Height and Cognition at Work
Labor market performance in a low income setting

Daniel LaFave
Colby College

Duncan Thomas
Duke University

August 2013[†]

Abstract

Evidence indicates that taller workers earn more, particularly in lower income settings. It is possible that stature is a marker of strength which is rewarded in the labor market, or that height is a proxy for other dimensions of health and human capital including cognition, early-life investments, and other family background characteristics. As such, height may be an informative signal of worker quality to an employer. This paper evaluates the relative importance of each of these potential mechanisms in a unified framework that treats human capital as multidimensional. We draw on twelve waves of a unique longitudinal survey collected in Central Java, Indonesia that includes measured height, multiple markers of cognition, physical health biomarkers, and extremely rich information on labor market outcomes including sectoral choice, occupations, hours, tenure, self-employed profits, and wages. We document a robust relationship between height and earnings after controlling cognition, other dimensions of health, family background, education, and occupational choice that exists for both formal wage work and informal self-employment. The results illustrate that the height premium is not explained by the rich array of observed indicators of human capital and suggest height is appropriately treated as one dimension of a multi-dimensional array of human capital.

Keywords: Height, Cognition, Labor Markets
JEL Codes: O15, I15, J24

[†] Daniel LaFave, Department of Economics, Colby College, Waterville, ME 04901. Email: daniel.lafave@colby.edu
Duncan Thomas, Department of Economics, Duke University, Durham, NC. Email: dthomas@econ.duke.edu

1. Human Capital and Labor Market Performance

Evidence indicates that taller workers earn more, particularly in lower income settings.[1] Several explanations have been suggested for the height premium in earnings including height may be a marker of strength that translates into greater productivity in physically demanding work, or that height is a reflection of cumulative investments in human capital and correlated with other traits rewarded in the labor market (e.g. Strauss and Thomas, 2008). As adult stature is largely pre-determined by age 2 or 3 (Martorell and Habicht, 1986), many studies treat height as a marker of the early childhood environment including nutrition and investments in health during pregnancy and the first few years of life.

Thinking about height as one dimension of human capital that captures very early investments suggests an alternative interpretation of the height premium: height is likely to be correlated with other early childhood, and possibly later life, human capital investments, many of which are difficult to measure. In this framework, height is likely to be correlated with schooling attainment (Case et al., 2009), cognition (Case and Paxson, 2008), non-cognitive traits such as ambition and confidence (Persico et al., 2004), as well as an array of other markers of health and human capital. Moreover, a portion of height is genetic, meaning it almost surely captures the role of family background and investments made across multiple generations. It is also possible that height, per se, is not rewarded in the labor market, but instead used by employers as a signal of worker-quality.

This paper explores each of these potential explanations for the association between height and labor market outcomes. Rather than pin our hopes on one of the explanations, we treat height as one measure of human capital investments that are likely to be correlated with many others. By treating height in this unified way, we attempt to measure the relative contributions of the different

[1] See, among others: Behrman et al. (2013), Case and Paxson (2008, 2008b), Gao and Smyth (2010), Lundborg et al. (2009), Persico et al. (2004), Thomas and Strauss (1997), and Vogl (2012).

explanations in a single study setting – rural Central Java. We draw on rich longitudinal survey data that was designed to provide the evidence necessary to address this question, and analyze the role human capital plays in predicting success in both formal and informal labor markets. Relying on several key features of the survey, this work highlights the importance of height, cognition, education, health, and their interactions and extends the literature in a number of ways. In addition to contributing to a better understanding of the complex relationships between different indicators of human capital and labor market performance, this research provides important insights into the functioning of labor markets in a low-income setting and policies aimed at improving human capital and welfare.

We briefly describe a conceptual framework that motivates the relationships between different markers of human capital and labor market outcomes before describing the rich longitudinal data, empirical approach, and results.

2. Conceptual Framework

The relationship between height, cognition, health, and labor market behavior is best understood in a framework that recognizes the multidimensionality and dynamics of human capital accumulation over the life course.

Given early childhood production functions for multiple types of human capital, parental choices concerning nutrition and other investments interact with environmental factors and child-specifc endowments to establish early levels of human capital. These parnental choices will reflect not only the prices and opportunity costs of differing investments, but also family background characteristics such as available resources and attitudes toward health. If differing markers of human capital share common inputs, correlations between cognitive and physical development naturally arise at a young age due to parental choices geared toward maximizing expected future utility.

As the individual transitions through adolescence, human capital development and skill

acquistion continues through choices regarding tenure in school and early labor market experiences. Presented with a labor market that features multiple sectors and occupations with varying returns, the decision to remain in school, for example, will be a reflection of the opportunity cost of forgone work that is dependent on both the individual's choices during young adulthood and a reflection of parental investments during early life.

Similarly, earnings in differing occupations and sectors may offer specific returns to different dimensions of human capital. As individuals choose to sort across formal wage work and informal self-employment, for example, their comparative advantage is a reflection not only of human capital at that point in time, but of the accumulation process throughout the life course. Individuals may continues to make health and cognitive investments as they age, with opportunities for further development dependent in part on their chosen sectors and occupations.

Thinking in terms of this simplified framework of a life-course production process for multiple dimensions of human capital illumintes several of the key relationships we explore in the data. The well established correlation between height and labor market performance could be due to a number of simultaneously occuring factors. As attained height is known to be reflective of the early-life health and nutrition environment, positive correlations between adult height and earnings may reflect parental investment, early-life events, or family background characteristics. Similarly, shared inputs between the height, cognitive, and health production functions may drive a relationship between physical and intellectual capacity. Finally, as the value of different traits may vary over time and differ depending on the sector and nature of work chosen by an individual, so too may the links between height, earnings, and additional human capital markers.

To empirically examine these complex relationships in the labor market requires rich, longitudinal data on sectoral and occupational choice, formal and informal earnings, and accurate measures of a wide array of human capital markers.

3. The Work and Iron Status Evaluation

The Work and Iron Status Evaluation (WISE), a large-scale longitudinal survey conducted in Central Java, Indonesia, is designed to collect detailed labor and human capital data necessary to examine the relationship between height, cognition, education, health, and labor market outcomes. After a listing survey in late 2001, a population-representative sample of households living in Purworejo kabupaten was interviewed every four months beginning in 2002 and continuing through 2005. Longer-term follow-ups were conducted five and seven years after the start of the survey in 2007 and 2009. All twelve waves of the survey are included in this study.

As the analysis relies on following individuals over time, it is imperative that selective attrition does not contaminate inferences. Attrition is extremely low in WISE: ninety-four percent of households from the 2002 baseline were re-interviewed seven years later in the 2009 wave (see Thomas et al. (2011) for a further discussion of tracking and attrition).

We focus on approximately 5,300 men between the ages of 25 and 65, comprising 38,000 person-wave observations.[2] The number of men included in each wave grows over time by the design of the tracking rule. As each individual interviewed at baseline is eligible to be followed and interviewed throughout the study, when an individual moves out of an original WISE household and forms a new household, all of the new household members become part of the study sample thereafter.

Labor market outcomes

Labor market outcomes remain the central dependent variables of interest throughout this paper. The WISE survey collects detailed information from every household member who was working on work status, employer and occupation, tenure, nature of work (tasks), and earnings in each job. The later is particularly important in the study setting where approximately three quarters of baseline

[2] See Appendix A for a discussion of selection into the sample of those who report earnings and for comparable results for females to those presented in later sections for males. We focus here on the 93 percent of 25-65 year old men who report earnings data in the survey. Selection into this group does not appear to drive the results.

households engage in farming and work at least part of the time in self-employment. Hourly earnings from wage work are calculated as total earnings from work in the market sector during the previous four months divided by hours worked during the same time period. Similarly, hourly earnings from self-employment are calculated as net profits from self-employment during the prior four months divided by the number of hours worked during that time. We select a four-month period to coincide with a single rice growing cycle, the primary crop in the area.[3] Total hourly earnings is the sum of earnings from all job divided by the number of hours worked in all jobs during the previous four months.

Table 1 reports means and standard errors for variables of interest. The first rows of Table 1 summarize total hourly earnings, hourly earnings from wage work, and hourly earnings from self-employment. All values are reported in Rp10,000 per hour (approximately 1 USD at the time of the survey). While Column 1 includes all workers, columns 2 through 4 divide the observations based on formal or informal self-employment, as distinctions across sectors is an important component of the analysis. Individuals who only ever work in the formal sector are included in Column 2, those who only ever work in self-employment are in Column 3, and those who we observe working in both sectors at some time during the study period are included in Column 4. The latter make up over half of the respondents, and offer unique opportunities to observe the same individual either simultaneously in formal and informal work or switching between the two over time. As farm plots are small and less than a half an acre on average, it is common for individuals to supplement self-employed farm earnings with off-farm labor.

Height

In addition to detailed information about labor market behaviors, the accurate measurement of height is central for this research. Although adult stature is fixed until older ages when individuals begin to shrink, we measured height in every survey wave to ensure we are able to mitigate problems

[3] We find that self-reported profits for the prior four months matches very closely to profits calculated from information collected at the business enterprise level on revenues and expenditure.

that may arise with measurement error. We define attained height as the mean of all adult height measurements for those who are in four or fewer waves of the survey. For those individuals who have height measured five or more times, approximately 74.6 percent of the sample used in this paper, we calculate attained height as the mean of the remaining values after removing the highest and lowest measures.[4] While the sample mean is 161cm, those who only work for wages are slightly taller than those who are self-employed or work in both sectors, suggesting height may be correlated with sectoral choice.

Measures of cognition

WISE assesses cognitive achievement using four different instruments. Each assessment was repeated to mitigate the impact of measurement error and is designed to measure a different axis of cognition.

The first is the Raven's Colored Progressive Matrices pattern recognition test. These matrices were administered three times to individuals over the age of 15. The pattern recognition test is commonly used as a marker of abstract reasoning and intelligence (Raven, 2000), and has been increasingly adopted in household surveys in developing settings (e.g. Barham et al., 2013).

Along with the Raven's Test, WISE included an adaptation of the Philippines National Intelligence Test developed by Guthrie et al. (1977). The test is similar to the Columbia Mental Maturity Scale, and originally designed to assess fluid intelligence in an area similar to the WISE study site. As such, it uses images of local objects and activities of daily life and is more reflective of experience, logical thinking, and the ability to recognize real world patterns than the abstract Raven's matrices. Respondents are shown a series of 5 images per question and asked to discriminate between the differences. See Figure 1 for a sample question. While several population-based surveys

[4] Using alternative approaches to calculating an accurate height value such as the median of an individual's measurements or using an un-trimmed mean does not significantly impact the results. Compared to the sample mean of 161.63cm for the method reported here, the sample mean for the median approach is 161.67cm and 161.66cm using the untrimmed person-mean. Neither measure is statistically different from the approach included here.

have included the Raven's assessments, a smaller number have sought to measure fluid intelligence.[5] The combination of both assessments is an important advantage of the WISE data.

The assessment of immediate and delayed memory is done through the use of word recall tests. Respondents are read a list of 10 common nouns and asked to immediately repeat back those that they remember in any order. The survey then continues with questions on physical and mental health conditions before the respondent is asked to repeat the same words back after approximately five minutes. Similar questions are administered in the Health and Retirement Survey and other HRS-style surveys (see Shih et al., 2011). Unlike other work that averages the two recall scores into a single memory measure (e.g. McArdle et al., 2011; Lei et al., 2012), we choose to examine immediate and delayed memory independently to allow for differential effects of the two markers.

Table 1 reports the within-person means for the four different markers and reveals noticeable differences based on the sector of employment.[6] In each case, the mean value is highest among those who specialize in formal market work and lowest among those who are only ever self-employed. As the unit of measurement of each test is not directly meaningful, all of the values are standardized to z-scores using the sample mean and standard deviation for the regressions that follow.

Additional health assessments

In addition to measures of the attained height of individuals, the survey includes several health markers that are potentially related to labor market outcomes. First, body mass index (BMI), weight (in kg) divided by height (in m) squared, is a second indicator of nutritional status that, unlike height, varies throughout the life course. While extreme values of BMI are predictive of mortality and morbidity, very few respondents in the sample are overweight or obese, implying low BMI is

[5] A similar version is included in the Cebu Longitudinal Health and Nutrition Survey (see Mendez and Adair, 1999; Glewwe and King, 2001; Daniels and Adair, 2005).

[6] Using the individual-specific mean over each time an individual takes the cognitive test aids in controlling for possible measurement error in a single test. Alternative cognition specifications such as the score from the first time an individual takes the test or their maximum score produce results consistent with the approach reported here.

predictive of poor health. Given the ranges observed in these data, higher BMI can be linked with elevated VO_2 max and work capacity and is likely to be associated with strength.

Resting blood pressure is also measured for each respondent. As in many other developing settings, there are high levels of undiagnosed hypertension in the study site. We capture this pattern by including both systolic blood pressure and the difference between systolic and diastolic blood pressure, pulse pressure, in the regression models. Whereas systolic blood pressure is indicative of the maximum pressure on the arteries, pulse pressure measures the pressure change that creates the pulse and is predictive of cardiovascular disease as an indicator of the hardening of artery walls (e.g. Blacher et al., 2000; Franklin et al., 1999; Mattance-Raso et al., 2004; Panagiotakos et al., 2005). Pulse pressures above 60 mmHg are considered elevated (Safar et al., 1987), while the mean in our sample is 46 mmHg.

Each respondent also provides information on a battery of self-assessed Activities of Daily Living (ADLs), and we focus on whether the respondent has difficulty running 1000m to capture an additional assessment of physical function. Given the rich longitudinal data on labor market outcomes, cognition, and health, we move to document the associations that exist between the multiple axes of human capital and earnings.

4. Descriptive Analysis

As WISE is unique in its collection of this specific set of cognition measures, it is first useful to describe the relationships between the different markers to emphasize that each captures a unique element of cognition. Panel A of Table 2 reports results from regressions of standardized Raven's scores on the other three test scores for the entire sample of 25-65 year olds, and separately for men and women to show the patterns are consistent across gender. Raven's is chosen as the dependent

variable as it is the most commonly used cognitive test of the four we consider.[7]

Each score is predictive of improvements in Raven's scores, with one standard deviation increases in fluid intelligence, immediate, and delayed word recall predictive of improvements in Raven's scores. Moreover, each score is independently predictive conditional on the others, highlighting the ability of the data to measure different components of cognition. While the scores are highly correlated with each other, each adds a particular element to the analysis.

Height is also positively related to each of the cognitive test scores. Panel B of Table 2 reports regression results from standardized test scores on the natural log of height for each of the tests. In all cases, increasing height is related to increasing test scores, with magnitudes between a 0.04 and 0.06 standard deviation increase for a 1 percent increase in height.

Figure 2 displays similar nonparametric regressions of test scores on height, showing that the positive relationship between height and cognition is largely consistent over the entire height distribution and for each cognition measure.

5. Human Capital and Earnings

We turn next to documenting the associations between height, cognition, education, health, and earnings using the following model for individual *i* in wave *t*:

$$\ln(earn_{it}) = \beta_0 + \beta_1 height_i + \beta_2 cog_i + \beta_3 X_{it} + \beta_4 \theta_{it} + \eta_t + \varepsilon_{it} \quad (1)$$

where $earn_{it}$ is the hourly earning rate caluclated over the previous four months, $height_i$ is the log of attained height of individual *i*, and cog_i are the within-person mean values of the four cognitive test scores standardized within the sample. Additional control variables include indicators for five year age brackets to flexibly control for age, and attained years of education. Health, θ_{it}, includes the log

[7] In this and future regression models, approximately ten percent of the sample do not have recorded values for the fluid intelligence and word recall tests. This is primarily a function of the tests not being included in the last two waves of the survey in 2007 and 2009. The missing values are replaced with the sample mean and noted by an indicator in the regressions. Results limiting the sample to those with no missing cognition scores are consistent with those reported here.

of BMI, an indicator for difficulty running 1km from the ADL module, and blood pressure measures. Wave fixed effects, η_t, are included to capture common aggregate conditions including seasonality and prices in the survey area. All standard errors throughout allow for clustering at the person level.

Table 3 reports results from equation (1) using the entire pooled sample to examine how different markers of human capital are related to log earnings. Columns 1 through 5 focus on hourly earnings, the combination of wages and self-employed net profits, and columns 6 and 7 consider formal and informal employment in turn.

We begin by establishing that associations between height, cognition, and earnings exist in the sample. Conditional on age and time effects, Column 1 illustrated that taller individuals earn considerably more, as a 1 percent increase in height relates to a 3.6 percent increase in hourly earnings.

Column 2 documents returns to cognition independent of height. One standard deviation increases in tests scores are related to 16 percent higher earnings for the Raven's and fluid intelligence tests. Returns to memory are also quite high at approximately 12 percent and 5 percent for immediate and delayed recall. The return to the individual cognitive assessments emphasizes the valued added of separately considering each of the four measures.

The positive associations of height and cognition with earnings are consistent with past work in the field, however it remains a question whether the findings are due solely to the correlation *between* height and cognition. Column 3 addresses this hypothesis by documenting that the returns to height and cognition simultaneously exist in a unified model. Conditional on cognitive scores, a 1 percent increase in height is related to a 2.3 percent increase in hourly earnings. This is a substantial reduction from the 3.6 percent estimate in Column 1 reflecting that height and cognition are positively related.[8] However, the return to height is still quite large and statistically significant,

[8] The difference between the two estimates is statistically significant (p-value of 0.00001).

suggesting that there is more to height than only a marker for cognition.

In contrast, coefficients on the cognition measures remain remarkably similar when controlling for height. Although Raven's and fluid intelligence scores decrease marginally, the word recall coefficients are statistically indistinguishable between the models that include height. While height is more than just cognition, clearly cognition is more than just height.

Column 4 adds years of attained education to the model, as attained education is likely closely related to cognition.[9] An additional year of education is related to a 8.3 percent increase in hourly earnings. Including education diminishes the returns to both height and cognition, but does not sweep either away, with the exception of delayed word recall which is no longer distinguishable from immediate word recall. The results clearly point to returns to height and cognition on top of education. Cognition may be measuring on the job skills or life experiences accumulated since completing education. These traits may be particularly valuable in the self-employed sector.

Thus far the results establish that there are returns to height, cognition, and education that exist independently of each other. In line with the "Brain vs. Brawn" literature (e.g. Pitt et al., 2012), it is also possible that health may play a major role in this setting and that height or cognition is simply reflecting improved heealth. While acknowledging the potential that health and earnings may be simulatanerously determined, Column 5 includes measures of health in the regression models. The estimated BMI elasticity of 1.02 suggests positive returns to increasing BMI, evidence that strength and work capacity is valued. Similarly, those reporting ADL difficulties are limited in their returns. The positive return to systolic blood pressure (SBP) of a 2.5 percent increase in earnings for a 10 mmHg increase in SBP may be due to high wage workers who have both sedentary jobs and can afford diets higher in animal fats. Consistent with the literature documenting negative effects of elevated pulse pressure, increasing pulse pressure by 10 mmHg is associated with a 4.5 percent reduction in earnings.

[9] Specifying a more flexible form for education to allow for nonlinearities produces results consistent with those shown here.

The results in Column 5 shed new light on the relationship between height, cognition and multiple measures of human capital. The estimates not only suggest that health markers have intuitive returns in our earnings models, but that they do not substantially influence the associations established in Column 4. Of the six height, cognition, and education coefficients in columns 4 and 5, only the return to education is statistically different between the two models at the 5 percent level (*p*-value 0.0001).

While illustratative, interpreting these results is a challenge given that they include both formal wage work and self-employed net profits combined to calculate hourly earnings. Columns 6 and 7 begin to illuminate sectoral differentiation by repeating the analysis in Column 5, but limited to only wage earnings in 6 and self-employed net profits in 7.[10] Comparing across the columns, the premium to height exists in both sectors although it is larger for self-employment. Returns to cognition also persist, although the return to fluid intellgence is restricted to the informal sector providing further evidence that the additional tests measure different axes of cognition than the traditional Raven's measure. Specific skill sets and experiences may translate to the fluid intelligence test and are valuable while operating one's own farm or small business. The health returns are also reflective of slight sectoral differences with BMI more highly valued in self-employment.

Sectoral Choice

However, one should acknowledge that individuals may choose in which sector to work. Table 3 abstracts from this choice, which we analyze in Table 4. As in the summary statistics, we divide the sample into three distinct groups: those who only ever work in wage work (19 percent of the sample), those who only ever work as self-employed (27 percent), and those who do both (54

[10] By maintaining the log of self-employed profits, these results exclude observations that report negative net profits over the past four months. These negative values appear to be driven almost exclusively by seasonality and the timing of the crop cycle. Alternative transformations to earnings preserving these negative values such as square or quartic roots are consistent with those shown here and suggest that restricting to non-negative profits is not driving the results. Logs are maintained for comparability and ease of interpretation.

percent). A particular advantage of the longitudinal structure of the data is that we observe many of the respondents working in different sectors at different times throughout the study period, with a number of individuals working in both sectors at the same time. This variation contributes substantially to identifying the differential effect of height and cognition on labor market performance in each sector.

Columns 1 and 2 of Table 4 examine characteristics associated with individuals in each of the three groups. The reported coefficients are odds-ratios from a multinomial logit model with the "both" sector group as the base category.[11] The patterns in columns 1 and 2 reveal clear sorting behavior within the sample. Focusing on the comparison of those who are only wage workers relative to both wage and self-employed, the samples are comparable on cognition, but not on education, as an increase in education is related to an increasing odds of working only in formal sector employment. This may be reflective of the signaling value in education, or that those with higher education levels are more apt at securing formal jobs. In comparison, those who are only in the profit sector appear worse on three of the four cognition scores, as higher scores are related to decreases in the odds of being only in the self-employed sector, with the exception of long-term memory. Long-term memory may be highly valued in self-employment when one is both the manager and employee. The results suggest certain skills lead to selection into different markets – in particular, attained education for wage work, and memory for self-employment.

Columns 3 through 5 return to documenting the sector-specific returns to height and cognition, limited to only those who work within a specific sector. Column 3 examines individuals who work only for formal wages, where a return to height persists but is now only significant at the 10 percent level. Abstract reasoning captured by Raven's scores remains the only significant cognitive measure, while years of education show a strong return. This appears to be a highly selected group in formal wage jobs such as government positions that require high levels of

[11] Tests of the independence of irrelevant alternatives based on Hausman and McFadden (1984) fail to reject the null for both outcomes.

education to obtain. Those who only work in self-employment, Column 4, see a smaller return to education, but strong returns to height, abstract cognition, and also fluid intelligence and memory.

The 54 percent of individuals who work in both sectors offers the opportunity to estimate how traits are differentially valued across formal and informal markets. Column 6 reports results from an extension of equation (1) that includes individual fixed effects to sweep out time invariant unobserved and observed characteristics of an individual. While this makes it infeasible to identify the average effect of attained height or the person-mean cognitive scores which do not vary over time, the *difference* of how height and cognition impact earnings in the two sectors is identified by examining earnings when working in the wage sector versus self-employment. Each of the reported coefficients in Column 6 comes from an interaction of the characteristic with an indicator for self-employment, with positive values indicative of the variable having a higher return in the self-employed sector. This is a novel strategy, as the results rely on detailed data on both formal and informal earnings as well as observing the same individual shift between the two sectors over time.

While there is no difference in the return to height or abstract cognition between the two sectors, increased fluid intelligence and memory have *higher* returns in self-employment for a given individual. This is consistent with the notion that specific entrepreneurial skill sets may be more highly valued in self-employment.

Occupational Choice

Given evidence on sorting into sectors, it is important to acknowledge that individuals may choose their occupations as well. Recent evidence from Mexico notes that occupational choice may play a key role in defining the relationship between height, cognition, and earnings if individuals who are taller and have higher cognitive scores select into occupations with higher wages (Vogl, 2012).

WISE records detailed descriptions of each individual's tasks that we use to classify jobs into specific sets of occupations. Following the literature's discussion of "Brain vs. Brawn," we first

examine whether certain characteristics are associated with selecting into strength-oriented occupations defined as agriculture or production work such as masonry or manual transportation operation where approximately 65 percent of the sample works. Column 7 of Table 4 reports coefficients from a linear probability model with an indicator for working in a strength occupation as the dependent variable. Those who are taller, more educated, and score higher on Raven's exams are less likely to work in strength-oriented positions. It remains a question whether occupational choice can explain a substantial part of the height and cognition premiums.

Columns 8 through 10 of Table 4 show that this is not the case by including eleven occupation category fixed effects in equation (1) to isolate variation within those who work in a specific occupation.[12] Throughout all specifications, the narrative remains consistent, and we are not able to sweep away the returns to height, cognition, education, or health. While occupational choice may play a role, it is not enough to account for the returns for the various human capital measures.

Family Background

To this point the results suggest height, cognition, education, and health are related to earnings in a complex multi-dimensional manner, with not one single hypothesis on the source of the height premium shining through. It remains a possibility that the relationships shown in Tables 3 and 4 are simply reflective of family background variables, and that failure to control family background when examining human capital and labor market performance substantially complicates interpretation of the relationships between height, cognition, and earnings. To overcome this obstacle, we limit the sample to those individuals whose parents we can identify in the WISE sample and include a set of direct measures of the human capital of the individual's parents as well as exploit within-family variation.

As a preliminary step, Column 1 of Table 5 directly controls for parental height and

[12] Columns 2 through 4 of Appendix Table A1 repeat this analysis excluding health variables showing the results are not driven by the potential joint determination of occupation and health.

education. The results suggest that family characteristics as captured by these two markers do not explain away the human capital premiums established earlier, and that only maternal education is positively related to earnings out of the set of included traits. This is particuarly interesting for the inclusion of parental height and the height premium, as height is partially reflective of one's genetic background.

A complementary strategy is to examine collections of siblings who share both genetic and environmental background. For our analysis, we isloate siblings with the use of mother fixed effects. Under this strategy, identification comes from comparing children of the same mother to control for common genetic and environmental components. Examining returns to height, cognition, education and health in this way is a novel approach as it relies on the extensive longitudinal data and tracking rule that follows siblings as they split-off from their primary residences.

The results in Column 2 show that even after sweeping away shared family background characteristics, a relationship between height and earnings remains, as well as returns to cognition, education, and health. As height is largely determined by a young age, this may reflect variation in the environment for children born at different time periods, or differential parental investments. Similarly, changing experiences between siblings may drive differences in cognition and education which relate to differences in earnings. Even when controlling for family background, both observed and unobserved, the data still show a clear relationship between multiple dimensions of human capital and labor market performance.

6. Discussion

Our results suggest a rich interpretation of how multiple markers of human capital relate to labor market returns. Ongoing work looks to delve deeper into these patterns, exploring the dynamics and potential endogeneity of our markers of human capital, as well as novel measures of non-cognitive skills and preferences included in the WISE study. As they stand, the results contribute to literatures

aiming to understand labor marker performance in a low-income setting and policies designed at improving these returns.

We show the claim that height is only a marker of cognition, education, health, or family background are unfounded in this sample. Returns to height persist across models incorporating sectoral choice, occupation, and family background. Taller individuals maintain an earnings premium, suggesting height is a valued and distinct measure of human capital.

The claim that cognition can be captured by height is also unfounded. Moreover, we document the importance of considering a broad array of cognitive measures, as different aspects of cognition are valued differently in certain sectors and markets. Incorporating these different axes of cognition helps in understanding sorting patterns across sectors. Those individuals who are particularly strong on fluid intelligence and memory may do particularly well running their own businesses.

We also do not find that sorting across employment sectors or occupations drives the relationship between height, cognition, and earnings. While different markers of human capital are certainly related to working in a specific sector or occupation, returns within these occupations are still influenced by human capital.

Height, cognition, education and health are related markers of human capital. However, one dimension does not completely capture the other components. Understanding the combined relationships provides evidence on the complex inter-linkages between multiple dimensions of human capital and labor market performance.

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Appendix

Selection into the Sample

The results in the body of the paper utilize a sample of men between the ages of 25-65 who ever report earnings during the study period. This is 93 percent of all 25-65 year old men. Column 1 of Appendix Table A1 compares this sample to the seven percent of individuals who do not report earnings using a linear probability model.

The results suggest there are slight differences in terms of Raven's scores and years of education for those who are omitted from the analysis. Physical limitation is also predictive of not reporting earnings.

Ongoing work looks to examine the sensitivity of our analysis to examining only the subset of wage and self-employed earners. Results from Table A1 suggest that selection into the sample is not a driving force behind our findings.

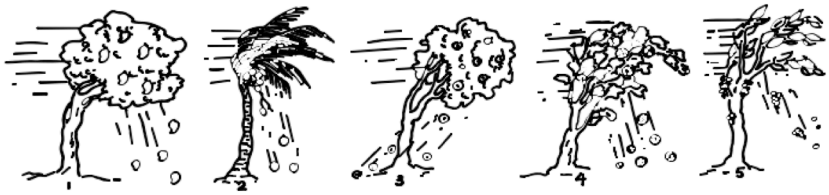
Human Capital and Labor Market Returns for Women

The design of WISE, and the detailed earnings measures for those who are self-employed in particular, makes it an ideal dataset to examine the relationship between labor market returns and markers of human capital for women. Work in progress examines these returns, acknowledging the potential endogeneity of labor force participation.

Table A2 repeats the baseline earnings analysis shown for men in Table 3. Results show strong returns for height and abstract and fluid intelligence across specifications. Word recall scores are insignificant once controlling for education. Perhaps the most striking difference is for self-employed earnings, which show no return to cognition in the parsimonious model in Column 7. These patterns are indicative of the importance of continuing to examine the returns to human capital for women.

Figures

Figure 1: Sample Fluid Intelligence Question.



Respondents are asked to pick which one of the pictures does not belong.
(No. 3 is the correct choice)

Figure 2: Nonparametric Relationship between Cognitive Assessments and Height

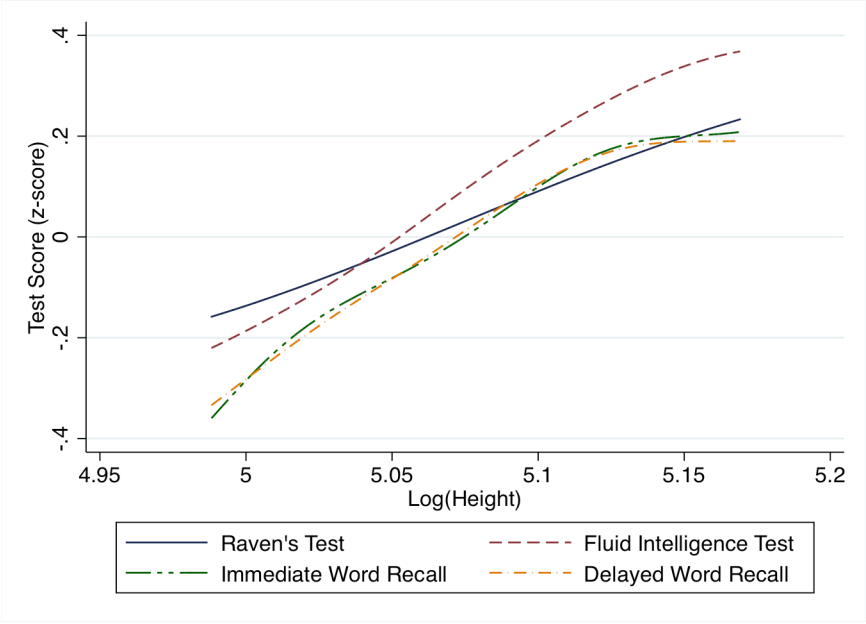


Table 1: Summary Statistics

		Individual Works in […]		
	All	**Wage Sector Only**	**Self-employed Sector Only**	**Both Sectors**
	(1)	**(2)**	**(3)**	**(4)**
Hourly earnings (Rp0,000)				
All work	0.35	0.50	0.40	0.29
	(0.03)	(0.02)	(0.10)	(0.01)
From work in wage sector	0.40	0.50		0.37
	(0.03)	(0.02)		(0.03)
From self-employment	0.44		0.40	0.48
	(0.05)		(0.10)	(0.06)
Height (cm)	161.63	163.70	160.59	161.47
	(0.09)	(0.21)	(0.17)	(0.12)
Raven's Test (%)	53.56	65.28	46.52	52.99
	(0.36)	(0.87)	(0.69)	(0.46)
Fluid Intelligence (%)	61.26	68.53	55.04	61.98
	(0.34)	(0.90)	(0.66)	(0.42)
Word Recall - Immediate	4.62	5.26	4.26	4.62
(out of 10)	(0.02)	(0.05)	(0.04)	(0.03)
Word Recall - Delayed	3.56	4.27	3.20	3.53
(out of 10)	(0.02)	(0.06)	(0.04)	(0.03)
Age	41.36	31.93	48.17	41.26
	(0.17)	(0.30)	(0.35)	(0.21)
Years of Education	8.25	10.63	7.23	7.93
	(0.06)	(0.12)	(0.11)	(0.08)
Body Mass Index	20.87	20.99	20.68	20.92
	(0.04)	(0.09)	(0.08)	(0.05)
Difficulty Running 1km (%)	16.89	9.00	26.80	14.71
	(0.51)	(0.91)	(1.17)	(0.66)
Systolic Bp (mm Hg)	125.18	123.59	127.88	124.36
	(0.25)	(0.51)	(0.55)	(0.33)
Pulse Pressure (mm Hg)	46.91	45.22	49.04	46.40
	(0.18)	(0.40)	(0.39)	(0.24)
N. Individual-Wave Obs.	38,430	4,521	8,576	34,274
N. Individuals	5304	1000	1429	2875

Table 2

Panel A: Relationship Between Cognition Measures
Dep. Var: Raven's Score

	Sample		
	All	**Male**	**Female**
	(1)	**(2)**	**(3)**
Fluid Intell. Score	0.477***	0.480***	0.469***
	(0.010)	(0.014)	(0.015)
Immediate Word Recall	0.154***	0.124***	0.195***
	(0.013)	(0.018)	(0.020)
Delayed Word Recall	0.109***	0.123***	0.091***
	(0.013)	(0.018)	(0.019)
N. Individuals	9,857	5,304	4,553
R-squared	0.393	0.367	0.425

Panel B: Height and Cognition

	Dependent Variable			
	Raven's Test	**Fluid Intelligence**	**Immediate Recall**	**Delayed Recall**
	(1)	**(2)**	**(3)**	**(4)**
Log Height	6.175***	5.890***	5.183***	4.744***
	(0.339)	(0.351)	(0.393)	(0.392)
N. Individuals	5,304	4,824	4,674	4,674
R-squared	0.060	0.068	0.043	0.035

Cognitive scores measured as z-scores standardized by the sample mean and standard deviation. Standard errors in parentheses robust to arbitrary forms of heteroskedasticity.
*** p<0.01, ** p<0.05, * p<0.1

Table 3 - Returns to Human Capital

	Dependent Variable: Log of Hourly […]						
			Earnings			**Wages**	**Profits**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Log Height	3.636***		2.354***	1.874***	1.942***	1.554***	2.239***
	(0.345)		(0.324)	(0.304)	(0.299)	(0.285)	(0.385)
Raven's Score		0.166***	0.160***	0.077***	0.073***	0.056***	0.058***
		(0.017)	(0.017)	(0.015)	(0.015)	(0.015)	(0.020)
Fluid Intelligence Score		0.164***	0.156***	0.056***	0.049***	0.008	0.082***
		(0.017)	(0.017)	(0.016)	(0.016)	(0.016)	(0.021)
Immediate Recall		0.127***	0.124***	0.052***	0.045**	0.038**	0.049**
		(0.021)	(0.021)	(0.019)	(0.019)	(0.020)	(0.025)
Delayed Recall		0.045**	0.045**	0.028	0.026	0.016	0.023
		(0.020)	(0.020)	(0.018)	(0.018)	(0.019)	(0.024)
Years of Education				0.083***	0.075***	0.070***	0.057***
				(0.003)	(0.003)	(0.003)	(0.004)
Log BMI					1.016***	0.791***	1.128***
					(0.096)	(0.101)	(0.124)
I(Running 1km Difficult)					-0.049**	-0.035	-0.022
					(0.024)	(0.026)	(0.028)
Systolic Bp					0.025***	0.024***	0.011
					(0.009)	(0.009)	(0.011)
Pulse Pressure					-0.045***	-0.043***	-0.021
					(0.011)	(0.010)	(0.014)
Age Controls	y	y	y	y	y	y	y
Wave FE	y	y	y	y	y	y	y
Observations	38,430	38,430	38,430	38,430	38,430	21,119	26,190

Cognitive scores measured as z-scores standardized by the sample mean and standard deviation. Standard errors in parentheses clustered at the individual level. See text for additional notes. *** p<0.01, ** p<0.05, * p<0.1

Table 4 - Sectoral and Occupational Choice

	Sectoral Choice						Occupational Choice			
	Multinomial Logit OR Base Category: Both		Returns to Human Capital							
			Pooled			Individual FE	LPM	Returns to Human Capital		
	Only Formal	Only Informal	Only Formal	Only Informal	Both	Both	Strength Occupation	Earnings	Wages	Profits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log Height	1.017**	1.012**	1.023*	2.290***	1.875***	0.331	-0.528***	1.730***	1.494***	1.961***
	(0.008)	(0.006)	(0.590)	(0.732)	(0.312)	(0.539)	(0.159)	(0.276)	(0.267)	(0.364)
Raven's Score	1.059	0.909*	0.067**	0.108***	0.042**	-0.002	-0.016**	0.057***	0.053***	0.052***
	(0.059)	(0.044)	(0.030)	(0.036)	(0.017)	(0.030)	(0.008)	(0.014)	(0.014)	(0.019)
Fluid Intelligence Score	0.964	0.924	0.019	0.067*	0.056***	0.105***	0.003	0.050***	0.009	0.081***
	(0.060)	(0.050)	(0.030)	(0.040)	(0.017)	(0.030)	(0.008)	(0.015)	(0.015)	(0.020)
Immediate Recall	1.014	0.894*	0.046	-0.037	0.069***	0.077**	-0.013	0.029*	0.030	0.032
	(0.078)	(0.056)	(0.035)	(0.043)	(0.021)	(0.036)	(0.009)	(0.018)	(0.018)	(0.024)
Delayed Recall	1.117	1.125*	0.019	0.090**	0.001	-0.030	-0.017*	0.019	0.013	0.018
	(0.080)	(0.070)	(0.037)	(0.046)	(0.019)	(0.034)	(0.009)	(0.017)	(0.018)	(0.022)
Years of Education	1.122***	1.023**	0.084***	0.056***	0.061***	0.009	-0.036***	0.047***	0.045***	0.039***
	(0.015)	(0.011)	(0.006)	(0.008)	(0.004)	(0.006)	(0.002)	(0.003)	(0.003)	(0.004)
Log BMI	0.624	1.191	0.564***	1.115***	0.982***	0.344*	-0.405***	0.758***	0.638***	0.853***
	(0.228)	(0.362)	(0.202)	(0.201)	(0.112)	(0.200)	(0.047)	(0.090)	(0.098)	(0.118)
I(Running 1km Difficult)	1.297*	1.206**	0.063	-0.047	-0.041	0.030	-0.024**	-0.063***	-0.053**	-0.038
	(0.186)	(0.112)	(0.054)	(0.046)	(0.026)	(0.035)	(0.010)	(0.023)	(0.024)	(0.028)
Systolic Bp	1.017***	1.002	-0.005	0.009	0.018*	-0.005	-0.016***	0.010	0.015*	0.002
	(0.004)	(0.003)	(0.017)	(0.018)	(0.009)	(0.014)	(0.004)	(0.008)	(0.008)	(0.010)
Pulse Pressure	0.987**	0.992*	-0.011	-0.024	-0.032***	0.004	0.033***	-0.018*	-0.029***	-0.001
	(0.005)	(0.005)	(0.020)	(0.025)	(0.011)	(0.017)	(0.005)	(0.010)	(0.010)	(0.014)
I(Informal Sector)					-0.377***	-2.893				
					(0.019)	(2.870)				
Wave FE			y	y	y	y	y	y	y	y
Occupation FE								y	y	y
Observations	5304	5304	4381	8482	38430	34508	37245	38430	38430	38430

All columns include flexible age controls, with robust standard errors in parenthese. These are clustered at the person level in Columns 3 through 10. Columns 1 and 2 report odds-ratios from a multinomial logit model examining sector choice. Columns 3 through 5 are pooled earnings regressions as in Table 3. Column 6 reports coefficients from models including individual FE. Coefficients are from interactions of the variable with an indicator for working in the informal sector. Column 7 is a linear probability model for choosing a strength oriented occupation, and columsn 8 through 10 include occupation fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table 5 - Family Background

	Pooled Earnings (1)	Mother Fixed Effects (2)
Log Height	1.813***	1.190*
	(0.546)	(0.716)
Raven's Score	0.058**	0.114**
	(0.023)	(0.048)
Fluid Intelligence Score	0.046*	-0.010
	(0.024)	(0.062)
Immediate Recall	0.029	0.001
	(0.029)	(0.053)
Delayed Recall	0.049*	0.051
	(0.029)	(0.069)
Years of Education	0.058***	0.019**
	(0.005)	(0.008)
Log BMI	0.509***	0.469
	(0.150)	(0.417)
I(Running 1km Difficult)	0.066	0.109***
	(0.044)	(0.041)
Systolic Bp	0.013	0.022*
	(0.015)	(0.013)
Pulse Pressure	-0.035**	-0.049***
	(0.016)	(0.013)
Parental Characteristics		
Mother's Height	0.365	
	(0.594)	
Father's Height	-0.187	
	(0.652)	
Mother's Years of Education	0.017**	
	(0.007)	
Father's Years of Education	0.009	
	(0.007)	
Age Controls	y	y
Wave FE	y	y
Observations	11,789	11,789
R-squared	0.189	0.094
Number of Mother FE		1,653

Sample is limited to those men 25-65 whom we can identify their parents.
Standard errors clustered at the sibling level. *** p<0.01, ** p<0.05, * p<0.1

Table A1 - Selection and Occupational Choice Excluding Health

	Selection Into the Sample No Earnings Data	Occupational Choice and Returns to Human Capital Excluding Health		
	(1)	Earnings (2)	Wages (3)	Net Profits (4)
Log Height	-0.022	1.681***	1.428***	1.897***
	(0.087)	(0.277)	(0.266)	(0.366)
Raven's Score	-0.027***	0.058***	0.053***	0.055***
	(0.005)	(0.014)	(0.014)	(0.019)
Fluid Intelligence Score	-0.009*	0.055***	0.013	0.085***
	(0.005)	(0.015)	(0.015)	(0.020)
Immediate Recall	-0.004	0.034*	0.036*	0.035
	(0.005)	(0.018)	(0.019)	(0.024)
Delayed Recall	-0.002	0.020	0.013	0.017
	(0.005)	(0.017)	(0.018)	(0.023)
Years of Education	0.005***	0.051***	0.047***	0.043***
	(0.001)	(0.003)	(0.003)	(0.004)
Log BMI	-0.045			
	(0.030)			
I(Running 1km Difficult)	0.043***			
	(0.010)			
Systolic Bp	0.000			
	(0.003)			
Pulse Pressure	0.007			
	(0.004)			
Occupation FE		Y	Y	Y
Observations	5,741	38,430	21,119	26,190
R-squared	0.218	0.228	0.300	0.159

S.E. clustered at the individual level in Col. 2-4. *** p<0.01, ** p<0.05, * p<0.1

Table A2 - Returns to Human Capital for Women

	Dependent Variable: Log of Hourly […]						
	Earnings					**Wages**	**Profits**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Log Height	3.600***		2.494***	2.117***	2.062***	1.983***	1.705***
	(0.438)		(0.395)	(0.360)	(0.357)	(0.446)	(0.484)
Raven's Score		0.185***	0.181***	0.068***	0.063***	0.096***	0.029
		(0.022)	(0.022)	(0.020)	(0.020)	(0.023)	(0.029)
Fluid Intelligence Score		0.192***	0.189***	0.051**	0.048**	0.094***	0.003
		(0.023)	(0.022)	(0.021)	(0.021)	(0.025)	(0.030)
Immediate Recall		0.034	0.024	-0.041	-0.049*	-0.036	-0.038
		(0.028)	(0.027)	(0.025)	(0.025)	(0.030)	(0.034)
Delayed Recall		0.076***	0.077***	0.031	0.029	0.037	0.007
		(0.026)	(0.026)	(0.024)	(0.023)	(0.028)	(0.032)
Years of Education				0.092***	0.090***	0.099***	0.062***
				(0.004)	(0.004)	(0.005)	(0.007)
Log BMI					0.611***	0.317***	-0.022
					(0.088)	(0.106)	(0.026)
I(Running 1km Difficult)					-0.020	-0.004	-0.096
					(0.018)	(0.023)	(0.126)
Systolic Bp					-0.126	-0.189	0.040
					(0.091)	(0.115)	(0.167)
Pulse Pressure					-0.023	-0.077	0.141
					(0.117)	(0.148)	(0.128)
Age Controls	y	y	y	y	y	y	y
Wave FE	y	y	y	y	y	y	y
Observations	28,838	28,838	28,838	28,838	28,838	15,812	15,455

Robust standard errors in parentheses. See table 3 for additional notes: *** p<0.01, ** p<0.05, * p<0.1