximately 2 inches) is associated with a 10 percent of a standard deviation increase in math and reading test scores reported at age 11. Similarly, a one standard deviation increase in height at age 11 (approximately 2.5 inches) is associated with a 2 percent average increase in non-cognitive ability. These effects are as large as growing up in middle class family versus a lower class family.

Second, we show that social skills play as important a role as cognition in explaining the stature-wage relationship. Using data from the NCDS, we find that separately including either cognitive or non-cognitive controls in the earnings equation reduces the stature estimates by roughly the same amount, from 0.015 to 0.009 for men and 0.010 to 0.003 for women[3]. We include social skill measures, in addition to cognitive test scores, to show that non-cognitive ability explains a substantial, independent portion of the height premium. Including both measures reduces the stature estimates to approximately zero, from 0.009 to 0.005 for men and 0.003 to 0.000 for women. These results indicate that neither aptitude separately explains the entire stature premium; rather both abilities are necessary to account for the entire relationship.

The paper proceeds as follows. Section II discusses the more popular view. It covers the pathways associated with taller individuals accumulating more social skills, and distinguishes which productive personality traits are particularly attributable to stature. Section III provides intuitive and empirical evidence that these social skills enhance productivity, and thus should provide a substantial contribution to the height premium. Section IV presents the empirical strategy. Section V describes the data, and section VI presents and discusses the results. Finally, section VII concludes.

[3] These estimates represent the return to stature net of parental investment.

II. Height and Non-Cognitive Ability

The traditional view suggests that stature is correlated with several personality traits conducive to worker productivity, such as emotional stability and extraversion[4]. This correlation is thought to work through various environmental pathways. For instance, numerous studies indicate that taller men are more attractive, and that attractiveness is associated with competence. These perceptions encourage individuals to provide taller individuals with more attention, praise and investment in their social development. As a result, these workers accumulate more extroversive characteristics, such as optimism and clear, persuasive communication skills. (Ross and Ferris 1981; Harper, 2000; Judge and Cable 2004; Mobius and Rosenblat, 2005).

Another popular argument is that taller individuals grow up in more nurturing environments. For example, more educated parents earn more, and thus can spend more income on their child's nutrition, medical care and opportunities to engage in social activities. Cogent parents are also more adept at creating emotionally healthy environments, which are pivotal to developing emotionally stable personalities (Patterson, 1989; Brooks-Gunn and Duncan, 1997; Bradley, 2002).

Recent neurobiological research supports the traditional view. These studies attribute stature's positive relationship with emotional stability and extraversion to a nature-nurture interaction[5]. Figure 1 illustrates the mechanism. Formally, adult stature represents an individual's net nutrition history. Growing bodies primarily use nutritional resources to carry out maintenance, physical activities and combating diseases. Remaining nutrients (surplus nutrition) are then converted to growth materials and growth stimulating components: e.g., shared insulin-like growth factors, such as thyroid and growth hormones (Tanner, 1978). The components are thought to stimulate simultaneous physical and neural growth, and to develop neurological regions managing

[4] These characteristics are sometimes referred to as social skills.
[5] This channel is sometimes referred to as the biological pathway due to its associated with the biological literatures.

our cognitive and non-cognitive processes[6]. Hence, this pathway suggests that taller adults are both more cognitively and non-cognitively able (Oppenheimer and Schwartz, 1997; Thompson and Potter, 2000; Fuster, 2001; Blair, 2004; Bechara, 2005).

[Insert Figure 1 here]

The psychological literature provides an in depth discussion as to why neural growth plays an important role in determining emotional stability. The social brain hypothesis suggests that our behavior is influenced by our instincts, what we innately want to do, and our experience, what common knowledge tells us is appropriate. When individuals choose between competing behaviors their instincts and experience assign weights to each alternative. Given this feedback, the mind chooses the action with the highest positive weight. The experience regions promote socially appropriate behavior because our instincts occasionally encourage improper actions. For example, our instincts may encourage us to sleep in, rather than work, when we wake up exhausted. In this case, our experience can overrule our instincts, and encourage us to work.

Healthy neural development increases the experience regions' authority in the decision making process. Initially, the instinctual regions are more developed[7]. This advantage allows our instincts to send stronger signals, and thus command more control over our actions. As the brain develops, the experience regions receive relatively more growth, which increases their relative authority over our behavior.

Empirical research supports the neurobiological theory. Liu et al. (2003) examines the extent to which neural growth contributes to social development. They measure a child's neural growth using a standard proxy: the child's nutritional status. Using data from the Mauritius Longitudinal Study, they show that malnourishment increases the frequency with which a child engages in an aggressive, antisocial, dishonest, and socially

[6] These regions are the insular, anterior cingulated, medial prefrontal and frontal cortices.
On average, the extent to which these biological channels operate on physical and neural growth is substantial. However, these studies also indicate that responses vary at the individual level.
[7] These synapses are also denser, and thus can transmit more signals.

inappropriate action from occasionally to constantly. Other studies report similar results using similar methods[8] (Stoch and Smythe 1963; Chase and Martin 1970; Grantham-McGreggor et al., 1982; Galler et al., 1983; Klein 1987).

III. Non-Cognitive Ability and Productivity

Most social scientists recognize that emotional stability and extraversion play an important role in worker productivity (Judge et al., 1999). Emotionally stable individuals are more adept at controlling their emotions and cultivating positive, rational personality traits, such as composure and optimism. These traits are thought to promote more amiable, ambitious and courteous dispositions, and are conducive to coping with stress and managing individuals. As a result, psychologists commonly link emotional stability to the following productive personality traits (social skills): authority, courtesy, discipline, ethical conduct, optimism and motivation[9] (Goldberg, 1990).

Most emotionally stable characteristics intuitively increase worker productivity. Authoritative workers are more attentive, reliable, and talented at managing resources and stress, which promotes their ability to recognize, analyze, and solve problems. Motivated and disciplined employees work harder and longer, and engage in more activities that enhance and broaden their skills (Goleman, 1998). Similarly, ethical employees oppose shirking, and thus work more. They are also more apt to follow rules, which are conducive to carrying out instructions and engaging in teamwork (Minkler, 2008).

How courtesy and optimism promote production is obscure. Courteous individuals are amiable and polite, and thus are more inclined to avoid engaging in counterproductive activities, such as antagonizing, intimidating, and threatening co-workers (Noland and Bakke, 1977). These unproductive actions can present substantial

[8] We would provide more precise empirical results. However, the estimates in these papers are not easy to interpret

[9] Discipline, ethics and motivation are also associated with conscientiousness. For this paper's purpose, this distinction is not very important as conscientiousness is non-cognitive characteristics.

costs to an employer. For example, Leymann (1990) estimated that antagonizing an additional employee is associated with a $30,000 to $100,000 increase in operating costs. Optimism enhances our capacity to cope with anxiety and negative emotions, and thus reduces our chances of contracting depression: a disease that substantially promotes apathy and shirking (DuPont et al., 2006).

Extroverts are assertive, optimistic, persuasive, and gregarious. As a result, they are more adept at clear communication and engaging individuals in social situations. These social skills intuitively play an important role in production. Clear communication reduces the time required to tell individuals what to do and how to do it (Goleman, 1998; Betz, 2008). These traits are fundamental for white collar workers. For example, most patients prefer physicians that are empathetic, can communicate clearly, and most importantly, have good bedside manners (Blue, 2007). These traits are also important for most non-professional workers. For instance, carpenters must clearly convey instructions and progress to their peers in order to expedite construction and reduce work related accidents.

Recent empirical evidence supports the intuition. In western countries, a one standard deviation increase in emotional stability is associated with a 7 to 11 percent increase in earnings. Extraversion's contribution to earnings is unclear. Most studies indicate that extraversion increases productivity. However, its contribution reduces to approximately zero once other personality traits are included in the earnings equation, such as conscientiousness and emotional stability (Gelissen and de Graaf, 2006; Mueller and Plug, 2006; Heineck, 2007).

IV. Empirical Framework

Our empirical task is to examine the extent to which cognitive and non-cognitive abilities contribute to the stature-wage relationship. The standard way to measure the height premium is to apply ordinary least squares (OLS) to:

$$Y_i = \beta H_i + \rho X_i + \varsigma_i, \tag{1}$$

where Y_i is the natural logarithm of individual i's hourly wages, H_i is adult height, X_i is a vector of exogenous covariates determined before labor market entry (e.g., race, residence, and parental investments) and ς_i is an error term (Case and Paxson, 2008). X_i excludes measures capturing worker productivity, such as occupational status and schooling. The rationale is that smarter, more socially adept workers commonly choose to complete more schooling and pursue more lucrative careers. Therefore, these characteristics are intuitively correlated with cognition and social skills, and thus their inclusion in equation one could understate these abilities contribution to the height premium.

The two views suggest that the estimated stature coefficient, $\hat{\beta}_{\text{OLS}}$, represents the extent to which stature is correlated with either cognition or social skills. We measure each aptitude's respective contribution to the stature premium by separately including cognitive and non-cognitive controls in equation one. A substantial reduction in the resulting stature estimate suggests that height is strongly correlated with the respective ability. This approach provides a way to test the competing views. Assuming the more popular view is correct, including non-cognitive controls should reduce the stature estimate the most, and vice versa.

Social skill is strongly correlated with cognition (Heckman, 2006). As a result, including non-cognitive controls in equation one may reduce the estimated stature coefficient due to non-cognition's correlation with cognitive ability, rather than due to its independent association with stature[10]. We estimate non-cognition's separate contribution to the stature premium by including non-cognitive, in addition to cognitive, controls in equation one. A substantial reduction in the resulting stature estimate, as compared to the

[10] The average cross-correlation coefficient between the cognitive and non-cognitive measures is 0.10. Hence, the correlation is not large enough that multicollinearity is an issue.

estimate obtained using only cognitive ability controls, would suggest that social skills provide a substantial, separate contribution to the premium.

V. Data

The analysis requires panel data containing measures of height, cognitive ability, non-cognitive ability, and adult labor market outcomes. A suitable data source is the 1958 National Childhood Development Study[11] (NCDS). The NCDS is a longitudinal survey which began as a perinatal mortality study in 1958. The initial sample included all children born in Britain during the week of March 3, 1958[12]. Several follow up surveys (sweeps) were conducted at ages 7, 11, 16, 23, 33 and 42. These sweeps collected a broad range of health, socioeconomic, cognitive, and non-cognitive measures.

The NCDS provides several measures of emotional stability and extraversion. Individuals evaluated their motivation, optimism and authority at ages 16, 23 and 33, respectively. The optimism assessment contains 24 questions, each asking whether the individual experiences various pessimistic temperaments, such as inadequacy, cynicism, anxiety, and sorrow. A higher score suggests that the individual is more pessimistic. The motivation assessment has 8 questions, each asking the individual their opinion regarding activities associated with ambition; e.g., it is important to work hard and complete more education. The answers are scaled using a 5 point system ranging from 1 – not true to 5 – very true. A higher score suggests that the individual is more motivated. Authority is attributed to management skills, such as leadership and the ability to give instructions.

[11] The NLSY 79 Child and Young Adult surveys also contain these measures. We do not use these data because the samples are relatively small. Also, many of the children are still not adults, and thus the survey lacks information on their wages at age 30.

[12] Environmental factors explain most average stature differences across populations (Malcolm, 1974; Martorelli and Habicht, 1986). Assuming environmental circumstances are significantly different between spring and the other seasons and these differences significantly affect individual characteristics, spring-born individuals may not adequately represent individuals born in other seasons. These conditions may hold because the spring disease environment is relatively gentle, especially compared to autumn and winter—the so-called cold and flu seasons. Also, spring-borns are exposed to more sunlight during infancy because the length of day increases during spring. Sunlight is required to produce vitamin D, which is required to use calcium.

Another issue is individuals with significantly different characteristics may conceive children during different seasons; however, Card (2001) indicates these differences modestly affect child characteristics and outcomes.

Individuals rate themselves on these characteristics using a 2 point scale ranging from 0 – not competent to 2 – very competent.

Ethical conduct represents the capacity to comply to authority. Teachers and parents evaluated the individual's integrity at ages 11 and 16. At age 16, teachers and parents evaluated the adolescent's honesty, truancy, vandalism record, minor crimes record, compliance to rules, and aggression towards peers. The questions are measured using a 2 point system ranging from 0 – the individual never expresses the characteristic to 2 – the individual constantly displays the temperament. At age 11, teachers assessed the student's hostility and arrogance towards peers and authorities. These questions are measured using a 10 point scale ranging from 1 – they are not hostile / arrogant to 10 – they are very hostile / arrogant.

Courtesy is associated with manners and an amiable, easy going attitude. Teachers evaluated their student's courtesy at age 16. The questions asked the teacher to rate the student's irritability, moodiness, social flexibility and restlessness. Each question was measured using the same 2 point scale employed to assess ethical conduct.

Extroverts are persuasive, gregarious and adept at clear communication. At age 33, individuals rated their ability to communicate and persuade individuals. Each question was measured using the same scale employed to assess individual authority. At age 16, teachers assessed their student's inclination to engage in social and solitary activities. Sociability was measured using a 5 point scale ranging from 1 – very social and amiable to 5 – very withdrawn, and introversion was assessed using the same 2 point scale employed to measure courtesy[13].

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[13] We separately include the above personality assessments in the analysis to estimate the extent to which emotional stability and extraversion contribute to the stature premium. This approach restricts our capability to report each social skill's individual return to earnings. First, the method requires me to include over a dozen personality assessments, and thus there is not enough room to accommodate these variables in a single-page table. Second, these variables are relatively collinear, which reduces their respective precision. We try to resolve this problem using a principle components analysis. However, it is unclear which temperaments the resulting components represent. Also, the analysis is unable to reduce the available measures into a smaller number of orthogonal components. For these reasons, we do not report each social skill's individual contribution to earnings in the main analysis. The appendix reports several

We measure cognition using the variables employed in Case and Paxson (2008): the individual's math and reading test scores reported at age 11. We also include the individual's problem solving assessment reported at age 33. This assessment asks individuals to evaluate their capacity to solve problems using computers with a 2 point scale ranging from 0 – not competent to 2 – very competent.

Table 1 presents summary statistics for two samples: the total sample, full-time workers[14] with height and wage measures; and the main sample, the previous sample restricted to workers with measures of cognition and social skill. The main sample consists almost entirely of individuals of European Caucasian descent. On average, men stand at 5 feet 10 inches tall in adulthood and women 5 feet 4 inches. The average logarithm of gross hourly earnings for men and women—in terms of the value of the pound between 1999-2000—is £10.0 ($16.17) and £7.2 ($11.64), respectively. Approximately 53 percent of the main sample was born to middle socioeconomic status (skilled labor) fathers; 16 percent to high socioeconomic (managers and professionals) fathers; and lastly, 31 percent to low socioeconomic (low skilled or semi-skilled labor) fathers.

[Insert Table 1 here]

Restricting the sample to workers with cognitive and non-cognitive measures may introduce selection bias if the availability of these measures is correlated with unobserved determinants of wage. The results in table 1 indicate that the two samples have approximately similar observable characteristic values, which suggests that the bias introduced by the restriction is potentially small.

social skills return to earnings, and provides evidence that non-cognitive abilities play an important role in productivity.

[14] Full-time workers are individuals who work 1000 or more hours a year.

VI. Results

The Association between Height, Cognition and Social Skills

We present evidence that stature is strongly correlated with cognitive and non-cognitive abilities. Table 2 reports OLS estimates of cognition at age 11 on stature at age 7 z-scores, and table 3 presents logistic results of social skill indicators at age 16 on height at age 11 z-scores[15]. We convert the stature measures to z-scores using the 2000 growth charts from the Centers for Disease Control (2002). This standardization makes it easier to compare estimates across ages and assessments. Column I controls for the individual's race, region of residence, and medical examination date. Column II includes an extensive range of parental investment variables, such as the father's socioeconomic group at age 7, household income, parents' academic achievement, parents' stature, and parents' involvement in their child's education. These extended controls are associated with the environmental investments contributing to taller individuals achieving more social development. If the traditional view is correct, then including these characteristics should substantially reduce the resulting stature estimates.

The results indicate that taller children are more cognitively and non-cognitively able than their shorter peers. Using extended controls, a one point increase in a boy's stature at age 7 z-score—approximately 2 inches—is associated with a 10 percent of a standard deviation increase in math and reading test scores. Similarly, a one point increase in a boy's stature at age 11 z-score—roughly 2.5 inches—is associated with a 2 percent average increase in non-cognitive ability. These effects are roughly as large as a two standard deviation increase in family income[16]. Similar results are reported for girls.

[Insert Tables 2 and 3 here]

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[15] The non-cognitive measures generally report whether an individual rarely, occasionally, or constantly displays a behavior. We transform these measures into dummy variables to simplify their interpretation (i.e., 0, the individual does not display the behavior and 1, the individual displays the behavior). This transformation does not significantly change the results.

[16] For girls, a one standard deviation increase in family income is associated with a 7 percent of a standard deviation increase in reading score at age 11 and a 1 percent increase in average cognitive ability.

The environmental controls explain a substantial portion of the relationship between stature and both cognitive and non-cognitive ability. Including these measures reduces the stature estimates approximately 30 percent, on average, and in some cases—such as motivation and optimism—explains the entire association. However, in most cases, roughly two-thirds of the correlation between stature and ability remains unexplained, which suggests that another pathway, such as the neurobiological channel, may play an important role in determining this relationship[17].

Height and Earnings

We examine the extent to which cognitive and non-cognitive ability separately contribute to the height premium. Tables 4 and 5 present regression results of the natural logarithm of gross hourly earnings on adult stature for men and women, respectively. Column I includes experience, ethnicity and region of residency controls. Column II controls for the father's socioeconomic status, household income, parents' education levels and the parents involvement in their child's education. Columns III-V include cognitive controls, non-cognitive controls and both ability controls, respectively.

[Insert Tables 4 and 5 here]

The results indicate that taller men and women earn substantially more than their shorter cohorts. A one inch increase in adult stature is associated with a 2.2 percent average increase in earnings for men and a 1.9 percent increase for women. These estimates are approximately equal in value to the estimates reported in Case and Paxson (2008) and Persico et al. (2004)[18].

The results in column III, tables 4 and 5, indicate that cognition does not explain the entire stature-wage relationship. Including cognitive controls substantially reduces the

[17] We would examine this topic further, but it is well beyond this paper's scope.

[18] As an interesting note, the disparity in stature between men and women does not explain the gender gap in earnings. We combine the men and women samples and estimate a regression of earnings on a male indicator. The estimate male wage premium is approximately 40 percent, which is approximately equal in value to the gender gap reported in Case and Paxson (2008). Controlling for cognition, social skills, stature and parental investment did not change the results.

height estimates, from 0.015 to 0.009 for men and 0.010 to 0.003 for women. The female premium is approximately equal to zero; however, the male premium remains substantial and statistically significant at the 10 percent level. This result suggests that another pathway, such as non-cognitive ability, continues to play an important role in determining the male stature premium.

The results in column IV indicate that social skills contribute as much to the stature-wage relationship as cognition. Including non-cognitive controls reduces the relationship approximately the same amount as cognitive ability: from 0.015 to 0.008 for men and 0.010 to 0.003 for women. The results in column V suggest that non-cognitive ability accounts for a substantial, independent portion of the height premium. Including non-cognitive controls, in addition to cognitive controls, reduces the stature estimates an additional standard deviation—from 0.009 to 0.005 for men and 0.003 to 0.000 for women—and renders them statistically insignificant and approximately equal to zero. Comparing the estimates in columns I and V, social skills individually reduce the height estimates roughly 20–35 percent. These results support the traditional view.

The evidence indicates that neither view is entirely correct. Cognition and social skills play an equally important role in determining the stature-wage relationship. However, neither aptitude individually explains the entire relationship. More importantly, the results imply that the stature premium is entirely associated to both cognitive and non-cognitive ability. Controlling for both abilities reduces the male and female stature premium approximately 75 and 100 percent, respectively.

Discrimination or Stature

Some social scientists suggest that the male stature premium represents discrimination. Taller men, they argue, are not smarter or more socially adept; rather, some societies associate stature with superiority, and thus are more inclined to employ and promote taller men into more prestigious positions (Saul, 1971). This argument implies that the male stature premium is associated with occupational sorting. Societies sort taller men into relatively well-paying professions, and thus these men earn more on average.

We test this hypothesis by regressing occupational status on stature. The NCDS reports three occupational groups: white collar workers, managers and professionals; skilled workers, manual and non-manual; and blue collar workers, semi-skilled and unskilled workers. The NCDS assigns workers into a group, in part, using the occupation's average wage rate. In general, white (blue) collar workers receive the highest (lowest) earnings.

Table 6 presents multinomial logistic regression results of occupational status on stature (the base category is skilled workers). Column I includes race and region controls. Column II controls for the father's socioeconomic status at age 7, parents' education levels, household income, and the parents involvement in their child's education. Column III includes cognitive and non-cognitive controls.

The evidence indicates that taller men are substantially more likely to select into white collar occupations as opposed to skilled vocations. However, the result is due to stature's association with cognition and social skills, rather than to discrimination. A one inch increase in adult stature is associated with a 2.7 percent increase in acquiring a white collar occupation over a skilled vocation. The effect is as large as a one standard deviation increase in household income. Including parental measures marginally reduces the stature estimates, while incorporating cognitive and non-cognitive controls reduces the stature estimates to approximately zero and renders them statistically insignificant. A one inch increase in stature is now associated with a .8 percent increase in acquiring a white collar occupation over a skilled job[19].

[Insert table 6 here]

[19] We conduct the same analysis using the female sample. The results indicate that stature is uncorrelated with occupational status among women. This result is consistent with the discrimination argument, which attributes the pathway solely to men.

The discrimination view also suggests that taller men are more physically attractive, and that some societies associate attractiveness with superiority. This hypothesis is related to the traditional view argument mentioned earlier. However, the two views have an important distinction. The tradition view suggests that attractive men accumulate more social skills, and thus it is non-cognitive ability that ultimately causes these men to earn more. In contrast, the discrimination view argues that attractiveness is uncorrelated with non-cognitive ability. Rather, employers tend to overestimate an attractive worker's productivity, which causes them to pay taller workers more than they are worth (Mobius and Rosenblat, 2005).

We examine the extent to which attractiveness contributes to the stature premium by including beauty controls in the main analysis. A substantial reduction in the resulting stature estimate suggests that attractiveness plays an important role in determining the premium. Beauty is measured at ages 11 and 33. At age 33, individuals report whether they are overweight or not. At age 11, teachers rate their student's physical attractiveness as attractive or unattractive[20].

Table 7 presents evidence that more attractive men receive a substantial wage premium. The results in column III indicate that attractive 11 year olds earn approximately 6.5 percent more as adults than their unattractive peers. However, including attractiveness controls does not change the stature estimate, which suggests that beauty's true return to the height premium is modest.

The discrimination views argue that only distinctively taller men receive a superiority premium, and that this premium causes these men to earn a substantial, discontinuous increase in earnings[21]. Figure 2 reports regression results of earnings on several stature dummies, controlling for experience, ethnicity and region. The results indicate that taller individuals do not receive a sizable, discontinuous increase in earnings; rather, the returns to stature increase at a decreasing rate, and approach

[20] We acknowledge that these measures are not ideal. However, they are the best measures given the available data.
[21] Distinctively taller men are one to two standard deviations taller than average.

approximately zero at 72 inches[22] (approximately one standard deviation above average stature). Shorter men receive significantly higher average returns accompanying gains in stature. This result supports the neurobiological pathway, which claims that the correlation between physical and neural development decreases as individuals undergo more physical growth. As a result, a gain in stature should provide shorter individuals, or those experiencing less physical development, with relatively more neurological growth, and thus a higher average increase in earnings.

[Insert Figure 2 here]

VII. Conclusion

Researchers have put forward two explanations for the height premium. The more established view claims that stature is positively correlated with non-cognitive abilities that are rewarded in the labor market (Stogdill, 1948; Baker and Redding, 1962; Adams, 1980; Judge and Cable, 2004; Persico, Postlewaite, and Silverman, 2004). Another view recently challenged this mechanism, arguing that cognitive development accompanying vigorous physical growth accounts for the relationship (Case and Paxson, 2008; Heineck, 2009).

This paper tests the competing hypotheses. Using data from the National Childhood Development Study (NCDS), we show that taller children are more cognitively able and socially adept than their shorter cohorts. A one standard deviation increase in stature at age 7 (approximately 2 inches) is associated with a 10 percent of a standard deviation increase in math and reading test scores reported at age 11. Similarly, a one standard deviation increase in height at age 11 (approximately 2.5 inches) is associated with a 2 percent average increase in non-cognitive ability. These effects are as large as growing up in middle class family versus a lower class family.

[22] Hubler (2009) and Case and Paxson (2008) report relatively similar results using the German Socio-Economic Panel and NCDS data, respectively.

We also show that each aptitude accounts for a substantial and approximately equal portion of the stature premium. Separately including either cognitive or non-cognitive controls in the standard earnings equation reduces the estimated stature coefficient roughly the same amount, from 0.015 to 0.009 for men and 0.010 to 0.003 for women. The non-cognitive controls explain a substantial, independent portion of the stature-wage relationship. Including non-cognitive, in addition to cognitive controls, reduces the stature estimates to approximately zero, from 0.009 to 0.005 for men and 0.003 to 0.000 for women. These results indicate that neither pathway individually explains the entire relationship; rather, both abilities are necessary to capture the whole relationship.

An implication of this paper's findings is that researchers should include stature variables in the standard Mincerian earnings equation when cognitive or non-cognitive measures are unavailable. Researchers use the Mincerian approach to estimate the true returns to schooling. However, schooling is positively associated with cognitive and non-cognitive ability, and thus analyses that omit ability measures will produce estimated schooling coefficients that are biased upward. The results show that adult height is strongly correlated with cognitive and non-cognitive ability. Hence, researchers can use stature measures to mediate this bias when ability scores are unavailable.

The empirical evidence suggests several areas for further research. A natural extension would examine the stature premium in poorer settings, such as developing nations. Poorer populations undergo substantially less physical growth, which, according to the neurobiological pathway, implies that a gain in stature should provide these populations with more neural growth, and thus a larger height premium. This mechanism suggests that the returns to productivity operating through gains in stature are relatively greater in developing countries. Hence, it would be interesting to test this implication, and measure the degree to which ability contributes to the stature-wage relationship in impoverished populations.

For policy makers, the next step is to examine the extent to which the environmental and nature-nurture interaction pathways separately contribute to the stature premium. One direction would test whether exogenous nutritional shocks contribute to the physical-neural growth relationship, and thus the link between stature and both cognitive and non-cognitive ability. Pediatric research indicates that consuming a nutritionally diverse diet—especially during pivotal growth stages, such as *in utero* and childhood—is conducive to producing more growth stimulating components, and thus to becoming taller and achieving more cognitive and non-cognitive development (Williams et al. 1978; Richards et al., 2002; Scheepens et al., 2005; Liu and Raine, 2006; Kiddie et al., 2010). Hence, it would be interesting to test this implication, and study which nutrients and growth stages play the most important role in determining the stature-ability relationship.

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TABLE 1
DESCRIPTIVE STATISTICS

	My Sample	Total Sample
Number of Observations	2,577	6,838
Ethnicity		
European Caucasian	0.99	0.99
Adult Height (Inches)		
Men	69.8	69.7
Women	64.3	64.2
Adult Gross Hourly Earnings (£)		
Men	10.0	9.6
Women	7.2	7.0
Father's socioeconomic group		
White Collar	0.17	0.16
Skilled	0.53	0.53

Note - The Total Sample is restricted to full-time workers that report wage and height data at age 33. My sample is the Total Sample restricted to individuals with cognition, non-cognition and socioeconomic group measures.

TABLE 2
COGNITIVE TEST SCORES AND HEIGHT IN CHILDHOOD

	Boys		Girls	
	Age 7 Height for Age z-Score			
Dependent variables	Limited Controls	Extended Controls	Limited Controls	Extended Controls
Reading at age 11	1.04***	0.70***	1.12***	0.73***
	(0.12)	(0.12)	(0.11)	(0.11)
Math at age 11	1.56***	0.93***	1.89***	1.37***
	(0.20)	(0.20)	(0.19)	(0.19)

Note.— ***: statistically significant at the 1 percent level; **: statistically significant at the 5 percent level; *: statistically significant at the 10 percent level. Sample sizes are 2,495 for men and 2,454 for women. Limited controls inclue the individual's race, region and medical exam date. Extended controls include household income, father's socioeconomic group, mother's and father's height, education and involvement in child's education.

TABLE 3

NON-COGNITIVE TEST SCORES AND HEIGHT IN CHILDHOOD

	Boys		Girls	
	Age 11 Height for Age z-Score			
Dependent variables	Limited Controls	Extended Controls	Limited Controls	Extended Controls
Indicator Behavior Scores at age 16				
Disobedient	-0.024***	-0.022**	-0.018***	-0.01
	(0.008)	(0.009)	(0.007)	(0.008)
Solitary	-.0.029***	-.0.031***	-0.025***	-0.030***
	(0.009)	(0.011)	(0.009)	(0.010)
Confident	0.034***	0.045***	0.020**	0.023**
	(0.008)	(0.009)	(0.008)	(0.009)
Dishonest	-0.028***	-0.021***	-0.021***	-0.014**
	(0.007)	(0.008)	(0.006)	(0.006)
Restless	-0.038***	-0.023**	-0.021***	-0.009**
	(0.008)	(0.009)	(0.006)	(0.006)
Thief	-0.018***	-0.010***	-0.004**	-0.003*
	(0.004)	(0.004)	(0.002)	(0.002)
Rude	-0.01	0.00	-0.022***	-0.013*
	(0.007)	(0.008)	(0.008)	(0.008)
Indexed Behavioral Scores				
Motivation at age 16	0.313**	0.008	0.591***	0.416***
	(0.125)	(0.134)	(0.116)	(0.124)
Pessimism at ag 23	-0.116**	-0.008	-0.324***	-0.263***
	(0.055)	(0.135)	(0.062)	(0.067)

Note.— ***: statistically significant at the 1 percent level; **: statistically significant at the 5 percent level; *: statistically significant at the 10 percent level. Sample sizes are 2,908 for men and 2,833 for women. Limited controls inclue the individual's race, region and medical exam date. Extended controls include household income, father's socioeconomic group, mother's and father's height, education and involvement in child's education. Each indicator behavioral score is equal to one when the individual expresses the characteristics either occasionally or constantly, and zero when they do not express the trait. These characteristics are regressed using a multinomial logit model, and the height coefficients represent marginal frequencies. The indexed behavioral scores are regressed using OLS.

TABLE 4

LOG AVERAGE HOURLY EARNINGS, COGNITION, NON-COGNITION, AND THE RETURNS TO HEIGHT

	Men				
Dependent Variable: Log Gross Hourly Earnings	(1)	(2)	(3)	(4)	(5)
Height at age 33	0.022***	0.016***	0.009*	0.008	0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Test for Overall Significance (F-Test)					
Cognitive Scores F-test (p-value)			20.04		
			(0.00)		
Non-Cognitive Scores F-test (p-value)				5.63	
				(0.00)	
Both Scores F-Test (p-value)					8.26
					(0.00)
N	1,383	1,383	1,383	1,383	1,383
Adjusted R^2	0.03	0.08	0.19	0.14	0.22

Note.—***: statistically significant at the 1 percent level; **: statistically significant at the 5 percent level; *: statistically significant at the 10 percent level

Column (1) includes experience, region of residence in 1911, and ethnicity measures

Column (2) includes father's socioeconomic group and parental involvement in child's education measures

Column (3) includes cognitive math and reading test scores, reported at age 11, and problem solving skills reported at age 33

Column (4) includes emotional stability and extraversion assessment scores reported at ages 11, 16, 23 and 33.

Column (5) includes cognition and non-cognition controls

TABLE 5

LOG AVERAGE HOURLY EARNINGS, COGNITION, NON-COGNITION, AND THE RETURNS TO HEIGHT

	Women				
Dependent Variable: Log Gross Hourly Earnings	(1)	(2)	(3)	(4)	(5)
Height at age 33	0.019***	0.010*	0.003	0.003	0.000
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Test for Overall Significance (F-Test)					
Cognitive Scores F-test (p-value)			16.12		
			(0.00)		
Non-Cognitive Scores F-test (p-value)				5.33	
				(0.00)	
Both Scores F-Test (p-value)					6.9
					(0.00)
N	1,167	1,167	1,167	1,167	1,167
Adjusted R^2	0.01	0.09	0.18	0.16	0.21

Note.—***: statistically significant at the 1 percent level; **: statistically significant at the 5 percent level; *: statistically significant at the 10 percent level

Column (1) includes experience, region of residence in 1911, and ethnicity measures

Column (2) includes father's socioeconomic group and parental involvement in child's education measures

Column (3) includes cognitive math and reading test scores, reported at age 11, and problem solving skills reported at age 33

Column (4) includes emotional stability and extraversion assessment scores reported at ages 11, 16, 23 and 33.

Column (5) includes cognition and non-cognition controls

TABLE 6

MALE OCCUPATIONAL PLACEMENT AND STATURE

	Men		
Dependent variable	(1)	(2)	(3)
	Height at age 33 Marginal Effects		
White Collar	0.027***	0.024***	0.008
	(0.006)	(0.006)	(0.007)
Blue Collar	-0.006	-0.005	0.001
	(0.004)	(0.004)	(0.004)

Note.— ***: statistically significant at the 1 percent level. The sample size is 963 men, and skilled workers are the base category. Column I include race and region controls. Column II includes parental education measures, family income, parental involvement in child's education and father's socioeconomic group at age 7. Column III includes cognitive and non-cognitive controls.

TABLE 7

LOG AVERAGE HOURLY EARNINGS, COGNITION, NON-COGNITION, BEAUTY AND THE RETURNS TO HEIGHT

	Men					
Dependent Variable: Log Gross Hourly Earnings	(1)	(2)	(3)	(4)	(5)	(6)
Height at age 33	0.023***	0.018***	0.018***	0.011**	0.009	0.005
	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)
Attractive at age 11			0.065**			
			(0.030)			
Over weight at age 33			(0.011)			
			(0.029)			
Controls:						
Family background		X	X	X	X	X
Cognitive test scores				X		X
Non-cognitive test scores					X	X
N	1,260	1,260	1,260	1,260	1,260	1,260
Adjusted R^2	0.03	0.07	0.08	0.19	0.15	0.22

Note.—***: statistically significant at the 1 percent level; **: statistically significant at the 5 percent level; *: statistically significant at the 10 percent level

Column (1) includes experience, region of residence in 1911, and ethnicity measures

Column (2) includes father's socioeconomic group at age 7, parents' academic achievement, household income, and parental involvement in child's education

Column (3) include attractiveness controls

Column (4) includes math and reading test scores, reported at age 11

Column (5) includes emotional stability and extraversion scores, reported at ages 11, 16, 23 and 33

Column (6) includes cognitive and non-cognitive assessment scores

FIG.1. THE BIOLOGICAL LINK BETWEEN STATURE AND SOCIAL SKILLS

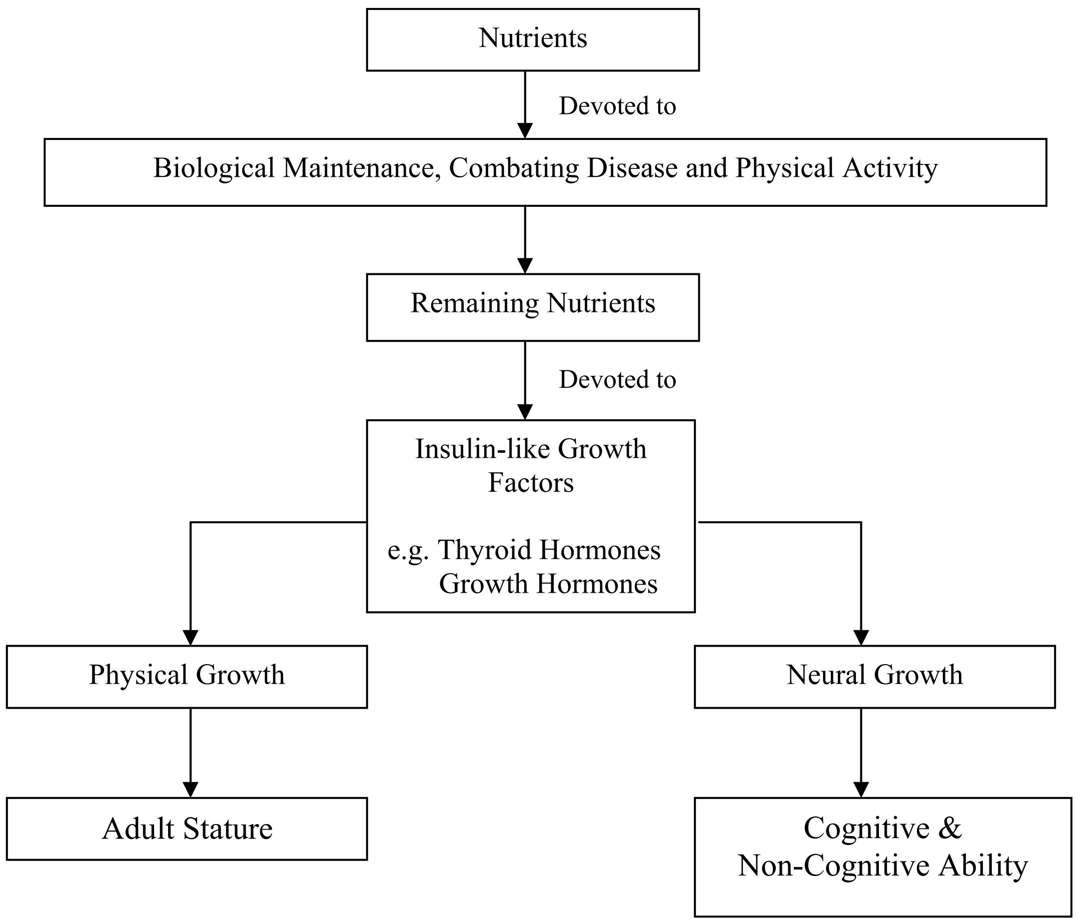
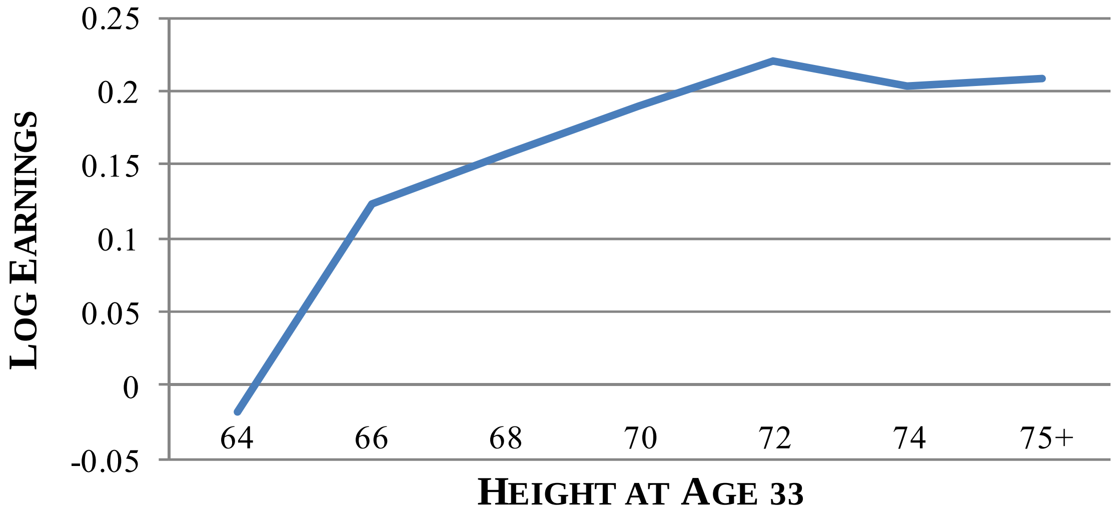


FIG. 2.—LOG EARNINGS AND STATURE FOR MEN



Appendix

Wages and Ability

This sections presents evidence that the market rewards the cognitive and non-cognitive abilities used in our analysis. Appendix table 1 reports separate regression results of adult earnings on cognition and social skills for men and women. We control for ethnicity, experience, location, household income, father's socioeconomic status at age 7, parents' academic achievement, and the parents involvement in their child's education. To capture each aptitude's independent contribution to earnings, we include social skill scores in the regression of earnings on cognition, and cognitive sores in the regression of earnings on non-cognitive ability. The results indicate that most productive temperaments substantially increase worker productivity. A one standard deviation increase in average cognitive ability is associated with a .20 standard deviation increase in average earnings for men and a .19 standard deviation increase for women. Similarly, a one standard deviation decrease in most socially unacceptable personality traits is associated with a .07 standard deviation increase in average earnings among men and women.

APPENDIX TABLE 1

EARNINGS, COGNITIVE ABILITY AND NON-COGNITIVE ABILITY

	Men		Women	
Dependent Variable: Gross Hourly Earnings	Ability Coefficient	Standardized BetaCoefficient	Ability Coefficient	Standardized BetaCoefficient
Cognitive Measures				
Math at age 11	0.010***	0.19	0.011***	0.21
	(0.001)		(0.002)	
Reading at age 11	0.017***	0.19	0.022***	0.24
	(0.002)		(0.003)	
Problem Solving at age 33	0.179***	0.26	0.083***	0.14
	(0.002)		(0.017)	
Non-Cognitive Measures				
Motivation at age 16	0.005**	0.05	0.009***	0.11
	(0.002)		(0.003)	
Confident	0.040**	0.05	0.016	0.02
	(0.019)		(0.018)	
Authority at age 33	0.050***	0.08	0.039**	0.06
	(0.017)		(0.020)	
Dishonest at age 16	-0.019	-0.01	-0.098**	-0.02
	(0.037)		(0.047)	
Shirks at age 16	-0.090**	-0.06	-0.060	-0.02
	(0.038)		(0.041)	
Rude at age 16	-0.005	-0.05	-0.038***	-0.09
	(0.012)		(0.012)	
Pessimism at age 23	-0.020***	-0.08	-0.011**	-0.07
	(0.006)		(0.005)	
Solitary at age 16	-0.095***	-0.10	-0.054*	-0.05
	(0.025)		(0.032)	
Anti-Social at age 16	-0.040***	-0.08	-0.042***	-0.08
	(0.013)		(0.014)	

Note.— ***: statistically significant at the 1 percent level; **: statistically significant at the 5 percent level; *: statistically significant at the 10 percent level. Sample sizes are 1,383 for men and 1,167 for women. All regressions control for the individual's region of residence, ethnicity, experience, father's socioeconomic group, parents's schooling and involvment in their child's education. I include cognition controls in the regression of earnings on non-cognitive, and personality trait controls in the regression of wages on cognition.