# THREE ESSAYS ON THE ECONOMICS OF CHILDHOOD DEVELOPMENT, HUMAN CAPITAL FORMATION AND PSYCHOSOCIAL WELL-BEING

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THREE ESSAYS ON THE ECONOMICS OF CHILDHOOD DEVELOPMENT, HUMAN CAPITAL FORMATION AND PSYCHOSOCIAL WELL-BEING

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Recently and emerging literature in economics highlights the importance of early childhood well-being and what are know as "noncognitive" skills to economic success. While growing evidence in links these skills to economic, behavioral and demographic outcomes in the developed countries, there is little such evidence linking these traits to economic outcomes in developing country contexts. Moreover, research in the economics literature generally estimates the effects of a general noncognitive aggregate rather than specific traits. In this dissertation I explore how various dimensions of human capital develop over childhood and how cognition and specific personality and noncognitive traits determine labor market outcomes.

Chapter 1 estimates how health, cognition and specific noncognitive abilities are jointly produced over the different stages of childhood in a developing country context. It estimates self- and cross-productivity effects across these different dimensions of child development and examines the role of parental inputs and home environment. The noncognitive abilities examined are risky behaviors, group socialization, positive affect and negative affect. Using a rich panel data set that follows a cohort of Filipino children from birth through adulthood, I estimate this production technology using the dynamic factor model developed in Cuhna and Heckman (2008). Findings show strong path dependency with current levels of child development largely dependent on previous levels causing early disparities in child development to persist throughout childhood into adult-

hood. Lagged health, in particular, is an important determinant of current health, cognition and socio-emotional well-being in this developing country context. Cognition and socio-emotional traits similarly exhibit both self- and cross-productivity. Findings imply that child development is cumulative in nature and that early disparities will persist until effective and early remediation is undertaken.

Chapter 2 estimates the effect of cognition and five specific personality traits on entrepreneurship and selection into different labor market segments for a sample of young adults in Madagascar. The personality traits examined are know as the Big Five Personality traits: Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism. Examining the effects of specific noncognitive traits will help to better compare results across studies and target policy. I find that both cognition and personality are significant predictors of labor market selection and entrepreneurial activities. Personality matters in determining labor market outcomes of interest and should therefore be considered when discussing and designing human capital targeted policies.

If the policy implications of the literature linking personality and outcomes are to be realized, then a better understanding of how these noncognitive traits are developed is needed. However, to date, the literature detailing how the Big Five Personality Traits are formed is much smaller. Chapter 3 explores the environmental and familial determinants of the Big Five Personality Traits. While I cannot directly control for genetics, we use information on maternal extended family to express a degree of genetic predisposition. I find that maternal background, extended family characteristics and other environmental determinants all interact and play a role in determining the five personality traits we examine.

**BIOGRAPHICAL SKETCH**

Kira was born in Austin, Texas in 1979 but grew up in the Chicagoland area. She graduated from Wheaton Warrenville High School in 1997 and University of WisconsinMadison in 2002 where she majored in International Relations with an area emphasis on Africa. In 2009, she received her Master's degree in Applied Economics and Management from Cornell University.

Generally, Kira is interested in the intersection of food, nutrition, health, and human development with poverty and economic development. More specifically, much of her research falls under two broad areas of interest. Firstly, she is interested in how inequalities develop early in childhood and persist into adulthood. To this end she is interested in exploring the mechanisms driving the link between early childhood well-being and a range of later life outcomes. Secondly, she is interested in understanding the many causes and consequences of health and nutritional status. Kira is especially interested in examining the role of parents and home environment in human development as well as investigating the link between maternal physical and mental health and child well-being.

Kira married Gary Villa in 2004 and they have two children together. Their first son, Aidan, was born in 2005 and their second son, Donovan, was born in 2013. They also have a dog, Olive, who is pretty darn fun.

This dissertation is dedicated to my husband. He supported me and carried me through this whole process. I do not know how anyone can do something like this without a partner like him standing behind them. Gary is my home and this is for him.

## ACKNOWLEDGEMENTS

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CHAPTER 1

# CHILD DEVELOPMENT AND THE JOINT PRODUCTION OF HEALTH, COGNITION AND NONCOGNITIVE ABILITY FOR A SAMPLE OF FILIPINO CHILDREN

## 1.1 Introduction

Across multiple disciplines including economics, nutrition, sociology and psychology, a large body of literature demonstrates that various childhood outcomes and experiences are important predictors of a broad range of later life outcomes including school attainment, occupation type, adult earnings and numerous other demographic, behavioral and economics outcomes (e.g., Alderman et al. (2006); Almond and Currie (2011); Barker (1998); Blau and Currie (2006); Dawson et al. (2000)). Studies in this literature find significant later life consequences resulting from numerous childhood outcomes and experiences including nutrition and health outcomes such as low birth weight and stunted growth, child home environments and early cognitive and emotional inputs such as preschool. Moreover, there is a rapidly growing body of evidence indicating that early life conditions can have an especially substantial and persistent impact on the development of individual health, cognition and what is sometimes referred to as noncognitive skills or ability.[1] Noncognitive skills include numerous personality traits and abilities relating to a person's socio-emotional well-being and psychosocial capacity. It can also include skills such as perseverance, self-control, time preference and concentration. A number of studies document that large ability gaps among children from various socioeconomic

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[1]See Almond and Currie (2011) for a food review of this literature

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groups emerge early and are persistent throughout life (Knudsen et al., 2006; Heckman, 2007).

The wide range of adult outcomes affected by multiple dimensions of early childhood well-being suggests that a child's development consists of a number of interrelated processes including physical development, cognitive development and socio-emotional development. However, many of these developmental processes have been studied individually rather than jointly. In doing so, this literature has made important contributions to our understanding of child development, the importance of childhood experiences throughout life and to how policymakers can positively impact human capital formation.

However, if interdependencies exist between the production of different developmental skills and traits, then there are likely gains to be had from taking a more comprehensive approach to modeling child development, where each of these processes are produced jointly within a system, rather than looking at them in isolation of each other. For example, a great deal of empirical work estimates the effects of a nutritional intervention on anthropometric indicators such as height-for-age and weight-for-height. However, if these interventions also affect nonphysical aspects of child development, such as cognitive or emotional well-being, then their importance might be undervalued by only considering their physical impact. Better knowledge of the potential synergies that exist between different elements of child development over different stages of childhood and how environment and parental investments influence this system can lead to better informed interventions targeting human capital development.

Understanding this system more fully would be particularly important in a developing country context where human capital growth is so essential to a country's overall

development and where barriers to healthy child development can still be substantial. Poverty is associated with many insults to child development including inadequate food, poor sanitation and hygiene all leading to increased infection and stunting rates. Poverty is also associated with poor maternal education, increased maternal stress and depression and inadequate stimulation in the home, which can further impede healthy child development (Grantham-McGregor et al., 2007). These risk factors frequently occur together resulting in cumulative deficits in child development staring in infancy and increasing with age (Grantham-McGregor et al., 2007; Evans and English, 2002). Grantham-McGregor et al. (2007) estimate that more than 200 million children under five fail to reach their developmental potential due to poverty, poor health and deficient care. The social, cultural and economic context of poverty exposes disadvantaged children to multiple and cumulating risks affecting children's development through brain structure, brain development, brain function and associated behaviors (Walker et al., 2008).

Only a handful of studies examine how different developmental processes occur jointly, and most of them look at samples from developed countries. In their pioneering works, Cuhna and Heckman (2008) and Cuhna et al. (2010) estimate the joint production of cognitive and noncognitive skills throughout childhood. Helmers and Patnam (2011) is the only study thus far that applies the framework developed in Cuhna and Heckman (2008) to a developing country context, estimating the joint production of cognitive and noncognitive skills for a sample of Indian children covering the ages 1 year to 5 years and 8 years to 12 years old. However, currently there is no study that estimates how health is produced jointly along with cognition and noncognitive ability. In developing countries especially, child health has been found to be an important determinant of human capital formation. Furthermore, health status exhibits much stronger variation in devel-

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oping countries than in developed ones. Child health in developing countries also tends to be particularly vulnerable to shocks and investment. There is therefore a strong case for including the production of health in a model of child development in developing countries.

With a few exceptions, the economics literature estimating the socio-emotional development of children estimates the formation of a general noncognitive aggregate. However, the term noncognitive is a large umbrella term that captures everything from specific task oriented skills such as concentration and self-discipline, to more general characteristics such as hardworking and trustworthiness, to overarching socio-emotional well-being. These various noncognitive skills and traits do not all necessarily correlate together. For example, an individual's emotional state tells us little about his organizational skills. These different noncognitive traits may also develop at different stages of childhood and be influenced by very different inputs. Different noncognitive skills are, thus, unlikely to covary in ways that warrant folding them into just one general noncognitive index. Therefore, when investigating the formation of noncognitive ability, it is important to be specific about the noncognitive trait that is being examined.

Using a rich data set from the Philippines, I estimate a model of child development in which health, cognition and a number of specific noncognitive traits are jointly produced. These data allow me to estimate this model of child development across all stages of childhood, from *in utero* to adulthood. This is the only paper I am aware of that estimates the joint production of these three dimensions of child development and covers the entire course of childhood in a developing country context. A comprehensive understanding of the process of child development in a developing country context will help to more fully

elucidate the implications of the many insults to child well-being common in the context of poverty such as nutritional shocks, poor school quality and the emotional stress of poverty. It will also aid policy makers in better targeting interventions designed to impact child well-being and human capital formation.

To estimate this model, I employ the dynamic factor model developed in Cuhna and Heckman (2008), with health included as an additional dimension of child development. Additionally, instead of examining the production of just one arbitrary noncognitive skill aggregate, I investigate the production of specific noncognitive skills, namely, risky behaviors, group participation, positive affect and negative affect[2]. In this analysis I will estimate the dynamic production of health, cognition and these noncognitive abilities, explore existing complementarities in the production of these dimensions of child development and explore the role of parental investment in this process throughout childhood.

The following sections, 1.2 and 1.3, describe existing evidence for what are know as critical and sensitive periods in child development and the interdependencies that likely exist between different dimensions of child development. Section 1.4 describes the theoretical model developed in Cuhna and Heckman (2007) on the technology of child development. Section 1.5 illustrates the empirical strategy used to estimate this model which employs the dynamic factor model developed in Cuhna and Heckman (2008). Section 3.4 describes the data used in this paper. Section 1.7 explains the estimation results and Section 3.7 concludes.

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[2]Affect in psychology refers to the experience of feeling or emotion

## 1.2 Critical and Sensitive Periods in Child Development

The development of health, cognition and noncognitive characteristics is a process consisting of multiple stages and continues throughout childhood. This process is thought to be characterized by 'sensitive' and 'critical' periods in child development (Knudsen et al., 2006; Heckman, 2007). Sensitive periods refer to stages in childhood in which inputs, such as parental investment and home environment, have a stronger impact on a child's development than in other periods. When there is only a single period in which investment is effective, that period is known as a critical period (Knudsen et al., 2006).

A large amount of compelling evidence exists demonstrating sensitive and critical periods in both humans and animals. Animal research shows that early experiences of shocks such as under-nutrition, iron deficiency, environmental toxins, stress and poor stimulation and social interaction affect brain function and structure resulting in lasting cognitive, emotional and physical consequences (Grantham-McGregor et al., 2007). Developmental events occur in a cumulative fashion each new event building on previous events. Therefore even small disruptions can have long-term effects on the structure and functional capacity of the brain (Grantham-McGregor et al., 2007). Thus although development continues throughout life, certain traits and abilities are more easily attained in certain stages of childhood than in others. During these sensitive periods neural development and the behaviors governed by this development is most plastic and therefore susceptible to environmental influences (Knudsen et al., 2006).

The early years of childhood are foundational for the development of a wide range of human abilities and characteristics. During this time individual development is highly

sensitive to both positive and negative shocks. The fetal programming literature demonstrates that health insults *in utero* and in infancy affect later adult health. Birth weight, fetal and maternal nutrition, growth in the first two years of life, etc. are all predictive of later adults health (Almond and Currie, 2011; Barker, 1998; Black et al., 2008; Victoria et al., 2008).

The literature further expounds on the importance of early life nutrition and health in determining a wide range of later life outcomes. Good nutrition is essential for children under the age of five (especially those under the age of two) due to rapid bone and tissue growth, linear growth and brain development. By the age of three a child is thought to have reached approximately half of his adult stature and by age two a child's brain will have reached approximately 90% of its adult size (Michaelsen et al., 2008). Thus the physical development that occurs during this period can have lifelong implications.

Adverse nutritional shocks in very young children may have irreversible and lifelong consequences and are associated with lower school attainment, decreased future productivity and earning capacity and shorter adult stature. For example, Alderman et al. (2006) found that low height-for-age in a sample of Zimbabwean children exposed to civil war and drought prior to age three, resulted in decreased adult stature, lower grade attainment and starting school later. Maluucio et al. (2009) found that preschool children in Guatemala randomly chosen to receive a high-protein supplementary energy drink between birth and 36 months had higher grade attainment and scored better on achievement tests than those randomly chosen to receive a low-energy (placebo) drink devoid of protein. Furthermore, regardless of whether catch-up growth is ultimately achieved, stunting under the age of two has been associated with impaired cognitive development

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and lower school attainment (Victoria et al., 2008).

Similarly, there is an emerging literature in child development demonstrating that early life experiences are highly influential in the evolution of cognitive, social and emotional capacities in adolescents and adults. These skills, in turn, are important determinants of educational attainment, crime participation, earnings and participation in risky behaviors (Blau and Currie, 2006; Cuhna et al., 2006; Curley et al., 2011; Dawson et al., 2000; Heckman, 2007; Knudsen et al., 2006; Marshall, 2009; Meany, 2001). A number of studies also consistently demonstrate the lasting effects of early cognitive interventions with benefits realized for up to even 17 years (Walker et al., 2008).

For example, the intervention literature has repeatedly reported significant improvements in a broad range of outcomes for disadvantaged children resulting from exposure to enriched preschool environments. Data from the Perry Preschool and Abecedarian programs demonstrate substantial positive effects of enriched early environments on a number of outcomes including school attainment, job performance and a number of social behaviors long after the intervention concluded (Barnett and Masse, 2007; Knudsen et al., 2006; Schweinhart, 2005). Participants of these programs were found to have received less special education, had lower rates of grade repetition, earned higher GPAs, attained higher levels education and performed better on intellectual, language and achievement tests then their control group counter parts (Barnett and Masse, 2007; Schweinhart, 2005).

## 1.3 Complementarities in the Acquisition of Health, Cognition and Noncognitive Ability

While it is increasingly accepted that early life experiences shape later life outcomes with regards to health, cognition and noncognitive capacities, these different developmental dimensions are often examined individually rather than jointly. However, numerous traits and abilities develop during childhood and they do not develop in isolation of each other. Compelling evidence points to strong interdependencies between health, cognition and noncognitive abilities. The abilities and traits developed in one stage of childhood augment their development in later stages. This self-reinforcing characteristic of a trait or ability enhancing its own production in later childhood stages is termed 'self-productivity'. 'Cross-productivity' refers to when one trait or ability augments the later production of another (Heckman, 2007).

Health status, cognition and noncognitive capacity are all interdependent. Evidence documenting the importance of early life environments in affecting a range of health, labor and behavioral outcomes suggests that there is a shared developmental process occurring (Heckman, 2007). There is evidence both that noncognitive skills foster the development of cognitive skills and cognitive skills foster the development of noncognitive skills (Cuhna and Heckman, 2007). For example, greater cognitive ability is associated with lower time preferences (increased farsightedness) by allowing a clearer foresight into future scenarios (Heckman, 2007). In turn, personality traits affect learning. More able learners are produced in more emotionally nurturing environments. For example, emotional security promotes greater child exploration and thus fosters increased cogni-

tive learning (Cuhna and Heckman, 2007; Heckman, 2007).

Better health is associated with higher educational attainment. Sufficient health and nutritional status in children is not only required for children to maintain linear growth and muscle, tissue and brain development, but it is also required for children to maintain sufficient energy and focus for learning and active play. Consequently, empirical research documents that adverse health conditions impair learning and noncognitive development. Studies consistently find significant associations between stunted growth in early childhood and later cognitive deficits, lower school achievement and greater dropout rates (Victoria et al., 2008; Walker et al., 2008). Low birth weight in infants is associated with lower cognitive scores, poorer problem solving ability and lower developmental levels in later childhood. Low birth weight infants have also been shown to be less active, vocal, happy, cooperative and more inhibited than their normal birth weight counterparts (Walker et al., 2008). Underweight and stunting in children has also been associated with increased apathy, less positive affect, lower levels of play, more insecure attachment, problems with conduct, poorer attention and poorer social relationships (Walker et al., 2008).

Additionally, cognitive and noncognitive abilities play important roles in affecting health and healthy behaviors beyond their effect through education. They affect the evolution of health capital through the choices made by parents and children. Those with greater self-control and conscientiousness have reduced health risks, better avoid accidents, better follow medical instructions and better care for themselves in a variety of ways. Lower time horizons and lower rates of time preference cause individuals to make more long-term investments in themselves (Heckman, 2007). A large body of evidence

also suggests that a person's moods, attitudes and social environment enhance individual ability to ward off and overcome various diseases and medical conditions (Heckman, 2007). For example, there has long been an association between the experience of mental stress and heart disease. One of the strongest and most extreme indicators of noncognitive capacity affecting health is the occurrence of failure to thrive (FFT) in infants and young children. FFT can occur when a neglected or otherwise emotionally abused child does not grow normally even though the child is receiving adequate nutrition and other health inputs (Krugman and Dubowitiz, 2003).

## 1.4 Formation of Health, Cognition and Noncognitive Abilities throughout Childhood

Cuhna et al. (2006) and Cuhna and Heckman (2007) develop a theoretical model on the technology of skill formation that embodies many of the characteristics described above. Their model describes human skill formation as a multistage process embodying sensitive and critical periods of development and accounts for the self- and cross-productive nature of different skills and traits.

While Cuhna et al. (2006) and Cuhna and Heckman (2007) focus only on the production of cognitive and noncognitive skills in their analysis, their framework easily accommodates the inclusion of other dimensions of child development, such as health. A great deal of empirical work from developing countries finds early life health to be an important predictor of a wide range of adult outcomes including adult health, school at-

tainment and economic productivity (Victoria et al., 2008). In developing countries, individual health is exposed to numerous shocks throughout the lifecycle resulting in much a greater variation in health than what is generally observed in developed countries. Given the relevance of health in the process of child development and its salience in a developing country context, I include health in the model of child development discussed in this paper and estimated for the sample of Filipino children.

Closely following the model developed in Cuhna et al. (2006) and Cuhna and Heckman (2007), assume an individual is born with initial conditions $\theta_0 = \{\theta_0^C, \theta_0^N, \theta_0^H\}$ where the superscripts C, N and H indicate cognition, noncognitive ability and health, respectively. Let $\theta_t = \{\theta_t^C, \theta_t^N, \theta_t^H\}$ denote the vector developmental stocks at each childhood period $t$. Then the technology of producing developmental stock $k$ in period $t+1$ is

$$\theta_{t+1}^k = f_{t+1}^k(\theta_t, I_{t+1}, X) \tag{1.1}$$

For $k \in \{C, N, H\}$ and $t \in \{1, ..., T\}$, where $T$ is the number of periods of childhood. $I_t$ denotes investment in period $t$, which can include parental inputs as well as many aspects of home environment. $X$ is a vector of parental characteristics. $f_t^k$ is assumed to be twice continuously differentiable and strictly increasing in $\theta_t$ and increasing and concave $I_t$. Thus in this model, stocks of development in the previous period produces current developmental stocks and affects the productivity of current levels of investment. Substituting $\theta_t, \theta_{t-1}, ...$ repeatedly we can write the production technology as a function of all previous investments.

$$\theta_{t+1}^k = f_{t+1}^k(\theta_0, I_t, ..., I_{t+1}, X) \tag{1.2}$$

For simplicity assume $t = 1, 2$. Then adult human capital can be defined to be:

$$h = g_2(\theta_0, I_1, I_2, X) \tag{1.3}$$

,

where the function $g$ is assumed to be continuously differentiable and increasing in $(\theta_0^C, \theta_0^N, \theta_0^H)$.

Stage 1 is a critical period for the production of $\theta_2^k$ if

$$\frac{\partial \theta_2^k}{\partial I_2} = \frac{\partial g_2^k(\theta_0, I_1, I_2, X)}{\partial I_2} \equiv 0 \text{ for all } \theta_0, I_2, I_1 \tag{1.4}$$

.

but

$$\frac{\partial \theta_2^k}{\partial I_1} = \frac{\partial g_2^k(\theta_0, I_1, I_2, X)}{\partial I_1} > 0 \text{ for some } \theta_0, I_2, I_1 \tag{1.5}$$

.

Meaning that the marginal effect of investment in period two of trait $k$ is zero for all $\theta_0, I_2, I_1$, but the marginal effect of investment in peroid one is greater than zero making period one a critical period.

Period 1 is a sensitive period if:

$$\frac{\partial \theta_2^k}{\partial I_2}\big|_{\theta_0=\bar{\theta}, I_2=\bar{I}} < \frac{\partial \theta_2^k}{\partial I_1}\big|_{\theta_0=\bar{\theta}, I_1=\bar{I}} \tag{1.6}$$

.

Meaning that the marginal effect of investment in period one on trait $k$ is greater than the marginal effect of investment in period two.

## 1.5 Estimating the Production of Health, Cognition and Noncognitive Development

Empirical estimation of the technology of child development poses numerous challenges. Choices between methods necessarily involve weighing the many tradeoffs between required assumptions and the information that can be extracted. Conventional approaches estimating the production of health, cognitive and noncognitive developmental stocks typically rely on fixed effects estimators or instrumental variables (IV) to deal with the endogeneity of inputs and individual latent ability. Although a great deal has been learned about child development (particularly about the development of health) from these methods, there are drawbacks to their use. IV can be problematic in the difficulty of satisfying exclusion restrictions and fixed effects methods require very specific assumptions about the nature of unobservables and their persistence over time. Additionally, the many measurements for child developmental stocks and parental inputs places large demands on standard IV and fixed effects procedures. The number of parental inputs, in particular,

tends to be much larger than the number of available instruments (Cuhna and Heckman, 2008; Cuhna et al., 2010). Furthermore, many of these methods do not allow for the production of different child developmental stocks to be jointly estimated. If, in fact, strong interdependencies do exist between these dimensions, as a great deal of compelling evidence suggest, then estimating them separately would lead to biased estimates resulting from omitted variables. This will be discussed further below.

To address these issues, I employ the dynamic factor model method developed in Cuhna and Heckman (2008) and Cuhna et al. (2010). This method offers a number of advantages particular to estimating a model of child development. The dynamic factor model circumvents many of the problems discussed with fixed effects and IV estimators. The idea underlying this approach is to model child developmental stocks, as well as parental investments, as low dimensional latent variables, whose joint distribution is revealed through factor analysis methods.

One advantage offered by the dynamic factor model is that it allows measurements for child developmental stocks and investment to differ at different stages of childhood. For example, an important parental investment for a young child (e.g., reading to the child or breastfeeding) may not be an important investment for a teenager. Thus allowing factor measurements to differ according to stages of development may allow for a more accurate depiction of the working technology underlying child development over all stages of childhood.

The dynamic factor model also allows for the use of a variety of measurements related to child development factors and investments in estimating their latent distributions. Thus a measurement such as height-for-age z-score would not itself be treated as

health status but rather it would be used in combination with other health measurements to uncover the unobserved distribution of of health status. This allows for the all measurements on child developmental stocks and investments in the data to be used together rather than being limited to just one or a few measures. Furthermore, the dynamic structure built into the dynamic factor model allows for both the investigation of sensitive and critical periods in a child's development as well as of the self- and cross-productive effects in the formation of different developmental stocks. However, the use of factor analysis is not without its own tradeoffs. Particularly, it requires strong assumption on the validity of the measurements used and on their structural relationship with the factors.

### 1.5.1   Law of Motion for Child Developmental Stocks

To investigate the production of health, cognitive and noncognitive development, I used the following system of equations, similar to that introduced in Cuhna and Heckman (2008):

$$
\begin{aligned}
\theta_{t+1}^N &= \alpha_{1,t+1}^N \theta_t^N + \alpha_{2,t+1}^N \theta_t^C + \alpha_{3,t+1}^N \theta_t^H + \alpha_{4,t+1}^N \theta_{t+1}^I + X_{t+1} + \eta_{t+1}^N \\
\theta_{t+1}^C &= \alpha_{1,t+1}^C \theta_t^N + \alpha_{2,t+1}^C \theta_t^C + \alpha_{3,t+1}^C \theta_t^H + \alpha_{4,t+1}^C \theta_{t+1}^I + X_{t+1} + \eta_{t+1}^C \\
\theta_{t+1}^H &= \alpha_{1,t+1}^H \theta_t^N + \alpha_{2,t+1}^H \theta_t^C + \alpha_{3,t+1}^H \theta_t^H + \alpha_{4,t+1}^H \theta_{t+1}^I + X_{t+1} + \eta_{t+1}^H,
\end{aligned}
\tag{1.7}
$$

where $\theta_t^k$ denotes child development stock $k$ in period $t$, $k \in \{C, N, H\}$, $t \in \{1, ..., T\}$ and $C$, $N$ and $H$ denote cognition, noncognitive skill and health, respectively. In the dynamic factor model framework, this child development stock is assumed to be latent. $\theta_{t+1}^I$ denotes current latent parental investment (including aspects of home environment) in

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child development in period $t + 1$. $X_{t+1}$ represents a vector of additional controls.

Note, if 1.7 accurately describes the technology of child development, then for any period, estimates of the self- or cross-productive effects of one period's developmental stock on a later period's stock will be biased if other dimensions of development are excluded from the estimation. For example, say $T = 3$ and we estimate the self-productive effect of period 2 (early childhood) health on period 3 (later childhood) health. Period 1 health represents initial health. Both cognitive and noncognitive ability are unobserved. Then we estimate:

$$\theta_3^H = \alpha_{3,2}^H \theta_2^H + \alpha_{4,2}^H \theta_3^I + \omega_3^H, \tag{1.8}$$

where $\omega_3^H = \alpha_{1,2}^H \theta_2^N + \alpha_{2,2}^H \theta_2^C + \eta_3^H$. Clearly, if 1.7 is true, then even if all the standard assumptions surrounding the error term are satisfied, $\theta_2^H$ is correlated with $\omega_3^H$ simply because $\theta_2^H$, $\theta_2^C$ and $\theta_2^N$ are all functions of initial health, cognition and noncognitive ability. Assuming last period's cognition and noncognitive ability have a positive effect on the current period's health, then $\alpha_{3,2}^H$ will be upwardly biased. $\alpha_{3,2}^H$ will still capture the important influence of period 2 health on period 3 health, but it will capture the net effect rather than a casual effect.

## 1.5.2 Dynamic Factor Model and the Model for the Measurements

In the dynamic factor model, the error terms in 1.7, $\eta_t^k$, are independent across agents and over time for the same agent. The correlation of developmental stocks across time for the

same agent is assumed to be captured within the model itself. However, $\eta_{t+1}^{k}$ and $\eta_{t}^{l}$ are feely correlated when $k \neq l$. In other words, measurements of different latent stocks can be correlated within the same time period.

Under the dynamic factor model of Cuhna and Heckman (2008), $\theta_{t}^{C}$, $\theta_{t}^{N}$, $\theta_{t}^{H}$ and $\theta_{t}^{I}$ are all unobserved and are estimated through confirmatory factor analysis using measurements for the child developmental stocks and parental investments. These measurements can include test scores, anthropometry measures, parental inputs, indicators of home environment, etc. Measurements are assumed to be represented by a dynamic factor structure such that:

$$Z_{j,t}^{N} = \mu_{j,t}^{N} + \lambda_{j,t}^{N}\theta_{t}^{N} + \epsilon_{j,t}^{N} \text{ for } j \in \left\{1, ..., m_{t}^{N}\right\} \tag{1.9}$$

$$Z_{j,t}^{C} = \mu_{j,t}^{C} + \lambda_{j,t}^{C}\theta_{t}^{C} + \epsilon_{j,t}^{C} \text{ for } j \in \left\{1, ..., m_{t}^{C}\right\} \tag{1.10}$$

$$Z_{j,t}^{H} = \mu_{j,t}^{H} + \lambda_{j,t}^{H}\theta_{t}^{H} + \epsilon_{j,t}^{H} \text{ for } j \in \left\{1, ..., m_{t}^{H}\right\} \tag{1.11}$$

$$Z_{j,t}^{I} = \mu_{j,t}^{I} + \lambda_{j,t}^{I}\theta_{t}^{I} + \epsilon_{j,t}^{I} \text{ for } j \in \left\{1, ..., m_{t}^{I}\right\}, \tag{1.12}$$

where $Z_{j,t}^{k}$ is the observed *jth* measurement for the latent variable $\theta_{t}^{k}$ in time period $t$. $m_{t}^{k}$ is the number of observed measurements for the latent variable $k$ in the time period $t$, $k \in \{C, N, H, I\}$. $\mu_{j,t}^{k}$ is the measure specific intercept and $\lambda_{j,t}^{k}$ is the factor loading of $\theta_{t}^{k}$ onto

$Z_{j,t}^k$. Denote $var(\epsilon_{j,t}^k) = \sigma^2$. To ensure that the model is not underidentified, I normalize $\lambda_{1,t}^k = 1$ to set scale for all $t$, $k \in \{C, N, H, I\}$. This is common practice in factor analysis. Further, the intercepts, $\mu_{j,t}^k$ and $E[\theta_t^k]$ cannot be separately identified. Therefore, I also normalize $E[\theta_t^k] = 0$ and identify all the intercepts. This simply centers the distribution of the factors on zero and is also common practice. Since the factors do not have cardinal value, this normalization does not have any implications for how we interpret our results. The $\epsilon's$ are assumed to be mean zero, are uncorrelated with the factors, are independent across agents and factors and over time for the same agent.

Since we observe $\{\{Z_{j,t}^k\}_{j=1}^{m_t^k}\}_{t=1}^T$ for every individual, we can compute $cov(Z_{j,t}^k, Z_{i,\tau}^l)$ from the data for all $k$, $l$, $t$ and $\tau$ pairs. Then we can compute the left hand side of all the following equations. Recall that $\lambda_{1,t}^k = 1$.

$$cov(Z_{1,t}^k, Z_{1,t+1}^k) = cov(\theta_t^k, \theta_{t+1}^k) \tag{1.13}$$

$$cov(Z_{j,t}^k, Z_{1,t+1}^k) = \lambda_{j,t}^k cov(\theta_t^k, \theta_{t+1}^k) \tag{1.14}$$

$$cov(Z_{1,t}^k, Z_{j,t+1}^k) = \lambda_{j,t+1}^k cov(\theta_t^k, \theta_{t+1}^k) \tag{1.15}$$

Then $\lambda_{j,t}^k$ and $\lambda_{j,t+1}^k$ can be computed with the ratios of 1.14 over 1.13 and 1.15 over 1.13, respectively, for $k \in \{C, N, H, I\}$. We can recover the joint distribution of $\left\{\theta_t^C, \theta_t^N, \theta_t^H, \theta_t^C\right\}_{t=1}^T$ using the following relationships:

$$cov(Z_{1,t}^k, Z_{j,t}^k) = \lambda_{j,t}^k var(\theta_t^k) \tag{1.16}$$

$$cov(Z_{1,t}^k, Z_{1,\tau}^l) = cov(\theta_t^k, \theta_\tau^l) \tag{1.17}$$

$$cov(Z_{j,t}^k, Z_{i,\tau}^l) = \lambda_{j,t}^k \lambda_{i,\tau}^l cov(\theta_t^k, \theta_\tau^l) \tag{1.18}$$

Finally we can compute $\sigma_{k,j,t}^2$ for $k \in \{C, N, H, I\}$.

$$var(Z_{j,t}^k) - (\lambda_{j,t}^k)^2 var(\theta_t^k) = \sigma^2 \tag{1.19}$$

Once the parameters of the measurement equations are identified along with the joint distribution of $\left\{\theta_t^C, \theta_t^N, \theta_t^H, \theta_t^C\right\}_{t=1}^T$ we can identify the parameters of the law of motion described in 1.7 using Full Information Maximum Likelihood (FIML).

### 1.5.3 Endogeneity of Parental Inputs

A great deal of theoretical and empirical work suggests child ability and well-being influences how parents allocate resources to their children. (Becker and Tomes, 1976; Behrman et al., 1997). Parents may simultaneously act to allocate resources in ways that *reinforce* ability differences among their children as well as decrease disparities by allocating resources so as to *compensate* for these differences. Clearly, parental investment is endoge-

nous if parents are investing in children based on their level of development. Following Cuhna et al. (2010), I address this issue by predicting level of parental investment, $\theta_t^I$ in 1.7, using an investment policy function to eliminate this source of bias. To do so, I assume that $\eta_t^k$ can be decomposed into two parts such that $\eta_t^k = \pi_t + v_t^k$. $v_t^k$ is assumed to be independent of all the right hand side variables in 1.7. $\pi_t$ is assumed to be serially correlated and follows an auto-regressive process to the order one (AR(1)). It is also assumed to be independently distributed across individuals in the first period. $\pi_t$ is further assumed to be realized prior to parents' investment decisions and thus parents respond to it. With these assumptions we can replace $\theta_t^I$ with parental investment predicted from the following policy function.

$$\theta_t^I = \delta + \beta_1\theta_t + \beta_2\theta^P + \beta_3 y_t + \pi_t \qquad (1.20)$$

where $\theta_t$ is the child's level of developmental stock in period $t$, $\theta^P$ is a vector of parental characteristics and $y_t$ is the natural log of per capita household income in period $t$. To correct for the fact that parental investment is predicted, I use a bootstrapping method to estimate the standard errors of the coefficients, $\alpha_{j,t}^k$ in the law of motion[3].

## 1.6  Cebu Longitudinal Health and Nutrition Survey

This study employs a rich panel data set from the Cebu Longitudinal Health and Nutrition Survey (CLHNS). Originally designed to study infant feeding patterns and diets,

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[3]I construct 50 replications of the data by sampling with replacement, estimate the model with each replicate, and compute the standard standard errors of the coefficients.

the CLHNS is part of an ongoing study of a cohort of Filipino women who gave birth between May 1, 1983 and April 30, 1984. Participants in the study are from metropolitan Cebu, the Philippines, which includes several urban, mountainous and coastal regions. In 17 urban and 16 rural randomly selected barangays (smallest administrative unit), all pregnant women giving birth in the designated time frame were canvassed to participate in the study. Women were surveyed in the third trimester, at birth and then every 2 months for the first 24 months of the child's life. Surveys were later extended and the mothers, index children, other caregivers and selected siblings were subsequently followed in 1991, 1994, 1998 and 2002, when the index children were approximately 8, 11, 15 and 19 years old. Approximately 3050 women and children were interviewed in the birth survey round. However, due to issues of attrition, missing data and interruption, the sample size for this analysis varies from period to period.

Detailed information was collected on health, nutrition, education and a number of other economic and demographic variables of interest. Anthropometric measures were taken in each survey round on both mother and child. Surveys also collected detailed surveys on schooling, home environments and cognitive testing. IQ test were performed on the sample children when they were eight and eleven years old. Achievement tests on math, English and Cebuano were also taken by the sample children when they were eleven. The 1998 and 2002 rounds additionally focused on reproductive health and risky behaviors including sexual behavior and substance abuse. In 2002 data were collected on schooling outcomes and labor force entry while continuing to monitor health, education, cognition, behavior and reproductive histories. These data provide uniquely broad and detailed information on health, education, cognition, behavior and home environment. Further, this information is collected for both mother and child at regular intervals from

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when the child is *in utero* until the child is grown.

Roughly 1800 individuals remained in sample without interruption from 1983 to 2002. Summary statistics for the boys and girls in this sample can be found in Table 1.1. Approximately 11% and 13% of boys and girls, respectively, were born with low birth weight[4]. On average, height-for-age- z-scores for both boys and girls seems to hover around or just below -2. At age 2, stunting rates for both boys and girls spikes to over 70%. A much larger proportion of boys partake in drug and alcohol use than do girls. At age 15, 41%, 54% and 4% of the boys engage in smoking, drinking and drug use, respectively. By age 19 these levels increase to 73%, 89% and 24%. For girls, smoking, drinking and drug use rates are much lowers at 8%, 23% and 0.2% respectively at age 15 and at 26%, 70% and 4%, respectively at age 19. In the Philippines, primary school is compulsory and both primary and secondary school are free. Therefore, school enrollment rates tend to be high. Most children in the sample completed at least some secondary school. By age 19, girls with average grade attainment of 10.90, tend to complete more than boys whose mean grade attainment by age 19 is 9.75. This is likely due to boys leaving school to join the labor force, since boys' and girls' grade attainment prior to age 19 was broadly similar.

There are issues of attrition, missing variables and respondents moving in and out of sample in these data. Baseline characteristics for children who remained in sample for the whole sample period are compared with those who attritted or moved in and out of sample in Table 1.2. Overall, characteristics between the two groups are broadly similar. However, children who did not stay in sample do appear to have a higher rate of low birth weight, a slightly smaller baseline household size and their mothers appear to have

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[4]An infant is considered low birth weight if she weighs less than 2500 grams

Table 1.1: Summary Statistics for Individuals in Sample for All Survey Rounds

|  | Males N=941 | | Females N=819 | |
|---|---|---|---|---|
|  | **Mean** | **Standard Dev.** | **Mean** | **Standard Dev.** |
| Low Birth Weight | 0.108 | 0.311 | 0.126 | 0.332 |
| Height for Age 1 Year | -1.81 | 1.168 | -1.586 | 1.065 |
| Height for Age 2 Years | -2.595 | 1.112 | -2.496 | 1.08 |
| Height for Age 8 Years | -2.098 | 0.935 | -1.988 | 0.934 |
| Height for Age 11 Years | -2.021 | 0.972 | -1.928 | 1.091 |
| Height for Age 15 Years | -1.887 | 0.865 | -1.839 | 0.791 |
| Height for Age 18 Years | -1.832 | 0.788 | -1.844 | 0.812 |
| IQ Score 8 Years | 50.793 | 12.594 | 52.284 | 12.019 |
| IQ Score 11 Years | 68.637 | 11.586 | 69.95 | 11.004 |
| Highest Grade at 15 Years | 8.695 | 2.354 | 8.775 | 1.619 |
| Highest Grade at 18 Years | 9.753 | 2.798 | 10.901 | 2.144 |
| Baseline Per Capita Household Income (pesos) | 2844.38 | 4322.922 | 2597.97 | 3353.245 |
| Baseline HH Size | 7.157 | 3.011 | | |
| Stunted at 1 Year | 0.532 | 0.499 | 0.429 | 0.495 |
| Stunted at 2 Years | 0.793 | 0.406 | 0.742 | 0.438 |
| Stunted at 8 Years | 0.554 | 0.497 | 0.523 | 0.5 |
| Stunted at 11 Years | 0.527 | 0.5 | 0.488 | 0.5 |
| Stunted at 15 Years | 0.433 | 0.496 | 0.427 | 0.495 |
| Stunted at 18 Years | 0.42 | 0.494 | 0.431 | 0.496 |
| Smoked at 15 Years | 0.406 | 0.491 | 0.082 | 0.274 |
| Drunk Alcohol at 15 Years | 0.544 | 0.498 | 0.233 | 0.423 |
| Tried Drugs at 15 Years | 0.043 | 0.202 | 0.002 | 0.049 |
| Smoked at 18 Years | 0.732 | 0.443 | 0.258 | 0.438 |
| Drunk Alcohol at 18 Years | 0.891 | 0.312 | 0.699 | 0.459 |
| Tried Drugs at 18 Years | 0.24 | 0.427 | 0.038 | 0.191 |

Table 1.2: Differences in Baseline Characteristics between Children Who Remained in Sample and Those Who Did Not

|  | Attritted from Sample | In Sample | Difference |
|---|---|---|---|
| Low Birth Weight | 0.143 | 0.116 | 0. 027** |
| Baseline Per Capita Income | 2790.757 | 2729.72 | 61.039 |
| Male | 0.521 | 0.535 | -0.014 |
| Baseline HH Size | 5.572 | 5.779 | -0.207** |
| Maternal Age | 26.475 | 26.513 | -0.038 |
| Maternal Height | 150.827 | 150.735 | 0.092 |
| Maternal Education | 7.733 | 7.356 | 0.377*** |

received slightly more education by the time of their birth.

With well over 500 parameters to estimate in the dynamic factor model, estimating all stages of childhood together was quite demanding on the data. Therefore the system of equations represented in 1.7 was estimated one stage at a time. Due to attrition and respondents moving in and out of sample, sample sizes vary from one period to the next. Summary statistics on baseline characteristics for the sample each period can be found in Table 1.3. Baseline characteristics look quite similar across samples. Indeed, Wald tests show that there are no statistically significant differences between any pairwise combination of baseline characteristics. I therefore do not believe that the slight differences in samples across time periods pose a problem for estimates.[5] Sample sizes across periods range from 1,995 to 2,286. Summary statistics on all variables used as measurements in

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[5]Results do not substantively change if the sample in each period is restricted to only those children who remain in sample for the entire sample period. Since the results are similar, I retain all available individuals for each period's estimation in order to retain as much information as possible.

Table 1.3: Descriptive Statistics of Samples from 1984, 1991, 1994, 1998 and 2002

| Year | 1983/4 | 1991 | 1994 | 1998 | 2002 |
|---|---|---|---|---|---|
| N | 2286 | 2055 | 2021 | 1995 | 2007 |
| Low Birth Weight | 0.121 | 0.114 | 0.114 | 0.113 | 0.117 |
| Household Per Capita Income (pesos) | 2770.97 | 2733.99 | 2816.44 | 2802.17 | 2731.88 |
| Household Size | 5.732 | 5.755 | 5.735 | 5.757 | 5.749 |
| Maternal Age | 26.634 | 26.493 | 26.429 | 26.403 | 26.464 |
| Maternal Height | 150.754 | 150.729 | 150.83 | 150.8204 | 150.776 |
| Maternal Grade Attainment | 7.395 | 7.413 | 7.576 | 7.551 | 7.386 |
| Male | 0.53 | 0.532 | 0.512 | 0.514 | 0.529 |

equations 1.9-1.12 can be found in Tables A.1-A.6 in the appendix. Table A.12 in the appendix shows Cronbach's alpha for each of the developmental factors estimated in equations 1.9-1.12. Cronbach's alpha is a coefficient that measures the internal consistency or reliability of instruments in measuring the unobserved factors. The reliability coefficient is simply defined as the square of the correlation between the measured scale and the underlying factor. Estimates for Cronbach's alpha in this analysis range from a value of 0.36 to 0.87, meaning that our measurement instruments range from low to high reliability. This is not entirely unexpected since the CLHNS surveys were not specifically designed to capture the latent factors we examine[6].

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[6]Reliability estimates might also be lower because there is more than one factor being captured by the measurements. For example, health measurements include measures of chronic/cumulative health, such as height-for-age z-score, as well as measures of acute or current health, such as diarrhea counts and wasting. However for the purposes of this analysis these measures are not separated because, theoretically, it stands to keep the estimated factors in tact and so as not to create too many factors than can be reasonably estimated with this system

## 1.7 Estimation and Results

The system of equations depicted in 1.7 are estimated for children at ages 1, 2, 8, 11 and 15. Adult heath, cognition and noncognitive ability are estimated for age 19. The CLHNS offer a number of potential variables to proxy or measure health, cognition, noncognitive ability and parental investment across the multiple stages of child development. However, indicator or measurement variables are not available for all these developmental dimensions at all ages surveyed in the data. More specifically, only health and parental investment variables are available in the first two years of life. At ages 8 and 11, variables indicating cognition become available in addition to health and parental investment. Noncognitive measures are not available until the index children are 15 years old. Therefore only the production of health is estimated in the first two years of life. The joint production of health and cognition is estimated when the index children are 8 and 11 years old. Finally, the joint production of health, cognition and noncognitive ability is estimated when the sample children are 15 years old and adults. This means that the estimates of the cross- and self-productive effects of the different child developmental dimensions are likely biased when one or more of those dimensions are unobserved. Furthermore, because health is the only developmental dimension observed in all stages of childhood, it is the only developmental stock that can be included in the investment policy function. Given the high correlation between all the developmental dimensions, health is likely a good proxy for general developmental well-being, however, this is nonetheless not ideal. While there is nothing that can be done about this with these data, it is worth keeping in mind.

If one has measurements $\left\{\theta_0^N, \theta_0^C, \theta_0^H\right\}$ as well as $\left\{\theta_1^I, ..., \theta_T^I\right\}$ then he could feasibly estimate

adult human capital as a function of initial stocks of human capital and investment in each period of childhood. Then the unbiased parameters of 1.7 could be backed out. However, since I only observe initial health, I cannot estimate the parameters of interest using this method.

Estimates for the intercepts, $\mu_{j,t}^k$, and the factor loadings, $\lambda_{j,t}^k$, of the measurement equations 1.9-1.12 can be found in Tables A.7-A.11 in the appendix[7]. Estimates on the parameters in the law of motion for health, cognition and noncognitive ability can be found in Tables 1.4, 1.6 and 1.8.[8] Estimates with parental investment replaced by predictions from the investment policy function can be found in Tables 1.5, 1.7 and 1.9. As mentioned for ages 1 and 2, only the production of health is estimated and for ages 8 and 11 only the production of health and cognition is estimated. This is due to data limitations which also mean that the stock of cognition is missing as an explanatory variable in the production of health at ages 1, 2 and 8 and as an explanatory variable for the production of cognition at age 8. Noncognitive developmental stocks are missing as explanatory variables at ages 1, 2, 8, 11 and 15. These missing developmental stocks as explanatory variables implies that the self- and cross-productive effects of developmental stocks might be upwardly biased, due to the positive synergies that likely exist between the three dimensions of development. That is not to say, for example, that the effect of health at age two on health at age eight is not important. Only that it might also capture some of the effects of cognition and

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[7]The estimates of intercepts and factor loadings in the measurement equations have been standardized so that estimates can be interpreted in terms of standard deviations. This is why $\lambda_{1,t}^k$ does not equal one in the reported results.

[8]The model's goodness of fit is poor. In each of the time periods statistical tests reject that the model performs as well as the saturated model, where the saturated model perfectly reproduces all the variances, covariances, and means of the observed variables. However, the overall $R^2$ for each childhood period is relatively high ranging from 0.7757 to 0.9999. Goodness of fit statistics can be found in Appendix Table A.13.

noncognitive ability at age two. Noncognitive stocks estimated at age 15 are group so-cialization and participation in risky behaviors. At age 19 risky behaviors, positive affect and negative affect are estimated as noncognitive stocks in adulthood. All latent factors have been standardized. Therefore estimated coefficients can be interpreted as the effect of a change in one standard deviation of a right-hand-side latent factor on the left-hand-side latent factor in standard deviations. At all ages, household per capita income is also controlled for in the estimation of health, cognitive and noncognitive production.

Table 1.4: Dynamic Factor Model Estimates for the Production of Health

|  | Current Period Health | | | | | |
|  | Age 1 | Age 2 | Age 8 | Age 11 | Age 15 | Adult |
|---|---|---|---|---|---|---|
| Lagged Health | 0.466*** | 0.862*** | 0.750*** | 0.879*** | 0.807*** | 0.656*** |
|  | (0.019) | (0.01) | (0.015) | (0.009) | (0.013) | (0.021) |
| Lagged Cognition |  |  |  | 0.060*** | -0.007 | 0.079 |
|  |  |  |  | (0.015) | (0.017) | (0.057) |
| Lagged Group Socialization |  |  |  |  |  | -0.004 |
|  |  |  |  |  |  | (0.073) |
| Lagged Risky Behaviors |  |  |  |  |  | -0.269*** |
|  |  |  |  |  |  | (0.024) |
| Current Parental Investment | 0.058*** | 0.027** | 0.043*** | 0.015 | 0.017 |  |
|  | (0.021) | (0.015) | (0.022) | (0.015) | (0.015) |  |

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results are nearly identical when parental investment is replaced by predictions from the policy function with when it is not. The only substantive change is that coefficients on the contribution of parental investment to the production of health substantially increase

Table 1.5: Dynamic Factor Model Estimates of Health Production Assuming Endogenous Investment

| | Current Period Health | | | | | |
|---|---|---|---|---|---|---|
| | Age 1 | Age 2 | Age 8 | Age 11 | Age 15 | Adult |
| Lagged Health | 0.434*** | 0.812*** | 0.745*** | 0.876*** | 0.806*** | 0.656*** |
| | (0.019) | (0.012) | (0.015) | (0.01) | (0.014) | (0.021) |
| Lagged Cognition | | | | 0.054*** | 0.001 | 0.079 |
| | | | | (0.015) | (0.017) | (0.057) |
| Lagged Group Socialization | | | | | | -0.004 |
| | | | | | | (0.073) |
| Lagged Risky Behaviors | | | | | | -0.269*** |
| | | | | | | (0.024) |
| Current Parental Investment | 0.260*** | 0.158*** | 0.057*** | 0.026* | 0.01 | |
| | (0.02) | (0.015) | (0.018) | (0.014) | (0.018) | |

Bootstrap corrected errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

in magnitude and the effect of investment on health when the index children are 15 becomes statistically significant. I will therefore focus my discuss on the results in which parental investment is treated as endogenous in Tables 1.5, 1.7 and 1.9.

In Table 1.5 we can see that health has a strong self-productive effect at all stages of childhood. In fact, in all stages of childhood the previous period's stock of health is the most important determinant of the current period's health. At age 11, cognition at age 8 has a statistically significant cross-productive effect on health. An increase in cognition at age 8 by one standard deviation increases health stock at age 11 by 0.054 standard deviations. However, this cross-productive effect is small compared to health's self-productive effect. For example, increasing health at age 8 by one standard deviation increases the

Table 1.6: Dynamic Factor Model Estimates of the Cognitive Production

| | Current Period Cognition | | | | | |
| | Age 1 | Age 2 | Age 8 | Age 11 | Age 15 | Adult |
|---|---|---|---|---|---|---|
| Lagged Health | | | 0.297*** | 0.135*** | 0.052*** | 0.006 |
| | | | (0.031) | (0.02) | (0.021) | (0.013) |
| Lagged Cognition | | | | 0.707*** | 0.618*** | 0.986*** |
| | | | | (0.026) | (0.027) | (0.075) |
| Lagged Group Socialization | | | | | | -0.056 |
| | | | | | | (0.08) |
| Lagged Risky Behaviors | | | | | | -0.115*** |
| | | | | | | (0.022) |
| Current Parental Investment | | | 0.521*** | 0.100*** | 0.236*** | |
| | | | (0.037) | (0.024) | (0.021) | |

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

subsequent period's health by 0.86 standard deviations. Intuitively, participating in risky behaviors at age 15 has a statistically significant negative effect on health stock in adulthood. Parental investment has a statistically significant positive effect on the production of health at ages 1, 2, 8 and 11. However, the magnitude of this effect decreases drastically with age with an estimated effect of 0.260 at age 1 to an effect of only 0.026 at age 11. As has been found in other studies, early childhood clearly appears to be a sensitive period for investing in health production.

Like health, Table 1.7 shows that cognition is also strongly self-productive in all of the stages we observe it. Participation in risky behaviors has a statistically significant neg-

Table 1.7: Dynamic Factor Model Estimates of Cognitive Production Assuming Endogenous Investment

| | Current Period Cognition | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Age 1 | Age 2 | Age 8 | Age 11 | Age 15 | Adult |
| Lagged Health | | | 0.309*** | 0.106*** | 0.047*** | 0.006 |
| | | | (0.031) | (0.02) | (0.023) | (0.013) |
| Lagged Cognition | | | | 0.665*** | 0.666*** | 0.986*** |
| | | | | (0.026) | (0.029) | (0.075) |
| Lagged Group Socialization | | | | | | -0.056 |
| | | | | | | (0.08) |
| Lagged Risky Behaviors | | | | | | -0.115*** |
| | | | | | | (0.022) |
| Current Parental Investment | | | 0.374*** | 0.206*** | 0.104*** | |
| | | | (0.031) | (0.024) | (0.026) | |

Bootstrap corrected standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, *$p < 0.1$

Table 1.8: Dynamic Factor Model Estimates of Noncognitive Production

| | Risky Behaviors | | Group Socialization | Positive Affect | Negative Affect |
| --- | --- | --- | --- | --- | --- |
| | Age 15 | Adult | Age 15 | Adult | Adult |
| Lagged Health | 0.121*** | 0.002 | 0.151*** | 0.112*** | 0.035 |
| | (0.031) | (0.027) | (0.032) | (0.037) | (0.028) |
| Lagged Cognition | -0.230*** | -0.153** | 0.540*** | 0.117 | -0.112* |
| | (0.031) | (0.064) | (0.037) | (0.096) | (0.066) |
| Lagged Group Socialization | | 0.09 | | 0.279** | -0.066 |
| | | (0.078) | | (0.118) | (0.08) |
| Lagged Risky Behaviors | | 0.946*** | | 0.011 | 0.025 |
| | | (0.025) | | (0.041) | (0.03) |
| Current Parental Investment | 0.022 | | 0.101*** | | |
| | (0.029) | | (0.032) | | |

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 1.9: Dynamic Factor Model Estimates of Noncognitive Production Assuming Endogenous Investment

|  | Risky Behaviors | | Group Socialization | Positive Affect | Negative Affect |
|---|---|---|---|---|---|
|  | Age 15 | Adult | Age 15 | Adult | Adult |
| Lagged Health | 0.116*** | 0.002 | 0.118*** | 0.112*** | 0.035 |
|  | (0.032) | (0.027) | (0.033) | (0.037) | (0.028) |
| Lagged Cognition | -0.239*** | -0.153** | 0.524*** | 0.117 | -0.112*** |
|  | (0.033) | (0.064) | (0.04) | (0.096) | (0.066) |
| Lagged Group Socialization |  | 0.09 |  | 0.279** | -0.066 |
|  |  | (0.078) |  | (0.118) | (0.08) |
| Lagged Risky Behaviors |  | 0.946*** |  | 0.011 | 0.025 |
|  |  | (0.025) |  | (0.041) | (0.03) |
| Current Parental Investment | 0.049 |  | 0.172*** |  |  |
|  | (0.034) |  | (0.038) |  |  |

Bootstrap corrected standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

ative effect on adult cognition. Unlike health, however, parental investment is effective in cognitive production for a longer window with statistically significant effects in all of the periods for which we estimate. These effects decrease in magnitude with age with estimated effects of 0.374, 0.206 and 0.104 for ages 8, 11 and 15, respectively. Health has a statistically significant cross-productive effect on the production of cognition at ages 8, 11 and 15. This effect also decreases in magnitude with age with estimated effects of 0.309, 0.106 and 0.047, respectively. This result, once again highlights the importance of early life health on child development.

Risky behaviors is the only noncognitive trait I observe in more than one period and it appears to be strongly self-productive. An increase in risky behaviors by one standard deviation at the age of 15 increases risky behaviors in adulthood by 0.946 standard deviations. Intuitively, lagged cognition has a statistically significant negative effect on risky

behaviors in both of the periods in which we observe it. Health at age 11 has a statistically significant positive effect on risky behaviors at age 15. While this might seem initially puzzling, other analysis showed that this result is entirely driven by young males in the sample, who at age 15 are likely in the initiation stage of risky behavior.[9] While health positively affects risky behavior participation at age 15 ,this effect goes away at age 19, and as noted, these risky behaviors at age 15 have a negative and statistically significant effect on adult health. Health also positively affects group socialization at age 15 and positive affect in adulthood. Cognition positively affects groups socialization at age 15 and negatively affects negative affect in adulthood. While of course we can imagine that some individuals can have high cognition and a very negative outlook on life and themselves (a depressed genius, so to speak), we can also imagine that, *on average*, individuals with high cognitive ability are also better able to cope with life's stressers and thus have lower levels of negative affect.

The results in Table 1.5 indicate the existence of sensitive periods in the production of health. Health displays sensitive periods in that parental investment only significantly and substantively affects health production at early ages and ceases to have a substantial effect in later childhood. In later childhood, health is largely determined by the child's existing stock of health and less by other influences. This is consistent with much of the health and nutrition literature which finds early childhood to be an important sensitive (and possibly critical) period in the development of health. Parental investment has a statistically significant effect on cognitive production for all ages it is estimated as well as on group socialization at age 15. It therefore appears that cognition and some noncognitive traits are more susceptible to environmental influence at later ages than is health stock.

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[9]Results available upon request.

Other studies have also found parental investment to significantly influence noncognitive production throughout adolescence (e.g., Cuhna and Heckman (2008).

What is most striking in the estimates found in Tables 1.4-1.9 is that there seems to be strong path dependency in the production of the different dimensions of child development. The strong self-productive nature of these dimensions implies that disparities between children starting out at different levels of development will continue to widen given the same inputs. This idea is illustrated in Figures 1, 2, 3 and 4, which are non-parametric locally weighted plots of standardized health and cognitive factor scores over childhood.

Figures 1, 2, 3 and 4 illustrate the persistence of health and cognitive disparities throughout childhood across children with normal and poor health outcomes early in childhood. Figures 1 and 3 show these disparities between children born at low birth weight and those born at normal birth weight. Figures 2 and 4 separate health and cognitive trajectories between children who experience stunting in the first two years of life and those who do not. In Figures 1 and 3 we see that the health gap decreases to a certain extant prior to the age of eight, after which, any catch-up being experienced by low-health children tapers off. This makes sense given that the first five years of life is thought to be the period when physical development is most susceptible to environmental influences and thus is the window when catch-up is thought to be most possible. Therefore, while children who experience poor health early in life do appear to exhibit some catch-up to their healthier counter parts early in childhood, they never completely catch-up and the health disparities persist into adulthood. Figures 2 and 4 demonstrate the persistence of cognitive disparities among these same children. As with health, there appears to be a

mild decreasing in early cognitive disparities but this gap never fully closes and these disparities also persist into adulthood.



Figure 1: Health Trajectories over Childhood by Birth Weight
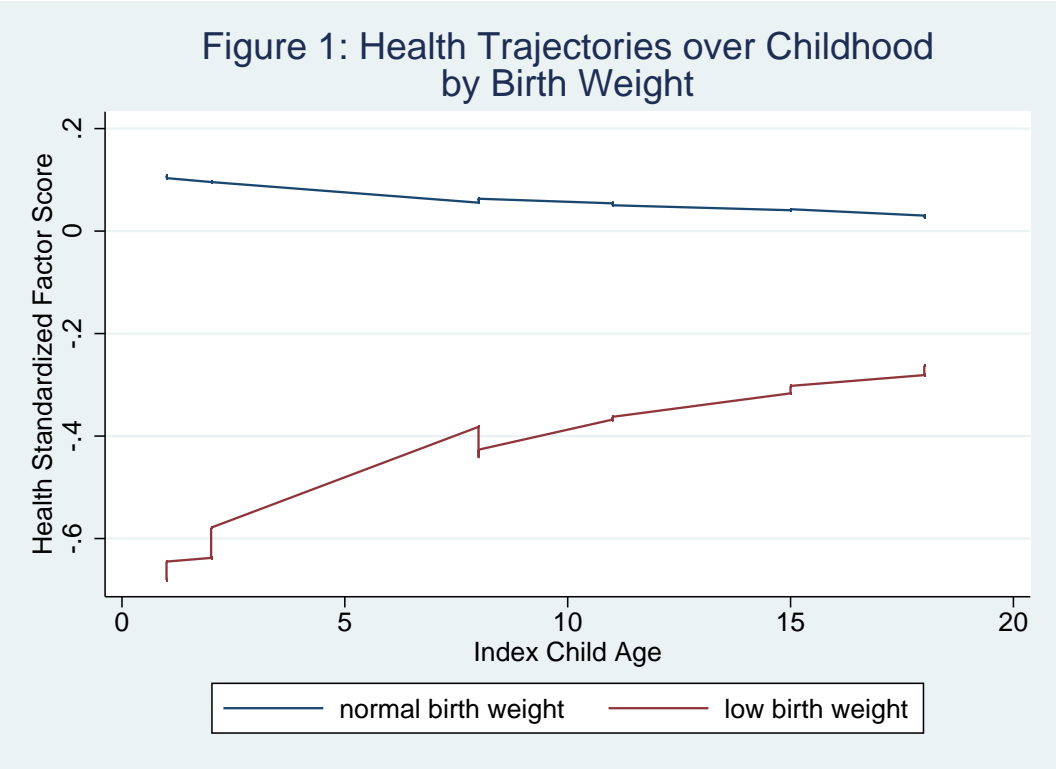
Figure 2: Cognitive Trajectories over Childhood by Birth Weight
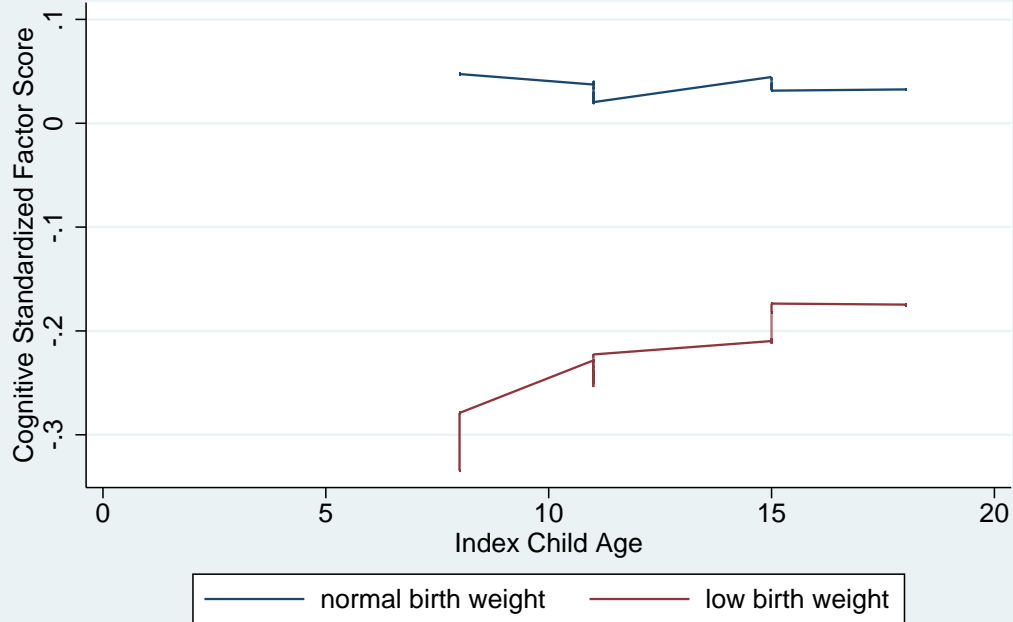
Figure 3: Health Trajectories over Childhood by 1st Year Stunting

Figure 4: Cognitive Trajectories over Childhood by 1st Year Stunting
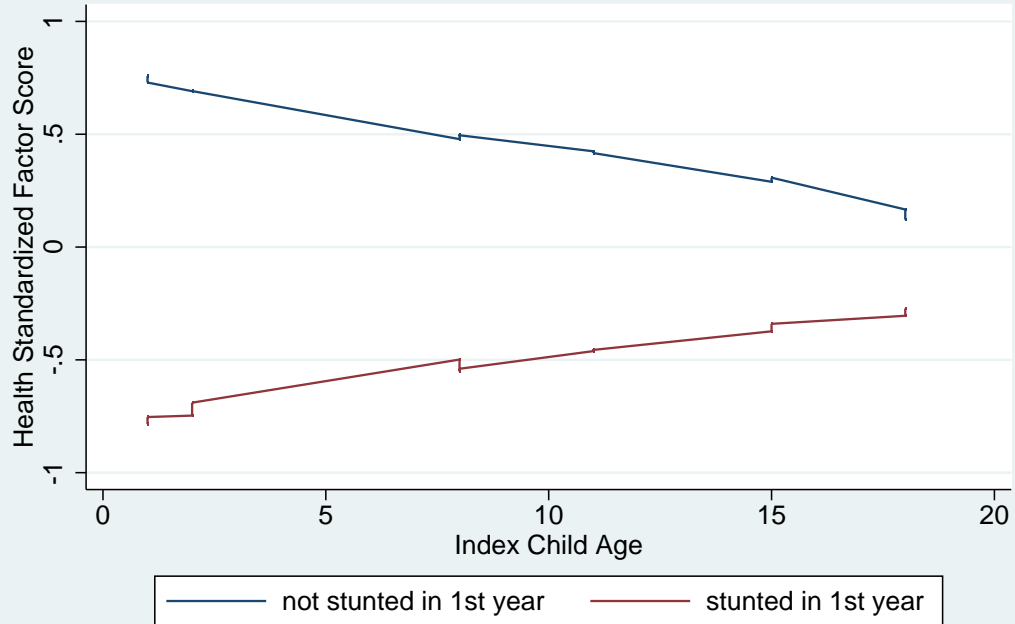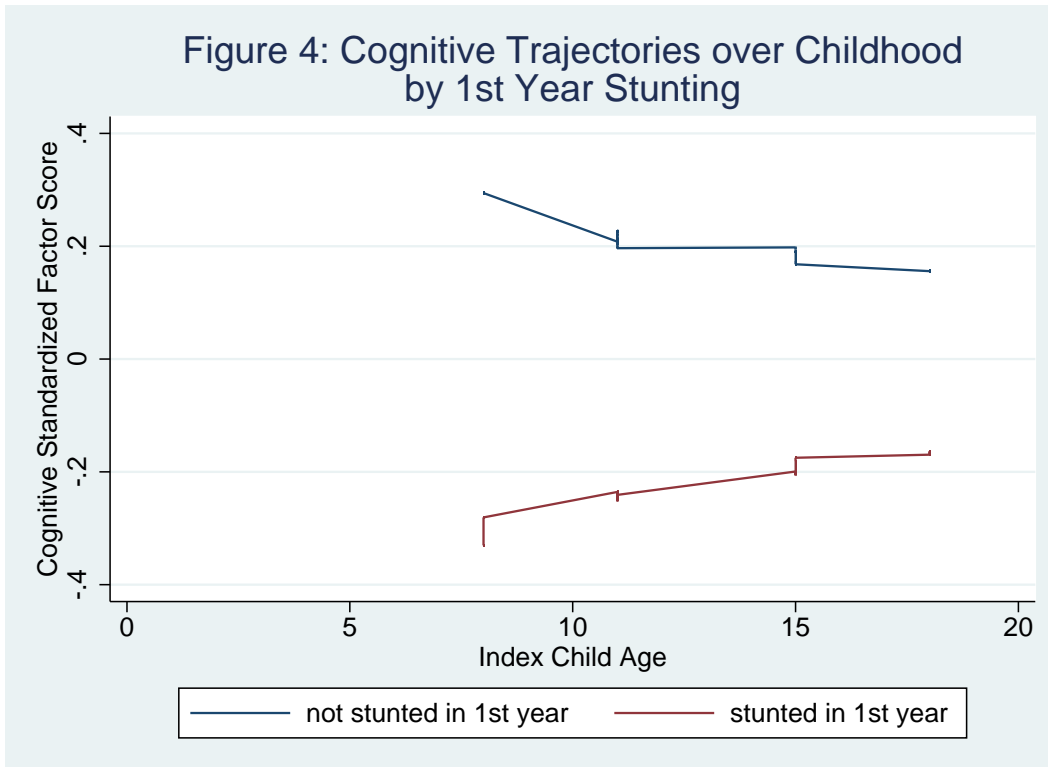
## 1.7.1 Sensitive Periods for Investment and Adult Outcomes

To compare the long-term importance of different investment windows to adult outcomes, Table 1.10 reports adult human capital outcomes in each of the developmental dimensions examined when an investment of one standard deviation is made in each childhood period. For each row in the table I assume that investment is zero in all child stages except the one listed. In the listed childhood stage, I assume that a parental investment of one standard deviation is made. I also assume that initial values of each developmental dimensions is zero (the mean level of development). The last row of the table assumes an investment of one standard deviation is made in each childhood period.

Coefficients reported in Tables 1.5, 1.7 and 1.9 are used to calculate adult outcomes.

Table 1.10: Adult Human Capital by Parental Investment Year

|  | Year of Parental Investment | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
|  | Year 1 | Year 2 | Year 8 | Year 11 | Year 15 | All Years |
| Health | 0.078 | 0.058 | 0.065 | 0.025 | 0.001 | 0.226 |
| Cognition | 0.044 | 0.033 | 0.169 | 0.069 | 0.087 | 0.402 |
| Positive | 0.032 | 0.024 | 0.066 | 0.026 | 0.062 | 0.209 |
| Negative | -0.004 | -0.003 | -0.028 | -0.012 | -0.021 | -0.069 |
| Risky | -0.001 | -0.0004 | -0.063 | -0.026 | 0.046 | -0.045 |
| Group Socialization (age 15) | 0.048 | 0.036 | 0.142 | 0.058 | 0.172 | 0.456 |

From these results we can further see that the first year of life is a sensitive period for the production of adult health, in that, holding all else equal, if we invest only in one period and that period is the first year, then we get the highest level of adult health. In other dimensions there also seems to be diminished adult outcomes if investment is made in the second year of life rather than the first. There is a jump the value of adult outcomes in cognitive and noncognitive dimensions if investment is made when the child is eight. This is the first period in which investment is able to affect non-physical dimensions of development in the estimation and thus the first period in which we can begin to account for their joint production. Clearly, the value of investment increases when we begin to account for its multidimensional effect.

To illustrate this point further, I estimate the law of motion in 1.7 as if cognition and noncognitive traits were unobserved and left in the error term for all childhood periods

Table 1.11: Adult Human Capital by Investment Year: Excluding Cognition and Noncognitive Skill in Production

|  | Year of Parental Investment | | | | | |
|  | Year 1 | Year 2 | Year 8 | Year 11 | Year 15 | All Years |
| --- | --- | --- | --- | --- | --- | --- |
| Health | 0.030 | 0.023 | 0.002 | 0.003 | -0.002 | 0.055 |
| Cognition | 0.042 | 0.032 | 0.002 | 0.004 | -0.003 | 0.077 |
| Positive | 0.023 | 0.018 | 0.001 | 0.002 | -0.001 | 0.043 |
| Negative | -0.006 | -0.005 | -0.0003 | -0.001 | 0.0003 | -0.011 |
| Risky | 0.002 | 0.001 | 8.34E-05 | 0.0001 | -9.7E-05 | 0.003 |

but not in adulthood (i.e., the child health production function is estimated throughout childhood without accounting for other dimensions of development and all adult outcomes are a function of health stock in the last period of childhood). Table 1.11 reports adult outcomes if we use these reported outcomes and do not account for the multidimensional nature of development. As in Table 1.10, each column reports adult human capital outcomes if one standard deviation of investment were to be made in the listed childhood period but no investment is made in other periods. Here we can see that all estimated adult outcomes would be improved (some substantially so) if the multidimensional nature of development is accounted for when estimating the long-term effect of investment in any childhood period. Thus if we only accounted for investment's affect on health in childhood, then we would certainly be undervaluing any investment made in child development in terms of its effect on adult outcomes.

## 1.8 Conclusion

A rapidly emerging literature documents the long term consequences of early childhood outcomes and environments. This literature highlights the importance of various aspects of childhood development for a broad range of later life outcomes including adult health status, economic productivity and numerous demographic outcomes. However, very few studies investigate how the many different dimensions of child development, including health, cognition and noncognitive traits, work jointly in the development of the child and his later human capital stock. Studies such as Heckman and Rubinstein (2001) and Cuhna and Heckman (2008) highlight, in particular, the importance of noncognitive traits working jointly with cognition in the technology of child development. Prior to these works, noncognitive development was largely ignored in the economics literature. Helmers and Patnam (2011) is one of the first studies to rigorously investigate the joint production of cognitive and noncognitive skills in a developing country context. However, to date, no work to my knowledge investigates the joint production of health, cognition and specific noncognitive traits in a developing country context. All three of these developmental dimensions have been shown, individually, to be enormously influential to human capital formation. Child health, in particular, has been repeatedly shown to be an important determinant to later human capital formation in developing countries, where the variation in child health is extremely high and children are often exposed to regular shocks to their health.

While much has been learned from the literature analyzing the individual effects of various dimensions of child development on adult human capital, much can still be gained if these same dimensions were instead investigated as parts of the same system in

a model of child development. Understanding the synergies that exist across the different dimensions of child development will allow parents and policymakers to better recognize the potential impact of inputs and interventions targeting specific aspects of child development. This will, in turn, allow for a better valuation of these interventions once these potential synergies are accounted for. This study finds that the impact of investment on ultimate adult outcomes is under-estimated when the multidimensional nature of child development is not accounted for. Thus, interventions may be being undervalued when they are evaluated in there impact on only one dimension of child development.

This study finds evidence for both self- and cross-productive effects in the production of multiple dimensions of child development, namely, health, cognition, risky behaviors, groups socialization, positive affect and negative affect. I also found evidence for sensitive periods for parental investment, particularly in the production of health. This implies that child development is a cumulative process. Therefore early disparities in child development, particularly in health, will persist unless effective and early remediation is undertaken.

CHAPTER 2

**THE ROLE OF PERSONALITY AND COGNITION IN DETERMINING**

**OCCUPATIONAL CHOICE AND EARNINGS**

## 2.1 Introduction

A large body of compelling evidence spanning multiple disciplines demonstrates that cognitive ability is an important predictor of a number of economic, demographic, and social outcomes of interest. However, recent research points to traits that are sometimes referred to as 'noncognitive' skills as being important for success in life. Noncognitive ability is a term that encompasses the socio-emotional status of an individual and numerous personality traits. It also includes characteristics such as motivation, perseverance, self-control, time preference, self-esteem and the ability to work with others. In the psychology and sociology literature, substantial evidence from developed countries points to the importance of various personality traits and noncognitive skills in determining outcomes such as job performance, wages, academic achievement, occupational choice, and health (Barrick and Mount, 1991; Chamorro-Premuzic and Furnham, 2003; Hampson et al., 2006; Hogan et al., 1996; Hogan and Holland, 2003; Ones et al., 2007; Robbins et al., 2006; Roberts et al., 2007; Schmidt and Hunter, 1998). In the last decade, a growing literature in economics further demonstrates the importance of noncognitive skills in determining a number of important economic, behavioral and demographic outcomes including school attainment, crime participation, earnings, and participation in risky behaviors (Blau and Currie, 2006; Cuhna et al., 2006; Curley et al., 2011; Heckman, 2007; Dawson et al., 2000; Knudsen et al., 2006; Marshall and Kenney, 2009; Meany, 2001).

Recent views hold that non-cognitive skills may be equally or even more important in determining economic success than cognition (Brunello and Schlotter, 2011).

With a few exceptions, the economics literature on this topic thus far largely focuses on the effects of some general noncognitive aggregate. However, for a number of reasons this is likely an insufficient approach to thinking about the relationship between noncognitive skills and outcomes of interest. Firstly, the term noncognitive is a large umbrella term that captures everything from specific task oriented skills such as concentration and self-discipline, to more general characteristics such as hardworking and trustworthiness, to overarching socio-emotional well-being. These various noncognitive skills and traits do not all necessarily correlate together. For example, whether or not someone suffers from depression tells us very little about that person's concentration skills. Therefore, different noncognitive skills are unlikely to covary in ways that warrant folding them into just one general non-cognitive index.

Furthermore, given the broad range of characteristics and traits encompassed by the term noncognitive, when a study finds that 'noncognitive' skills do or do not have an effect on some outcome of interest, this actually tells us very little about what is affecting this outcome. Is it some component of emotional stability or is it an individual's work ethic or leadership skills? If we do not know more specifically about what is affecting our outcomes of interest, then we are unable to compare findings across different studies. Additionally, there is little we can infer from this work to direct policy. An effect of general noncognitive skills on, say earnings gives us little in the way of a policy recommendation. Should we be teaching organizational skills to high school students or should we be looking more at activities focused on emotional support? Therefore, when we investigate

the effect of a noncognitive skill on any outcome of interest, we need to be more specific as to what we are actually examining.

While growing evidence continues to link noncognitive skills and personality traits to economic, demographic, and behavioral outcomes in the developed world, to our knowledge, to date, there is no evidence linking these characteristics to outcomes of interest in developing countries. There are a number of reasons why understanding the role of personality and specific noncognitive abilities in determining a number of outcomes in a developing country context might be of interest. In developing countries where schooling is not universal and school quality is generally lower, the importance of personality for success in life may be even greater than it is in developed countries. Personality traits may be able to explain much in the way of earnings, occupational choice, entrepreneurship, whether an individual works in the formal or informal sector, and a number of demographic and health outcomes.

In this paper, we estimate the effect of cognition and five specific personality traits on occupational choice and entrepreneurship for a sample of young adults in Madagascar. The five personality traits are what is known in the psychology literature as the Big Five Personality traits. They are Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism. This is the first study to our knowledge that links personality to job market outcomes in a developing country context. It is also one of the few studies in the economics literature to relate specific personality traits to job market outcomes rather than investigating the effects of a more general noncognitive aggregate.

In the following section we describe some of the research on labor market segmentation and entrepreneurship in developing countries. In Section 2.3 we summarize research

on personality and noncognitive skills in the economics literature. Then in Section 3.2 we discuss the Big Five Personality traits and their relationship to economic outcomes. Section 3.4 describes our data and methods for measuring personality. Section 3.5 describes our estimation strategy. In Section 3.6 we explain our results and Section 3.7 concludes.

## 2.2 Occupational Segmentation and Entrepreneurship in Developing Countries

It is often useful to consider different segments of labor markets in developing countries. While not completely distinct from each other, the conventional classification of labor market segments by job quality and the nature of employment is useful especially since they are likely to differ in returns to different skill sets, and thus wages and the likelihood of being employed (De Beyer and Knight, 1989; Gindling, 1991; Glick and Sahn, 1997; Khandker, 1992; Nasir, 2005; Vijverberg, 1986, 1993). Much of the literature examining labor market segmentation focuses predominately on the idea that there exists a dual labor market consisting of formal and informal segments. However, it can also be useful to think about further labor market segmentation where different labor sectors can include formal wage employment in the public or private sector, self-employment and work in family-run enterprises among others.

Better understanding how individuals select into different labor market segments helps us to better understand important welfare implications of labor market segmentation in developing countries. Modeling sectoral selection helps us to see which individual

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characteristics and traits are rewarded or taxed depending on the employment segment. It also sheds light onto potential barriers that exist between labor market segments and prevent entry into more stable and/or prosperous jobs, particularly wage employment.

Most studies examining occupational selection in developing countries focus on selection into formal and informal employment and the role of education in this process. Indeed, many studies have found that education increases the likelihood of an individual participating in the formal wage market (De Beyer and Knight, 1989; Khandker, 1992; Vijverberg, 1986, 1993) For example, Vijverberg (1993) finds that education and experience increase the likelihood of being a formal wage earner. He surmises that these findings suggest that human capital, either in the form of education or experience, has greater rewards (or increases productivity more) in the formal labor market than in self-employment. In a meta-analysis assessing whether and to what extent education affects entrepreneurship entry and performance in developing countries, van der Sluis et al. (2005) find that more educated workers tend to opt for wage employment over non-farm entrepreneurship and they also prefer non-farm entrepreneurship over farming.

A few studies use a multinomial logit approach to look at occupational choice in a developing country setting beyond just the formal and informal market division. Nasir (2005) examines occupational determinants for males and females in Pakistan. His main finding is that higher education is associated with being in a high paying job in the managerial, professional, teaching and medical sectors. He also finds that education has less of an effect on occupational choice as one moves down the occupational ladder. Finally he finds that educations exerts a relatively larger effect on the the likelihood of a women being in a high paying job than a man.

Glick and Sahn (1997) investigate the urban labor market structure in the Guinean capital of Conakry. Using a multinomial logit approach, they look at four labor market segments: self-employment, privates sector wage-employment, public sector wage employment and non-participation. Specifically they explore whether labor market segments differ in terms of entry determinants and earnings. They also look at sector specific returns to schooling as well as gender differences in access to and earning within each labor market sector. The authors find that for both men and women, more education reduces the likelihood of being self-employed while it strongly increases the likelihood of being in the public wage sector. They also find that education increases the probability of women working as a private wage employee.

In this analysis we explore occupational choice and entrepreneurship for a group of young adults in Madagascar. We not only look at selection into formal and informal labor sectors but also into family enterprises and domestic work and non-participation. Since the individuals in our sample are still relatively young, many of them have not yet completed their education. Therefore we also account for individuals who are still in school. Like much of the literature on occupational choice in developing countries, we are interested in the role of human capital in this process. However, while much of this literature has focused on education as a proxy for human capital as a determinant, we are more interested in understanding directly the role of cognitive skills measured by a set of cognitive tests, and noncognitive skills, specifically, personality traits.

## 2.3 Noncogntive Skills in the Economics Literature

The importance of noncognitive skills first became apparent in the economics literature in a series of groundbreaking papers on the economic and behavioral outcomes of high school drop-outs who completed a General Education Development (GED) Test. Cameron and Heckman (1993) observed that although GED recipients have what are supposed to be equivalent cognitive qualifications as regular high school graduates, they earn much lower wages. Heckman et al. (2000) further demonstrate that after controlling for cognitive ability, GED recipient high school drop outs actually earn less, have lower hourly wages and obtain lower levels of schooling than their normal high school drop out counterparts. The performance gap between these two groups was then attributed to some unmeasured element of noncognitive ability.

In their pioneering study, Heckman et al. (2006) explicitly estimate specific noncognitive skills and provide direct evidence for their importance in numerous behavioral and labor market outcomes. The noncognitive skills they investigate are self-esteem and locus of control. An individual's locus of control indicates the degree to which an individual feels he possess control over his own life. They find that for a variety of the outcomes they measure, a change in noncognitive skills from the lowest to the highest level of the ability distribution produces comparable or even greater effect than a similar change in cognitive skill. For example, they found that if an individual moves from the 25th to the 75th percentile in the noncognitive skills distribution then their wages would in increase approximately 10 percent for males and 40 percent for females. A similar movement in the cognitive skill distribution would increase wages about 20 percent for males and 40 percent for females. They found that noncognitive skills raise wages through not only

a direct effect on productivity, but also through an indirect effect through schooling and work experience. Once the authors controlled for the effects of schooling, they found that earnings respond more strongly to noncognitive skills than they do to cognitive skills.

Using ability measures resulting from Swedish military enlistment, Lindqvist and Vestman (2011) investigate the relationship between cognitive and noncognitive skills and labor market outcomes. The noncognitive skill in this work is extrapolated from personality tests given at the time of enlistment and were designed to assess the conscript's ability to handle the psychological demands of serving in the military. The authors find that both cognitive and noncognitive skills are important predictors of labor market earnings. Moreover, they find that the effect of noncognitive skills on wages is strongest for individuals at the lower end of the earnings distribution. At the tenth percentile, the effect of noncognitive skills on wages is between 2.5 and 4 times than that of cognitive skills. This result is partly explained by the fact that the men in the study with low noncognitive ability were more likely to be unemployed than were men with low cognitive ability. Men with low noncognitive ability were also more likely to experience longer spells of unemployment.

Carneiro et al. (2007) find that for a sample of individuals in Great Britain a general measure of noncognitive skills was important in explaining a number of educational and employment outcomes including whether or not an individual drops out of school by age 16, whether a degree is obtained by age 42, employment status at 42, work experience and wages. In this sample general noncognitive skill also explains risky behaviors such as teen smoking, teen pregnancy, crime participation, health, truancy and exclusion from school. The authors then split noncognitive skill into twelve different domains. They found that

'inconsequential behavior' at age 11 is a associated with the likelihood of dropping out of school by age 16, teen smoking and later truancy and crime participation. They also found that depression at age 11 is associated with school attainment, teen smoking, school exclusion and adult depression.

## 2.4 The Big Five Personality Trait Taxonomy

A widely accepted taxonomy of personality traits is found in the Five-Factor Model of personality, also referred to as the Big Five Personality Traits. Most variables used to asses personality in the field of personality psychology can be mapped into one or more dimensions of the Big Five Personality Traits: Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism (John et al., 2008; McCrae and Costa, 2008; Brunello and Schlotter, 2011). *Openness to Experience* is the degree to which a person is curious, needs intellectual stimulation, change and variety. It describes the complexity, depth and originality of an individual. *Conscientiousness* captures the attitude of being hardworking, organized and dependable as opposed to lazy, disorganized and unreliable. People high in Conscientiousness tend to be able to delay gratification, follow the rules, adhere to norms and think before acting. It describes the characteristics behind task- and goal-oriented behavior. *Extroversion* captures the preference for human contact, empathy, gregariousness, assertiveness and a wish to inspire people. Extroverted individuals have an energetic approach to social and material life. *Agreeableness* is the degree to which someone is cooperative, altruistic, modest, warm and agreeable, in contrast to being cold, disagreeable and antagonistic. *Neuroticism* is the extent to which an individual is inse-

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cure, anxious, depressed and emotional rather than calm and self-confident (McCrae and Costa, 2008). These five personality traits are summarized in Table 3.1.

Table 2.1: The Big Five Personality Traits

| Personality Trait | Basic Tendencies | Characteristic Adaptations |
|---|---|---|
| Openness to Experience | a need for variety, novelty, and change | intellectual curiosity; interest in travel; many different hobbies; diverse vocational interests |
| Conscientiousness | strong sense of purpose and high aspiration levels | leadership skills; long-term planner; hard-working; organized; dependable |
| Extroversion | preference for companionship and social stimulation | social skills; numerous friendships; gregarious; assertive; talkative |
| Agreeableness | a willingness to defer to others during interpersonal conflict | forgiving attitude; belief in cooperation; warm |
| Neuroticism | sadness, hopelessness, guilt | Low self-esteem; pessimistic attitude; insecure; anxious; depressed |

Historically, researchers in personality psychology were beset by a wide ranging array

of personality scales with little guidance how to choose between or use them. The Five Factor Model of Personality first rose out of lexicographic studies describing personality (John et al., 2008). Since then the use of this model has increased substantially and the field of psychology has reached an initial consensus around the five factor framework (John et al., 2008). This has given way to replication and consistent definitions, even though there remain variations in methodology and data sources. The model has also been consistent, and argued to be relevant, across different cultures and across different periods of the adult lifespan (McCrae and Costa, 2008).

Evidence from sociology and psychology link the Big Five Personality Traits to educational outcomes, job performance, occupational choice and earnings[1]. Agreeableness negatively predicts heart disease. High Neuroticism is associated with less successful coping with and poorer reactions to illness. Extroversion, on the other hand is associated with more social support and close relationships, which are important for coping with illness (John et al., 2008). Conscientiousness has been shown to be an important predictor of grades, years of education, job performance in a wide range of jobs and leadership ratings (Borghans et al., 2008; Brunello and Schlotter, 2011; John et al., 2008). Furthermore, evidence shows that self-discipline (an aspect of Conscientiousness) accounts for more than twice as much of the variation in grades than does IQ (Brunello and Schlotter, 2011). Research shows Openness to Experience to be the best personality predictor of the number of years of education . Agreeableness positively and Neuroticism negatively predict job performance where people work in groups. Openness predicts success in artistic jobs. Neuroticism is an important negative predictor of job satisfaction (Brunello and Schlotter,

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[1]The Big Five Personality Traits are also related to health outcomes. Conscientiousness has been shown to be an important predictor of good health habits, health outcomes and longevity and is inversely related to participation in numerous risky behaviors (Hampson et al., 2006; John et al., 2008)

2011; John et al., 2008).

Mueller and Plug (2006) investigate how the Big Five Personality Trait taxonomy explains male and female earnings. They found that all five traits had significant earnings effects. Agreeableness and Neuroticism were negatively associated with male earnings while conscientiousness is positively associated with female earnings. Openness to Experience has a significant positive effect on the earnings of both men and women. Of the five traits Agreeableness was the largest determinant of wage gaps between men and women where men were much less Agreeable than women and were rewarded in the labor market for their lack of that trait.

Ham et al. (2009) examine personality determinants of whether individuals select into a blue or white collar occupations. They find that Conscientiousness has a significant and positive effect on the likelihood of being in a white collar occupation for both males and females. For males only they further find that Openness to Experience positively determines the probability of being in a while collar job while Neuroticism and Agreeableness have a negative impact on this likelihood.

Cobb-Clark and Tan (2010) also investigate the effect of personality on the male-female wage gap, both in how it affects earnings indirectly through occupational selection and directly on earnings within occupations. They find that personality has substantial effects on selection into certain occupations. Among their findings they find that Agreeableness negatively affects selection into managerial positions, science-related professions and business-related professions. Openness to Experience positively selects into these professions as well as into education-related professions. Conscientiousness positively selects into managerial positions and negatively select into factory labor and education-

related professions.

These studies, while still few in number, are also all from developed country contexts. While they begin to provide some basis for generalization, the number of studies are few, and they also have important differences from each other, and our work. For example, the studies that do examine occupational choice vary widely in the labor market segments examined and often look solely at currently working individuals and therefore do not account for selection into the labor market. We do so, using a household based sample, rather than limiting our model to only those currently working. Furthermore, none of the studies we are aware of model how both cognitive skills and specific personality traits affect occupational choice. The fact that we can control for test scores, and their potential impact on labor market outcomes, is indeed unique. There is also no study we are aware of that examines the effect of personality on entrepreneurship, which we are able to do since we designed a special module in our questionnaire to explore entrepreneurial activities. And of course, our study comes from a developing country where the nature and characteristics of the labor market are dramatically different from a developed country context. This includes the large share of persons engaged in family enterprises and outside the formal wage sector. Our study on young adults in Madagascar, thus adds to this limited global literature, and as far as we know, is unique in terms of the dimensions above, and even more generally in terms of looking at how these crucial personality traits affect occupational choice and entrepreneurship in a developing country context.

## 2.5 Madagascar Life Course Transitions of Young Adults Survey

The data used in this paper come from the *Madagascar Life Course Transitions of Young Adults Survey*. The survey 2011-2012 re-interviewed a cohort of 1749 young adults between the ages of 21 and 24 years, who were originally surveyed in 2004. 1733 of these individuals were administered a personality questionnaire and approximately 1500 if those individuals also took cognitive tests. Five cognitive tests were administered: written math, oral math, written French, oral French and a 'life skills' test, which was designed to measure practical knowledge and covered topics such as health practices, nutrition and civics. Cognitive tests were scored by adding the number correct. In our estimation we aggregate the scores of the 2012 two math and two french tests together and then standardize this aggregate using the data's sample moments.[2]

The surveys were specifically designed to capture the transition from adolescence to young adulthood and thus included detailed information on household characteristics, family background and health. Detailed community surveys were also conducted in 2004 and 2012 and the 2004 surveys also include detailed information on schools. We include a range of controls in the models from these surveys. After accounting for missing variables at the individual and community level, we are left with 1475 individuals in our working sample. Table 2.2 compares the characteristics of individuals included in our working sample and those left out due to missing information. Overall, it appears that individuals excluded from our sample exhibited lower levels of Openness to Experience and Conscientiousness. They were also sightly older on average, had lower grade attainment, their

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[2]We also performed the following estimations using each cognitive test scores separately, using separate French and math score aggregates and oral and written score aggregates. None of these specifications had a substantive effect on our results.

mothers also had lower grade attainment, their 2004 households had a lower asset index, and they were more likely to live in a rural area. Thus the individual exclusion from our sample is non-random and we are more likely to miss individuals who are more disadvantaged and from a rural area. While there is nothing we can do about this, it is worth keeping in mind.

Table 2.2: Comparison of Characteristics between Sample and Non-Sample Individuals

|  | Not in Sample | In Sample | Difference |
|---|---|---|---|
| Openness to Experience | -0.163 | 0.029 | -0.192*** |
| Conscientiousness Zscore | -0.107 | 0.019 | -0.126* |
| Extraversion Zscorre | -0.052 | 0.009 | -0.061 |
| Agreeableness Zscore | -0.064 | 0.011 | -0.075 |
| Neuroticism Zscore | -0.004 | 0.001 | -0.005 |
| 2004 Asset Index | -0.069 | 0.082 | -0.151* |
| Male | 0.476 | 0.484 | -0.008 |
| Mother's Education | 3.15 | 4.864 | -1.713*** |
| Age | 22.987 | 22.749 | 0.238*** |
| Grade | 6.193 | 8.064 | -1.872*** |
| Urban | 0.141 | 0.268 | -0.128 |

General descriptive statistics on our working sample can be found in Table 2.3. Roughly 48% of the sample is male, 27% lives in an urban area and the average age is approximately 22 years. The mean level of education around 8 years while their mothers and fathers have attained around 5 and 5.5 years of education, respectively. Approxi-

mately 15% of the sample has engaged in some sort of entrepreneurial activity.

Table 2.3: Summary Statistics N=1475

|  | Mean | St. Dev. | Min | Max |
|---|---|---|---|---|
| Male | 0.484 | 0.5 | 0 | 1 |
| Age | 21.941 | 1.263 | 14 | 26 |
| Highest Grade Attained | 8.064 | 4.314 | 0 | 89 |
| Mother's Education | 4.864 | 3.612 | 0 | 17 |
| Father's Education | 5.548 | 3.97 | 0 | 17 |
| Entrepreneurship | 0.147 | 0.354 | 0 | 1 |
| Transfers into Household | 245.359 | 1345.104 | 0 | 29440 |
| Urban | 0.268 | 0.443 | 0 | 1 |
| Households in Community with Electricity | 0.464 | 0.499 | 0 | 1 |
| Access to Secondary School in Community | 0.603 | 0.49 | 0 | 1 |
| Health Center in Community | 0.844 | 0.363 | 0 | 1 |

In this paper we estimate selection into five occupational categories: employment in the formal public or private sector, self-employment, working in a family enterprise or doing domestic work in another household, student and unemployed (i.e., neither a student nor working). Much of our sample (47% or 687 individuals) is employed in a family enterprise or are doing domestic work in a household that is not their own. 365 individuals in the sample are self-employed and 195 are employed in the formal public or private sector. There are over twice as many males as females in the public or private sector. 235 individuals are still students and 96 are unemployed. Individuals in the the formal public or private sector are largely working in skilled or semi-skilled jobs or are in upper or mid-

dle management positions. Self-employed individuals are predominately working in the agricultural or livestock sector. However some self-employed individuals can be found in service or low-skill industries as well. Individuals working in a family enterprise or who are doing domestic work are also largely found in the agricultural/livestock sector and are mostly working as some sort of caregiver. Table 2.4 describes occupational segment by entrepreneurship status. 217 entrepreneurs were defined in out sample. An individual was defined as an entrepreneur if he claimed to own his own business in which he was the sole worker or he highered some number on other workers.[3] Of the 217 entrepreneurs in our sample, 141 are self-employed and 61 work in a family enterprise or are doing domestic work. Only 15 of our entrepreneurs are working in the formal public or private sector.

Table 2.4: Entrepreneurship by Labor Market Segment

|  | Entrepreneur | | |
| --- | --- | --- | --- |
|  | No | Yes | Total |
| Public/Private Sector | 180 | 15 | 195 |
| Self-Employed | 224 | 141 | 365 |
| Family/Domestic Work | 526 | 61 | 587 |
| Student | 232 | 0 | 232 |
| Undemployed | 96 | 0 | 96 |
| Total | 1,258 | 217 | 1,475 |

[3]These workers could be salaried, unpaid, daily or intermittent, partners or apprentices.

### 2.5.1 Measuring Personality

The 2012 questionnaire includes a module designed to characterize personality traits. This module has 116 questions designed capture how individuals behave and respond to different situations. For each question in the personality module, individuals were asked to rate their response to a statement as 1-Strongly Disagree, 2-Somewhat Disagree, 3-Neither Agree or Disagree, 4-Tend to Agree and 5-Strongly Agree. These questions are then used as inputs to measure the Big Five Personality Traits for each individual. A few examples of questions used to measure each personality trait can be found in Table 3.5. Tables C.1-C.5 in the appendix lists summary statistics for all the questions used to measure each personality trait.

We model the Big Five Personality Traits as unobserved variables and use confirmatory factor analysis to uncover their latent distributions. By using confirmatory factor analysis we can estimate the latent joint distribution of our five personality traits using the variance-covariance structure of survey questions designed to measure each trait. Personality traits are then estimated using the following measurement system:

$$
\begin{aligned}
Z_j^O &= \mu_j^O + \lambda_j^O \theta^O + \epsilon_j^O && \text{for } j \in \left\{1, ..., m^O\right\} \\
Z_j^C &= \mu_j^C + \lambda_j^C \theta^C + \epsilon_j^C && \text{for } j \in \left\{1, ..., m^C\right\} \\
Z_j^E &= \mu_j^E + \lambda_j^E \theta^E + \epsilon_j^E && \text{for } j \in \left\{1, ..., m^E\right\} \\
Z_j^A &= \mu_j^A + \lambda_j^A \theta^A + \epsilon_j^A && \text{for } j \in \left\{1, ..., m^A\right\} \\
Z_j^N &= \mu_j^N + \lambda_j^N \theta^N + \epsilon_j^N && \text{for } j \in \left\{1, ..., m^N\right\}
\end{aligned}
\tag{2.1}
$$

where O indexes Openness to Experience, C indexes Conscientiousness, E indexes Ex-

Table 2.5: Examples Questions Measuring the Big Five Personality Traits

| **Openness to Experience** |
| --- |
| I find the world very interesting |
| In any situation I can find something interesting |
| I'm very interested in other countries and their cultures |
| **Conscientiousness** |
| I never leave a task without completing it |
| I do my job without waiting |
| I like to order things around me |
| I always keep my promises |
| **Extroversion** |
| I like to animate groups |
| I take the initiative in conversations |
| I always have something to say |
| I work better when I'm alone |
| **Agreeablesness** |
| I respect the decisions of the group |
| I think honesty is the basis of trust |
| I am rarely angry |
| **Neuroticism** |
| I panic easily |
| I am often sad |
| I get discouraged easily |
| I am often worried |

troversion, A indexes Agreeableness and N indexes Neuroticism. $Z_j^p$ is the observed $j^{th}$ measurement for latent personality trait $\theta^p$. $m^p$ is the number of observed measurements for latent trait $p$, $p \in \{O, C, E, A, N\}$. To ensure that the model is not underidentified, we normalize $\lambda_1^p = 1$ for all $p \in \{O, C, E, A, N\}$. This simply sets scale and is common practice in factor analysis. We also normalize $E[\theta^p] = 0$. Doing so centers the distribution of the latent factors over zero and is also common practice. Since the factors do not have any cardinal value, this normalization does not have any implications for how we interpret our results. The $\epsilon's$ are assumed to be mean zero, are uncorrelated with the factors and are independent across agents and factors. Using confirmatory factor analysis we predict the factor loadings, $\lambda_j^p$, and predict a personality trait factor score for each individual sample. We then use the standardized factor scores to estimate their effect on occupational choice and entrepreneurship. Estimated factor loadings, $\lambda_j^p$, and intercepts, $\mu_j^p$, from the measurement model can be found in Appendix Tables C.6-C.10. Appendix Table C.11 show Cronbach's $\alpha$ for each of the personality traits estimated in equation 3.1. Cronbach's $\alpha$ is a coefficient that measures the internal consistency or reliability of the measurements being used to estimate the five personality factors. Estimates for Cronbach's $\alpha$ for each personality trait is 0.71, 0.92, 0.80, 0.66 and 0.82 for Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism, respectively. Thus for the most part our measurement instruments are reasonably consistent. The only personality factor with questionaable reliability is that measuring Agreeableness. However, given our data there is little we can do to improve upon this measure.

Table 2.6 describes the standardized personality factor scores by gender. On average males in the sample exhibit statistically significantly more Openness to Experience and Extroversion and less Neuroticism than the females in our sample. Table 2.7 gives the

Table 2.6: Standardized Personality Traits by Gender

|  | Female | Male | Difference |
|---|---|---|---|
| Openness to Experience Zscore | -0.061 | 0.124 | -0.185*** |
| Conscientiousness Zscore | -0.019 | 0.059 | -0.079 |
| Extroversion Zscore | -0.066 | 0.089 | -0.156*** |
| Agreeableness Zscore | -0.019 | 0.043 | -0.062 |
| Neuroticism Zscore | 0.079 | -0.083 | 0.163*** |

correlation matrix of each of the five personality traits and the standardized aggregate cognitive test score. Each of these variables are statistically significantly correlated at the one percent level. In particular there is a high degree of correlation between Openness to Experience, Conscientiousness and Extroversion. Of the five personality traits, the aggregate cognitive test score is most correlated with Openness to Experience. Figure 1 describes personality traits by occupation type. Self-employed individuals and those working in a family enterprise or domestic work appear to have much lower levels of Conscientiousness, Extroversion, Openness and Agreeableness and higher levels of Neuroticism than individuals in other employment sectors. Individuals in the other sectors, public/private, students and unemployed, appear to have fairly high levels of all the personality traits except Neuroticism. Students and individuals in the formal public or private sector appear to have strikingly high levels of Openness to Experience. Figures 2 through 4 describe personality traits by entrepreneurial status in each of the three working occupational categories. While there is some variation across categories, overall entrepreneurs appear to exhibit higher levels of Openness to Experience and lower levels of Agreeableness.

Table 2.7: Correlation Matrix of Personality Traits and Cognitive Test Score

| | Openness to Experience Zscore | Conscientiousness Zscore | Extroversion Zscore | Agreeableness Zscore | Neuroticism Zscore | Aggregate Math/French Zscore |
|---|---|---|---|---|---|---|
| Openness to Experience Zscore | 1 | | | | | |
| Conscientiousness Zscore | 0.6559*** | 1 | | | | |
| Extroversion Zscore | 0.6294*** | 0.7471*** | 1 | | | |
| Agreeableness Zscore | 0.5159*** | 0.7200*** | 0.7496*** | 1 | | |
| Neuroticism Zscore | -0.1735*** | -0.3357*** | -0.4357*** | -0.2798*** | 1 | |
| Aggregate Math/French Zscore | 0.2295*** | 0.1356*** | 0.1763*** | 0.0877*** | -0.1253*** | 1 |

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## 2.6  Estimation Strategy

### 2.6.1  Occupational Choice

We estimate two models: one of selection into different labor market segments and the other of entrepreneurship. For market segment selection we look at selection into five different employment categories: employment in the formal public or private sector, self-employment, working in a family enterprise or doing domestic work in another household, student and unemployed. Following a similar approach as Glick and Sahn (1997) and Nasir (2005), we use the multinomial logit model to estimate the probabilities that an individual will be found in each employment sector. Briefly outlining this model, the utility of individual $i$ in occupation alternative $k$, $V_{ik}$, is specified in linear form:

$$V_{ik} = \mu_k + \sum_{p=1}^{5} \beta_k^p \theta_i^p + \beta_k^6 \theta_i^{Cog} + \gamma_k X_i + \delta_k R_i + \epsilon_{ik} \tag{2.2}$$

where $\theta_i^p$ is the level of individual $i's$ personality trait $p \in \{O, C, E, A, N\}$. $\theta_i^{Cog}$ is individual $i's$ cognitive skill measured by the cognitive test score aggregate, $X_i$ is a vector of individual characteristics and $R_i$ is a vector of community characteristics. Included individual characteristics are gender, age, a household asset index constructed from the 2004 survey round, mother's and father's highest grade attainment and non-labor income in the form of transfers.[4] Community characteristics included are an urban indicator, whether or not any household's in the community have electricity, whether or not there

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[4]Non-labor income includes cash and the value of in-kind transfers both from individuals outside the household and from the government.

is a secondary school in the community and whether there is a community health center. A set of province dummy variables are also included.

An individual is assumed to select into occupational sector $k \in \{1, 2, 3, 4, 5\}$ for which he receives the highest utility (i.e., for which $V_{ik}$ is the highest). Thus the probability that individual $i$ selects into sector $k$ is

$$P_{ik} = Pr\left(V_{ik} > V_{il}\right) \text{ for all } k \neq l \tag{2.3}$$

Since the formulation of (3) is a function of differences in utilities derived from choosing each sector, some normalization is required. We therefore use working in the formal public or private sector as the base category in our estimation. The estimated coefficients are therefore interpreted as the effects of a variable on the utility of being in employment alternative $j$ relative to the utility derived from the base category of working in the formal public or private sector.

## 2.6.2 Entrepreneurship

We model whether or not individuals engage in entrepreneurial activities using a probit model approach. Suppose $Y_i^*$ is individual $i's$ unobserved tendency towards entrepreneurial activities. Then we model this tendency as

$$Y_i^* = \mu + \sum_{p=1}^{5} \beta^p \theta_i^p + \beta^6 \theta_i^{Cog} + \gamma X_i + \delta R_i + \eta_i \tag{2.4}$$

where $\theta_i^p$, $\theta_i^{Cog}$, $X_i$ and $R_i$ are defined as they are in equation (2). An individual engages in entrepreneurial activities if $Y^* > 0$. Thus $Y = 1$ if an individual is an entrepreneur and

$$Y = \begin{cases} 1 & \text{if } Y^* \geq 0 \\ 0 & \text{if } Y^* < 0 \end{cases}.$$ (2.5)

Then after making some distributional assumptions the probability than indiviudal $i$ is an entrepreneur is defined as

$$Pr\left(Y_i = 1 | \theta_i^p, \theta_i^{Cog}, X_i, R_i\right) = Pr\left(Y_i^* > 0\right) = \Phi\left(\mu + \sum_{p=1}^{5} \beta^p \theta_i^p + \beta^6 \theta_i^{Cog} + \gamma X_i + \delta R_i\right)$$ (2.6)

where $\Phi(*)$ is the Cumulative Distribution Function of the standard normal distribution.

### 2.6.3 Instrumenting for Cognitive Test Scores

Finally, performance on achievement tests is clearly endogenous to occupational selection. For example, individuals who are still in school are more likely to have higher levels of completed schooling and are thus likely to perform better on the math and French achievement tests than those who left school earlier to join the work force. Furthermore, there is likely unobserved heterogeneity, which jointly affects cognition and labor force choices. Therefore estimated coefficients depicting the effect of cognitive test scores on

occupational selection and entrepreneurship are likely to be biased. Thus we instrument cognitive test scores with the following first-stage equation

$$\theta_i^{Cog} = \mu^{Cog} + \rho Z_i + \sum_{p=1}^{5} \beta^p \theta_i^p + \gamma X_i + \nu_i \tag{2.7}$$

where $Z_i$ is a vector of instruments from the 2004 survey round which includes rich information on the primary school in the community closest to the center of town. For instruments we use the distance between the center of town and this primary school[5], whether or not this primary schools participated in a government sponsored nutrition program and a school facilities quality index. The facilities quality index is formed using factor analysis on indicators on the availability of electricity, medicine, toilets, separate toilets, recreation grounds and clean water in the school. Finally, we include whether or not there is a private school in the community as an instrument. We also include all the individual- and community-level controls found in equations (2) and (4).

It is important to note that the primary school conditions measured for our instruments are not necessarily measuring the conditions of the primary school attended by the sample individual. These are the conditions of the primary school closest to the center of town. We use this information because primary school conditions in the area where the sample individual grew up are unlikely to affect adult occupational selection or entrepreneurship except through their effect on cognitive ability. Furthermore, while communities in the sample generally have a primary school, many do not have a secondary school. Therefore there is also weak correlation between primary school quality and sec-

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[5]Note, this is not necessarily the primary school that the sample individual attended

ondary school quality, strengthening the case that our instruments meet the necessary exclusion restrictions. Indeed only 60% of our sample communities have secondary school and the presence of secondary school is not a significant predictor of adult cognitive ability.

Table 2.8 reports first stage results. An F-test on the joint significance of our instruments is statistically significant at the one percent level with an F-Statistic value of 13.70 meaning that is is highly unlikely that our results would suffer from a weak instrument problem.

## 2.7 Results

### 2.7.1 Occupational Selection

Table 2.9 reports coefficient estimates from equation (2) without instrumenting for cognitive test scores. Table 2.10 reports estimated coefficients after instrumenting for cognitive test scores. Again, working in the formal public or private sector is used as a base outcome. Therefore the estimated coefficients can be interpreted as the effect of a variable on the utility of being in an alternative sector relative to being employed in the base category of the formal public or private sector. Examining Tables 2.9 and 2.10 we see that instrumenting for cognitive test scores has little to no effect on most of the estimated coefficients on personality traits. The coefficients on Openness to Experience are the only ones to change substantially once we instrument for cognitive ability. This makes sense

## Table 2.8: First-Stage Results Predicting Standardized Cognitive Test Scores

|  | Cognitive Score |
| --- | --- |
| Primary School Facility Quality Index | 0.2215*** |
|  | (0.033) |
| Distance between Town Center and Primary School | 0.0063 |
|  | (0.021) |
| Primary School Participation in Nutrition Program | 0.1234*** |
|  | (0.043) |
| Private School in Community | 0.0080 |
|  | (0.046) |
| Conscientiousness Zscore | -0.0574 |
|  | (0.038) |
| Extroversion Zscore | -0.0033 |
|  | (0.039) |
| Openness to Experience Zscore | 0.1557*** |
|  | (0.031) |
| Agreeableness Zscore | -0.0086 |
|  | (0.034) |
| Neuroticism Zscore | -0.0823*** |
|  | (0.023) |
| Male | 0.0421 |
|  | (0.042) |
| Age | -0.0246 |
|  | (0.018) |
| 2004 Asset Index | 0.1417*** |
|  | (0.026) |
| Mother's Education | 0.0496*** |
|  | (0.007) |
| Father's Education | 0.0432*** |
|  | (0.007) |
| Nonlabor Transfers | 0.0000 |
|  | (0.000) |
| HHs with Electricity in Community | -0.1550*** |
|  | (0.053) |
| Secondary School in Community | 0.4486*** |
|  | (0.048) |
| Health Center in Community | 0.1563** |
|  | (0.063) |
| Constant | -0.5576** |
|  | (0.280) |
| Observations | 1,475 |
| R-squared | 0.396 |

Robust standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

given that Openness is the personality trait most correlated with cognitive scores.

When we do not instrument for cognitive test scores, cognitive ability has a significant negative effect on whether someone is self-employed or works in a family enterprise or does domestic work relative to working in the public or private sector. Cognitive ability has a positive effect on the utility of someone who is a student relative to working in the public or private sector. However once we instrument for cognitive test scores the effect of cognitive ability on the utility of working in a family enterprise disappears and the positive coefficient on being a student becomes a significant negative coefficient. This suggests that individuals who stay in school longer are indeed able to perform better on achievement tests over those who leave school to join the workforce. However, after controlling for the endogenous relationship between being enrolled in school and test performance, it appears individuals with higher cognitive ability tend to drop out of school earlier in order to join the formal public or private sector. Individuals with higher cognitive ability are also less likely to be self-employed than to work in the formal sector. Similar to Vijverberg (1986), this is suggestive of higher returns to human capital in the formal public and private wage sector.

Focusing on Table 2.10, there are no statistically significant personality differences between individuals who remain in school and those who leave school to work in the public or private sector. More extroverted individuals are more likely to be unemployed than be in the formal sector and individuals with lower levels of Conscientiousness are more likely to work in a family enterprise or be involved in domestic work. Appendix Tables B.12-B.15 report the multinomial logit coefficient estimates for each employment sector with and without additional controls. Adding individual- and community-level controls

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Table 2.9: Multinomial Logit Coefficients on Occupational Status: Non-Instrumented Cognitive Test Scores

| | Occupational Category | | | | |
| --- | --- | --- | --- | --- | --- |
| | Public/Private | Self Employed | Family Enterprse/ Domestic Work | Student | Unemployed |
| Conscientiousness Zscore | Base Outcome | -0.2060 | -0.4488*** | -0.1481 | -0.0639 |
| | | (0.185) | (0.174) | (0.205) | (0.243) |
| Extraversion Zscore | | 0.3171* | 0.2579 | -0.1677 | 0.6776** |
| | | (0.194) | (0.182) | (0.232) | (0.277) |
| Openness to Experience Zscore | | -0.2488* | -0.3813*** | -0.0521 | -0.6401*** |
| | | (0.149) | (0.140) | (0.175) | (0.207) |
| Agreeableness Zscore | | -0.0717 | 0.1296 | 0.2159 | -0.1127 |
| | | (0.187) | (0.175) | (0.198) | (0.232) |
| Neuroticism Zscore | | 0.0596 | 0.0955 | 0.0381 | 0.1718 |
| | | (0.112) | (0.106) | (0.126) | (0.150) |
| Aggregate Math/French Zscore | | -1.0790*** | -0.6075*** | 0.8160*** | -0.1579 |
| | | (0.140) | (0.130) | (0.155) | (0.199) |
| Male | | -0.5436** | -0.7967*** | -0.8814*** | -1.6162*** |
| | | (0.214) | (0.198) | (0.229) | (0.300) |
| Age | | -0.0596 | -0.1494* | -0.4800*** | 0.0079 |
| | | (0.088) | (0.082) | (0.092) | (0.119) |
| 2004 Asset Index | | 0.1086 | -0.0185 | 0.2473* | 0.1142 |
| | | (0.151) | (0.132) | (0.133) | (0.180) |
| Mother's Highest Grade Attainment | | -0.1269*** | -0.0869*** | 0.0179 | 0.0175 |
| | | (0.035) | (0.032) | (0.034) | (0.048) |
| Father's Highest Grade Attainment | | -0.0142 | -0.0387 | -0.0132 | 0.0541 |
| | | (0.031) | (0.029) | (0.033) | (0.043) |
| Nonlabor Transfers into Household | | 0.0003* | 0.0001 | 0.0003** | 0.0002 |
| | | (0.000) | (0.000) | (0.000) | (0.000) |
| Urban | | -1.3116*** | -0.7646** | 0.2631 | -0.2926 |
| | | (0.359) | (0.323) | (0.397) | (0.439) |
| Households with Electricity in Community | | 0.3952 | -0.0298 | -0.7351** | 0.3192 |
| | | (0.289) | (0.281) | (0.362) | (0.408) |
| Secondary School in Community | | -0.4003 | -0.1537 | -0.3106 | -0.4983 |
| | | (0.299) | (0.280) | (0.312) | (0.399) |
| Health Center in Community | | -0.6002* | -0.4891 | -0.5931* | -0.9048* |
| | | (0.357) | (0.329) | (0.363) | (0.464) |
| Constant | | 3.7914* | 6.1402*** | 10.5645*** | 0.1046 |
| | | (2.030) | (1.895) | (2.104) | (2.689) |
| Province Dummies | YES | YES | YES | YES | YES |

Robust standard errors in parentheses

*** p¡0.01, **p¡0.05, *p¡0.1

## Table 2.10: Multinomial Logit Coefficients on Occupational Status: Instrumented Cognitive Test Scores

| | | | Occupational Category | | |
|---|---|---|---|---|---|
| | Public/Private | Self Employed | Family Enterprse/ Domestic Work | Student | Unemployed |
| Conscientiousness Zscore | Base Outcome | -0.1763 | -0.4754*** | -0.1575 | -0.1957 |
| | | (0.187) | (0.175) | (0.208) | (0.297) |
| Extraversion Zscore | | 0.3117 | 0.2744 | -0.0213 | 0.5925** |
| | | (0.215) | (0.181) | (0.198) | (0.308) |
| Openness to Experience Zscore | | -0.0031 | -0.2556 | 0.2576 | -0.3281 |
| | | (0.197) | (0.208) | (0.224) | (0.244) |
| Agreeableness Zscore | | -0.1826 | 0.0888 | 0.0113 | -0.1411 |
| | | (0.181) | (0.175) | (0.206) | (0.268) |
| Neuroticism Zscore | | -0.0049 | 0.0586 | -0.0534 | 0.1079 |
| | | (0.105) | (0.119) | (0.138) | (0.137) |
| Instrumented Aggregate Math/French Zscore | | -2.6119*** | -1.0127 | -1.5142** | -0.8494 |
| | | (0.650) | (0.794) | (0.785) | (0.997) |
| Male | | -0.5358*** | -0.8133*** | -0.8474*** | -1.6505*** |
| | | (0.203) | (0.189) | (0.193) | (0.296) |
| Age | | -0.0444 | -0.1369** | -0.4080*** | -0.0955 |
| | | (0.076) | (0.067) | (0.080) | (0.126) |
| 2004 Asset Index | | 0.4431*** | 0.0988 | 0.6340*** | 0.2649 |
| | | (0.172) | (0.176) | (0.201) | (0.241) |
| Mother's Highest Grade Attainment | | -0.0112 | -0.0677 | 0.1080*** | 0.0495 |
| | | (0.048) | (0.045) | (0.044) | (0.067) |
| Father's Highest Grade Attainment | | 0.0365 | -0.0209 | 0.0842* | 0.0934 |
| | | (0.039) | (0.046) | (0.051) | (0.066) |
| Nonlabor Transfers into Household | | 0.0002 | 0.0000 | 0.0004*** | 0.0002 |
| | | (0.001) | (0.000) | (0.000) | (0.000) |
| Urban | | -1.6128*** | -0.8125** | -0.3671 | -0.4286 |
| | | (0.346) | (0.259) | (0.367) | (0.455) |
| Households with Electricity in Community | | 0.0916 | -0.1636 | -0.4510 | 0.0843 |
| | | (0.324) | (0.281) | (0.405) | (0.449) |
| Secondary School in Community | | 0.5308 | 0.1817 | 0.7696 | -0.0764 |
| | | (0.446) | (0.458) | (0.481) | (0.587) |
| Health Center in Community | | -0.4844 | -0.5143 | -0.2159 | -0.7023 |
| | | (0.332) | (0.342) | (0.365) | (0.455) |
| Constant | | 2.1906 | 5.5330*** | 7.7688*** | 1.8552 |
| | | (1.769) | (1.725) | (1.926) | (3.130) |
| Province Dummies | YES | YES | YES | YES | YES |

Bootstrap corrected standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

has little to no effect on the estimated personality and cognition coefficients. This alleviates concerns that unobserved characteristics correlated with our control variables bias our estimated coefficients.

Table 2.11 reports the average marginal effects of each right-hand-side variable on the probability that each sample individual is employed in each sector. Conscientiousness and cognitive ability have a statistically significant positive effect on the likelihood an individual is employed in the formal public or private sector. Here we see that if an individual is higher in Conscientiousness or cognition by one standard deviation, then the likelihood that he is employed in the public or private sector increases by 3% and 15%, respectively. It is noteworthy that cognitive ability has the highest average marginal effect on the likelihood an individual is employed in the formal public or private sector of any of the determinants we examine. Thus it appears that in this sector cognitive ability is a highly valued form of human capital.

Agreeableness and cognitive ability have statistically significant negative effects on the likelihood an individual is self-employed. If an individual is higher in Agreeableness by one standard deviation then he is four percent less likely to be self-employed. In this case individuals who are more agreeable may not have the aggressiveness and assertiveness required to sustain a living in the informal self-employment sector. If an individual's cognitive ability increases by one standard deviation his is eleven percent less likely to be self-employed. This is likely because individuals with higher cognitive ability are more likely to select into formal wage employment (both the the high-skill public/private sector and in the low-skill family enterprise/domestic work sector).

It is interesting to note that while cognitive ability is a positive predictor of working

### Table 2.11: Average Marginal Effects on Probability of Being in Each Employment Sector

| | Occupational Category | | | | |
|---|---|---|---|---|---|
| | Public/Private | Self Employed | Family Enterprse/ Domestic Work | Student | Unemployed |
| Conscientiousness Zscore | 0.0300* | 0.0239 | -0.0677*** | 0.0106 | 0.0032 |
| | (0.0157) | (0.0191) | (0.0210) | (0.0180) | (0.0141) |
| Extraversion Zscore | -0.0246 | 0.0163 | 0.0137 | -0.0300* | 0.0245* |
| | (0.0169) | (0.0240) | (0.0235) | (0.0168) | (0.0147) |
| Openness to Experience Zscore | 0.0075 | 0.0218 | -0.0550** | 0.0428** | -0.0171 |
| | (0.0177) | (0.0178) | (0.0281) | (0.0204) | (0.0114) |
| Agreeableness Zscore | 0.0021 | -0.0360** | 0.0378* | 0.0039 | -0.0078 |
| | (0.0165) | (0.0164) | (0.0203) | (0.0173) | (0.0118) |
| Neuroticism Zscore | -0.0020 | -0.0064 | 0.0122 | -0.0096 | 0.0058 |
| | (0.0100) | (0.0131) | (0.0177) | (0.0117) | (0.0064) |
| Agreggate Math/French Zscore | 0.1549** | -0.2697*** | 0.1291 | -0.0411 | 0.0268 |
| | (0.0678) | (0.0714) | (0.0939) | (0.0565) | (0.0489) |
| Male | 0.0840*** | 0.0342* | -0.0415* | -0.0183 | -0.0584*** |
| | (0.0174) | (0.0187) | (0.0212) | (0.0142) | (0.0164) |
| Age | 0.0177*** | 0.0172* | -0.0039 | -0.0349*** | 0.0038 |
| | (0.0063) | (0.0091) | (0.0082) | (0.0067) | (0.0059) |
| 2004 Asset Index | -0.0336** | 0.0420* | -0.0550* | 0.0482*** | -0.0016 |
| | (0.0146) | (0.0252) | (0.0300) | (0.0176) | (0.0109) |
| Mother Education | -0.00002 | 0.0014 | -0.0181*** | 0.0138*** | 0.0028 |
| | (0.0040) | (0.0051) | (0.0058) | (0.0035) | (0.0032) |
| Father Education | -0.0030 | 0.0046 | -0.0132** | 0.0075** | 0.0041 |
| | (0.0041) | (0.0048) | (0.0059) | (0.0037) | (0.0029) |
| Transfers into Household | -0.00001 | 0.00002 | -0.00004 | 0.00003** | 4.49e-06 |
| | (0.00001) | (0.00008) | (0.00005) | (0.00001) | (0.00002) |
| Urban | 0.0885*** | -0.1637*** | 0.0162 | 0.0412 | 0.0178 |
| | (0.0260) | (0.0414) | (0.0480) | (0.0286) | (0.0212) |
| HHs with Electricity in Community | 0.0147 | 0.0402 | -0.0243 | -0.0442 | 0.0136 |
| | (0.0294) | (0.0288) | (0.0344) | (0.0313) | (0.0202) |
| Secondary School in Community | -0.0394 | 0.0489 | -0.0454 | 0.0617* | -0.0258 |
| | (0.0402) | (0.0510) | (0.0578) | (0.0360) | (0.0296) |
| Heath Center in Community | 0.0458 | -0.0135 | -0.0329 | 0.0209 | -0.0203 |
| | (0.0304) | (0.0333) | (0.0402) | (0.0294) | (0.0227) |
| Province Dummies | YES | YES | YES | YES | YES |
| Observations in each category | 195 | 365 | 587 | 232 | 96 |

Standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

in the public or private sector and a negative predictor of being self-employed, it does not significantly predict the probability that an individual is a student, unemployed or is working in a family enterprise or doing domestic work.

Working in a family enterprise or doing domestic work in another household is positively predicted by Agreeableness and negatively predicted by Conscientiousness and Openness to Experience. If an individual is higher in Conscientiousness and Openness to Experience by one standard deviation, then he is seven percent and six percent, respectively, less likely to be employed in this sector. Individuals higher in the intellectual curiosity and creativity encompassed Openness to Experience seem to be more likely to still be pursuing their studies in school. Individual lower in Conscientiousness may be limited to finding work either in low-skilled activities or working in firms owned by family members. If an individual is higher in Agreeableness by one standard deviation, then he is four percent more likely to be employed in this sector. Highly agreeable people might have the the necessary people skills to succeed in this type of work.

Openness to Experience has a statistically significant positive effect on the likelihood an individual is still enrolled in school and Extroversion has a negative effect. If an individual is higher in Openness to Experience by one standard deviation, then he is four percent more likely to still be in school. This finding is consistent with other research from developed countries which finds that Openness to Experience is the most important personality predictor of ultimate grade attainment (Brunello and Schlotter, 2011; John et al., 2008). Interestingly, increasing an individual's Openness to Experience by one standard deviation has a larger effect on the probability that the individual is still in school than increasing his mother's education by one year (which would only increase this probability

by one percent). Nonlabor transfers into the household also has a statistically significant effect on the likelihood an individual is a student. While the coefficient appears small with a value of 0.00003, the effect is actually quite large. If one were to transfer say, 95,0000 Malagasy Ariary to the household (which is approximately 10% of mean reported household income in the sample), then the likelihood that this individual is still a student increases by 29% on average. Thus it appears that financial constraints are still a large barrier to obtaining higher education either at the secondary or university level.

Extroversion is the only significant personality predictor of being unemployed. If an individual is more Extroverted by one standard deviation, then he two percent more likely to be unemployed. There are no testable explanations for this result using this data set. However, people who are more extroverted might also have stronger social networks able to support them during a period of unemployment. In this case, they are more able to sustain a period of unemployment. If would be interesting to see if this result is replicated in other developing country settings.

## 2.7.2 Entrepreneurship

Table 2.12 reports the estimated probit coefficients from equation (4) and the average marginal effects of each explanatory variable on the likelihood of becoming an entrepreneur. In Appendix Table B.16 we report estimated coefficients from equation (4) with and without added control variables. As with the multinomial logit model, adding extra controls has little effect on the cognitive and personality coefficients of interest. Again, this helps to alleviate concerns that unobserved characteristics correlated with

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these controls bias our estimates.

Openness to Experience and Agreeableness both have a statistically significant effect on the likelihood an individual is an entrepreneur. If a sample individual is higher in Openness to Experience he is 5% more likely to be an entrepreneur. If he is higher in Agreeableness by one standard deviation, he is 4% less likely to be an entrepreneur. The effect of Openness to Experience on entrepreneurship is fairly intuitive. Someone who has more Openness to Experience is more likely to risk entering into new business ventures. Individuals who are more Agreeable tend to be less aggressive and assertive and more submissive and thus less likely to undertake entrepreneurial activities. Other studies find that Agreeableness has a negative effect on earnings (Mueller and Plug, 2006). Research as also found that Agreeableness has a negative effect on the likelihood that individuals enter into other occupations that require a certain level of assertiveness such as managers, science or engineer professionals and business professionals (Cobb-Clark and Tan, 2010).

## 2.8   Conclusions

While there has long been a focus on the influence of education and health in determining economic outcomes of interest, more recently an emerging literature has pointed to the importance of other, "noncognitive", dimensions of human capital. Indeed, a number of studies coming from industrialized countries finds noncognitive skills to be as important or even more important to economic success than cognitive skills. This appears to be particularly true for individuals in the lower end of the income distribution. In a developing country context, it is reasonable to think that certain "noncognitive" skills may

## Table 2.12: Probit Estimation of Entrepreneurship

| | Probit Coefficients | Average Marginal Effects |
|---|---|---|
| Conscientiousness Zscore | -0.0208 | -0.0046 |
| | (0.072) | (0.0159) |
| Extraversion Zscore | 0.0093 | 0.0020 |
| | (0.075) | (0.0166) |
| Openness to Experience Zscore | 0.2092*** | 0.0460*** |
| | (0.074) | (0.0162) |
| Agreeableness Zscore | -0.1798*** | -0.0395*** |
| | (0.068) | (0.0149) |
| Neuroticism Zscore | -0.0710 | -0.0156 |
| | (0.051) | (0.0111) |
| Instramented Aggegate Math/French Zscore | -0.4231 | -0.0930 |
| | (0.291) | (0.0638) |
| Male | 0.0212 | 0.0047 |
| | (0.085) | (0.0186) |
| Age | 0.0578* | 0.0127* |
| | (0.034) | (0.0074) |
| 2004 Household Asset Index | 0.0882 | 0.0194 |
| | (0.084) | (0.0184) |
| Mother's Highest Grade Attainment | -0.0091 | -0.0020 |
| | (0.020) | (0.0043) |
| Father's Highest Grade Attainment | -0.0087 | -0.0019 |
| | (0.019) | (0.0042) |
| Nonlabor Transfers into Household | -0.0000 | -0.0000 |
| | (0.000) | (0.0000) |
| Urban | -0.1256 | -0.0276 |
| | (0.148) | (0.0324) |
| Households with Electricity in Community | 0.0427 | 0.0094 |
| | (0.119) | (0.0262) |
| Secondary School in Community | 0.1564 | 0.0344 |
| | (0.180) | (0.0395) |
| Health Center in Community | 0.3116** | 0.0685** |
| | (0.140) | (0.0307) |
| Constant | -2.5120*** | |
| | (0.789) | |
| Province Dummies | YES | YES |

Robust standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

prove to be even more important to economic well-being since school quality and school enrollment rates are generally lower in these countries than in industrialized ones. For this same reason, measured cognitive skills may also ultimately be a more informative economic determinant than school attainment.

For a sample of young adults in Madagascar, we estimate the effect of cognition and the Big Five Personality Traits on entrepreneurship and selection into five different labor market segments: the formal private and public wage sector, self-employment, working in a family enterprise or doing domestic work in another household, being a student and unemployment. The Big Five Personality Traits are Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism. After instrumenting for cognitive test scores, we find that both cognition and various personality traits are important predictors of the likelihood of working in the different labor market segments.

Cognitive skills and Conscientiousness positively predict the likelihood of working in the formal private or public wage sector, where often wages are higher and employment more stable. The probability of being self-employed decreases with an individual's level of Agreeableness and cognition. Conscientiousness and Openness to Experience negatively predict the probability of working in a family enterprise or doing domestic work while cognitive skills positively affect selection into this labor market segment. More extroverted individuals are less likely to be students and consistent with research from developed countries, Openness to Experience has a significant positive effect on the likelihood of still being a student. Somewhat surprisingly, however, cognitive skills have no statistically significant effect on the probability of being a student. This is likely due to high returns to cognitive skills in the formal wage sector. Finally, we find that more

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extroverted individuals are more likely to be unemployed. These individuals may have more developed social networks that can support them through periods of unemployment. Finally, the likelihood that an individual undertakes entrepreneurial activities in this sample increases with Openness to Experience and decreases with his level of Agreeableness.

Our results indicate that both cognition and personality matter in determining labor market outcomes, specifically, entrepreneurship and selection into different labor market segments. As research continues to evaluate the role of human capital in economic success and development, it is becoming increasingly salient that we need to also consider "noncognitive" dimensions of human capital such as personality and elements of psychosocial well-being in addition to cognitive ability, education and health. These elements of human capital matter not only in terms of confounding our results as they relate to innate ability but as as important determinants in and of themselves and thus warrant a place in the discussion and design of human capital targeted policy.

CHAPTER 3

**FAMILY BACKGROUND, SCHOOLING AND COMMUNITY IN THE**

**FORMATION OF THE BIG FIVE PERSONALITY TRAITS**

## 3.1 Introduction

Growing literature in the last ten to fifteen years demonstrates the importance of what are know as "noncognitive" skills to numerous economic, demographic, health and behavioral outcomes of interest (e.g., Borghans et al. (2008); Brunello and Schlotter (2011); Carneiro et al. (2007); Heckman et al. (2000, 2006); Lindqvist and Vestman (2011)). Noncognitive ability is a term that encompasses the socio-emotional status of an individual and numerous personality traits. It also includes characteristics such as motivation, perseverance, self-control, time preference, self-esteem and the ability to work with others. Substantial evidence from developed countries demonstrates the importance of various noncognitive skills and personality traits to outcomes such as job performance, wages, academic achievement, occupational choice and health (Barrick and Mount, 1991; Chamorro-Premuzic and Furnham, 2003; Hampson et al., 2006; Hogan et al., 1996; Hogan and Holland, 2003; Ones et al., 2007; Robbins et al., 2006; Roberts et al., 2007; Schmidt and Hunter, 1998). Evidence from the economics literature further demonstrates the important influence these skills have on outcomes such as school attainment, crime participation, earnings and participation in risky behaviors (Blau and Currie, 2006; Curley et al., 2011; Dawson et al., 2000; Heckman, 2007; Knudsen et al., 2006). Some argue that noncognitive skills may be equally or even more important in determining economic well-being than cognition (Brunello and Schlotter, 2011).

As we begin to better understand the importance of personality and other noncognitive traits to economic success, it becomes increasingly important to understand how these traits and skills are formed so as to better inform policy. Some argue that personality traits are innate, leaving little room for policy intervention. Other work has shown different noncognitive skills to be highly mailable to early childhood and adolescence environments (Barnett and Masse, 2007; Blau and Currie, 2006; Cuhna and Heckman, 2008; Schweinhart, 2005). If research on the relationship between "noncognitive" skills and numerous economic and behavioral outcomes is to have real policy implications, we need to understand which "noncognitive" skills are important to these outcomes, how these skills are then developed and thus where there might be room for effect policy interventions.

With a few exceptions, the economics literature on this subject chiefly focuses on the effects of a general noncognitive aggregate. While much has been learned from this work, this is likely an insufficient approach to tackling this topic for a number of reasons. Given the broad range of characteristics encompassed by the term noncognitive, when a study finds that 'noncognitive' skills do or do not have an effect on some outcome of interest, this actually tells us very little about what is affecting this outcome. Is it some component of emotional stability or is it an individual's work ethic or leadership skills? If we do not know more specifically about what is affecting our outcomes of interest, then we are unable to compare findings across different studies. There is also then little we can infer from these results to direct policy. An effect of general noncognitive skill on, say earnings, gives little in the way of policy recommendation. Should we be teaching organizational skills to teenagers or be more focused on emotional stability in early childhood? Therefore, when we are both investigating how noncognitive skills develop and their effect on outcomes of interest, we need to be specific as to the specific trait we are examining.

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Researchers are increasingly investigating how noncognitive skill develop but much of this work has been done in a developed country context. However, there are reasons to think that understanding noncognitive development in a developing country context may be even more important. In developing countries where schooling in not universal and school quality is generally lower, the importance of various noncognitive traits may be even more important to overall well-being than they are in developed countries. Futhermore, children growing up in the context of poverty that characterizes life in many developing countries face regular and numerous insults to healthy socio-emotional development. Grantham-McGregor et al. (2007) estimate that more than 200 million children under five fail to reach their developmental potential due to poverty poor health and deficient care. The social, cultural and economic context of poverty exposes disadvantaged children to multiple and cumulating risks affecting their development through brain structure, brain development, brain function and associated behaviors (Walker et al., 2008).

In this paper, we attempt to provide a better understanding of some of the determinants of personality development for a cohort of young adults in Madagascar. Due the complicated and multifaceted nature of individual psychosocial development, it is exceedingly difficult to draw any causal relationships between individual personality traits and their developmental determinants. However, using rich information on schooling characteristics, family background, and on the childhood and family history of the cohort members parents, we are able to tell a useful descriptive story on personality development in this African country. We specifically look at associations between determinants and the formation of what are know as the Big Five Personality Traits: Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism.

In the following section we describe the Big Five Personality Traits and discuss some of the research on them. In Section 3.3 we discuss some of the existing literature on personality formation and how genes and environment intimately interact in this process. Section 3.4 describes the *Madagascar Life Course Transitions of Young Adults Survey*, which we use in this paper. Section 3.5 discusses the our estimation strategy for exploring personality determinants. Section 3.6 explains our results and 3.7 concludes.

## 3.2  The Big Five Personality Trait Taxonomy

A widely accepted taxonomy of personality traits is found in the Five-Factor Model of personality, also referred to as the Big Five Personality Traits. Most variables used to assess personality in the field of personality psychology can be mapped into one or more dimensions of the Big Five Personality Traits: Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism (Brunello and Schlotter, 2011; John et al., 2008; McCrae and Costa, 2008). *Openness to Experience* is the degree to which a person is curious, needs intellectual stimulation, change and variety. It describes the complexity, depth and originality of an individual. *Conscientiousness* captures the attitude of being hardworking, organized and dependable as opposed to lazy, disorganized and unreliable. People high in Conscientiousness tend to be able to delay gratification, follow the rules, adhere to norms and think before acting. It describes the characteristics behind task- and goal-oriented behavior. *Extroversion* capture the preferences for human contact empathy, gregariousness, assertiveness and a wish to inspire people. *Agreeableness* is the degree to which someone is cooperative, altruistic, modest, warm and agreeable, in contrast to be-

ing cold, disagreeable and antagonistic. *Neuroticism* is the extent to which an individual is insecure, anxious, depressed and emotional rather than calm and self-confident (McCrae and Costa, 2008). The Big Five Personality Traits are summarized in Table 3.1.

Table 3.1: The Big Five Personality Traits

| Personality Trait | Basic Tendencies | Characteristic Adaptations |
|---|---|---|
| Openness to Experience | a need for variety, novelty, and change | intellectual curiosity; interest in travel; many different hobbies; diverse vocational interests |
| Conscientiousness | strong sense of purpose and high aspiration levels | leadership skills; long-term planner; hard-working; organized; dependable |
| Extroversion | preference for companionship and social stimulation | social skills; numerous friendships; gregarious; assertive; talkative |
| Agreeableness | a willingness to defer to others during interpersonal conflict | forgiving attitude; belief in cooperation; warm |
| Neuroticism | sadness, hopelessness, guilt | Low self-esteem; pessimistic attitude; insecure; anxious; depressed |

Historically, researchers in personality psychology were beset by a wide ranging array of personality scales with little guidance how to choose between or use them. The Five Factor Model of Personality first rose out of lexicographic studies describing personality (John et al., 2008). Since then the use of this model has increased substantially and the field of psychology has reached an initial consensus around the five factor framework (John et al., 2008). This has given way to replication and consistent definitions, even though there remain variations in methodology and data sources. The model has also been consistent, and argued to be relevant, across different cultures and across different periods of the adult lifespan (McCrae and Costa, 2008).

Evidence from sociology and psychology link the Big Five Personality Traits to educational outcomes, job performance, occupational choice and earnings. Conscientiousness has been shown to be an important predictor of grades, years of education, job performance in a wide range of jobs and leadership ratings (Borghans et al., 2008; Brunello and Schlotter, 2011; John et al., 2008). Furthermore, evidence shows that self-discipline (an aspect of Conscientiousness) accounts for more than twice as much of the variation in grades than does IQ (Brunello and Schlotter, 2011). Research shows Openness to Experience to be the best personality predictor of the number of years of education . Agreeableness positively and Neuroticism negatively predict job performance where people work in groups. Openness predicts success in artistic jobs. Neuroticism is an important negative predictor of job satisfaction (Brunello and Schlotter, 2011; John et al., 2008).

The Big Five Personality Traits are also related to health outcomes. Conscientiousness has been shown to be an important predictor of good health habits, health outcomes and longevity. Low Conscientiousness has been linked to a greater likelihood of participat-

ing in numerous risky behaviors such as smoking, substance abuse, poor diet and poor exercise habits (Hampson et al., 2006; John et al., 2008). Agreeableness negatively predicts heart disease. High Neuroticism is associated with less successful coping with and poorer reactions to illness. Extroversion, on the other hand is associated with more social support and close relationships, which are important for coping with illness (John et al., 2008).

## 3.3 Personality Development, Genes and Environment

While the Big Five Personality Traits have been repeatedly shown to be important predictors of numerous outcomes of interest, to date, there is surprisingly little know about their development. For a long time, it was thought that certain aspects of personality were inherited while others were acquired. Yet, this strict dichotomy between nature versus nurture is no longer as persuasive as it once was. Instead, evidence now shows strong interactions between environment and inherited genetics in producing individual skills and traits. For example, inherited genes can be turned on or off by environmental influences (Knudsen et al., 2006; Committee, 2000). Therefore even genetic components of personality can be influenced by environment.

There is currently little research elucidating the formation of the Big Five Personality Traits during childhood and adolescence. Research on personality in childhood focuses predominately on temperament and specific traits such as sociability, shyness and impulsivity. But these traits, as yet, have not been organized into a coherent taxonomy or systematically linked to the Big Five Personality Traits in adulthood (John et al., 2008).

While some research finds that children even as young as 5-7 years old begin to show stable and externally valid evidence of the Big Five domains for Extroversion, Agreeableness and Conscientiousness, there is yet little known about the developmental origins of the Big Five (John et al., 2008). Much of the evidence, to date, expounds on the development of specific behavioral traits and personality disorders. While there is much contention concerning the ability of environment to influence personality, there is little debate that environment affects personality through biological mediation.

There is growing recognition of the importance and extent of gene-environment interactions and correlations. Through twin and adoptions studies substantial evidence has been found that genetic influences are important for a broad scope of human behavior including personality traits and disorders. Research demonstrates genetic influences for personality traits, attitudes, values and even for the extent to which environment can influence personality (Rutter et al., 1999a). For numerous personality attributes, heritability estimates of the proportion of their variance owing to genetic differences range from 0.20 to 0.80 (Pomerantz and Thompson, 2008). This means that 20 to 80% of the variance of these attributes can be explained by genetic influences. In a longitudinal study following a cohort of adopted children, their biological parents, their adoptive parents and a cohort of matched control children (raised by their biological parents), Robert et al. (1997) find that as these children get older their cognitive ability increasingly resembles that of their biological parents and diverges from their adoptive parents. Correlations between their cognitive ability and that of their adoptive parents are near zero where as correlations with genetically related parents are around 0.30 for both biological and control parents.

However, heritability estimates can be markedly lower in populations with higher en-

vironmental diversity. For example, Turkheimer et al. (2003) found that more than 80% of the variance in IQ for seven-year-old twins growing up in affluent homes could be explained by genetic influences. However, environmental influences explained that same proportion of IQ variance for twins in poor families. Therefore it appears that environmental influences are stronger where there is greater variability in resources. Furthermore, experiences do affect gene expression and biological development is affected by adaptations to environmental conditions that prevail during the developmental period. Thus even traits that are strongly genetically influenced can be markedly altered by environmental changes (Rutter et al., 1999a).

Evans and English (2002) find that low income children were exposed to more psychosocial stressors and impoverished living conditions all of which impinge on their socioemotional development. They argue that the confluence of these multiple insults from the sample children's immediate environment, resulted in cumulative impact on their socioemotional health. Thus children living in poverty had lower levels of measured mental health, lower self-perceived psychological well-being, were less able to delay gratification (lower levels of self-regulation), had higher resting blood pressure and higher levels of stress hormones.

The data used in this paper do not allow for direct testing of of genetic and environmental determinants of personality. Indeed, the multifaceted and complicated interaction between genetics and environment would make determining causal relationships difficult, if not impossible, with any data. Due to genetic risk, the same environmental event may cause a personality disorder in one individual and pose absolutely no threat to another. Therefore, instead of telling a causal story in this paper, we tell a descrip-

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tive story of associations related to personality development using information on community, schools, household characteristics, parental characteristics and characteristics of extended family.

## 3.4 Madagascar Life Course Transitions of Young Adults Survey

The data used in this paper come from the *Madagascar Life Course Transitions of Young Adults Survey*. The survey in 2011-2012 re-interviewed a cohort of 1749 young adults between the ages of 21 and 24 years, who were originally surveyed in 2004. 1733 of these individuals were administered a personality questionnaire. These surveys were specifically designed to capture the transition from adolescence to young adulthood and thus included detailed information on household characteristics (both current and childhood home) and family background. Extensive community surveys were also conducted in 2004 and 2012 and the 2004 surveys also include detailed information on schools. Due to the complicated nature of personality formation, we do not, for the most part, examine associations between individual variables and the development of each of the five personality traits. Variation in one variable alone will unlikely be a causal determinant for personality trait formation, it's influence will instead be mediated by other environmental and genetic factors. Instead we use the wealth of information available in these data to construct indices indicating various aspects of an individuals home, community and family background.

A unique feature of this data set is that it contains not only information on the cohort member's parents, homes and childhood homes, but it also contains information

on their parent's childhood homes and educational information on their parents' parents and siblings. Using this information in factor analysis, we construct an index for maternal childhood home quality and for extended family education.[1] The maternal childhood home quality index gives an indication of the environmental quality of the mother's upbringing. We do not have any genetic information on individuals in the sample so we are not able to explicitly control for genetic characteristics. Nor can we make the genetic assertions that twin and adoption studies are able to make. However, after controlling for other aspects of family background and parental characteristic, the extended family education index may give some indication of genetic predisposition towards education and associated characteristics from the mother's side. In addition to the above two indices, using factor analysis we also construct indices on 2004 community quality, primary school facility quality in the community and the quality of teaching resources in the school. A summary of the variables used as instruments to construct the factors can be found in Table 3.2.[2]

Missing information on control variables reduces our sample to 1460. Of those, we have information maternal childhood homes and maternal uncles[3] for 976 individual.[4] Table 3.3 compares baseline characteristics between individuals who remain in the sample and those who are dropped. In every variable except Neuroticism, gender and a

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[1]While we also have information to construct these two indices for the father's side of the family, we have fewer observations on father's background. Therefore we do not generate the paternal version of these to variables to protect sample size

[2]Since some of these indices are likely correlated (e.g., the mother home quality index and extended family education index) one could also construct these indices by extracting the factor scores from the same measurement matrix. However, the literature we are aware using multiple indices coming from the same data set estimate them separately (e.g., Grolnick and Slowiaczek (1994)). We have done the same.

[3]We use educational information for maternal uncles and not aunts because far fewer maternal aunts were educated and we loose too much sample size if we include them.

[4]Note, some of individuals drop out not because we are missing information on maternal uncles but because they do not have uncles on their mother's side.

Table 3.2: Instruments for Constructing Family and Environment Indices

| **Maternal Extended Family Education Index** |
| --- |
| Maternal uncle's school completion |
| Maternal grandfather attended school |
| Maternal grandmother attended school |
| **Maternal Childhood Home Quality Index** |
| Presence of secondary school in community |
| Presence of middle school in community |
| Presence of primary school in community |
| Type of toilet in household |
| Type of flooring in household |
| **Community Quality Index** |
| Access to community health center |
| Immunization campaign since 1986 |
| Access to children's nutrition information |
| Access to maternal health information |
| **School Facility Quality Index** |
| There is electric lighting |
| School has an infirmary |
| Type of toilet facility |
| Separate toilets for boys and girls |
| Presence of a sports field |
| Drinking water available |
| **Teaching Resource Quality Index** |
| Presence of a library |
| Proportion of blackboards per student |
| Proportion of textbooks per student |

household asset index, differences between the two samples are statistically significant. Individuals who remain in the sample exhibit higher levels of Conscientiousness, Extroversion, Openness to Experience and Agreeableness than those who do not. They are also slightly younger and they and their parents have more education on average. The communities sample individuals live in are less likely to be urban and more likely to have electricity and a health center. While some of these differences are quite small in magnitude, they are statistically significant nonetheless. Our estimation sample thus appears to be slightly better of in terms on education and community quality. Clearly, these differences most be kept in mind as we interpret our findings.

General summary statistics on our sample can be found in Table 3.4. Approximate 50% of our sample is male and are 22 years old on average. Mean grade attainment for sample individuals is around eight years and individuals mothers and fathers have received, on average, around 5 and 5.5 years of education, respectively. 22% of individuals in the sample live in an urban area and around 90% of those have a health center in the community and 50% live in a community in which some households have electricity.

### 3.4.1 Measuring Personality

The 2012 questionnaire includes a module designed to characterize personality traits. This module has 116 questions designed capture how individuals behave and respond to different situations. For each question in the personality module, individuals were asked to rate their response to a statement as 1-Strongly Disagree, 2-Somewhat Disagree, 3-Neither Agree or Disagree, 4-Tend to Agree and 5-Strongly Agree. These questions are

Table 3.3: Comparison of Characteristics between Sample and Non-Sample Individuals

|  | Not in Sample | In Sample | Difference |
|---|---|---|---|
| Conscientiousness Zscore | -0.075 | 0.058 | -0.133*** |
| Extroversion Zscore | -0.058 | 0.045 | -0.103** |
| Openness to Experience Zscore | -0.06 | 0.046 | -0.106** |
| Agreeableness Zscore | -0.049 | 0.038 | -0.087* |
| Neuroticism Zscore | -0.005 | 0.004 | -0.01 |
| Male | 0.482 | 0.475 | 0.007 |
| Age | 22.847 | 22.711 | 0.136*** |
| Grade | 7.476 | 8.022 | -0.546*** |
| Mother's Education | 4.364 | 4.891 | -0.527*** |
| Father's Education | 5.189 | 5.547 | -0.358* |
| 2004 Household Asset Index | 0.114 | 0.042 | 0.072 |
| Urban | 0.295 | 0.224 | 0.071*** |
| Health Center in Community | 0.779 | 0.89 | -0.112*** |
| Households in Community with Electricity | 0.405 | 0.458 | -0.053** |

then used as inputs to measure the Big Five Personality Traits for each individual. A few examples of questions used to measure each personality trait can be found in Table 3.5. Tables C.1-C.5 in the appendix lists full sample summary statistics for all the questions used to measure each personality trait.

We model the Big Five Personality Traits as unobserved variables and use confirmatory factor analysis to uncover their latent distributions. By using confirmatory factor

|  | Mean | St. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Male | 0.4754 | 0.5 | 0 | 1 |
| Age | 22.711 | 1.123 | 18 | 26 |
| Highest Grade Attained | 8.022 | 3.79 | 0 | 18 |
| Mother's Education | 4.891 | 3.647 | 0 | 17 |
| Father's Education | 5.547 | 3.977 | 0 | 17 |
| 2004 Household Asset Index | 0.042 | 0.97 | -0.685 | 4.179 |
| Urban | 0.224 | 0.417 | 0 | 1 |
| Health Center in Community | 0.89 | 0.313 | 0 | 1 |

analysis we can estimate the latent joint distribution of our five personality traits using the variance-covariance structure of survey questions designed to measure each trait. Personality traits are then estimated using the following measurement system:

$$
\begin{aligned}
Z_j^O &= \mu_j^O + \lambda_j^O \theta^O + \epsilon_j^O \quad \text{for } j \in \left\{1, ..., m^O\right\} \\
Z_j^C &= \mu_j^C + \lambda_j^C \theta^C + \epsilon_j^C \quad \text{for } j \in \left\{1, ..., m^C\right\} \\
Z_j^E &= \mu_j^E + \lambda_j^E \theta^E + \epsilon_j^E \quad \text{for } j \in \left\{1, ..., m^E\right\} \\
Z_j^A &= \mu_j^A + \lambda_j^A \theta^A + \epsilon_j^A \quad \text{for } j \in \left\{1, ..., m^A\right\} \\
Z_j^N &= \mu_j^N + \lambda_j^N \theta^N + \epsilon_j^N \quad \text{for } j \in \left\{1, ..., m^N\right\}
\end{aligned}
\tag{3.1}
$$

where O indexes Openness to Experience, C indexes Conscientiousness, E indexes Extroversion, A indexes Agreeableness and N indexes Neuroticism. $Z_j^p$ is the observed $j^{th}$ measurement for latent personality trait $\theta^p$. $m^p$ is the number of observed measurements

Table 3.5: Examples Questions Measuring the Big Five Personality Traits

| **Openness to Experience** |
| --- |
| I find the world very interesting |
| In any situation I can find something interesting |
| I'm very interested in other countries and their cultures |

| **Conscientiousness** |
| --- |
| I never leave a task without completing it |
| I do my job without waiting |
| I like to order things around me |
| I always keep my promises |

| **Extroversion** |
| --- |
| I like to animate groups |
| I take the initiative in conversations |
| I always have something to say |
| I work better when I'm alone |

| **Agreeablesness** |
| --- |
| I respect the decisions of the group |
| I think honesty is the basis of trust |
| I am rarely angry |

| **Neuroticism** |
| --- |
| I panic easily |
| I am often sad |
| I get discouraged easily |
| I am often worried |

for latent trait $p$, $p \in \{O, C, E, A, N\}$. To ensure that the model is not underidentified, we normalize $\lambda_1^p = 1$ for all $p \in \{O, C, E, A, N\}$. This simply sets scale and is common practice in factor analysis. We also normalize $E[\theta^p] = 0$. Doing so centers the distribution of the latent factors over zero and is also common practice. Since the factors do not have any cardinal value, this normalization does not have any implications for how we interpret our results. The $\epsilon's$ are assumed to be mean zero, are uncorrelated with the factors and are independent across agents and factors. Using confirmatory factor analysis we predict the factor loadings, $\lambda_j^p$, and predict a personality trait factor score for each individual sample. We then use the standardized factor scores to estimate their effect on occupational choice and entrepreneurship. Estimated factor loadings, $\lambda_j^p$, and intercepts, $\mu_j^p$, from the measurement model can be found in Appendix Tables C.6-C.10. Appendix Table C.11 show Cronbach's $\alpha$ for each of the personality traits estimated in equation 3.1. Cronbach's $\alpha$ is a coefficient that measures the internal consistency or reliability of the measurements being used to estimate the five personality factors. Estimates for Cronbach's $\alpha$ for each personality trait is 0.71, 0.92, 0.80, 0.66 and 0.82 for Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism, respectively. Thus for the most part our measurement instruments are reasonably consistent.

Once factor scores were generated for each of the five personality traits, each was then standardized. The standardized factor score for each personality trait is used as our dependent variables. Table 3.6 gives the correlation matrix of each of the five personality traits. The personality traits are all statistically significantly correlated at the one percent level. Conscientiousness, Extroversion and Agreeableness are particularly highly correlated. Neuroticism is negatively correlated with the other four personality traits and has a relatively low correlation with Agreeableness and Openness to Experience.

Table 3.6: Correlation Matrix of Personality Traits

| | Conscientiousness | Extroversion | Openness to Experience | Agreeableness | Neuroticism |
|---|---|---|---|---|---|
| Conscientiousness | 1 | | | | |
| Extroversion | 0.7436*** | 1 | | | |
| Openness to Experience | 0.6474*** | 0.62*** | 1 | | |
| Agreeableness | 0.7102*** | 0.7288*** | 0.4994*** | 1 | |
| Neuroticism | -0.3133*** | -0.4106*** | -0.144*** | -0.235*** | 1 |

## 3.5 Estimating the Formation of the Big Five Personality Traits

While it is possible to estimate the effect of trait determinants for each personality separately using Ordinary Least Squares, it is likely that the formation of the five personality traits are correlated for each individual. Therefore we use a seemingly unrelated regression (SUR) approach to our estimation (Zellner, 1962). Using this approach we have the following system of equations:

$$P_{i,v}^{O} = \alpha^{O} + \beta^{O} X_{i,v} + \gamma^{O} S_v + \delta^{O} GE_{i,v} + \epsilon_{i,v}^{O}$$

$$P_{i,v}^{C} = \alpha^{C} + \beta^{C} X_{i,v} + \gamma^{C} S_v + \delta^{C} GE_{i,v} + \epsilon_{i,v}^{C}$$

$$P_{i,v}^{E} = \alpha^{E} + \beta^{E} X_{i,v} + \gamma^{E} S_v + \delta^{E} GE_{i,v} + \epsilon_{i,v}^{E} \qquad (3.2)$$

$$P_{i,v}^{A} = \alpha^{A} + \beta^{A} X_{i,v} + \gamma^{A} S_v + \delta^{A} GE_{i,v} + \epsilon_{i,v}^{A}$$

$$P_{i,v}^{N} = \alpha^{N} + \beta^{N} X_{i,v} + \gamma^{N} S_v + \delta^{N} GE_{i,v} + \epsilon_{i,v}^{N}$$

where $P_{i,v}^{k}$ is the standardized factor score of personality trait $k$ for individual $i$ in community $v$, $k \in \{O, C, E, A, N\}$ and O, C, E, A and N index Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism, respectively. $X_{i,v}^{k}$ is a vector of individual characteristics including age, gender, mother's grade attainment, a 2004 household asset index, maternal childhood home quality index and the extended family education index. $S_v$ is a vector of community and school characteristics including the 2004 community quality index, the school facility quality index, the teaching resources quality index and the 2004 remoteness index. Finally $GE_{i,v}$ is a vector of interactions between the maternal extended family education index and maternal childhood home quality index with of the individual and community/school variables except for the remoteness index.

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In the seemingly unrelated regression approach the parameters in each of the five equations are allowed to differ, however, the errors in each equation may be correlated for each individual $i$. In other words using SUR, we are making an assumption about the error terms such that $cov(\epsilon_{i,v}^k, \epsilon_{i,v}^l) = \sigma_{k,l}$, but $cov(\epsilon_{i,v}^k, \epsilon_{j,r}^l) = 0$ for any $k, l \in \{O, C, E, A, N\}$ and $i \neq j$. Because the right-hand side regressors are the same in each of the five equations, there is no added information contained in each of the equations. Therefore, OLS gives identical point estimates as SUR. The only gains that come is the strength of the inference based on sampling error. Therefore the standard errors on the estimated coefficients are slightly smaller when using SUR over OLS.

## 3.6   Results

Table 3.7 displays the correlation matrix of the error terms in equation 3.2. All of the error terms are highly correlated and a Breusch-Pagan test rejects that the error terms are independent across equations at the one percent level with a test statistic of $\chi_2(10) = 2813.038$. Therefore using the seemingly unrelated regression appears to be an appropriate approach to this estimation.

Table 3.8 reports estimated coefficients for each of the equations described in 3.2 with the interaction terms excluded. Table 3.9 reports the estimated coefficients with interactions included. Environmental variables seem to be important to some degree in predicting each of the five personality traits. The remoteness index has a statistically significant effect for each personalty trait. Interestingly, the maternal extended family genetic index has a statistically significant positive effect on predicting Conscientiousness and Extro-

Table 3.7: Correlation Matrix of Error Terms

| | $\epsilon_{i,v}^{C}$ | $\epsilon_{i,v}^{E}$ | $\epsilon_{i,v}^{O}$ | $\epsilon_{i,v}^{A}$ | $\epsilon_{i,v}^{N}$ |
|---|---|---|---|---|---|
| $\epsilon_{i,v}^{C}$ | 1 | | | | |
| $\epsilon_{i,v}^{E}$ | 0.727 | 1 | | | |
| $\epsilon_{i,v}^{O}$ | 0.631 | 0.6018 | 1 | | |
| $\epsilon_{i,v}^{A}$ | 0.6942 | 0.7207 | 0.48 | 1 | |
| $\epsilon_{i,v}^{N}$ | -0.3158 | -0.4301 | -0.1344 | -0.2429 | 1 |

version when there are no interactions and this effect goes away once interactions are included. Its effect on Openness to Experience goes from insignificant to significant and negative when interactions are included and it goes from significantly positive to significantly negative in its effect on Agreeableness. When interactions are included in the regression most of the effects of the maternal extended family education index appear to be mediated through its interactions with other variables. This seems to suggest that, if this index does in fact point to some genetic predisposition, then the genetic influence we are picking up is highly mediated through environmental context. The only personality trait in which the maternal extended family education index has no significant effect on, either by itself or in interaction with other variables, is Neuroticism. This personality trait seems to be predominately determined by environmental variables and exogenous individual characteristics in our sample. Other research has found that personality disorders encompassed by Neuroticism (e.g., depression) is can be highly heritable under certain environmental risks (Rutter et al., 1999b).

Table 3.10 reports the average marginal effects for variables of interest when inter-

Table 3.8: Estimated Effects of Environment & Family Background on Personality: No Interactions

| | Conscientiousness | Extroversion | Openness | Agreeablenss | Neuroticism |
|---|---|---|---|---|---|
| **Individual Characteristics** | | | | | |
| Age | 0.0598** | 0.0559** | 0.0327 | 0.0444* | -0.0182 |
| | (0.027) | (0.027) | (0.028) | (0.027) | (0.028) |
| Male | 0.1440** | 0.1845*** | 0.2648*** | 0.1026* | -0.1412** |
| | (0.061) | (0.060) | (0.063) | (0.061) | (0.063) |
| **School/Community Characteristics** | | | | | |
| School Facility Quality Index | 0.0908** | 0.0816* | 0.0679 | 0.0328 | 0.0691 |
| | (0.043) | (0.042) | (0.044) | (0.043) | (0.045) |
| Teacher Quality Index | 0.0225 | 0.0557 | 0.0492 | 0.0522 | -0.0315 |
| | (0.036) | (0.035) | (0.037) | (0.036) | (0.038) |
| 2004 Community Quality Index | 0.0452 | 0.0227 | 0.0213 | 0.0396 | -0.0495 |
| | (0.030) | (0.030) | (0.031) | (0.030) | (0.031) |
| 2004 Remoteness Index | 0.1000*** | 0.0859*** | 0.0637** | 0.0851*** | -0.0466 |
| | (0.029) | (0.029) | (0.030) | (0.029) | (0.030) |
| **Maternal Background Characteristics** | | | | | |
| Maternal Genetic Index | 0.0811** | 0.1127*** | 0.0374 | 0.0997** | -0.0019 |
| | (0.039) | (0.038) | (0.040) | (0.039) | (0.040) |
| Mom Childhood Home Quality Index | 0.0158 | 0.0731* | 0.0409 | 0.0358 | -0.1196*** |
| | (0.040) | (0.040) | (0.042) | (0.040) | (0.042) |
| **Parent/Household Characteristics** | | | | | |
| Mother's Education | 0.0114 | 0.0106 | 0.0394*** | -0.0022 | 0.0177* |
| | (0.010) | (0.010) | (0.011) | (0.010) | (0.011) |
| 2004 Asset Index | 0.0856** | 0.0220 | 0.0735* | 0.0252 | -0.0758* |
| | (0.039) | (0.038) | (0.040) | (0.039) | (0.040) |
| Provence Dummies | YES | YES | YES | YES | YES |
| Constant | -1.7467*** | -1.6782*** | -1.3646** | -1.3310** | 0.3892 |
| | (0.634) | (0.621) | (0.654) | (0.635) | (0.658) |
| Observations | 976 | 976 | 976 | 976 | 976 |
| R-squared | 0.104 | 0.095 | 0.103 | 0.051 | 0.051 |

Standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

Table 3.9: Estimated Effects of Environment & Family Background on Personality: Interactions Included

| | Conscientiousness | Extroversion | Openness | Agreeablenss | Neuroticism |
|---|---|---|---|---|---|
| **Individual Characteristics** | | | | | |
| Age | 0.0586** | 0.0536** | 0.0303 | 0.0447* | -0.0149 |
| | (0.027) | (0.027) | (0.028) | (0.027) | (0.028) |
| Male | 0.1497** | 0.1916*** | 0.2708*** | 0.1043* | -0.1473** |
| | (0.061) | (0.060) | (0.063) | (0.061) | (0.063) |
| **School/Community Characteristics** | | | | | |
| School Facility Quality Index | 0.0819* | 0.0774* | 0.0633 | 0.0128 | 0.0580 |
| | (0.043) | (0.043) | (0.045) | (0.043) | (0.045) |
| Teacher Quality Index | -0.0021 | 0.0401 | 0.0253 | 0.0252 | -0.0371 |
| | (0.038) | (0.037) | (0.039) | (0.038) | (0.039) |
| 2004 Community Quality Index | 0.0236 | 0.0170 | 0.0283 | 0.0190 | -0.0586* |
| | (0.031) | (0.030) | (0.032) | (0.031) | (0.032) |
| 2004 Remoteness Index | 0.0801*** | 0.0761** | 0.0599* | 0.0617** | -0.0567* |
| | (0.030) | (0.030) | (0.031) | (0.030) | (0.032) |
| **Maternal Background Characteristics** | | | | | |
| Maternal Genetic Index | -1.0161 | -0.9898 | -1.7806** | -1.2818* | -0.4718 |
| | (0.701) | (0.690) | (0.723) | (0.701) | (0.731) |
| Mom Childhood Home Quality Index | 0.6520 | 1.0925 | 2.2886*** | 0.3723 | -1.5816** |
| | (0.705) | (0.694) | (0.727) | (0.705) | (0.736) |
| **Parent/Household Characteristics** | | | | | |
| Mother's Education | 0.0114 | 0.0089 | 0.0392*** | -0.0031 | 0.0173 |
| | (0.011) | (0.010) | (0.011) | (0.011) | (0.011) |
| 2004 Asset Index | 0.0681 | 0.0189 | 0.1190** | 0.0346 | -0.0710 |
| | (0.056) | (0.055) | (0.057) | (0.056) | (0.058) |
| **Interactions** | | | | | |
| (Age)x(Maternal Genetic Index) | 0.0503* | 0.0500* | 0.0833*** | 0.0627** | 0.0211 |
| | (0.031) | (0.030) | (0.032) | (0.031) | (0.032) |
| (Age)x(Mother Home Index) | -0.0290 | -0.0448 | -0.1018*** | -0.0169 | 0.0641** |
| | (0.031) | (0.031) | (0.032) | (0.031) | (0.032) |
| (Male)x)(Maternal Genetic Index) | -0.0862 | -0.0707 | -0.1709** | -0.0744 | -0.0032 |
| | (0.069) | (0.068) | (0.071) | (0.069) | (0.072) |
| (Male)x(Mother Home Index) | 0.0320 | -0.0168 | 0.0877 | 0.0838 | 0.0195 |
| | (0.069) | (0.068) | (0.071) | (0.069) | (0.072) |
| (School Facility Index)x(Maternal Gentic Index) | -0.0384 | -0.0448 | -0.0856* | -0.0451 | -0.0304 |
| | (0.043) | (0.043) | (0.045) | (0.043) | (0.045) |
| (School Facility Index)x(Mother Home Idex) | 0.0283 | 0.0097 | 0.0683 | 0.0931** | 0.0714 |
| | (0.043) | (0.043) | (0.045) | (0.043) | (0.045) |
| (Teacher Quality Index)x(Mathernal Genetic Index) | 0.1141*** | 0.0930** | 0.0865** | 0.1087*** | -0.0270 |
| | (0.039) | (0.038) | (0.040) | (0.039) | (0.040) |
| (Teacher Quality Index)x(Mother Home Index) | -0.0166 | -0.0505 | -0.0442 | -0.0263 | 0.0411 |
| | (0.038) | (0.038) | (0.040) | (0.038) | (0.040) |
| (Community Quality Index)x(Maternal Genetic Index) | 0.0147 | -0.0254 | -0.0080 | 0.0223 | 0.0483 |
| | (0.037) | (0.036) | (0.038) | (0.037) | (0.038) |
| (Community Quality Index)x(Mother Home Index) | 0.0816** | 0.0717** | 0.0094 | 0.0817** | -0.0045 |
| | (0.036) | (0.036) | (0.037) | (0.036) | (0.038) |
| (2004 Asset Index)x(Maternal Genetic Index) | -0.0677* | -0.0093 | -0.0219 | -0.0398 | 0.0262 |
| | (0.041) | (0.041) | (0.043) | (0.042) | (0.043) |
| (2004 Asset Index)x(Mother Home Index) | 0.0485 | 0.0029 | -0.0344 | -0.0183 | -0.0355 |
| | (0.045) | (0.045) | (0.047) | (0.045) | (0.047) |
| Provence Dummies | YES | YES | YES | YES | YES |
| Constant | -1.6580*** | -1.5776** | -1.2742* | -1.2742** | 0.3230 |
| | (0.634) | (0.624) | (0.654) | (0.634) | (0.662) |
| Observations | 976 | 976 | 976 | 976 | 976 |
| R-squared | 0.129 | 0.110 | 0.126 | 0.077 | 0.066 |

Standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

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actions are included in the estimation. Gender is a significant predictor of each of the five personality traits and levels of Conscientiousness, Extroversion and Agreeableness all appear to increase with age. Conscientiousness and Extroversion, in this sample, both seem to have an environmental and genetic component with the maternal extended family education index and school facility quality index both having a statistically significant positive effect. Genetics also seem to play a role in the formation of Agreeableness. In this sample Neuroticism seems to be generally predicted by environmental and parental characteristics, with both the community quality index and the maternal childhood home index having significant negative effects.

Table 3.10: Average Marginal Effect of Environment & Family Background on Personality

| | Conscientiousness | Extroversion | Openness | Agreeableness | Neuroticism |
|---|---|---|---|---|---|
| Community Quality Index | 0.028 | 0.020 | 0.029 | 0.024 | **-0.057*** |
| Maternal Extended Family Education Index | **0.084**** | **0.112***** | 0.031 | **0.106***** | 0.004 |
| Maternal Home Index | 0.003 | 0.065 | 0.019 | 0.023 | **-0.117***** |
| 2004 Asset Index | 0.068 | 0.019 | **0.116**** | 0.032 | -0.072 |
| School Facility Quality Index | **0.082*** | **0.076*** | 0.064 | 0.016 | 0.061 |
| Teaching Resource Quality Index | 0.001 | 0.041 | 0.026 | 0.027 | -0.036 |
| Age | **0.059**** | **0.052**** | 0.028 | **0.046*** | -0.011 |
| Male | **0.149***** | **0.188***** | **0.270***** | **0.106*** | **-0.146**** |

According to Table 3.10, on average, the remoteness index, gender and the 2004 asset index are the only variables that appear to be significant predictors of Openness to Experience. However, according to Table 3.9 the extended family education index and numerous environmental characteristics appear to interact substantially to influence the formation of this personality trait. However, this influence appears to wash out in the average marginal effects.

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## 3.7 Conclusion

Recently, a rapidly growing literature has demonstrated the importance of "noncognitive" skills to numerous outcomes of interest spanning the economic, demographic, behavioral and health domains. Noncognitive traits have have been shown to effect outcomes such as job performance, wages, academic achievement and crime participation. If the policy implications of this literature are to be realized, then a better understanding of how these noncognitive traits are developed is needed. However, to date, the literature detailing how these noncognitive traits are formed is much smaller. This paper explores the environmental and familial determinants of the Big Five Personality Traits: Openness to Experience, Conscientiousness, Extroversion, Agreeableness and Neuroticism.

A large literature in psychology demonstrates the strong influence of genes in interaction with environment in determining an individual's personality. While we cannot control directly for genetic make-up, the data used in the paper provide unique information on parental childhood environments and extended family education. Using this information we constructed indices on maternal childhood home quality and extended family education. After controlling for numerous parental, household and community characteristics, the extended family education index may provide some insights into individuals' genetic predisposition toward education and associated characteristics and the role this has in personality formation.

We find that maternal background, extended family characteristics and other environmental determinants all interact and play a role in determining the five personality traits we examine. While this paper is descriptive in nature and cannot make any causal asser-

tions, our findings do indicate that improving school and community quality will aid in increasing levels of relatively desirable personality traits such as Conscientiousness and Openness to Experience and decreasing levels of less desirable traits such as Neuroticism.

APPENDIX A

**CHAPTER 1 APPENDIX**

Table A.1: Summary Statistics of Year One Measurements N=2286

|  | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| ***Measurements of Initial Health*** | | | | |
| Height-for Age Z-score | -0.558 | 1.037 | -5.43 | 3.54 |
| Weight-for-Age Z-score | -0.797 | 0.901 | -4.98 | 1.95 |
| Low Birth Weight | 0.121 | 0.326 | 0 | 1 |
| Born in Hospital or Clinic | 0.363 | 0.481 | 0 | 1 |
| Delivered by Doctor | 0.601 | 0.49 | 0 | 1 |
| Delivered by Cesarean | 0.022 | 0.146 | 0 | 1 |
| ***Health Measurements*** | | | | |
| Height-for Age Z-score | -1.718 | 1.132 | -5.82 | 2.6 |
| Child is Stunted | 0.494 | 0.5 | 0 | 1 |
| Child is Wasted | 0.245 | 0.43 | 0 | 1 |
| # Diarrhea Incidences in Past Year | 0.696 | 0.861 | 0 | 5 |
| ***Parental Investment Measurements*** | | | | |
| Child is Given Vitamins | 0.708 | 0.455 | 0 | 1 |
| Child has been vaccinated | 0.378 | 0.485 | 0 | 1 |
| Animals live in/under household | 0.905 | 0.293 | 0 | 1 |
| Household has piped water | 0.311 | 0.463 | 0 | 1 |
| Child Drinking Water not Treated | 0.405 | 0.491 | 0 | 1 |
| Mother works for pay | 0.486 | 0.5 | 0 | 1 |
| Father is in residence | 0.094 | 0.291 | 0 | 1 |

Table A.2: Summary Statistics of Year Two Measurements N=2286

|  | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| *Health Measurememts* | | | | |
| Height-for Age Z-score | -2.564 | 1.119 | -6 | 0.65 |
| Child is stunted | 0.771 | 0.42 | 0 | 1 |
| Child is wasted | 0.233 | 0.423 | 0 | 1 |
| # Diarrhea Incidences in Past Year | 0.783 | 0.958 | 0 | 5 |
| *Parental Investment Measurements* | | | | |
| Child is Given Vitamins | 0.472 | 0.499 | 0 | 1 |
| Child has been vaccinated | 0.098 | 0.297 | 0 | 1 |
| Animals live in/under household | 0.929 | 0.257 | 0 | 1 |
| Household has piped water | 0.326 | 0.469 | 0 | 1 |
| Solids have been introduced | 0.996 | 0.066 | 0 | 1 |
| Child's water is not treated | 0.461 | 0.499 | 0 | 1 |
| Father is in residence | 0.083 | 0.275 | 0 | 1 |

## Table A.3: Summary Statistics of Year Eight Measurements N=2055

|  | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| ***Health Measurements*** | | | | |
| Height-for Age Z-score | -2.06 | 0.943 | -5.38 | 3.09 |
| Body Mass Index (BMI) Z-score | -0.816 | 0.892 | -4.88 | 4.29 |
| Child is stunted | 0.539 | 0.499 | 0 | 1 |
| Child is wasted | 0.089 | 0.284 | 0 | 1 |
| ***Cognitive Measurements*** | | | | |
| IQ Z-score | -0.0108 | 0.994 | -3.152 | 3.165 |
| Current Grade in School | 1.827 | 0.864 | 0 | 5 |
| Age Entered School | 6.399 | 1.373 | 0 | 8 |
| ***Parental Investment Measurements*** | | | | |
| Child given worm medication | 0.690 | 0.463 | 0 | 1 |
| Child given vitamins | 0.140 | 0.347 | 0 | 1 |
| Child has been vaccinated | 0.755 | 0.430 | 0 | 1 |
| Child bathes at least 3x per week | 0.957 | 0.204 | 0 | 1 |
| Mother is dead | 0.011 | 0.105 | 0 | 1 |
| Child and Mother live together | 0.925 | 0.263 | 0 | 1 |
| Extended family lives in household | 0.178 | 0.382 | 0 | 1 |
| Household has piped water | 0.304 | 0.460 | 0 | 1 |
| Household has toilet that flushes | 0.566 | 0.496 | 0 | 1 |
| Garbage disposal regular/away from hh | 0.283 | 0.451 | 0 | 1 |
| Household has electric lighting | 0.736 | 0.441 | 0 | 1 |
| Household uses clean cooking fuel | 0.373 | 0.484 | 0 | 1 |
| Excreta visible around household | 0.474 | 0.499 | 0 | 1 |
| Area where food kept is clean | 0.219 | 0.414 | 0 | 1 |
| Child always uses soap when bathing | 0.967 | 0.178 | 0 | 1 |

## Table A.4: Summary Statistics of Year Eleven Measurements N=2021

|  | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| ***Health Measurements*** | | | | |
| Height-for Age Z-score | -1.938 | 1.023 | -5.45 | 1.84 |
| Body Mass Index (BMI) Z-score | -1.065 | 1.096 | -4.77 | 3.31 |
| Child is stunted | 0.489 | 0.5 | 0 | 1 |
| Child is wasted | 0.183 | 0.386 | 0 | 1 |
| ***Cognitive Measurements*** | | | | |
| IQ Z-score | 0.083 | 0.948 | -4.076 | 2.571 |
| Current grade in school | 4.185 | 0.924 | 1 | 6 |
| Math achievement test z-score | 0.075 | 0.979 | -2.073 | 2.526 |
| English achievement test z-score | 0.068 | 0.986 | -1.943 | 3.027 |
| Cebuano achievement test z-score | 0.061 | 0.995 | -2.062 | 2.584 |
| Child reads children's books | 0.969 | 0.172 | 0 | 1 |
| Child reads adult books | 0.475 | 0.499 | 0 | 1 |
| Child reads magazines | 0.452 | 0.498 | 0 | 1 |
| Child reads comic books | 0.517 | 0.5 | 0 | 1 |
| Child reads newspapers | 0.406 | 0.491 | 0 | 1 |
| ***Parental Investment Measurements*** | | | | |
| Someone reads to child | 0.402 | 0.49 | 0 | 1 |
| Child and Mother live together | 0.911 | 0.284 | 0 | 1 |
| Mother is dead | 0.015 | 0.121 | 0 | 1 |
| Household attends church regularly | 0.623 | 0.485 | 0 | 1 |
| Children's books in household | 0.584 | 0.493 | 0 | 1 |
| Adult books in household | 0.476 | 0.5 | 0 | 1 |
| Magazines in household | 0.258 | 0.438 | 0 | 1 |
| Comic books in household | 0.228 | 0.419 | 0 | 1 |
| Newspapers in household | 0.280 | 0.449 | 0 | 1 |
| Hours per day child spends working | 0.152 | 0.588 | 0 | 7.5 |
| Hours per day child spends at chores | 0.769 | 0.650 | 0 | 5 |
| Hours per day child cares for siblings | 0.346 | 0.563 | 0 | 5 |
| Hours per day child spends playing | 1.72 | 0.966 | 0 | 7 |
| Extended family lives in household | 0.063 | 0.244 | 0 | 1 |
| Child has been vaccinated | 0.265 | 0.441 | 0 | 1 |
| Child given worm medication | 0.448 | 0.497 | 0 | 1 |
| No one generally helps child with homework | 0.298 | 0.457 | 0 | 1 |
| Parents generally help child with homework | 0.336 | 0.472 | 0 | 1 |
| Second language spoken in household | 0.01 | 0.101 | 0 | 1 |
| Child bathes at least 3x per week | 0.905 | 0.293 | 0 | 1 |
| Child always uses soap when bathing | 0.986 | 0.119 | 0 | 1 |

Table A.5: Summary Statistics of Year Fifteen Measurements N=1995

|  | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| *Health Measurements* | | | | |
| Height-for Age Z-score | -1.834 | 0.824 | -4.67 | 0.79 |
| Body Mass Index (BMI) Z-score | -0.848 | 1.05 | -4.18 | 3.03 |
| Child is stunted | 0.413 | 0.492 | 0 | 1 |
| Child is wasted | 0.129 | 0.336 | 0 | 1 |
| *Cognitive Measurements* | | | | |
| Current Grade in School | 8.926 | 1.826 | 1 | 12 |
| Has child repeated grade since 1994 | 0.204 | 0.403 | 0 | 1 |
| Number of languages reads in books | 1.135 | 0.694 | 0 | 3 |
| *Group Socialization Measurements* | | | | |
| Child is member of club/group organization | 0.24 | 0.427 | 0 | 1 |
| Number of close friends | 6.438 | 4.228 | 0 | 50 |
| Number of school group activities | 0.399 | 0.618 | 0 | 3 |
| Number of nonschool group activities | 0.578 | 0.726 | 0 | 4 |
| Number of sedentary group activities | 1.118 | 0.756 | 0 | 4 |
| *Risky Behavior Measurements* | | | | |
| Child has tried smoking | 0.248 | 0.432 | 0 | 1 |
| Child has drunk alcohol | 0.395 | 0.489 | 0 | 1 |
| Child has tried drugs | 0.024 | 0.152 | 0 | 1 |
| *Parental Investment Measurements* | | | | |
| Household owns books | 0.463 | 0.499 | 0 | 1 |
| Household connected to electrical system | 0.885 | 0.319 | 0 | 1 |
| Extended family lives in household | 0.164 | 0.37 | 0 | 1 |
| Household has piped water | 0.609 | 0.488 | 0 | 1 |
| Household has toilet that flushes | 0.744 | 0.436 | 0 | 1 |
| Garbage disposal regular/away from hh | 0.505 | 0.5 | 0 | 1 |
| Household has electric lighting | 0.873 | 0.333 | 0 | 1 |
| Household uses clean cooking fuel | 0.679 | 0.467 | 0 | 1 |
| Excreta visible around household | 0.722 | 0.448 | 0 | 1 |
| Area where food kept is clean | 0.121 | 0.326 | 0 | 1 |

## Table A.6: Summary Statistics of Adult Measurements N=2001

| | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| | | | *Health Measurements* | |
| Body Mass Index (BMI) Z-score | -0.664 | 1 | -3.84 | 4.01 |
| Tricep skinfold measure (cm) | 13.034 | 5.619 | 3 | 40.333 |
| Subscapular skinfold measure (cm) | 12.755 | 4.69 | 4.667 | 39 |
| | | | *Cognitive Measurements* | |
| Highest grade attained | 10.254 | 2.633 | 0 | 15 |
| Education level aspires to | 5.547 | 1.075 | 0 | 8 |
| Child neither working nor at school | 0.234 | 0.423 | 0 | 1 |
| | | | *Positive Affect Measurements* | |
| Frequency felt happy for past four weeks | 2.279 | 0.537 | 1 | 3 |
| Frequency felt hopeful about future for past four weeks | 2.282 | 0.7 | 1 | 3 |
| Frequency enjoyed normal daily activities for past four weeks | 2.599 | 0.554 | 1 | 3 |
| | | | *Negative Affect Measurements* | |
| Would like to change something about body | 0.639 | 0.48 | 0 | 1 |
| Feels must have sex with someone to be loved by them | 0.104 | 0.306 | 0 | 1 |
| Has difficulty falling asleep over past four weeks | 1.397 | 0.556 | 1 | 3 |
| Frequency felt lonely over past four weeks | 1.639 | 0.622 | 1 | 3 |
| Frequency felt people were unfriendly over past four weeks | 1.492 | 0.579 | 1 | 3 |
| Frequency felt disliked by people over past four weeks | 1.496 | 0.563 | 1 | 3 |
| Frequency felt life not worth living over past four weeks | 1.212 | 0.443 | 1 | 3 |
| Frequency felt worthless over past four weeks | 1.31 | 0.506 | 1 | 3 |
| Frequency wished was dead over past four weeks | 1.153 | 0.387 | 1 | 3 |
| Frequency had idea to take own life over past four weeks | 1.1 | 0.325 | 1 | 3 |
| | | | *Risky Behavior Measurements* | |
| Child has tried smoking | 0.507225 | 0.5000724 | 0 | 1 |
| Child has drunk alcohol | 0.796712 | 0.4025457 | 0 | 1 |
| Child has tried drugs | 0.142501 | 0.3496506 | 0 | 1 |
| Child has been/gotten someone pregnant | 0.10862 | 0.3298999 | 0 | 3 |
| Child sexually active by age 16 | 0.111111 | 0.314348 | 0 | 1 |

Table A.7: Measurement Equation Estimates for Year One

|  | $\mu_{j,t}^{k}$ | $\lambda_{j,t}^{k}$ |
|---|---|---|
| ***Measurement of Initial Health*** | | |
| Height-for Age Zscore | -0.538*** | 0.766*** |
| Weight-for-Age Zscore | -0.885*** | 0.931*** |
| Low Birth Weight | 0.371*** | -0.681*** |
| Born in Hospital or Clinic | 0.755*** | 0.127*** |
| Delivered by Doctor | 1.229*** | 0.108*** |
| Delivered by Cesarean | 0.150*** | 0.038* |
| ***Measurements of Health at Age 1 Year*** | | |
| Height-for Age Zscore | -1.586*** | 0.958*** |
| Child is Stunted | 1.043*** | -0.760*** |
| Child is Wasted | 0.584*** | -0.190*** |
| # Diarrhea Incidences in Past Year | 0.812*** | -0.055*** |
| ***Measurements of Parental Investments at Age 1 year*** | | |
| Child is Given Vitamins | 1.556*** | 0.266*** |
| Child has been vaccinated | 0.779*** | 0.152*** |
| Animals live in/under household | 3.088*** | -0.095*** |
| Household has piped water | 0.671*** | 0.906*** |
| Child Drinking Water not Treated | 0.824*** | -0.606*** |
| Mother works for pay | 0.972*** | -0.098*** |
| Father is in residence | 0.321*** | 0.047** |

Table A.8: Measurement Equation Estimates for Year Two

| | $\mu_{j,t}^{k}$ | $\lambda_{j,t}^{k}$ |
|---|---|---|
| ***Measurements of Health at Age 2 Years*** | | |
| Height-for Age Zscore | -2.414*** | 0.934*** |
| Child is stunted | 1.925*** | -0.708*** |
| Child is wasted | 0.590*** | -0.319*** |
| # Diarrhea Incidences in Past Year | 0.828*** | -0.088*** |
| ***Measurements of Parental Investments at Age 2 Years*** | | |
| Child is Given Vitamins | 0.946*** | 0.263*** |
| Child has been vaccinated | 0.329*** | 0.031 |
| Animals live in/under household | 3.609*** | -0.045** |
| Household has piped water | 0.695*** | 0.921*** |
| Solids have been introduced | 15.086*** | 0.005 |
| Child's water is not treated | 0.925*** | -0.694*** |
| Father is in residence | 0.300*** | 0.041* |

Table A.9: Measurement Equation Estimates for Year Eight

|  | $\mu_{j,t}^k$ | $\lambda_{j,t}^k$ |
|---|---|---|
| *Health Measurements at Age 8 Years* | | |
| Height-for Age Zscore | -2.34*** | 0.977*** |
| Body Mass Index (BMI) Zscore | -0.929*** | 0.098*** |
| Child is stunted | 1.198*** | -0.792*** |
| Child is wasted | 0.310*** | 0.01 |
| *Cognitive Measurements at Age 8 Years* | | |
| IQ Zscore | -0.037 | 0.701*** |
| Current Grade in School | 2.11*** | 0.411*** |
| Age Entered School | 4.66*** | 0.311*** |
| *Measurements for Parental Investments at Age 8 Years* | | |
| Child given worm medication | 1.492*** | 0.185*** |
| Child given vitamins | 0.403*** | 0.420*** |
| Child has been vaccinated | 1.754*** | 0.086*** |
| Child bathes at least 3x per week | 4.700*** | 0.199*** |
| Mother is dead | 0.106*** | -0.049** |
| Child and Mother live together | 3.513*** | -0.008 |
| Extended family lives in household | 0.465*** | 0.095*** |
| Household has piped water | 0.660*** | 0.365*** |
| Household has toilet that flushes | 1.141*** | 0.642*** |
| Garbage disposal regular/away from hh | 0.629*** | 0.396*** |
| Household has electric lighting | 1.671*** | 0.617*** |
| Household uses clean cooking fuel | 0.772*** | 0.633*** |
| Excreta visible around household | 0.949*** | -0.167*** |
| Area where food kept is clean | 0.530*** | 0.385*** |
| Child always uses soap when bathing | 5.447*** | 0.151*** |

## Table A.10: Measurement Equation Estimates for Year Eleven

| | $\mu_{j,t}^k$ | $\lambda_{j,t}^k$ |
|---|---|---|
| **Measurements for Health at Age 11 Years** | | |
| Height-for Age Zscore | –2.160*** | 0.986*** |
| Body Mass Index (BMI) Zscore | 7.501*** | 0.384*** |
| Child is stunted | 1.182*** | –0.795*** |
| Child is wasted | 0.515*** | –0.170*** |
| **Measurements for Cognition at Age 11 Years** | | |
| IQ Zscore | –0.093*** | 0.675*** |
| Current grade in school | 4.422*** | 0.558*** |
| Math achievement test zscore | –0.158*** | 0.882*** |
| English achievement test zscore | –0.172*** | 0.906*** |
| Cebuano achievement test zscore | –0.163*** | 0.840*** |
| Child reads children's books | 5.595*** | 0.102*** |
| Child reads adult books | 0.867*** | 0.326*** |
| Child reads magazines | 0.812*** | 0.372*** |
| Child reads comic books | 0.974*** | 0.232*** |
| Child reads newspapers | 0.726 | 0.388*** |
| **Measurements for Parental Investments at Age 11 Years** | | |
| Someone reads to child | 0.820*** | 0.266*** |
| Child and Mother live together | 3.208*** | 0.047** |
| Mother is dead | 0.123*** | –0.045* |
| Household attends church regularly | 1.285*** | 0.290*** |
| Children's books in household | 1.186*** | 0.378*** |
| Adult books in household | 0.952*** | 0.481*** |
| Magazines in household | 0.590*** | 0.701*** |
| Comic books in household | 0.543*** | 0.574*** |
| Newspapers in household | 0.623*** | 0.641*** |
| Hours per day child spends working | 0.259*** | 0.024 |
| Hours per day child spends at chores | 1.184*** | –0.170*** |
| Hours per day child cares for siblings | 0.615*** | –0.137*** |
| Hours per day child spends playing | 1.782*** | 0.007 |
| Extended family lives in household | 0.260*** | 0.188*** |
| Child has been vaccinated | 0.600*** | 0.062** |
| Child given worm medication | 0.901*** | 0.187*** |
| No one generally helps child with homework | 0.651*** | –0.303*** |
| Parents generally help child with homework | 0.711*** | 0.299*** |
| Second language spoken in household | 0.102*** | 0.108*** |
| Child bathes at least 3x per week | 3.09*** | 0.085*** |
| Child always uses soap when bathing | 8.288*** | 0.059*** |

## Table A.11: Measurement Equation Estimates for Adulthood

| | $\mu_{j,t}^{k}$ | $\lambda_{j,t}^{k}$ |
|---|---|---|
| *Health Measurements at Age 18 Years* | | |
| Body Mass Index (BMI) Zscore | -0.664*** | 0.704*** |
| Tricep skinfold measure | 2.322*** | 0.881*** |
| Subscapular skinfold measure | 2.689*** | 0.943*** |
| *Measurements of Cognition at 18 Years* | | |
| Highest grade attained | 3.896*** | 0.996*** |
| Education level aspires to | 5.164*** | 0.602*** |
| Child neither working nor at school | 0.553*** | -0.112*** |
| *Measurements of Positive Affect at 18 Years* | | |
| Frequency felt happy for past four weeks | 4.249*** | 0.391*** |
| Frequency felt hopeful about future for past four weeks | 3.263*** | 0.521*** |
| Frequency enjoyed normal daily activities for past four weeks | 4.690*** | 0.472*** |
| *Measurements of Negative Affect at 18 Years* | | |
| Would like to change something about body | 1.330*** | 0.109*** |
| Feels must have sex with someone to be loved by them | 0.341*** | 0.087*** |
| Has difficulty falling asleep over past four weeks | 2.513*** | 0.320*** |
| Frequency felt lonely over past four weeks | 2.636*** | 0.310*** |
| Frequency felt people were unfriendly over past four weeks | 2.576*** | 0.393*** |
| Frequency felt disliked by people over past four weeks | 2.658*** | 0.425*** |
| Frequency felt life not worth living over past four weeks | 2.738*** | 0.727*** |
| Frequency felt worthless over past four weeks | 2.591*** | 0.688*** |
| Frequency wished was dead over past four weeks | 2.979*** | 0.655*** |
| Frequency had idea to take own life over past four weeks | 3.380*** | 0.562*** |
| *Measurements of Risky Behavior at 18 Years* | | |
| Child has tried smoking | 1.015*** | 0.725*** |
| Child has drunk alcohol | 1.982*** | 0.420*** |
| Child has tried drugs | 0.409*** | 0.560*** |
| Child has been/gotten someone pregnant | 0.327 *** | 0.153*** |
| Child sexually active by age 16 | 0.354*** | 0.296*** |

Table A.12: Cronbach's $\alpha$ Measure of Factor Reliability

| | |
|---|---|
| Health Factors | |
| Initial Health | 0.63 |
| Health 1 year old | 0.49 |
| Health 2 years old | 0.45 |
| Health 8 years old | 0.57 |
| Health 11 years old | 0.72 |
| Health 15 years old | 0.65 |
| Adult Health | 0.87 |
| Cognition Factors | |
| Cognition 8 years old | 0.50 |
| Cognition 11 years old | 0.81 |
| Cognition 15 years old | 0.45 |
| Adult Cognition | 0.52 |
| Noncognitive Factors | |
| Group Socialization 15 years old | 0.38 |
| Risky Behaviors 15 years old | 0.55 |
| Adult Positive Affect | 0.45 |
| Adult Negative Affect | 0.69 |
| Adult Risky Behaviors | 0.55 |
| Investment Factors | |
| Investment 1 year old | 0.44 |
| Investment 2 years old | 0.36 |
| Investment 8 years old | 0.57 |
| Investment 11 years old | 0.59 |
| Investment 15 years old | 0.71 |

Table A.13: Goodness of Fit Statistics for each Childhood Period

|  | Test Statistic | Overall $R^2$ |
|---|---|---|
| Year 1 | $\chi^2(393) = 5862.56$ | 0.9947 |
| Year 2 | $\chi^2(372) = 4428.75$ | 0.7757 |
| Year 8 | $\chi^2(895) = 10336.99$ | 0.7923 |
| Year 11 | $\chi^2(723) = 10114.97$ | 0.9999 |
| Year 15 | $\chi^2(603) = 6886.85$ | 0.9997 |

# CHAPTER 2 APPENDIX

Table B.1: Measurement Summary Statistics for Openness to Experience

|  | Mean | Std. Dev. | Min | Max |
| --- | --- | --- | --- | --- |
| I find the world very interesting | 3.4311 | 1.066 | 1 | 5 |
| I am never bored | 3.8074 | 0.8355 | 1 | 5 |
| I am proficient in several areas | 3.019 | 1.0338 | 1 | 5 |
| I am always busy with something interesting | 3.6604 | 0.8602 | 1 | 5 |
| I am interested in many things | 3.1393 | 1.043 | 1 | 5 |
| In any situation I can find something interesting | 3.1142 | 0.9656 | 1 | 5 |
| I think my life is very interesting | 3.2809 | 0.9649 | 1 | 5 |
| I am very interested in other countries and their cultures | 3.2378 | 1.136 | 1 | 5 |
| I am not very curious about what is happening in the world | 2.6983 | 1.0739 | 1 | 5 |
| I am interested in very few things | 2.314 | 0.9426 | 1 | 5 |

Table B.2: Measurement Summary Statistics for Conscientiousness

|  | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| I am always ready | 4.232 | 0.7408 | 1 | 5 |
| I love to bring order | 4.1423 | 0.7 | 1 | 5 |
| I do things quickly | 3.7816 | 0.8333 | 1 | 5 |
| I never leave a task without completeing it | 3.8899 | 0.8424 | 1 | 5 |
| I like to step up to the plate | 4.0562 | 0.7486 | 1 | 5 |
| I am always up to my jobs/tasks | 3.9795 | 0.7731 | 1 | 5 |
| I always keep my promises | 4.0287 | 0.7736 | 1 | 5 |
| I like to tidy up | 4.161 | 0.6693 | 1 | 5 |
| I benefit well from my work | 3.714 | 0.8906 | 1 | 5 |
| I never leave work to be done | 3.6405 | 0.8943 | 1 | 5 |
| I do my job without waiting | 3.8273 | 0.805 | 1 | 5 |
| I like when everything is in its place | 4.1706 | 0.654 | 1 | 5 |
| I finish tasks no matter what obstacles encountered | 3.5386 | 0.9475 | 1 | 5 |
| I start work without delay | 3.8589 | 0.8176 | 1 | 5 |
| I like ordering things around me | 3.8466 | 0.7961 | 1 | 5 |
| I can clearly articulate ideas | 3.6036 | 0.8498 | 1 | 5 |
| I always keep my word | 4.024 | 0.7492 | 1 | 5 |
| I like order and regularity | 4.1434 | 0.6939 | 1 | 5 |
| I always act first | 3.6447 | 0.8812 | 1 | 5 |
| I work with conviction | 4.1781 | 0.6612 | 1 | 5 |
| I am a workaholic | 3.4646 | 0.968 | 1 | 5 |
| I am a planner | 3.2162 | 1.0027 | 1 | 5 |
| I can bounce back after challenges | 3.7335 | 0.8795 | 1 | 5 |
| I am faithful to my own values | 3.8664 | 0.9077 | 1 | 5 |
| I do things by following a plan | 3.8049 | 0.8153 | 1 | 5 |
| I quickly realize the tasks to do | 3.6452 | 0.8407 | 1 | 5 |
| I am not distracted when I work | 3.7067 | 0.8846 | 1 | 5 |
| I immediately begin my chores | 3.8799 | 0.7526 | 1 | 5 |
| I am a person who sets goals | 4.082 | 0.7488 | 1 | 5 |
| I pay attention to detail | 3.8202 | 0.8217 | 1 | 5 |

Table B.3: Measurement Summary Statistics for Extroversion

| | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| I get involved in community/collective activities | 3.9918 | 0.8363 | 1 | 5 |
| I like to animate groups | 3.1517 | 1.095 | 1 | 5 |
| I like belonging to a group | 3.7278 | 0.9096 | 1 | 5 |
| I can captivate people's attention | 3.1598 | 0.9853 | 1 | 5 |
| I can keep my cool | 3.945 | 0.7471 | 1 | 5 |
| I take the initiative in conversations | 3.784 | 0.8354 | 1 | 5 |
| I talk easily | 3.2412 | 1.0591 | 1 | 5 |
| I can clearly articulate ideas | 3.6036 | 0.8498 | 1 | 5 |
| I interact with different people when they are gathered | 3.7458 | 0.8428 | 1 | 5 |
| I am uncomfortable working in a group | 2.1945 | 0.9444 | 1 | 5 |
| I always have something to say | 2.7206 | 0.9702 | 1 | 5 |
| I like to draw attention to myself | 2.8036 | 1.0521 | 1 | 5 |
| I am not usually talkative | 3.1003 | 0.997 | 1 | 5 |
| I prefer to do it alone | 2.5329 | 1.0009 | 1 | 5 |
| I am not talkative | 3.0592 | 0.9997 | 1 | 5 |
| I have trouble expressing my feelings | 2.693 | 1.0355 | 1 | 5 |
| I work better when I'm alone | 3.0568 | 1.0799 | 1 | 5 |
| I do not like to take the lead | 3.3175 | 1.0145 | 1 | 5 |
| I wait for others to lead the way | 2.587 | 1.0475 | 1 | 5 |
| I keep to myself | 3.1567 | 1.0937 | 1 | 5 |
| I do not talk a lot | 3.0439 | 1.0191 | 1 | 5 |
| I rarely associate with others | 2.0334 | 0.8765 | 1 | 5 |
| I try not to attract attention to myself | 2.864 | 1.1806 | 1 | 5 |
| I'm afraid to draw attention to myself | 2.7013 | 1.0785 | 1 | 5 |
| I leave others to take the initiative | 2.16 | 0.8988 | 1 | 5 |
| I leave others to decide | 2.2724 | 0.9446 | 1 | 5 |
| I feel comfortable with people | 3.8729 | 0.8385 | 1 | 5 |
| I am a team player | 3.9531 | 0.7876 | 1 | 5 |

Table B.4: Measurement Summary Statistics for Agreeablenss

|  | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| I get involved in community/collective activities | 3.9918 | 0.8363 | 1 | 5 |
| I like belonging to a group | 3.7276 | 0.9096 | 1 | 5 |
| I think honesty is the basis of trust | 4.1107 | 0.8364 | 1 | 5 |
| I always keep my word | 4.024 | 0.7492 | 1 | 5 |
| I respect the decisions of the group | 4.0698 | 0.7066 | 1 | 5 |

Table B.5: Measurement Summary Statistics for Neuroticism

| | Mean | Std. Dev. | Min |
|---|---|---|---|
| I have often worried | 2.7822 | 1.0794 | 1 |
| I am not often worried | 3.1987 | 1.0505 | 1 |
| I am often sad | 2.2237 | 0.9623 | 1 |
| I feel hopeless | 2.2168 | 0.9887 | 1 |
| I have mood swings | 3.7036 | 0.9111 | 1 |
| I can bounce back after challenges | 3.7335 | 0.8795 | 1 |
| I have a bad feeling about what is going to happen | 2.2425 | 1.0305 | 1 |
| I panic easily | 2.2015 | 0.9466 | 1 |
| I lie to get out of things | 2.085 | 1.0118 | 1 |
| I see problems everywhere | 2.4671 | 1.0085 | 1 |
| I am rarely angry | 3.2019 | 1.1439 | 1 |
| I get frustrated quickly | 2.2806 | 0.941 | 1 |
| I have trouble expressing my feelings | 2.693 | 1.0355 | 1 |
| I am a difficult person to understand | 2.8143 | 1.0515 | 1 |
| I give up easily | 2.0234 | 0.8925 | 1 |
| I get discouraged easily | 2.0152 | 0.8768 | 1 |
| I rarely worry | 3.225 | 0.9958 | 1 |
| I sometimes feel dishonest | 1.8089 | 0.8451 | 1 |
| I am easily intimidated | 2.0299 | 0.8768 | 1 |
| It's often difficult for me to have fun | 2.3705 | 1.0309 | 1 |
| I exaggerate my troubles | 2.0709 | 0.8706 | 1 |
| I fear the worst will happen | 2.7825 | 1.1412 | 1 |
| I am unflappable | 3.2151 | 1.045 | 1 |
| I have a lot of fun | 2.9795 | 0.9856 | 1 |
| I'm consumed by my own problems | 2.2973 | 0.947 | 1 |

Table B.6: Measurement Equation Estimates for Openness to Experience

| | $\lambda_j^O$ | $\mu_j^O$ |
|---|---|---|
| I find the world very interesting | 1.0000 | 3.4310*** |
| I am never bored | 0.4714*** | 3.8080*** |
| I am proficient in several areas | 0.6707*** | 3.0206*** |
| I am always busy with something interesting | 0.7073*** | 3.6624*** |
| I am interested in many things | 0.6845*** | 3.1368*** |
| In any situation I can find something interesting | 0.8995*** | 3.1133*** |
| I think my life is very interesting | 0.7382*** | 3.2813*** |
| I am very interested in other countries and their cultures | 1.1427*** | 3.2372*** |
| I am not very curious about what is happening in the world | -0.4902*** | 2.6976*** |
| I am interested in very few things | -0.1742*** | 2.3147*** |

Table B.7: Measurement Equation Estimates for Conscientiousness

| | $\lambda_j^C$ | $\mu_j^C$ |
|---|---|---|
| I am always ready | 1.0000 | 4.2289*** |
| I love to bring order | 0.9489*** | 4.1407*** |
| I do things quickly | 1.2030*** | 3.7812*** |
| I never leave a task without completeing it | 1.2790*** | 3.8906*** |
| I like to step up to the plate | 1.3252*** | 4.0532*** |
| I am always up to my jobs/tasks | 1.4385*** | 3.9787*** |
| I always keep my promises | 1.3067*** | 4.0272*** |
| I like to tidy up | 1.0557*** | 4.1591*** |
| I benefit well from my work | 1.3832*** | 3.7114*** |
| I never leave work to be done | 1.3590*** | 3.6387*** |
| I do my job without waiting | 1.3382*** | 3.8273*** |
| I like when everything is in its place | 0.9487*** | 4.1697*** |
| I finish tasks no matter what obstacles encountered | 1.4048*** | 3.5376*** |
| I start work without delay | 1.3734*** | 3.8587*** |
| I like ordering things around me | 1.1400*** | 3.8439*** |
| I can clearly articulate ideas | 1.3056*** | 3.5985*** |
| I always keep my word | 1.2625*** | 4.0219*** |
| I like order and regularity | 1.1098*** | 4.1431*** |
| I always act first | 1.1263*** | 3.6458*** |
| I work with conviction | 0.9899*** | 4.1750*** |
| I am a workaholic | 1.3058*** | 3.4624*** |
| I am a planner | 1.1236*** | 3.2170*** |
| I can bounce back after challenges | 1.5037*** | 3.7321*** |
| I am faithful to my own values | 1.2373*** | 3.8622*** |
| I do things by following a plan | 1.3231*** | 3.8025*** |
| I quickly realize the tasks to do | 1.2905*** | 3.6452*** |
| I am not distracted when I work | 1.0688*** | 3.7067*** |
| I immediately begin my chores | 1.2344*** | 3.8817*** |
| I am a person who sets goals | 1.2342*** | 4.0816*** |
| I pay attention to detail | 1.1054*** | 3.8196*** |

## Table B.8: Measurement Equation Estimates for Extroversion

|  | $\lambda_J^E$ | $\mu_j^E$ |
|---|---|---|
| I get involved in community/collective activities | 1.0000 | 3.9923*** |
| I like to animate groups | 0.9976*** | 3.1530*** |
| I like belonging to a group | 1.0798*** | 3.7271*** |
| I can captivate people's attention | 0.8997*** | 3.1607*** |
| I can keep my cool | 0.8390*** | 3.9468*** |
| I take the initiative in conversations | 1.0952*** | 3.7844*** |
| I talk easily | 0.7552*** | 3.2392*** |
| I can clearly articulate ideas | 0.9967*** | 3.6060*** |
| I interact with different people when they are gathered | 1.0291*** | 3.7460*** |
| I am uncomfortable working in a group | -0.7069*** | 2.1955*** |
| I always have something to say | 0.5207*** | 2.7212*** |
| I like to draw attention to myself | 0.7325*** | 2.8021*** |
| I am not usually talkative | -0.4272*** | 3.1010*** |
| I prefer to do it alone | -0.2628*** | 2.5346*** |
| I am not talkative | -0.5708*** | 3.0602*** |
| I have trouble expressing my feelings | -0.6399*** | 2.6929*** |
| I work better when I'm alone | 0.0865 | 3.0561*** |
| I do not like to take the lead | -0.1796*** | 3.3207*** |
| I wait for others to lead the way | -0.3261*** | 2.5883*** |
| I keep to myself | -0.1505** | 3.1559*** |
| I do not talk a lot | -0.5989*** | 3.0443*** |
| I rarely associate with others | -0.7581*** | 2.0307*** |
| I try not to attract attention to myself | -0.6578*** | 2.8641*** |
| I'm afraid to draw attention to myself | -0.6918*** | 2.6988*** |
| I leave others to take the initiative | -0.8393*** | 2.1577*** |
| I leave others to decide | -0.7280*** | 2.2705*** |
| I feel comfortable with people | 0.8178*** | 3.8748*** |
| I am a team player | 0.9104*** | 3.9545*** |

Table B.9: Measurement Equation Estimates for Agreeableness

|  | $\lambda_j^A$ | $\mu_j^A$ |
|---|---|---|
| I get involved in community/collective activities | 1.0000 | 3.9924*** |
| I like belonging to a group | 0.9792*** | 3.7273*** |
| I think honesty is the basis of trust | 0.5626*** | 4.1097*** |
| I always keep my word | 0.6772*** | 4.0240*** |
| I respect the decisions of the group | 0.6460*** | 4.0698*** |

Table B.10: Measurement Equation Estimates for Neuroticism

|  | Factor Loading | Constant |
|---|---|---|
| I have often worried | 1.0000 | 2.7825*** |
| I am not often worried | -0.5230*** | 3.1974*** |
| I am often sad | 1.0921*** | 2.4965*** |
| I feel hopeless | 1.1355*** | 2.2169*** |
| I have mood swings | 0.2514*** | 3.7021*** |
| I can bounce back after challenges | -0.4762*** | 3.7305*** |
| I have a bad feeling about what is going to happen | 0.7088*** | 2.2470*** |
| I panic easily | 1.0688*** | 2.2045*** |
| I lie to get out of things | 0.5988*** | 2.0857*** |
| I see problems everywhere | 0.9497*** | 2.4675*** |
| I am rarely angry | -0.0347 | 3.2033*** |
| I get frustrated quickly | 0.9652*** | 2.2825*** |
| I have trouble expressing my feelings | 0.9433*** | 2.6950*** |
| I am a difficult person to understand | 0.7272*** | 2.8174*** |
| I give up easily | 1.0426*** | 2.0266*** |
| I get discouraged easily | 1.1387*** | 2.0165*** |
| I rarely worry | -0.1413*** | 3.2287*** |
| I sometimes feel dishonest | 0.9316*** | 1.8085*** |
| I am easily intimidated | 0.9783*** | 2.0307*** |
| It's often difficult for me to have fun | 0.7225*** | 2.3729*** |
| I exaggerate my troubles | 0.8541*** | 2.0751*** |
| I fear the worst will happen | 1.1304*** | 2.7843*** |
| I am unflappable | -0.3405*** | 3.2122*** |
| I have a lot of fun | -0.1185** | 2.9775*** |
| I'm consumed by my own problems | 1.0307*** | 2.2991*** |

Table B.11: Estimates of Cronbach's $\alpha$ Measure of Factor Reliability

|  | Cronbach's $\alpha$ |
|---|---|
| Openness to Experience | 0.7091 |
| Conscientiousness | 0.921 |
| Extroversion | 0.8028 |
| Agreeableness | 0.6635 |
| Neuroticism | 0.8171 |

Table B.12: The Effect of Personality and Cognition on Selection into Self-Employment

| | Self Employed | Self Employed | Self Employed | Self Employed |
|---|---|---|---|---|
| Conscientiousness Zscore | -0.1173 | -0.1316 | -0.1626 | -0.1763 |
| | (0.194) | (0.180) | (0.163) | (0.187) |
| Extraversion Zscore | 0.3301* | 0.3560* | 0.3007* | 0.3117* |
| | (0.192) | (0.191) | (0.173) | (0.214) |
| Openness to Experience Zscore | -0.1144 | -0.1237 | 0.0827 | -0.0031 |
| | (0.158) | (0.148) | (0.171) | (0.197) |
| Agreeableness Zscore | -0.1357 | -0.1313 | -0.1493 | -0.1826 |
| | (0.184) | (0.199) | (0.131) | (0.181) |
| Neuroticism Zscore | -0.0060 | 0.0021 | -0.0855 | -0.0049 |
| | (0.0903) | (0.112) | (0.141) | (0.105) |
| Agreggate Math/French Zscore | -1.9183*** | -1.7655*** | -3.2443*** | -2.6119*** |
| | (0.194) | (0.267) | (0.706) | (0.650) |
| Male | | -0.5971*** | -0.5614*** | -0.5358** |
| | | (0.232) | (0.186) | (0.203) |
| Age | | -0.0739 | -0.0583 | -0.0444 |
| | | (0.095) | (0.085) | (0.076) |
| 2004 Asset Index | | -0.0891 | 0.4694** | 0.4431*** |
| | | (0.144) | (0.232) | (0.172) |
| Mother Education | | -0.0464 | 0.0113 | -0.0112 |
| | | (0.044) | (0.047) | (0.048) |
| Father Education | | 0.0000 | 0.0604* | 0.0365 |
| | | (0.031) | (0.036) | (0.039) |
| Transfers into Household | | 0.0001 | 0.0002 | 0.0002 |
| | | (0.001) | (0.000) | (0.001) |
| Urban | | | -1.5734*** | -1.6128*** |
| | | | (0.424) | (0.346) |
| HHs with Electricity in Community | | | 0.3786 | 0.0916 |
| | | | (0.259) | (0.324) |
| Secondary School in Community | | | 1.0035** | 0.5308 |
| | | | (0.441) | (0.446) |
| Heath Center in Community | | | 0.2042 | -0.4844 |
| | | | (0.324) | (0.332) |
| Constant | 0.6858*** | 2.8890 | 1.3193 | 2.1906 |
| | (0.109) | (2.20) | (2.13) | (1.77) |
| Regional Dummies | NO | NO | NO | YES |

Bootstrap corrected standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

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## Table B.13: The Effect of Personality and Cognition on Selection into Family Enterprises or Domestic Work

| | Family Enter./ Dom. Work | Family Enter./ Dom. Work | Family Enter./ Dom. Work | Family Enter./ Dom. Work |
|---|---|---|---|---|
| Conscientiousness Zscore | -0.3742** | -0.3910** | -0.3943** | -0.4754*** |
| | (0.183) | (0.179) | (0.175) | (0.174) |
| Extraversion Zscore | 0.1177 | 0.1566 | 0.1681 | 0.2744 |
| | (0.179) | (0.192) | (0.169) | (0.181) |
| Openness to Experience Zscore | -0.1642 | -0.1813 | -0.1410 | -0.2556 |
| | (0.152) | (0.168) | (0.155) | (0.208) |
| Agreeableness Zscore | 0.0950 | 0.0998 | 0.1020 | 0.0888 |
| | (0.170) | (0.176) | (0.137) | (0.175) |
| Neuroticism Zscore | -0.0505 | -0.0344 | -0.0230 | 0.0586 |
| | (0.084) | (0.113) | (0.108) | (0.119) |
| Agreggate Math/French Zscore | -1.4131*** | -1.0716*** | -1.3585** | -1.0127 |
| | (0.153) | (0.221) | (0.640) | (0.794) |
| Male | | -0.7944*** | -0.8251*** | -0.8133*** |
| | | (0.203) | (0.170) | (0.189) |
| Age | | -0.1234 | -0.1207* | -0.1369** |
| | | (0.086) | (0.074) | (0.067) |
| 2004 Asset Index | | -0.1345 | 0.1133 | 0.0988 |
| | | (0.100) | (0.178) | (0.176) |
| Mother Education | | -0.0610 | -0.0445 | -0.0677 |
| | | (0.040) | (0.039) | (0.045) |
| Father Education | | -0.0076 | 0.0022 | -0.0209 |
| | | (0.034) | (0.038) | (0.046) |
| Transfers into Household | | -0.0001 | -0.0001 | 0.0000 |
| | | (0.000) | (0.000) | (0.000) |
| Urban | | | -0.7036** | -0.8125*** |
| | | | (0.334) | (0.259) |
| HHs with Electricity in Community | | | -0.1294 | -0.1636 |
| | | | (0.245) | (0.281) |
| Secondary School in Community | | | 0.3071 | 0.1817 |
| | | | (0.400) | (0.457) |
| Heath Center in Community | | | -0.2626 | -0.5143* |
| | | | (0.333) | (0.342) |
| Constant | 1.2442*** | 4.7709** | 4.8817*** | 5.5330*** |
| | (0.097) | (1.994) | (1.743) | (1.725) |
| Regional Dummies | NO | NO | NO | YES |

Bootstrap corrected standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

Table B.14: The Effect of Personality and Cognition on Selection as Student

| | Student | Student | Student | Student |
|---|---|---|---|---|
| Conscientiousness Zscore | -0.0697 | -0.1735 | -0.2020 | -0.1575 |
| | (0.196) | (0.205) | (0.190) | (0.208) |
| Extraversion Zscore | -0.1005 | -0.0512 | -0.0482 | -0.0213 |
| | (0.193) | (0.215) | (0.199) | (0.198) |
| Openness to Experience Zscore | 0.1233 | 0.2813 | 0.3862* | 0.2576 |
| | (0.163) | (0.197) | (0.209) | (0.224) |
| Agreeableness Zscore | 0.0580 | 0.0301 | 0.0189 | 0.0113 |
| | (0.159) | (0.165) | (0.180) | (0.206) |
| Neuroticism Zscore | 0.1228 | -0.0436 | -0.0695 | -0.0534 |
| | (0.115) | (0.117) | (0.130) | (0.138) |
| Agreggate Math/French Zscore | 0.3383** | -1.2838*** | -1.9233*** | -1.5142** |
| | (0.159) | (0.308) | (0.757) | (0.785) |
| Male | | -0.8933*** | -0.8853*** | -0.8474*** |
| | | (0.225) | (0.196) | (0.193) |
| Age | | -0.3613*** | -0.3628*** | -0.4080*** |
| | | (0.104) | (0.081) | (0.080) |
| 2004 Asset Index | | 0.4092*** | 0.6391*** | 0.6340*** |
| | | (0.125) | (0.189) | (0.201) |
| Mother Education | | 0.0845** | 0.1170** | 0.1080*** |
| | | (0.042) | (0.056) | (0.044) |
| Father Education | | 0.0825** | 0.1058*** | 0.0842* |
| | | (0.040) | (0.043) | (0.051) |
| Transfers into Household | | 0.0003** | 0.0004** | 0.0004*** |
| | | (0.000) | (0.000) | (0.000) |
| Urban | | | -0.4227 | -0.3671 |
| | | | (0.414) | (0.367) |
| HHs with Electricity in Community | | | -0.1479 | -0.4510 |
| | | | (0.282) | (0.405) |
| Secondary School in Community | | | 0.5164 | 0.7696* |
| | | | (0.439) | (0.481) |
| Heath Center in Community | | | -0.1378 | -0.2159 |
| | | | (0.327) | (0.365) |
| Constant | 0.0333 | 7.4944*** | 7.2288*** | 7.7688*** |
| | (0.132) | (2.355) | (1.995) | (1.926) |
| Regional Dummies | NO | NO | NO | YES |

Bootstrap corrected standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

## Table B.15: The Effect of Personality and Cognition on Selection into Unemployment

|  | Unemployed | Unemployed | Unemployed | Unemployed |
|---|---|---|---|---|
| Conscientiousness Zscore | -0.0737 | -0.1783 | -0.1744 | -0.1957 |
|  | (0.253) | (0.242) | (0.211) | (0.297) |
| Extraversion Zscore | 0.5317* | 0.5880** | 0.5679** | 0.5925** |
|  | (0.265) | (0.259) | (0.280) | (0.308) |
| Openness to Experience Zscore | -0.4035** | -0.2486 | -0.2438 | -0.3281 |
|  | (0.211) | (0.226) | (0.233) | (0.244) |
| Agreeableness Zscore | -0.1129 | -0.1588 | -0.1383 | -0.1411 |
|  | (0.214) | (0.220) | (0.218) | (0.268) |
| Neuroticism Zscore | 0.1885 | 0.0363 | 0.0461 | 0.1079 |
|  | (0.147) | (0.145) | (0.173) | (0.138) |
| Agreggate Math/French Zscore | 0.0427 | -1.1397** | -1.2552 | -0.8494 |
|  | (0.272) | (0.482) | (0.852) | (0.997) |
| Male |  | -1.6762*** | -1.6750*** | -1.6505*** |
|  |  | (0.302) | (0.258) | (0.296) |
| Age |  | -0.0871 | -0.0901 | -0.0955 |
|  |  | (0.119) | (0.108) | (0.125) |
| 2004 Asset Index |  | 0.2091 | 0.2753 | 0.2649 |
|  |  | (0.183) | (0.234) | (0.241) |
| Mother Education |  | 0.0652 | 0.0708 | 0.0495 |
|  |  | (0.050) | (0.065) | (0.067) |
| Father Education |  | 0.1114** | 0.1157*** | 0.0934 |
|  |  | (0.049) | (0.045) | (0.066) |
| Transfers into Household |  | 0.0002 | 0.0002 | 0.0002 |
|  |  | (0.000) | (0.000) | (0.000) |
| Urban |  |  | -0.4223 | -0.4286 |
|  |  |  | (0.440) | (0.455) |
| HHs with Electricity in Community |  |  | 0.2840 | 0.0843 |
|  |  |  | (0.353) | (0.449) |
| Secondary School in Community |  |  | 0.1563 | -0.0764 |
|  |  |  | (0.537) | (0.587) |
| Heath Center in Community |  |  | -0.3984 | -0.7023 |
|  |  |  | (0.401) | (0.455) |
| Constant | -0.7012*** | 0.9977 | 1.2375 | 1.8552 |
|  | (0.177) | (2.536) | (2.584) | (3.130) |
| Regional Dummies | NO | NO | NO | YES |

Bootstrap corrected standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

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## Table B.16: The Effect of Personality and Cognition on Entrepreneurship

|  | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Conscientiousness Zscore | -0.0274 | -0.0357 | -0.0204 | -0.0365 | -0.0208 |
|  | (0.071) | (0.072) | (0.073) | (0.074) | (0.072) |
| Extraversion Zscore | -0.0296 | -0.0111 | -0.0135 | -0.0308 | 0.0093 |
|  | (0.079) | (0.079) | (0.080) | (0.081) | (0.075) |
| Openness to Experience Zscore | 0.1065* | 0.1509** | 0.1220* | 0.1890*** | 0.2092*** |
|  | (0.059) | (0.061) | (0.063) | (0.073) | (0.074) |
| Agreeableness Zscore | -0.1288* | -0.1473** | -0.1392** | -0.1456** | -0.1798*** |
|  | (0.067) | (0.068) | (0.069) | (0.069) | (0.068) |
| Neuroticism Zscore | -0.0662 | -0.0830* | -0.0450 | -0.0765 | -0.0710 |
|  | (0.047) | (0.048) | (0.050) | (0.052) | (0.051) |
| Agreggate Math/French Zscore |  | -0.1922*** | 0.1651 | -0.2403 | -0.4231 |
|  |  | (0.073) | (0.144) | (0.267) | (0.291) |
| Male |  |  | -0.0008 | 0.0159 | 0.0212 |
|  |  |  | (0.082) | (0.083) | (0.085) |
| Age |  |  | 0.0483 | 0.0510 | 0.0578* |
|  |  |  | (0.033) | (0.033) | (0.034) |
| 2004 Asset Index |  |  | -0.0389 | 0.0666 | 0.0882 |
|  |  |  | (0.060) | (0.084) | (0.084) |
| Mother Education |  |  | -0.0319* | -0.0142 | -0.0091 |
|  |  |  | (0.017) | (0.020) | (0.020) |
| Father Education |  |  | -0.0369** | -0.0204 | -0.0087 |
|  |  |  | (0.015) | (0.018) | (0.019) |
| Tansfers into Household |  |  | -0.0000 | -0.0000 | -0.0000 |
|  |  |  | (0.000) | (0.000) | (0.000) |
| Urban |  |  |  | -0.1517 | -0.1256 |
|  |  |  |  | (0.152) | (0.148) |
| HHs with Electricity in Community |  |  |  | 0.0123 | 0.0427 |
|  |  |  |  | (0.111) | (0.119) |
| Secondary School in Community |  |  |  | 0.2411 | 0.1564 |
|  |  |  |  | (0.165) | (0.180) |
| Heath Center in Community |  |  |  | 0.2687** | 0.3116** |
|  |  |  |  | (0.130) | (0.140) |
| Constant | -1.0592*** | -1.0656*** | -1.7673** | -2.3655*** | -2.5120*** |
|  | (0.041) | (0.041) | (0.737) | (0.791) | (0.789) |
| Observations | 1,475 | 1,475 | 1,475 | 1,475 | 1,475 |

Robust standard errors in parentheses

*** p¡0.01, ** p¡0.05, * p¡0.1

# CHAPTER 3 APPENDIX

Table C.1: Measurement Summary Statistics for Openness to Experience

|  | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| I find the world very interesting | 3.4311 | 1.066 | 1 | 5 |
| I am never bored | 3.8074 | 0.8355 | 1 | 5 |
| I am proficient in several areas | 3.019 | 1.0338 | 1 | 5 |
| I am always busy with something interesting | 3.6604 | 0.8602 | 1 | 5 |
| I am interested in many things | 3.1393 | 1.043 | 1 | 5 |
| In any situation I can find something interesting | 3.1142 | 0.9656 | 1 | 5 |
| I think my life is very interesting | 3.2809 | 0.9649 | 1 | 5 |
| I am very interested in other countries and their cultures | 3.2378 | 1.136 | 1 | 5 |
| I am not very curious about what is happening in the world | 2.6983 | 1.0739 | 1 | 5 |
| I am interested in very few things | 2.314 | 0.9426 | 1 | 5 |

Table C.2: Measurement Summary Statistics for Conscientiousness

|  | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| I am always ready | 4.232 | 0.7408 | 1 | 5 |
| I love to bring order | 4.1423 | 0.7 | 1 | 5 |
| I do things quickly | 3.7816 | 0.8333 | 1 | 5 |
| I never leave a task without completeing it | 3.8899 | 0.8424 | 1 | 5 |
| I like to step up to the plate | 4.0562 | 0.7486 | 1 | 5 |
| I am always up to my jobs/tasks | 3.9795 | 0.7731 | 1 | 5 |
| I always keep my promises | 4.0287 | 0.7736 | 1 | 5 |
| I like to tidy up | 4.161 | 0.6693 | 1 | 5 |
| I benefit well from my work | 3.714 | 0.8906 | 1 | 5 |
| I never leave work to be done | 3.6405 | 0.8943 | 1 | 5 |
| I do my job without waiting | 3.8273 | 0.805 | 1 | 5 |
| I like when everything is in its place | 4.1706 | 0.654 | 1 | 5 |
| I finish tasks no matter what obstacles encountered | 3.5386 | 0.9475 | 1 | 5 |
| I start work without delay | 3.8589 | 0.8176 | 1 | 5 |
| I like ordering things around me | 3.8466 | 0.7961 | 1 | 5 |
| I can clearly articulate ideas | 3.6036 | 0.8498 | 1 | 5 |
| I always keep my word | 4.024 | 0.7492 | 1 | 5 |
| I like order and regularity | 4.1434 | 0.6939 | 1 | 5 |
| I always act first | 3.6447 | 0.8812 | 1 | 5 |
| I work with conviction | 4.1781 | 0.6612 | 1 | 5 |
| I am a workaholic | 3.4646 | 0.968 | 1 | 5 |
| I am a planner | 3.2162 | 1.0027 | 1 | 5 |
| I can bounce back after challenges | 3.7335 | 0.8795 | 1 | 5 |
| I am faithful to my own values | 3.8664 | 0.9077 | 1 | 5 |
| I do things by following a plan | 3.8049 | 0.8153 | 1 | 5 |
| I quickly realize the tasks to do | 3.6452 | 0.8407 | 1 | 5 |
| I am not distracted when I work | 3.7067 | 0.8846 | 1 | 5 |
| I immediately begin my chores | 3.8799 | 0.7526 | 1 | 5 |
| I am a person who sets goals | 4.082 | 0.7488 | 1 | 5 |
| I pay attention to detail | 3.8202 | 0.8217 | 1 | 5 |

## Table C.3: Measurement Summary Statistics for Extroversion

|  | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| I get involved in community/collective activities | 3.9918 | 0.8363 | 1 | 5 |
| I like to animate groups | 3.1517 | 1.095 | 1 | 5 |
| I like belonging to a group | 3.7278 | 0.9096 | 1 | 5 |
| I can captivate people's attention | 3.1598 | 0.9853 | 1 | 5 |
| I can keep my cool | 3.945 | 0.7471 | 1 | 5 |
| I take the initiative in conversations | 3.784 | 0.8354 | 1 | 5 |
| I talk easily | 3.2412 | 1.0591 | 1 | 5 |
| I can clearly articulate ideas | 3.6036 | 0.8498 | 1 | 5 |
| I interact with different people when they are gathered | 3.7458 | 0.8428 | 1 | 5 |
| I am uncomfortable working in a group | 2.1945 | 0.9444 | 1 | 5 |
| I always have something to say | 2.7206 | 0.9702 | 1 | 5 |
| I like to draw attention to myself | 2.8036 | 1.0521 | 1 | 5 |
| I am not usually talkative | 3.1003 | 0.997 | 1 | 5 |
| I prefer to do it alone | 2.5329 | 1.0009 | 1 | 5 |
| I am not talkative | 3.0592 | 0.9997 | 1 | 5 |
| I have trouble expressing my feelings | 2.693 | 1.0355 | 1 | 5 |
| I work better when I'm alone | 3.0568 | 1.0799 | 1 | 5 |
| I do not like to take the lead | 3.3175 | 1.0145 | 1 | 5 |
| I wait for others to lead the way | 2.587 | 1.0475 | 1 | 5 |
| I keep to myself | 3.1567 | 1.0937 | 1 | 5 |
| I do not talk a lot | 3.0439 | 1.0191 | 1 | 5 |
| I rarely associate with others | 2.0334 | 0.8765 | 1 | 5 |
| I try not to attract attention to myself | 2.864 | 1.1806 | 1 | 5 |
| I'm afraid to draw attention to myself | 2.7013 | 1.0785 | 1 | 5 |
| I leave others to take the initiative | 2.16 | 0.8988 | 1 | 5 |
| I leave others to decide | 2.2724 | 0.9446 | 1 | 5 |
| I feel comfortable with people | 3.8729 | 0.8385 | 1 | 5 |
| I am a team player | 3.9531 | 0.7876 | 1 | 5 |

Table C.4: Measurement Summary Statistics for Agreeablenss

| | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| I get involved in community/collective activities | 3.9918 | 0.8363 | 1 | 5 |
| I like belonging to a group | 3.7276 | 0.9096 | 1 | 5 |
| I think honesty is the basis of trust | 4.1107 | 0.8364 | 1 | 5 |
| I always keep my word | 4.024 | 0.7492 | 1 | 5 |
| I respect the decisions of the group | 4.0698 | 0.7066 | 1 | 5 |

Table C.5: Measurement Summary Statistics for Neuroticism

|  | Mean | Std. Dev. | Min |
|---|---|---|---|
| I have often worried | 2.7822 | 1.0794 | 1 |
| I am not often worried | 3.1987 | 1.0505 | 1 |
| I am often sad | 2.2237 | 0.9623 | 1 |
| I feel hopeless | 2.2168 | 0.9887 | 1 |
| I have mood swings | 3.7036 | 0.9111 | 1 |
| I can bounce back after challenges | 3.7335 | 0.8795 | 1 |
| I have a bad feeling about what is going to happen | 2.2425 | 1.0305 | 1 |
| I panic easily | 2.2015 | 0.9466 | 1 |
| I lie to get out of things | 2.085 | 1.0118 | 1 |
| I see problems everywhere | 2.4671 | 1.0085 | 1 |
| I am rarely angry | 3.2019 | 1.1439 | 1 |
| I get frustrated quickly | 2.2806 | 0.941 | 1 |
| I have trouble expressing my feelings | 2.693 | 1.0355 | 1 |
| I am a difficult person to understand | 2.8143 | 1.0515 | 1 |
| I give up easily | 2.0234 | 0.8925 | 1 |
| I get discouraged easily | 2.0152 | 0.8768 | 1 |
| I rarely worry | 3.225 | 0.9958 | 1 |
| I sometimes feel dishonest | 1.8089 | 0.8451 | 1 |
| I am easily intimidated | 2.0299 | 0.8768 | 1 |
| It's often difficult for me to have fun | 2.3705 | 1.0309 | 1 |
| I exaggerate my troubles | 2.0709 | 0.8706 | 1 |
| I fear the worst will happen | 2.7825 | 1.1412 | 1 |
| I am unflappable | 3.2151 | 1.045 | 1 |
| I have a lot of fun | 2.9795 | 0.9856 | 1 |
| I'm consumed by my own problems | 2.2973 | 0.947 | 1 |

Table C.6: Measurement Equation Estimates for Openness to Experience

|  | $\lambda_j^O$ | $\mu_j^O$ |
|---|---|---|
| I find the world very interesting | 1.0000 | 3.4310*** |
| I am never bored | 0.4714*** | 3.8080*** |
| I am proficient in several areas | 0.6707*** | 3.0206*** |
| I am always busy with something interesting | 0.7073*** | 3.6624*** |
| I am interested in many things | 0.6845*** | 3.1368*** |
| In any situation I can find something interesting | 0.8995*** | 3.1133*** |
| I think my life is very interesting | 0.7382*** | 3.2813*** |
| I am very interested in other countries and their cultures | 1.1427*** | 3.2372*** |
| I am not very curious about what is happening in the world | -0.4902*** | 2.6976*** |
| I am interested in very few things | -0.1742*** | 2.3147*** |

Table C.7: Measurement Equation Estimates for Conscientiousness

|  | $\lambda_j^C$ | $\mu_j^C$ |
|---|---|---|
| I am always ready | 1.0000 | 4.2289*** |
| I love to bring order | 0.9489*** | 4.1407*** |
| I do things quickly | 1.2030*** | 3.7812*** |
| I never leave a task without completeing it | 1.2790*** | 3.8906*** |
| I like to step up to the plate | 1.3252*** | 4.0532*** |
| I am always up to my jobs/tasks | 1.4385*** | 3.9787*** |
| I always keep my promises | 1.3067*** | 4.0272*** |
| I like to tidy up | 1.0557*** | 4.1591*** |
| I benefit well from my work | 1.3832*** | 3.7114*** |
| I never leave work to be done | 1.3590*** | 3.6387*** |
| I do my job without waiting | 1.3382*** | 3.8273*** |
| I like when everything is in its place | 0.9487*** | 4.1697*** |
| I finish tasks no matter what obstacles encountered | 1.4048*** | 3.5376*** |
| I start work without delay | 1.3734*** | 3.8587*** |
| I like ordering things around me | 1.1400*** | 3.8439*** |
| I can clearly articulate ideas | 1.3056*** | 3.5985*** |
| I always keep my word | 1.2625*** | 4.0219*** |
| I like order and regularity | 1.1098*** | 4.1431*** |
| I always act first | 1.1263*** | 3.6458*** |
| I work with conviction | 0.9899*** | 4.1750*** |
| I am a workaholic | 1.3058*** | 3.4624*** |
| I am a planner | 1.1236*** | 3.2170*** |
| I can bounce back after challenges | 1.5037*** | 3.7321*** |
| I am faithful to my own values | 1.2373*** | 3.8622*** |
| I do things by following a plan | 1.3231*** | 3.8025*** |
| I quickly realize the tasks to do | 1.2905*** | 3.6452*** |
| I am not distracted when I work | 1.0688*** | 3.7067*** |
| I immediately begin my chores | 1.2344*** | 3.8817*** |
| I am a person who sets goals | 1.2342*** | 4.0816*** |
| I pay attention to detail | 1.1054*** | 3.8196*** |

## Table C.8: Measurement Equation Estimates for Extroversion

| | $\lambda_J^E$ | $\mu_j^E$ |
|---|---|---|
| I get involved in community/collective activities | 1.0000 | 3.9923*** |
| I like to animate groups | 0.9976*** | 3.1530*** |
| I like belonging to a group | 1.0798*** | 3.7271*** |
| I can captivate people's attention | 0.8997*** | 3.1607*** |
| I can keep my cool | 0.8390*** | 3.9468*** |
| I take the initiative in conversations | 1.0952*** | 3.7844*** |
| I talk easily | 0.7552*** | 3.2392*** |
| I can clearly articulate ideas | 0.9967*** | 3.6060*** |
| I interact with different people when they are gathered | 1.0291*** | 3.7460*** |
| I am uncomfortable working in a group | -0.7069*** | 2.1955*** |
| I always have something to say | 0.5207*** | 2.7212*** |
| I like to draw attention to myself | 0.7325*** | 2.8021*** |
| I am not usually talkative | -0.4272*** | 3.1010*** |
| I prefer to do it alone | -0.2628*** | 2.5346*** |
| I am not talkative | -0.5708*** | 3.0602*** |
| I have trouble expressing my feelings | -0.6399*** | 2.6929*** |
| I work better when I'm alone | 0.0865 | 3.0561*** |
| I do not like to take the lead | -0.1796*** | 3.3207*** |
| I wait for others to lead the way | -0.3261*** | 2.5883*** |
| I keep to myself | -0.1505** | 3.1559*** |
| I do not talk a lot | -0.5989*** | 3.0443*** |
| I rarely associate with others | -0.7581*** | 2.0307*** |
| I try not to attract attention to myself | -0.6578*** | 2.8641*** |
| I'm afraid to draw attention to myself | -0.6918*** | 2.6988*** |
| I leave others to take the initiative | -0.8393*** | 2.1577*** |
| I leave others to decide | -0.7280*** | 2.2705*** |
| I feel comfortable with people | 0.8178*** | 3.8748*** |
| I am a team player | 0.9104*** | 3.9545*** |

Table C.9: Measurement Equation Estimates for Agreeableness

| | $\lambda_j^A$ | $\mu_j^A$ |
|---|---|---|
| I get involved in community/collective activities | 1.0000 | 3.9924*** |
| I like belonging to a group | 0.9792*** | 3.7273*** |
| I think honesty is the basis of trust | 0.5626*** | 4.1097*** |
| I always keep my word | 0.6772*** | 4.0240*** |
| I respect the decisions of the group | 0.6460*** | 4.0698*** |

## Table C.10: Measurement Equation Estimates for Neuroticism

|  | Factor Loading | Constant |
|---|---|---|
| I have often worried | 1.0000 | 2.7825*** |
| I am not often worried | -0.5230*** | 3.1974*** |
| I am often sad | 1.0921*** | 2.4965*** |
| I feel hopeless | 1.1355*** | 2.2169*** |
| I have mood swings | 0.2514*** | 3.7021*** |
| I can bounce back after challenges | -0.4762*** | 3.7305*** |
| I have a bad feeling about what is going to happen | 0.7088*** | 2.2470*** |
| I panic easily | 1.0688*** | 2.2045*** |
| I lie to get out of things | 0.5988*** | 2.0857*** |
| I see problems everywhere | 0.9497*** | 2.4675*** |
| I am rarely angry | -0.0347 | 3.2033*** |
| I get frustrated quickly | 0.9652*** | 2.2825*** |
| I have trouble expressing my feelings | 0.9433*** | 2.6950*** |
| I am a difficult person to understand | 0.7272*** | 2.8174*** |
| I give up easily | 1.0426*** | 2.0266*** |
| I get discouraged easily | 1.1387*** | 2.0165*** |
| I rarely worry | -0.1413*** | 3.2287*** |
| I sometimes feel dishonest | 0.9316*** | 1.8085*** |
| I am easily intimidated | 0.9783*** | 2.0307*** |
| It's often difficult for me to have fun | 0.7225*** | 2.3729*** |
| I exaggerate my troubles | 0.8541*** | 2.0751*** |
| I fear the worst will happen | 1.1304*** | 2.7843*** |
| I am unflappable | -0.3405*** | 3.2122*** |
| I have a lot of fun | -0.1185** | 2.9775*** |
| I'm consumed by my own problems | 1.0307*** | 2.2991*** |

Table C.11: Estimates of Cronbach's $\alpha$ Measure of Factor Reliability

|  | Cronbach's $\alpha$ |
| --- | --- |
| Openness to Experience | 0.7091 |
| Conscientiousness | 0.921 |
| Extroversion | 0.8028 |
| Agreeableness | 0.6635 |
| Neuroticism | 0.8171 |

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