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The Unstoppable Entrepreneur:

Do they have more Children?

The story continues

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Preface

During 2011 I had the opportunity to investigate whether German entrepreneurs produced more offspring than the German non-entrepreneurs. Surprisingly, the outcome of this investigation was that German entrepreneurs indeed produced more offspring. For my Master Thesis I am enthusiastic to further investigate and find out if I can replicate this finding for the Australian population.

I am very grateful for comments from my thesis supervisor Matthijs van der Loos as well as the continued support of Arnoud Post. Without them this Master Thesis would not have become the Thesis it is today. I hope you enjoy reading this Master Thesis as much as enjoyed writing it.

Mirjam Koek

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Executive Summary

The role of the occupational status of an entrepreneur on reproductive success is a rather unexplored area of literature. This paper will investigate the relationship between being an entrepreneur and the number of offspring the entrepreneur produces compared to non-entrepreneurs.

Using the occupational status of individuals together with a compilation of genetic as well as environmentally influenced features that are characteristic of self-employed individuals, a model is formed in order to test the hypothesis that self-employed individuals have higher reproductive success compared to non-self-employed individuals and that the genetic as well as circumstantial characteristics that are typical of such individuals also have a positive effect on reproductive success. This is done by using the dataset of the Household, Income and Labour Dynamics in Australia (HILDA).

The results of this thesis provide evidence that entrepreneurs tend to have more offspring than non-entrepreneurs, hereby giving credit to (or at the very least not disproving) the proposed hypotheses.

1 Introduction

The occupation type "entrepreneurship" is widely recognized for its importance in terms of societal contributions. Van Praag and Versloot (2007) conclude that entrepreneurs have a very important role in the economy - they contribute to the creation of jobs, produce and commercialize high-quality innovations and contribute to productivity growth and are more satisfied with their job. Given the desirability of entrepreneurs due to their ability to contribute to society through their success, natural selection suggests that the population should exhibit more of these characteristics over the span of several generations. This, however, implies that entrepreneurs reproduce sufficiently so as to propel their genes and characteristics throughout the population.

Given their role in society and assuming that "entrepreneurship" is positively related to the reproductive fitness of an individual, it is expected that entrepreneurs produce more offspring than non-entrepreneurs. This paper therefore sets out to investigate whether or not there is a link between the occupational role of an entrepreneur and the number of offspring they successfully produce and raise using Australian data over the years 2006 up and until 2010. To the best of my knowledge, this is one of the first studies of its kind.

The expectation of such a link is not ill-founded as even a preliminary t-test (as shown in **Table 1**) based on observations from the Household, Income and Labour Dynamics in Australia (HILDA) Survey of the number of children produced by entrepreneurs vs. non-entrepreneurs suggests that entrepreneurs have a significantly larger average number of children when compared to the average number of children produced by a non-entrepreneur.

Table 1

Entrepreneurs and their children

Entrepreneur	Mean number of children	Standard deviation	Observations
Yes	3.462	1.514	20,093
No	2.822	1.886	40,124
p-value		0.000	

Additionally, Reynolds (1997) found that promising entrepreneurs have the tendency to produce more children than non-entrepreneurs. Further, research by Lee-Gosselin and Grisé (1990) showed that Quebec female entrepreneurs have the tendency to produce more children than Quebec female non-entrepreneurs.

While only genetic features can be passed on through reproduction, the features that characterize an entrepreneur consist of genetic as well as learnt and circumstantial features (i.e. it is not only genetic factors that drive the reproductive success of an entrepreneur). From twin studies, Nicolaou et al. (2008a) conclude that between 37 and 42 percent of the variance in four different measures of the tendency to be an entrepreneur is accounted for by genetic factors whereas non-shared-environmental factors accounted for the remaining variance.

A more comprehensive study (as will be discussed in the limitations section of this report) would make a distinction between pure genetic and pure circumstantial characteristics of an entrepreneur and measure the separate effects of the two categories on the reproductive success of an entrepreneur. As an initial step, however, given that it is the combination of genetic and circumstantial features that define an entrepreneur, it is this combination as a whole that this paper will use to determine whether or not entrepreneurs do indeed reproduce sufficiently. For the purposes of this paper, "sufficient reproduction" is interpreted as a relative term and implies that reproduction is above average so as to make it feasible that the characteristics of entrepreneurs as opposed to other human types are propelled throughout the population.

Using "entrepreneurship" as a form of natural selection, it is then possible to test the theory that natural selection has a positive effect on reproductive success by regressing the number of children successfully produced and raised by entrepreneurs against innate and circumstantial features of an entrepreneur. This then not only identifies a potential trend, but will also explain why that trend is occurring.

This paper therefore aims to answer the following research question: *Does the average entrepreneur have more children than the average non-entrepreneur?*

The contribution of the present article is that, while earlier studies focus on natural selection with respect to specific traits in both animal populations as well as in human population, we extend the existing literature to use the occupational type "entrepreneurship" as a form of natural selection. Hence, it is investigated whether being an entrepreneur has a positive effect on the reproductive success. Second, it is determined whether gender matters in this process.

In order to answer the research question, the remainder of this paper is organized as follows. Section 2 and 3 discuss the related literature on entrepreneurship and reproductive success. In section 4, the hypotheses are formulated, followed by section 5, which describes the data and methodology of the research. Section 6 then presents the empirical analysis and discusses the results. The research paper will be concluded in section 7 by summarizing the main results and highlighting the limitations of the research.

2 Entrepreneurs

This section will discuss the concepts and the definitions of an entrepreneur, as it is necessary to have an understanding of what an entrepreneur is before we can research the relation between the occupational status of an entrepreneur and his/her reproductive success. Afterwards, the theory underlying this research is presented.

2.1 Definition of an Entrepreneur

Extensive research has been done with respect to entrepreneurs and entrepreneurship. However, there does not seem to be consensus on a definition of an entrepreneur (Berglann et al., 2011).

There are multiple views on what makes an entrepreneur. Firstly, there is the view that anyone can learn the necessary skills provided he or she puts in enough time and effort. Secondly, there is the view that people are either born with the right personality and skills or they are not (Koellinger et al., 2010).

Studies show that entrepreneurs differ from non-entrepreneurs by their personal characteristics. These characteristics are included in **Table 2**, which shows that the traits altruism in dictator games, creativity, educational attainment, extravert, gambling, general cognitive ability and intelligence, innovativeness, internal locus of control, job satisfaction, need for achievement, need for cognition, novelty seeking, opportunity recognition, optimism, overconfidence, risk-seeking, risk-taking, self-confidence, vocational interests and work values (left column) are defined as entrepreneurial traits by the authors in the right column.

Table 2

Studies defining entrepreneurial traits

Characteristic	Reference(s)
Altruism in dictator games	Knafo et al., 2008; Israel et al., 2008
Creativity	Blanchflower and Oswald, 1998; Burke et al., 2008

Educational attainment	Miller et al., 2001
Extravert	Burke, FitzRoy and Nolan, 2000; Shane, 2003; Van Praag and Ophem, 1995; Roberts, 1991
Gambling	Bell, 2009; Eisen et al., 1998; Eisenegger et al., 2010; Juhasz et al., 2010; Pérez de Castro et al., 1997; Comings et al., 1996
General cognitive ability and intelligence	Deary et al., 2006; Plomin, 1999; Plomin and Kosslyn, 2001; Plomin and Spinath, 2004
Innovativeness	Nair and Pandey, 2006; Schumpeter, 1934
Internal locus of control	Di Zhang and Bruning, 2011; Evans and Leighton, 1989; Littunen, 2000; Rauch and Frese, 2000; Rotter, 1966; Schiller and Crewson, 1997
Job satisfaction	Arvey et al., 1989
Need for achievement	Di Zhang and Bruning, 2011; Collins et al., 2001; McClelland, 1961; Stewart and Roth, 2004
Need for cognition	Di Zhang and Bruning, 2011
Novelty seeking	Ebstein et al., 1996; Kluger et al., 2002; Kohler et al., 1999; Rodgers et al., 2001
Opportunity recognition	Baron and Ensley, 2006; Casson and Wadeson, 2007; Gaglio and Katz, 2001; Shane, 2000; Shane, 2003; Shane and Venkataraman, 2000
Optimism	Cooper et al., 1988
Overconfidence	Busenitz, 1999; Cesarini et al., 2009b
Risk-seeking	Cesarini et al., 2009a
Risk-taking	Bell, 2009; Ho and Koh, 1992; Kihlstrom and Laffont, 1979; Kuhnen and Chiao, 2009; McClelland, 1965; Mill, 1984; Mintzberg, 1973; Palmer, 1971; Stern, 2010; Stewart and Roth, 2001; Welsh and White, 1981; Zhong et al., 2009
Self-confidence	Turan and Kara, 2007; Busenitz and Barney, 1997
Vocational interests	Betsworth et al., 1994
Work values	Keller et al., 1992

From the extensive research on the characteristics of entrepreneurs compared to non-entrepreneurs, it can be concluded that there are differences between these characteristics of entrepreneurs between countries and gender. **Table 3** contains an overview of these entrepreneurial traits (middle column), for various countries (left column) and with reference(s) to the author(s) who wrote about the characteristics (right column). For example, Di Zhang and Bruning (2011) defined need for achievement, need for cognition and internal locus of control as traits which define an entrepreneur in Canada.

Table 3

Studies that show a positive relationship between specific characteristics and entrepreneurship

Country	Characteristics	Reference(s)
Canada	Need for achievement, need for cognition, internal locus of control	Di Zhang and Bruning (2011)
Greece	Higher level of education	Alexander (1964)
Greece - females	Higher level of education, majority married with children, business-owning family	Sarri and Trihopoulou (2005)
Ireland	Maturity in age (35), family history of self-employment, higher level of education, need for achievement, internal locus of control, highly responsible	Turan and Kara (2007)
Italy - females	Majority married with children, maturity in age (36-55), higher level of education	Aristotle University of Thessaloniki (2002)
Lebanon	Higher level of education	Sayigh (1962)
Netherlands - females	Maturity in age (36-45), higher level of education, more single women	Hogeschool van Amsterdam (1994)

Philippines	Higher level of education	Carroll (1965)
State of Kerala	Economic status of family, maturity in age (>35), technical education and work experience, more innovative	Nair and Pandey (2006)
Turkey	Maturity in age (40), family history of self-employment, need to achieve, self-confident, internal locus of control	Turan and Kara (2007), Hisrich (1988)

On the basis of these characteristics, many researchers have tried to define what an entrepreneur is. For instance, Bygrave (1994) defines an entrepreneur as "someone who perceives an opportunity and creates an organization to pursue it". Schumpeter (1965) uses a similar definition and defines entrepreneurs as individuals who exploit market opportunities through technical and/or organizational innovation (Turan and Kara, 2007). Of course these definitions are very subjective and it is hard to measure the number of entrepreneurs with such definitions.

Van Praag and Versloot (2007) use a more quantitative definition and define an entrepreneur as a person who meets the following conditions. First, they employ fewer than 100 employees. Second, their business is younger than seven years old. And last, they are new entrants into the market. The Global Entrepreneurship Monitor defines nascent entrepreneurs as "people who are taking certain steps to become self-employed but are not yet officially established" (Reynolds et al., 2004). Van der Zwan, Thurik and Grilo (2010) also use the aforementioned definition. Therefore, entrepreneurs can be defined as the people who already are self-employed. In accordance with Parker (2004) and Burke, FitzRoy and Nolan (2008) we will use this last definition.

2.2 Natural selection in general

The variations of personal characteristics in which entrepreneurs differ from non-entrepreneurs can be explained as being a function of evolution in which those characteristics, which are most adaptive, will increase the probability of survival (Darwin,

1859; Fortunato and Furey, 2009). This is the process of natural selection, by which certain inherited traits, which improve an individual's fitness, will become more dominant within a population over time since those individuals are more likely to reproduce (Darwin, 1859). This aspect of evolution can also be described as 'survival of the fittest' (Brook, 2008).

Both Darwin and Wallace (1858) and Darwin (1859) acknowledged that some individual variation is passed from parent to children. The critical insight is that variation throughout individuals within a population of crucial traits and individual variation in the chances of survival are linked together or covary. The relation between these variations is the driving factor of natural selection – the result of mutations (Crow, 1997) and sexual reproduction (Hamilton and Zuk, 1982; Williams, 1975) – and the chances of surviving to adulthood and successfully reproducing (Price, 1970). A trait can evolve when variation around the mean of the trait is partly due to genes (Houle, 1992); evolvable variation is not the same as heritability. Heredity refers to the amount of genetic effect on the dissimilarities between individuals for any particular trait, but it is also essential to think about the spreading of a trait within a population (Geary, 2010).

The relation between this variation, the key factors of genetic variation and individual differences in survival or reproductive results are illustrated in **Figure 1.1**. For each generation, the strength of evolutionary selection is the product of these two factors.

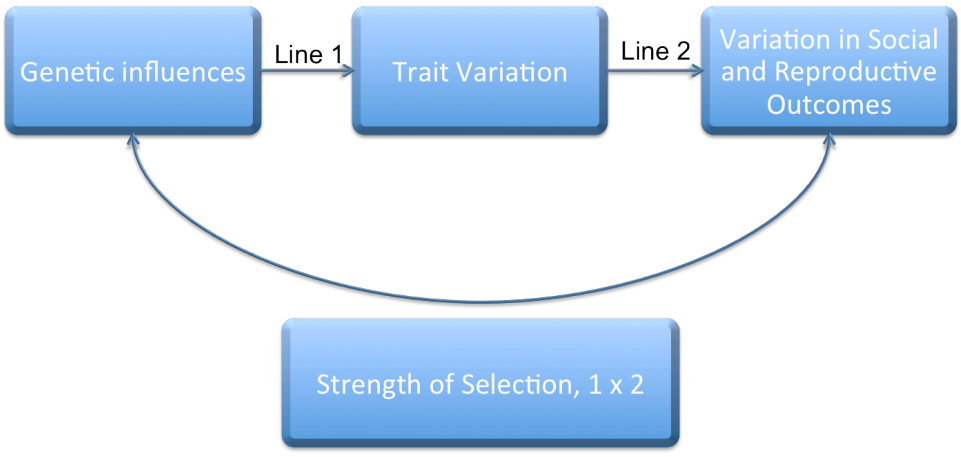

Figure 1.1. The strength of evolutionary selection. When two circumstances are present, evolution of a trait occurs. First, individual differences must be genetic, represented by Line 1 Secondly; individual variances in the trait must covary with specific variances in survival or reproductive results, represented by Line 2. The strength of evolutionary selection is the product (line 1 x line 2) of these two factors (Geary, 2010).

2.3 Natural selection of entrepreneurial traits

Many researchers have done research with respect to natural selection of characteristics of an individual. Three of these characteristics, that are present within an entrepreneur, are discussed below. These characteristics are risk taking, altruism and overconfidence.

2.3.1 Risk taking

Galor and Michalopoulos (2012) developed an evolution theory that emphasizes the significance of the evolution of entrepreneurial spirit in the transition from stagnation to growth. The theory rests upon two fundamental components. First, technological change is affected in a positive way by the frequency of risk-tolerant traits in the population. The intensity of entrepreneurial spirit influences the coexistent production choices and improves the technological frontier available to the next generations. The second component is the heritability of those traits throughout generations (Galor and Michalopoulos, 2012).

The effect of natural selection is essential for the escape from a period of stagnation. The level of income per worker may be stationary and fertility will be at a replacement level if entrepreneurial traits are not genetic and the distribution of these traits does not change over time (Galor and Michalopoulos, 2012).

In Galor and Michalopoulos' evolution theory with respect to the entrepreneurial spirit, they also discussed one of the specific traits of an entrepreneur, namely risk taking. Variances in the degree of risk taking across individuals influence reproductive success and is transferred across generations, either culturally or genetically. Risk aversion has an adverse effect on fertility and reproductive success in the early stages of development, raising the frequency of risk-tolerant growth stimulating traits in the economy and stimulating the growth progression. Risk aversion has a positive effect on reproductive success as economies develop, weakening the growth prospective of the economy (Galor and Michalopoulos, 2012).

The turnaround in the evolutionary advantage of the risk-tolerant traits is the result of the effect of the level of income on the relative cost of consumption and raising children. The alternative cost of raising children increases relative to consumption as the economy progresses and income per capita increases. When income levels are at a sufficiently low level the cost of children is lower relative to the cost of consumption. Risk-tolerant individuals optimally allocate more funds towards raising children and the representation of their kind increases in the population over time, because their choices are more reactive to the relative prices than risk-averse individuals. The cost of raising children increases relative to the cost of consumption as the economy progresses and income per capita increases. Risk-tolerant individuals optimally allocate more funds towards consumption and less towards children and over time the occurrence of entrepreneurial spirit declines (Galor and Michalopoulos, 2012).

Stern (2010) also researched the natural selection of the entrepreneurial trait risk taking. He found that risk-tolerant individuals have an evolutionary benefit at the early stages of economic growth, and that the introduction of such traits in an environment with very low-income levels should have resulted in a considerable increase in their representation in the population.

When the expected reproductive fitness of the individual is unchanged by the making of the risky choice, natural selection, up to the point of extinction, favors the risk-averse types. However, if children are permitted to inherit a small part of the parent's decreased or increased fitness acquired through risk-taking, the situation is completely reversed. In the presence of this so-called "cultural inheritance", the long-shot risk-taking types are preferred, even when 90% of individuals were rendered sterile by a failing choice (Stern, 2010).

2.3.2 Altruism

Biologists for decades considered it infeasible that altruistic behavior could have an evolutionary benefit. In evolutionary biology the driving motivation for behavior is maximization of reproductive fitness or the likely number of offspring an individual produces during its life. An organism therefore is said to act altruistically when its behavior benefits other organisms' reproductive fitness at a cost to its own fitness. The drive for this behavior

is not considered (Manner and Gowdy, 2010). However, in economic analysis various researches have researched natural selection of the entrepreneurial trait altruism and come to a different conclusion.

Boehm (1999), looking at natural selection, split behavior that is useful to the group into three types (see Sober and Wilson, 1998): 1. the altruistic behavior that combines individual sacrifice with group benefit; 2. behavior that is selectively neutral for individuals but useful to groups; and 3. behavior that is useful to both group and individual reproductive success. Simon (1993) suggested that an altruistic standard could survive given the trend of socialized norms to be personally fitness enhancing (Manner and Gowdy, 2010), therefore altruism can benefit both the group as the individual (Boehm's third group).

Gintis (2003) used Simon's theory to develop a multi-level gene-culture co-evolutionary model, which showed how altruistic socialized norms will tend to push out norms that are socially harmful. Altruistic behavior may increase fitness by giving a competitive benefit to a particular group.

In economic analysis the motivation of the actor is explicitly considered in defining whether an action is altruistic. Altruism is defined by Kolm (2006) as "the preference for the good of some other people in itself". Becker (1974), Frank (1987), Miller (1988), Collard (1992) and Zamagni (1995) all comparably describe an altruistic action as an act motivated by a concern for the welfare or interests of others. However, altruism is usually also measured operationally in terms of reduced own consumption in favor of a group or others, as welfare is equivalent to consumption in economic analysis. The statement that economic altruism is fitness decreasing to the individual is no longer true by definition with this replacement, but is rather a theory that should be empirically confirmed before being acknowledged (Manner and Gowdy, 2010).

Frey and Stutzer (2002) classify job satisfaction, leisure time, family and companionship and health in addition to consumption as important influences on welfare. If the positive effect of altruism on welfare is greater than the negative effect of a lower relative income then altruism can in fact increase welfare. Much of the evidence describing the positive influences of altruism on welfare relate to positive health effect that could clearly have reproductive fitness benefits (Manner and Gowdy, 2010).

2.3.3 Overconfidence

Bernando and Welch (2001) show that overconfident entrepreneurs are more likely to explore their environment and less likely to imitate their equals. Entrepreneurial activity can therefore deliver valuable extra information to their social group. When overconfident entrepreneurs follow their own information, down weighting the information in the group, their actions as a result broadcast their private information to the rest of their group.

Without knowing, overconfident entrepreneurs act altruistically, making illogical choices that help their group but are disadvantageous to themselves. Because the group carries a relatively small amount of information, this is only slightly individually suboptimal. Bernando and Welch argue that groups with a few overconfident individuals have an evolutionary benefit over groups without such individuals. They show that overconfidence or entrepreneurship can be beneficial if groups are large enough to profit from the positive information externality, if individuals have less precise information, and if overconfidence is modest rather than extreme (Bernando and Welch, 2001).

2.4 Genetic entrepreneurial traits

In order for natural selection to take place, the specific characteristics that define an entrepreneur need to be genetic. There is growing empirical evidence that entrepreneurial traits are at least to some extent due to genetic differences (Koellinger et al., 2010). Examples of these entrepreneurial traits are included in **Table 4**.

Table 4

Studies defining genetic entrepreneurial traits

Characteristic	Reference(s)
Altruism in dictator games	Knafo et al., 2008; Israel et al., 2008
Educational attainment	Miller et al., 2001
Extravert	Eaves et al., 1989; Bouchard and Loehlin, 2001; Jang et al., 1996 ; Jokela et al., 2011; Neyer & Asendorpf, 2001; Riemann et al., 1997; Waller, 1999

Gambling	Bell, 2009; Eisen et al., 1998; Eisenegger et al., 2010; Juhasz et al., 2010; Pérez de Castro et al., 1997; Comings et al., 1996
General cognitive ability and Intelligence	Deary et al., 2006; Plomin, 1999; Plomin and Kosslyn, 2001; Plomin and Spinath, 2004
Internal locus of control	Miller and Rose, 1982; Pedersen et al., 1989; Rotter, 1966
Job satisfaction	Arvey et al., 1989
Need for achievement	McGue, 1993; Tellegen et al., 1988
Novelty seeking	Ebstein et al., 1996; Jokela et al., 2011; Kluger et al., 2002; Kohler et al., 1999; Rodgers et al., 2001
Overconfidence	Cesarini et al., 2009b
Risk seeking	Cesarini et al., 2009a
Risk taking	Bell, 2009; Kuhnen and Chiao, 2009; Stern, 2010; Zhong et al., 2009
Vocational interests	Betsworth et al., 1994
Work values	Keller et al., 1992

2.5 Genetic occupational type "entrepreneurship"

Several researches show that genetic factors influence occupational choices in general (Carter, 1932). Prior studies found that genetic factors affect work interests (Vandenberg and Stafford, 1967) and vocational interests (Lykken, Bouchard, McGue and Tellegen, 1993; Moloney et al., 1991; Betsworth et al., 1994). They also found that identical twins, whether raised separately or together, tend to have a more similar job interest than their genealogical counterparts (Bouchard et al., 1990); and adopted children are much more likely to want to work in the same occupations as their biological parents than in those of their adoptive parents (Betsworth et al., 1994).

Tambs et al. (1989) show a genetic result for the choice between skilled labor, unskilled labor, non-manual labor and professional work. Genes also influence the individual preferences for organizational values and work environments (Bouchard et al., 2004; Keller

et al., 1992). Genetic influences even affect job and occupational change (McCall et al., 1997).

Empirical evidence implies that the occupation entrepreneurship has the tendency to run in families. Lentz and Laband (1990) found that around half of all US self-employed proprietors are second-generation business owners. Evans and Leighton (1989) show that the likelihood of self-employment rises when the father is a manager, and decreases when the father is unskillful. Moreover, Dunn and Holtz-Eakin (2000) show that parental self-employment both increases the fraction of time that offspring spend in self-employment and reduces the age at which they enter. Colombier and Masclet (2008) show intergenerational association for self-employment in France. Andersson and Hammarstedt (2010) find that having both a self-employed father and a self-employed grandfather positively influences self-employment propensities for third-generation male immigrants in Sweden. Finally, several studies imply that the probability of self-employment is affected by genetic factors (Nicolaou et al., 2008a, b; Nicolaou and Shane, 2009a; Nicolaou et al., 2009; Nicolaou and Shane, 2010; Nicolaou et al., 2011; Shane et al., 2010; Zhang et al., 2009).

2.6 Differences between male and female entrepreneurs

Zhang et al. (2009) found a greater heritability of entrepreneurship for females than for males. However, the prevalence of entrepreneurship is much higher under men than under women. One of the explanations therefore is that women are to some extend discriminated against (Zhang et al., 2009). Brush, for instance, concluded that female entrepreneurs encounter obstacles that their male counterparts do not, namely being taken seriously, gaining growth and expansion capital, responsibilities for child and dependent care, and lack of entrepreneurial education and training (Brush, 1997; Envick and Langford, 1998**)**. The difficulties for women might be a result from the general gender-stereotypes against women (Zhang et al., 2009).

The Global Entrepreneurship Monitor (2001) reports a higher age for women entrepreneurs than for men in Portugal. Also, Turan and Kara (2007) conclude that female entrepreneurs are more conservative and are not willing to take as much risk as the male entrepreneurs. They therefore seem to set up businesses in areas with which they are familiar. 80% of female entrepreneurs start businesses at home and choose to remain small

(Capowski, 1994; Envick and Langford, 1998). Additionally, female entrepreneurs tend to use entrepreneurship as a way to balance work and family, rather than achieving financial success (Bird & Brush, 2002; Brush, 1992; Kepler & Shane, 2007; Zhang et al., 2009). Female entrepreneurs reduce family-career conflict by spending less time at work, where male entrepreneurs increase their time at work (Envick and Langford, 1998; Parasuraman et al., 1996).

Given that the literature shows women entrepreneurs face more obstacles and use entrepreneurship in different ways than their male counterparts, it is expected that the genetic entrepreneurial traits have a different effect on the reproductive success of women entrepreneurs compared to male entrepreneurs.

3 Reproductive Success

This section will discuss the concepts and the definitions of reproductive success as it is important to have an understanding of what reproductive success is before we research the relation between entrepreneurs and the number of children they produce.

3.1 Definition of Reproductive Success

Clutton-Brock (1990) in his study of animal breeding systems defined reproductive success by whether or not an individual has met several criteria - the most prominent one of which is the achievement of both the production and raising of offspring. By extension, "reproductive success" throughout this paper will be equated to the existing number of children successfully attained by an individual. The number of children per individual acts as the dependent variable in the model proposed under the "empirical study" section of the paper.

3.2 Included variables

Reproductive success is a factor that can be influenced by many variable types. These variables can be genetic and/or circumstantial in nature. Given the proposed research question of whether or not entrepreneurs have more children than non-entrepreneurs, this investigation of variables expected to influence reproductive success will be limited to those variables that either define or shape an entrepreneur. There are existing articles documenting the expected effect and testing of these variables. For each variable mentioned in this section, the source and/or reasoning leading to the inclusion of a factor as an independent variable is stated as well as the effect the independent variable is expected to have on the dependent variable (reproductive success).

A distinction is made between the expected direction of the effect a variable has on reproductive success amongst entrepreneurs with respect to males and females, as the physiology as well as the societal role of gender is considered to have an impact on the relationship held between a genetic/circumstantial feature and the ensuing reproductive

success. The variables discussed and later included in the tested models are: 1) Marital status, 2) Health, 3) Height, 4) Weight, 5) Income, 6) Age, 7) Satisfaction with Partner and 8) Education.

3.2.1 Marital Status

In the case of "marital status" and its effects on reproductive success, there is much literature studying its impact on a limited section of the population (e.g. tribes in sub-Saharan Africa). One such study by Leonetti et al. (2004) investigates the contributive effect of a husband on reproductive success and child rearing in Northeast India, where women tend to have direct control over assets. The study indicates that the presence of a husband has a positive effect on such things as "number of live-born children, child survival, and growth of children" which appears to be more particular to cases where "the husband is reported to be the head of the household" since in instances where this is not the case, negative effects between these variables have also been observed. In general, however, it appears that being married - in the case of females - has a positive effect on reproductive success.

Bereczkei and Csanaky (1996) indicate that reproductive success may not necessarily be influenced by marital status, but rather marital success. "Marital success" appears to be a derivation of mainly age and education. Males are said to opt for relatively younger females in marriage, while females are said to opt for relatively more educated males in marriage. Consequently, reproductive success is said to be characteristic of those marriages consisting of relatively younger females and relatively highly educated males. This finding is also consistent with the literature discussed with respect to education, income and age since education and income share a positive relationship with reproductive success while relatively young females is a determinant factor in the reproductive success of older men. As it is the quality of the marriage that appears to dictate the effect of marriage on reproductive success, in the case of males it is difficult to determine the expected direction of the result.

3.2.2 Health

The perceived fitness of the individual is expected to have a positive effect on reproductive success. Llaurens et al. (2009) state in their report on ritual fights and reproductive success that the condition of a male body shares a positive relationship with reproductive success. Fitness also acts as an enabler for mental and physical capacity and hence is expected to enhance the effects of the other variables on reproductive success.

3.2.3 Height

Nettle (2002) states that based on a population of British men, there appears to be a positive relationship between male height and reproductive success. This effect, however, plateaus at a certain height, as extremely tall individuals are more prone to health complications, which is damaging their reproductive success. Sear et al. (2004), in their study on Gambian women, noted a similar positive correlation between female height and female reproductive success. This is attributed to the physiological characteristics of tall individuals. Interestingly, there appears to be a trade off between female height and age at first birth (i.e. taller females tend to have children later in life), however taller females also exhibit lower infant mortality rates and a generally more successful long run reproductive cycle.

A second article by Nettle (2002), however, indicates that the relationship between female height and reproductive success is not as strong as that between male height and reproductive success and he reasons this through the argument that males opt for features of fertility when selecting their sexual partners, whereas height (while an apparent indication of maturity) is not an indication of female fertility. Consequently, female height is not expected to exhibit as strong a positive effect as male height on reproductive success.

3.2.4 Weight

Moran et al. (2011) suggest that weight, and in particular obesity, has an adverse effect on reproductive success in women. Obese women are three times more likely to be infertile than women of normal BMI. Bellver (2009) came to the same conclusion. Oliveria

Reis and Goulart Fernandes Dias (2012) found evidence that obesity may also affect the male reproduction adversely by reducing sperm concentrations.

3.2.5 Income

Hopcroft (2005) suggests that income has a positive effect on reproductive success only for males. Income is considered to be a measurement for wealth and social status (Essock-Vitale, 1984) and is expected to and has been shown to have a positive effect on reproductive success amongst males because of its role as an enabler. Wealth grants individuals access to scarce resources such as healthcare or food (Sterns, 1999) and in doing so makes the individual as well as those dependent on the individual more likely to survive. While there is suggestive evidence that populations with high levels of parental investments exhibited small family sizes for individuals with the highest level of wealth, wealth within a population tends to have a positive effect on reproductive success (Mace, 1997).

3.2.6 Age

While much of the literature relating to "age & reproductive success" covers animals of the primate and avian variety, Rudi et al. (1998) conducted a study on human aging and its effects on reproduction and reproductive success. From their research they conclude that, in the case of women, there appears to be a general positive correlation between age and reproductive success. More accurately, the positive correlation holds only for the period between female sexual maturity and menopause. The implication of the study is that women who live longer appear to have a higher chance of successfully reproducing. It is interesting to note that Anderson (1986) in her study on reproductive success notes a similar positive correlation between age and attraction (and hence reproductive success) amongst female primates. Rudi et al. (1998) also note that there appears to be a negative correlation between female age at first birth and number of children reared (i.e. the younger the female gives birth, the likelier she is to have more children throughout her life).

Silber et al. (1997) wrote an article on male infertility and the effect of female age and ovarian reserve on pregnancy rates in which it was noted that female pregnancy rates begin to decline after the age of 32 in the sample studied. The conclusion was that

pregnancy rates among couples that included infertile males decreased with female age (as well as female ovarian reserve and quality). This is to say that younger females with healthier ovarian reserves appear to achieve a higher pregnancy rate than older females with less healthy ovarian reserves. In summary, younger females appear to have a higher probability of successful pregnancy than older females, however the longer a female lives (at least until they reach menopause), the higher their chance of successfully producing offspring.

Liu and Case (2012) describe that the mean age of females' menopause in Western countries is 51, although there is a significant range, from 40 to 60 years of age. Childbearing usually ends ten years before the start of the menopause, regardless of the age of menopause (Liu and Case, 2012; Stein, 1985; Te Velde, 2002). A schematic representation of the decrease in fertility and menopause is found in **Figure 3.1**.

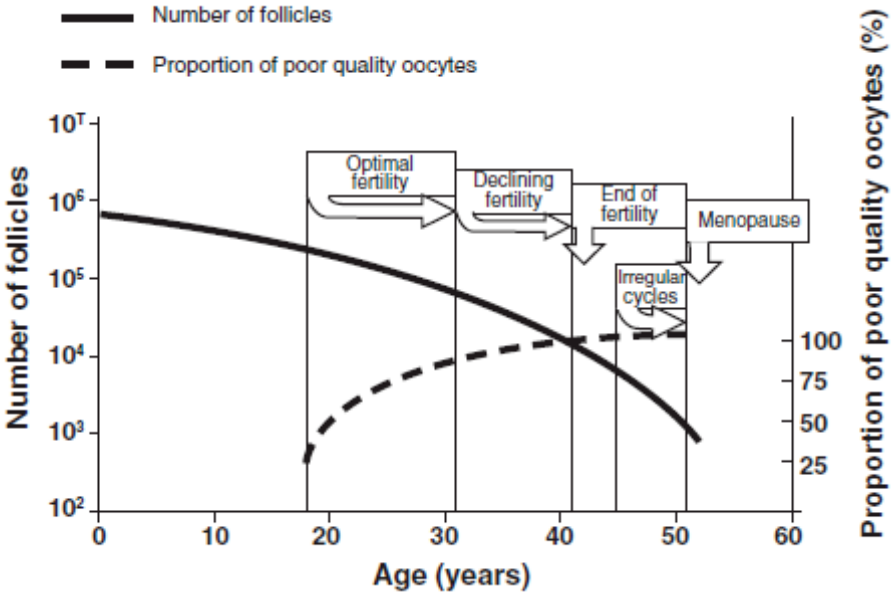

Figure 3.1 Schematic representation of the reproductive events optimal fertility, declining fertility, end of fertility and menopause for females (Hansen et al., 2008; Liu and Case, 2012).

There has been less research on the topic of the effect of paternal age on reproductive success. Kidd et al. (2001) noted in their study on age and male fertility that there is an apparent negative correlation between male human age and quality of sperm. Additionally, Studies show that a paternal age of over 40 years appears to be associated with risk of spontaneous abortion (Kleinhaus et al., 2006; Liu and Case, 2012; Maconochie et al., 2007).

Liu and Case (2012) found that a paternal age over 40 years increases the risk of abortion. Kendro-McAnlis et al. (2008) confirm that male age is important and conclude that a significant decrease in implantation, clinical pregnancy and live birth rates take place for males of 45 years of age and older. Frattarelli et al. (2008) found a significant increase in pregnancy loss, a decrease in the live birth rate, and decrease in blastocyst formation rate in males of 50 years of age and older. Consequently younger males have a higher probability of successfully impregnating a female, however given that variables such as education and income (which are expected to have a positive effect on reproductive success) tend to be higher with age, the overall expectation is that male age is positively correlated with reproductive success.

3.2.7 Satisfaction with Partner

There are no studies that investigate the relation between satisfaction between partners and the number of children they produce and raise. However, Bereczkei and Csanaky (1996) indicate that marital success may have a greater effect on the reproductive success than marital status. It is therefore expected that there is a positive relation between the satisfaction with the partner and the number of children produced as the success of the relationship is assumed to be of greater importance than the marital status itself.

3.2.8 Education

Hopcroft (2005) also suggests that education has a positive effect on reproductive success and that the effect is stronger for males than for females. Stearns (1999) quotes Kaplan (1995) by stating, “humans maximize status and income-earning opportunities, both of which are enhanced by education.” Education therefore should be conducive to income, status and wealth and hence should arguably share a positive relationship with reproductive success.

However, Australia experienced that the education level increased and the fertility decreased at the same time (Yu, 2006). The decreasing fertility is primarily a result of the increased opportunity costs of child-bearing and rearing for women with higher levels of

education and high labour force participation (Becker, 1991; Schultz, 1969; Yu, 2006). Education may influence female autonomy, family formation and gender equality and therefore decrease fertility (Basu, 2002; Bratti, 2003; Mason, 1986; Yu, 2006). Women with a higher level of education have a higher ability to control their fertility and realize their fertility objective (Basu, 2002; Cheng and Nwachukwu, 1997; Lam and Duryea, 1999; Rosenzweig and Schultz, 1985; Schultz, 1993; Yu, 2006). As our research studies Australian entrepreneurs and non-entrepreneurs, it is expected that education has a negative effect on the reproductive success.

4 Formulation of Hypotheses

Given the extensive literature documenting the relationship between natural selection and reproductive success in general and the relatively limited research on natural selection with respect to a combination of specific traits or a specific occupation and their impact on reproductive success, it appears that this paper and its corresponding research question helps fill a gap in that it attempts to demonstrate the joint effect of individual variables previously studied in existing literature (as these together help define a specific type of individual: an entrepreneur) on reproductive success. In the interest of refining the result, three main hypotheses are suggested of which two help account for differences in gender.

Hypothesis 1. *Male entrepreneurs have higher reproductive success than male non-entrepreneurs.*

There is plenty of evidence to suggest that certain human genetic and circumstantial characteristics have a positive effect on reproductive success. Given that many of these characteristics are found in male entrepreneurs (see for instance Di Zhang and Bruning, 2011; Hisrich, 1988; Turan and Kara, 2007), it appears feasible that male entrepreneurs should then have an above average reproductive success rate when compared to male non-entrepreneurs who do not necessarily posses these features. With this hypothesis, it is therefore suggested that main characteristic features of an entrepreneur, will have a positive effect on reproductive success and in doing so show that male entrepreneurs are likely to have a higher reproductive success rate than male non-entrepreneurs.

Hypothesis 2. *Female entrepreneurs have higher reproductive success than female non-entrepreneurs.*

Using the reasoning provided above, it is equally natural to expect that female entrepreneurs have an above average reproductive success rate when compared to female non-entrepreneurs who do not necessarily posses the characteristics expected to positively influence reproductive success. Hence, characteristic features of a female entrepreneur are expected to have a positive influence on female reproductive success, hereby showing that female entrepreneurs likely have a higher reproductive success rate than female non-

entrepreneurs.

Hypothesis 3. *Entrepreneurs have higher reproductive success than non-entrepreneurs.*

In order to be able to provide a general conclusion on the reproductive success of entrepreneurs, the final hypothesis looks at the population of entrepreneurs as a whole and compares it to the entire sample population of non-entrepreneurs. As the two previous hypotheses, looking at the genders in isolation, state that entrepreneurs have a higher reproductive success than non-entrepreneurs, this final hypothesis states the same relationship for the population of mixed genders.

In addition to these main hypotheses, directly addressing the research problem, several sub-hypotheses are defined in order to identify the relationship between the other factors found in the literature review and the number of children. These sub-hypotheses are as follows:

Sub-Hypothesis 1. *Marital status has a positive effect on reproductive success*.

As concluded by the literature review, individuals who are married have a higher reproductive success than individuals who are not married. For this reason, it is expected that a married individual will have more children than a non-married individual. This effect is expected to be particularly strong for females, however the positive effect of marriage on children is also found in the male population.

Sub-Hypothesis 2. *Health status has a positive effect on reproductive success.*

From a medical perspective it is predicted that the better the physical condition of an individual, the higher the potential reproductive success. This leads to the assumption that an individual with a better health status will have more children than an individual with a lower health status. This relationship holds for both the male and female model.

Sub-Hypothesis 3. *Height has a positive effect on reproductive success.*

From the literature review it can be concluded that the higher one is, the more reproductive success one will have. Therefore, it is expected that height has a positive effect on reproductive success. It is expected that this relation is stronger for men than for women.

Sub-hypothesis 4. *Weight has a negative effect on reproductive success.*

From a medical perspective it is predicted that the more one weighs, the lower one's reproductive success. For this reason, it is expected that there is a negative effect between weight and reproductive success. This effect is expected to be larger for females than for males.

Sub-Hypothesis 5. *Income has a positive effect on reproductive success.*

The effect predicted from the literature review is that individuals with a higher income level have more reproductive success. For this reason, an individual with a higher weekly wage should have more children than an individual with a lower weekly wage. This effect is expected to be more dominant in the male model in comparison to the female model.

Sub-Hypothesis 6. *Age has a positive effect on reproductive success.*

Age is predicted to have a positive effect on reproductive success for both males and females. This means, that an older individual has a higher number of children than a younger individual.

Sub-Hypothesis 7. *Satisfaction with one's Partner has a positive effect on reproductive success.*

Concerning reproductive success, a positive relationship is predicted between the satisfaction with one's partner. This effect is expected to be similar for both the male and female model.

Sub-Hypothesis 8. *Education has a negative effect on reproductive success.*

From the literature, it is expected that an individual with more education has less reproductive success. For this reason, an individual with a higher educational number is expected to have a lower number of children than an individual with lower education score. This effect is expected to be stronger in the female than in the male model.

5 Empirical Research

This thesis first investigates whether male entrepreneurs have more reproductive success than male non-entrepreneurs. Secondly, it will investigate whether female entrepreneurs have more reproductive success than female non-entrepreneurs. Finally, it will discuss whether entrepreneurs in general, males and females combined, have more reproductive success than non-entrepreneurs. In this section first the data used in the models will be considered, followed by the variables and models used.

5.1 Data

In order to answer the research question and test the hypotheses of this thesis, data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey is used. HILDA is a household-based panel study, which began in 2001. The panel provides data on various topics necessary to perform this study, including occupational biographies, employment and household compositions.[1]

To construct a relevant dataset for this research, which is also linked to the contemporary literature, data from the most recent years are used. In the years 2006 until 2010 the panel provides full detail on all the essential variables needed to test the hypotheses, so that these are the years used to construct the dataset. The panel data has been converted into cross-sectional data, as the number of children in the dataset at hand both grows due to births and decreases as children pass away. To be able to research whether entrepreneurs significantly have more children than non-entrepreneurs, the maximum number of children per respondent is taken into consideration instead of the number of children per year, as this would affect the outcome of the research in a non-transparent way.

Further it is important to mention that the HILDA questionnaire gives its respondents the option to answer one of the following, when the given answers were not sufficient or the respondent did not want to answer: a) Not applicable, b) Don't know, c) Refused/Not stated. If the respondents chose one of these answers, they obtained a value of

[1] http://www.melbourneinstitute.com/hilda/

-2, -3 and -4 respectively. The questionnaire also registered: a) when a question was not asked, b) when there are multiple responses, c) when there is an implausible value, d) when the answer is not able to be determined and e) when the household or person did not respond. These answers obtained a number value of -1, -5, -6, -7, -8, -9 and -10.

In order to avoid skewedness in the data, these variables had to be recoded. In this respect, all data that was 'not valid' or where respondents did not provide an answer were recoded into missing variables in order to exclude them from the data set.

5.2 Gender stratified

As women entrepreneurs tend to be older than their male counterparts (The Global Entrepreneurship Monitor, 2001), are more conservative and not willing to take as much risk as the male entrepreneurs and therefore set up businesses in fields with which they are familiar (Turan and Kara, 2007), it is expected that the effect of entrepreneurship on reproductive success is higher for men than for women entrepreneurs. For this reason, two of the models tested are gender stratified, meaning one model only looks at females while the other only looks at males. For this purpose the population has been split into two samples, namely male and female. Only in the final model, the entire population is used without gender specifications.

5.3 Dependent variable

The dependent variable, the 'number of children', reflects the number of children ever had. The respondents were asked: "How many children in total have you ever had? That is, ever [fathered / given birth to] or adopted?" The answer to this question ranges from 0 children to a maximum of 18 children.

This variable counts both natural as well as adopted children. As I am investigating the reproductive success of entrepreneurs, this variable should preferably only contain the number of natural children attained. However, the HILDA survey does not contain such a variable. As the number of adoptions in Australia is very low, around 400 to 600 per year and

412 in 2009-2010 (AIHW, 2010) compared to 297,900 natural births in 2010,[2] it is not expected that the inclusion of adopted children will alter the outcome of the research.

The variable 'number of children' will be treated as a numeric variable. The number of children is in turn selected as a proxy for reproductive success. Therefore, a higher number of children refer to greater reproductive success. This implies that a unit of reproductive success is equivalent to having successfully passed on ones genetic material to the next generation.

5.4 Independent variables

The main relationship studied in this thesis is between the dependent variable, number of children, and the independent variable, self-employment, which is used to sample out entrepreneurs. In addition to self-employment, various other independent variables are used to complete the model. These variables are included as they estimate effects for other factors that influence the reproductive success of individuals either from a genetic or behavioral-characteristic point of view. By including the following variables, the aim is to accurately model the influence of self-employment on reproductive success, by completing the model with other important factors that have an impact.

5.4.1 Self-Employment

In order to capture the individuals who are entrepreneurs, data of becoming 'self-employed' is the key variable to divide the sample. The variable used is the 'current employment status' where respondents could answer 1) Employee 2) Employee of own business 3) Employer/own account worker or 4) Unpaid family worker. The data was recoded and it assigns the value '1' if the respondent is an employee (control group) and the value '2' if the respondent is self-employed (prior numbers '2' and '3' combined). The data from the group 'Unpaid family worker' has been dropped in order to have a clear control group.

[2] http://www.abs.gov.au/ausstats/abs@.nsf/Products/F7B863853E2AF406CA25793300167434?opendocument

The variable 'self-employment' is a dummy variable, and equals 2 if the individual is self-employed between the years 2006 and 2010, and 1 if the individual is not self-employed in that period of time. Self-employment is used as a direct proxy for the individual being an entrepreneur. By reviewing existing literature, a positive effect of self-employment on reproductive success is expected. For this reason, an individual who is self-employed should have a higher number of children in comparison to an individual who is not self-employed. This effect is expected to be the same for both the male and female model.

5.4.2 Marital Status

The 'marital status' of the individual is used as a proxy for a stable and intact relationship between the individual and his or her spouse and is measured by a dummy variable. The variable used is 'marital status from the person questionnaire. The respondent could answer with 1) Legally married 2) De facto 3) Separated 4) Divorced 5) Widowed and 6) Never married and not de facto.

As the variable is used as a proxy for a stable and intact relationship, the data is recoded so that the variable takes a value of '1' for being married and value '2' for not being married, including being single, married but separated, divorced and widowed.

5.4.3 Health

As reproduction is a physical matter, the individual's physical condition needs to be taken into consideration. The body condition is being estimated by the individual's 'self-assessed health status' that lies in a range between 1 and 5. Value 1 refers to an excellent health status while a value of 5 refers to a poor health status, with the values in between being very good, good and fair.

5.4.4 Height

As height also has effect on the reproductive success, the variable 'height' was included. The variable takes on any value between 110 and 205, defining the length of the respondent in centimeters.

5.4.5 Weight

Also the respondents weight is taken into consideration. The variable weight can take any value between 33 and 250, defining the weight in number of kilograms.

5.4.6 Income

To approximate the income level of the individual, the variable 'weekly wage' is used. The variable takes on the value of zero if no income is obtained and another value when income was generated, defining the amount earned. Since this variable is obtained at a certain point in time, this variable may not be an exact reflection of the individual's income level. However, it should be seen as a general level of income comparable across the sample and not as a precise measure of wealth.

5.4.7 Age

The age is a quantitative variable that indicates the age of the individual. In the data used the variable can vary from 15 to 93 years of age. As the literature describes that childbearing for women ends ten years before the start of the menopause and latest menopause is registered at 60 years of age, a cut-off point of 50 years of age for women is chosen for this dataset. For men the risks increase significantly after 50 years of age, so also for men the dataset is limited to 50 years of age.

5.4.8 Satisfaction with Partner

As the martial status of an individual does not always reflect the health of a relationship and not being married does not necessarily indicate that the relationship is not healthy and strong, the variable 'satisfaction with partner' is used as a proxy for a stable and intact relationship between the individual and his or her spouse. The variable can take a value between 0 and 10, whereby 0 stands for completely dissatisfied and 10 stands for completely satisfied.

5.4.9 Education

Nine educational levels are included in the HILDA dataset, ranging from values 1 to 9: 1) Postgrad – master or doctorate 2) Grad diploma, grad certificate 3) Bachelor or honours

4) Advanced diploma 5) Certificate III or IV 6) Certificate I or II 7) Certificate not defined 8) Year 12 and 9) Year 11 and below. These nine educational levels are ordered from highest amount or quality of education to least amount of education or lowest quality of education. This means, the lower the value the individual has, the more educated the individual is. This data was recoded in order to drop the tenth possible answer, namely undetermined.

In order to give an overview of the variables used in the models, the descriptive statistics of the variables are reported in **Table 5**. From these statistics we can conclude that the number of respondents consists of almost as much men as women.

Table 5
Descriptive statistics of the respondents

Variable	Mean	Std. Dev.	Min	Max
Number of children	2.896	1.726	0	18
- *Male*	*2.881*	*1.755*	*0*	*18*
- *Female*	*2.910*	*1.701*	*0*	*14*
Self-employed	1.333	0.471	1	2
- *Male*	*1.361*	*0.480*	*1*	*2*
- *Female*	*1.308*	*0.462*	*1*	*2*
Gender	1.531	0.499	1	2
- *Male*	*1*	*0*	*1*	*1*
- *Female*	*2*	*0*	*2*	*2*
Marital Status	1.418	0.493	1	2
- *Male*	*1.412*	*0.492*	*1*	*2*
- *Female*	*1.423*	*0.494*	*1*	*2*
Health	2.389	0.870	1	5
- *Male*	*2.404*	*0.869*	*1*	*5*
- *Female*	*2.376*	*0.871*	*1*	*5*
Height	171.292	10.120	110	205
- *Male*	*178.482*	*7.522*	*127*	*205*
- *Female*	*164.940*	*7.541*	*110*	*199*
Weight	77.639	18.045	33	250
- *Male*	*86.210*	*16.326*	*39*	*250*
- *Female*	*70.067*	*15.988*	*33*	*182*
Income	815.323	769.165	0	8206
- *Male*	*1096.468*	*873.011*	*0*	*8206*
- *Female*	*566.956*	*556.338*	*0*	*8206*
Age	34.522	9.125	15	50
- *Male*	*35.430*	*9.105*	*15*	*50*
- *Female*	*33.720*	*9.067*	*15*	*50*
Age squared	1275.044	625.046	225	2500
- *Male*	*1338.198*	*633.760*	*225*	*2500*

- *Female*	*1219.254*	*611.887*	*225*	*2500*
Satisfaction with Partner	8.101	1.994	0	10
- *Male*	*8.147*	*1.965*	*0*	*10*
- *Female*	*8.061*	*2.019*	*0*	*10*
Education	5.338	2.563	1	9
- *Male*	*5.309*	*2.455*	*1*	*9*
- *Female*	*5.364*	*2.655*	*1*	*9*

5.5 Methodology

5.5.1 Model specifications

This study estimates the relationship between the independent variables and the dependent variable, with the aim to approximate the relationship between entrepreneurs and the number of children they obtain in comparison to non-entrepreneurs.

The number of children for an individual (N_i) is posited to be an exponential function of entrepreneurship (E_i), exogenous variables ($a_i, b_i, c_i, d_i, e_i, f_i, g_i, h_i, i_i$), and a random error ($u_{1i}$):

$$N_i = \exp\left(E_i\beta_1 + a_i\beta_2 + b_i\beta_3 + c_i\beta_4 + d_i\beta_5 + e_i\beta_6 + f_i\beta_7 + g_i\beta_8 + h_i\beta_9 + i_i\beta_{10}\right) + u_{1i} \quad (1)$$

where N_i represent the number of children obtained; E_i represents entrepreneurship; a_i is the individual's marital status; b_i is the individual's health; c_i is the individual's height; d_i is the individual's weight; e_i is the individual's income; f_i is the individual's age; g_i is the individual's age squared; h_i is the individual's satisfaction with his or her partner; i_i is the individual's education; and u_{1i} captures variation in an individual's unobserved characteristics as well as random error. The exponential function guarantees non-negative numbers.

Due to the fact that the dependent variable, number of children, is a count variable, the discreteness and non-negativity of this variable call for a Count Data Regression Model to test the three models at hand (Trivedi, 1997; Wooldridge, 2002). The first Count Data

Regression model that can be used is the basic Poisson regression model, which assumes equidispersion, namely that the conditional mean is equal to the conditional variance (Wooldridge, 2002).

$$Var\left(y|x\right) = E\left(y|x\right) \tag{2}$$

From the goodness-of-fit test it can be concluded that the conditional mean is close to, but not equal to the conditional variance. The generalized linear model (GLM) uses a weaker variance-mean assumption in which the variance-mean ratio is allowed to be any positive constant (Wooldridge, 2002).

$$Var\left(y|x\right) = \sigma^2 E\left(y|x\right) \tag{3}$$

When the conditional variance is larger than the conditional mean, there is overdispersion. The estimates of a basic Poisson regression model for overdispersed data are unbiased, but inefficient with standard errors biased downward (Cameron and Trivedi, 1998; Long, 1997). The negative binomial regression model is a model in which assumption (3) holds. Therefore, the negative binomial regression model was considered in order to test if this is a better model than the Poisson regression model.

As alpha in the negative binomial regression model is almost 0 (3.07e-08), there is a clear indication that there is no overdispersion. As the log likelihood of the negative binomial regression model and the Poisson regression model are the same, the Poisson regression model has one degree of freedom less and a lower Akaike information criterion (AIC) and Bayes information criterion (BIC), the Poisson regression model is the best model to use for this data.

Before starting to run the Poisson regressions, it is essential to check if all the assumptions for a Poisson regression model are met. If any of the assumptions are violated, the regression model can be invalid. The assumptions tested include: equidispersion, normality and no collinearity. Furthermore, all variables were tested for correlation using the Pearson coefficient. Above the assumption of equidispersion has already been discussed.

The second assumption, regarding a normal distribution of the residuals, has been tested both graphically with a P-P Plot and Q-Q Plot and statistically with an inter-quartile range test and Shapiro-Wilkinson test. The plots show minor non-normalities. However, the plots are inconclusive. The inter-quartile range test shows that there are no severe outliers and the distribution seems fairly symmetric. The residuals have an approximately normal distribution. From the Shapiro Wilk test, it is concluded that the residuals are not normally distributed. However, due to the fact that there are no severe outliers in the inter-quartile range and a large sample size of over 14,000 observations, the non-normality of the residuals will not cause any problems for our model.

Finally, the assumption of no collinearity is tested using the variance inflation factor (VIF). Agreeing with the correlation results, the VIF suggests multicollinearity to exist between the variables Age and Age squared. After this has been detected, new models were regressed, excluding first Age then Age squared and finally both variables, just to find that the models got worse. As both these variables are essential to the model, it has been decided to keep both of them included in the models, as the multicollinearity between them does not seem to harm the model.

In order to draw comparative conclusions between the genders and on the entrepreneur population as a whole, all three models use identical dependent and independent variables and just the sample used differs. Only in the third model, for the entire population, the model is being controlled for gender, which is not the case in the other two. Robust standard errors for the parameter estimates were used in order to control for mild violation of the distribution assumption that the conditional variance equals the conditional mean (Cameron and Trivedi, 2009).

6 Discussion

As described in the previous section, the regression analysis used is the Poisson regression model. With this regression analysis, the independent variable self-employment is used to predict the number of children by additionally estimating effects of: a) marital status, b) health status, c) height, d) weight, e) income, f) age, g) satisfaction with partner and h) education. Furthermore, Model 3 includes a control variable for gender.

The previously listed constellation of variables is the same for all three models; however, the sample population is different for each. In model 1, the sample population only consists of males and results in a total of 6,971 observations, in model 2 only of females including a total number of 7,891 observations and in model 3 both males and females are included with a total of 14,862 observations. All three models are significant at the 5 percent level.

A summary of the results is given in Table 6. The self-employment variable in the three models will be examined first, followed by a discussion on the independent variables from the sub-hypotheses.

Table 6

Summary of models	Model 1: Male		Model 2: Female		Model 3: All	
Variable	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Self-employed	0.117	0.000	0.111	0.000	0.116	0.000
Marital Status	-0.104	0.000	-0.063	0.000	-0.086	0.000
Health Status	0.013	0.134	0.009	0.191	0.012	0.026
Height	-0.000	0.736	0.000	0.637	-0.000	0.853
Weight	0.000	0.785	0.001	0.001	0.001	0.012
Income	0.000	0.812	-0.000	0.000	-0.000	0.051
Age	0.102	0.000	0.127	0.000	0.113	0.000
Age squared	-0.001	0.000	-0.002	0.000	-0.001	0.000
Satisfaction with partner	-0.005	0.201	-0.003	0.262	-0.004	0.086
Education	0.008	0.008	0.010	0.000	0.009	0.000
Control for gender	No		No		Yes	
Number of observations	6,971		7,891		14,862	
p-value	0.0000		0.0000		0.0000	

6.1 Self-Employment

The results of Model 1 show that self-employment has a positive and significant effect on the number of children a male individual has. As self-employment is used as an indication for entrepreneurship and reproductive success is proxied by the number of children an individual has, this result fully confirms the predictions stated in hypothesis 1: Male entrepreneurs have higher reproductive success than male non-entrepreneurs. As suggested by the literature, male entrepreneurs have a set of genetic and behavioral traits uncommon to male non-entrepreneurs that result in greater reproductive success.

In Model 2, the effect self-employment has on the number of children is again positive and significant. However, the effect is slightly weaker than in Model 1. As hypothesis 2 states, female entrepreneurs have more reproductive success than female non-entrepreneurs, and the results clearly confirm this expectation. The literature review provides plausible explanations for this, the main one being that female entrepreneurs are more likely to possess certain attributes that increase their chances of reproductive success in comparison to female non-entrepreneurs.

Model 3 is used to check the robustness of the results for Models 1 and 2. The results of Model 3 confirm the positive and significant relationship of self-employment and the number of children an individual has. With this result, the final hypothesis is confirmed and the general conclusion that entrepreneurs have more reproductive success than non-entrepreneurs can be drawn. This supports the assumption that entrepreneurship is regarded as a form of natural selection which increases the potential for reproductive success of the individual in order to pass on the specific, beneficial traits that differentiate entrepreneurs from non-entrepreneurs.

6.2 Independent Variables

In total eight further independent variables are included in each model in order to give a better prediction of the relationship between the dependent and main independent variable. The results for these variables are described below.

6.2.1 Marital Status

The dummy for being married has a negative and significant effect on the number of children in all three models, hereby rejecting sub-hypothesis 1. The negative influence is strongest in the male model. This is surprising as the literature predicts a positive influence on the number of children.

In research done under Khase women, it was found that there is a positive relation between the marital status and reproductive success. These effects pertain particularly if the husband is reported to be head of the household. If the husband was not head of the household, the effects can be negative (Leonetti et al., 2004). This might explain the results found. Further, a negative relationship between intelligence and fertility has been described repeatedly. Meisenberg and Kaul (2010) found that this relationship is far stronger for unmarried than married people.

6.2.2 Health

The health status of the individual has a positive influence on the number of children in all models. However, these results are only significant in the overall model. A positive and significant result was expected in all models, since the physiological body condition can influence the reproductive organs and with that the reproductive success of an individual. However, since the overall model shows a positive influence on the number of children, sub-hypothesis 2 is not rejected.

6.2.3 Height

The height of an individual has a slightly negative effect for both the male and the overall model and a very small positive effect for the female model. In all three models this result is not significant. This is surprising as the literature suggests a positive relationship between male height and reproductive success, which plateaus at a certain height. For women this relation is also suggested. Therefore, sub-hypothesis 3 is rejected.

Sear (2006) concludes that the environmental context needs to be taken into account when analyzing human reproductive behavior. She found that there is no significant relationship between height and the number of children Gambian men produce.

6.2.4 Weight

The weight of an individual has a very small positive and significant effect in all three models. However, this result is only significant in the female and overall model. As a negative effect was expected, sub-hypothesis 4 is rejected.

Even though the literature suggests that weight has an adverse effect on reproductive success as obesity causes health conditions, this finding is not that surprising. It is not only obesity that has adverse effects on the reproductive success. In the case of women, the same holds for underweight. Extremes in body weight are associated with infertility (Davies, 2006; Fedorcsák et al., 2004). The relationship between fertility and body weight has the shape of an inverted U (Correa and Jacoby, 1978; Davies, 2006; Huss-Ashmore, 1980). Paasch et al. (2010) found that underweight also decreased sperm counts and the total sperm count with normal morphology showed a similar inverse, U-shaped distribution.

6.2.5 Income

Model 1 shows a very small positive effect and Model 2 and 3 show a very small negative effect of income on the number of children, thereby indicating that the effect of income is different for males and females. This finding however is only significant for the female model.

The literature argues that on the basis of cultural discrepancies, income can have either a positive or negative effect, yet generally speaking has a positive effect on reproductive success. As the result in the overall model shows a negative effect, there is an indication that sub-hypothesis 5 should be rejected as income in general has a negative effect on reproductive success.

6.2.6 Age

The age of an individual gives positive and significant results for all three models, confirming the expectations of sub-hypothesis 6. This result is mainly explained by the fact that the number of children any individual has is more or equal at a later age than at an earlier age as more time has passed to conceive additional children (the exception being the death of a child over time).

Due to this simple explanation of the positive effect of age on the number of children an individual has, it is essential to look at the second age variable, namely Age squared. This is negative and significant for all three models, from which one can conclude that even though the number of children tends to increase with age, this happens at a decreasing rate as age increases.

6.2.7 Satisfaction with Partner

The satisfaction with one's partner has a negative and insignificant effect in all models. This is surprising as the literature indicates that marital success, and thus the satisfaction with one's partner, has a greater effect on the reproductive success than marital status. It was expected that satisfaction with one's partner would have a positive effect on the number of children. Therefore, sub-hypothesis 7 is rejected.

A possible explanation for this result, though not covered by the current literature, is that couples, in which the partners are very satisfied with each other, think the presence of children will not alter overall life satisfaction but would only take up their time. Therefor they choose not to have children.

6.2.8 Education

Education has a very small positive and significant effect in all models. Therefore, sub-hypothesis 8 is confirmed. In order to draw better results from this variable however, it would be beneficial to have more detailed information on the spouses' educational levels, as

in combination this variable has more explanatory power concerning the reproductive success of the individual.

7 Conclusion & Limitations

The aim of this thesis is to answer the following research question: “Does the average entrepreneur have more children than the average non-entrepreneur?”. The results compiled and discussed above provide interesting insights into the relationship posed in the research question. Through gender-stratification, three hypotheses are established linking entrepreneurship to reproductive success for a male, female and total population sample, respectively. The sub-hypotheses also suggest a relationship between the eight independent variables used and reproductive success. The results obtained from running Poisson regressions with the three models confirmed all three main hypotheses as well as three of the eight sub-hypotheses, which lead to the general conclusion that entrepreneurs have more children on average than non-entrepreneurs.

Through the literature review, the assumption has been made that entrepreneurship is a form of natural selection. The contribution of this thesis is therefore to link reproductive success to a modern form of natural selection, namely entrepreneurship; a relationship hardly researched in existing literature. Both a selection of genetic and behavioral traits are more commonly found in entrepreneurs, setting them apart from non-entrepreneurs. It is these characteristics that the entrepreneur wants to pass on to the next generation and through this the higher reproductive success in entrepreneurs can be explained.

The major surprising findings, therefore, do not lie in the confirmation of the expected positive relationship between entrepreneurship and reproductive success, but more in the discovered relationships between the other independent variables and reproductive success. For instance, the contradicting effect of marital status, weight and satisfaction with the partner on the number of children does not align with the predictions suggested by the literature review. On the other hand, the strong effects of the health, age and education strengthen the predictions of existing literature. These discrepancies from existing literature confirm the lack of research undergone on this topic and validates that the thesis at hand is a first attempt to shed more light onto this field of research.

7.1 Limitations

Despite the carefulness with which this thesis has been orchestrated and the data selected and processed, there are several limitations to both the data used and the thesis itself. These are described below:

Number of children produced

While the number of children produced is focused on, there is no indication of the number of children successfully raised. The number of children produced is proxied by the number of children ever had. This variable counts both natural as well as adopted children. As the reproductive success of entrepreneurs is investigated, this variable should preferably only contain the number of natural children attained. This implies that the variable "number of children" is not entirely accurate, though the number of adopted children in Australia is very small.

Lack of causality

While this thesis explores whether or not being an entrepreneur results in the production of more children than non-entrepreneurs, there is no certainty of the direction of the causality. It is possible that the two variables ("self-employment" and "number of children") share a positive correlation because having more children has a tendency to lead individuals to become self-employed. This thesis does not test for the strength of this alternative.

Feature type

This thesis focuses on genetic as well as circumstantial characteristics of an entrepreneur when attempting to determine whether or not there is a positive effect of being an entrepreneur on reproductive success. While this thesis addresses the distinction between genetic and circumstantial features, no attempt is made to separate the two types of features. Consequently, this thesis does not test for the effect of the differences in feature types on reproductive success.

Multicollinearity

When testing the variables used in the model, there remained an issue of multicollinearity between the variables Age and Age squared. Attempts made to remove the presence of multicollinearity resulted in additional issues such. Since each potential solution for this introduced an additional problem, nothing was done about this particular issue.

Endogeneity

As entrepreneurship is expected to be endogenous and therefore correlated with unobservables relegated to the error term, it was preferred to use an instrumental variables (IV) model as endogeneity biases estimated returns to entrepreneurship. Possible instrumental variable candidates would be whether or not a parent of the respondent is an entrepreneur or whether there has been a policy change, which favors entrepreneurs. However, in the database used there was no data or approximating variable that could be used as an instrumental variable for entrepreneurship. Therefore, it was chosen to proceed with the Poisson regression model.

Missing variable data

The literature studied for this thesis suggested several other variables that are expected to affect (mostly in a positive way) the reproductive success of human males and females. These variables included: 1) frequency of sex as a control variable for potential reproductive success, 2) nationality as this may account for differences in culture and hence behavior, and 3) intelligence as this too affects chosen behavior. In the database used, however, there was no data or approximating variable that could be used for the inclusion of these variables in the model. Consequently, these variables were not included in the model. It is expected that the observed outcome, had these variables been included, would have been more.

Partner information

The original plan had been to include information on the partner of the individuals whose data had been used for the regressions. This would have acted as a control variable and could have resulted in better estimates for such variables as income and education. Because of the lack of information on partners, this control variable was not included.

7.2 Recommendations

The recommendations for future research are largely based on the limitations presented in this thesis. It is recommended that in future research pertaining to this topic, the authors make use of a larger dataset that provides more complete and accurate information on a larger population so that all the all the desired variables may be included in the model using results over a wider time-span.

Future research should also make a distinction between genetic and environmentally formed characteristics of the individuals being studied and test to see which of these characteristic types lead to a more accurate prediction of the relationship between self-employment and reproductive success.

This research should then also address and account for the issue of causality perhaps by testing additional hypotheses (e.g. reproductive success leads to self-employment) and comparing the strength of the predictive accuracy of the model used to test for this to test the other direction of causality.

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Correlations

Table 1
Correlation matrix

	Self-employed	Number of children	Gender	Marital Status	Health	Height
Self-employed	1.0000					
Number of children	0.2209	1.0000				
	0.0000					
Gender	-0.0420	0.0468	1.0000			
	0.0000	0.0000				
Marital Status	-0.1351	-0.3019	-0.0312	1.0000		
	0.0000	0.0000	0.0000			
Health	0.0080	0.1086	0.0192	-0.0244	1.0000	
	0.1473	0.0000	0.0003	0.0000		
Height	0.0218	-0.0322	-0.6517	0.0306	-0.0415	1.0000
	0.0009	0.0000	0.0000	0.0000	0.0000	
Weight	0.0521	0.1134	-0.3931	-0.1030	0.1848	0.4798
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Income	-0.0388	0.1356	-0.2482	-0.2013	-0.0631	0.2073
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Age	0.2130	0.4751	0.0126	-0.4908	0.1726	-0.0267
	0.0000	0.0000	0.0103	0.0000	0.0000	0.0000
Age squared	0.2005	0.4456	0.0110	-0.4668	0.1722	-0.0289
	0.0000	0.0000	0.0243	0.0000	0.0000	0.0000

Satisfaction with partner	-0.0238	-0.0558	-0.0267	-0.0636	-0.1828	0.0162
	0.0002	0.0000	0.0000	0.0000	0.0000	0.0319
Education	-0.0863	-0.1782	-0.0153	0.2581	0.0637	-0.0165
	0.0000	0.0000	0.0018	0.0000	0.0000	0.0091

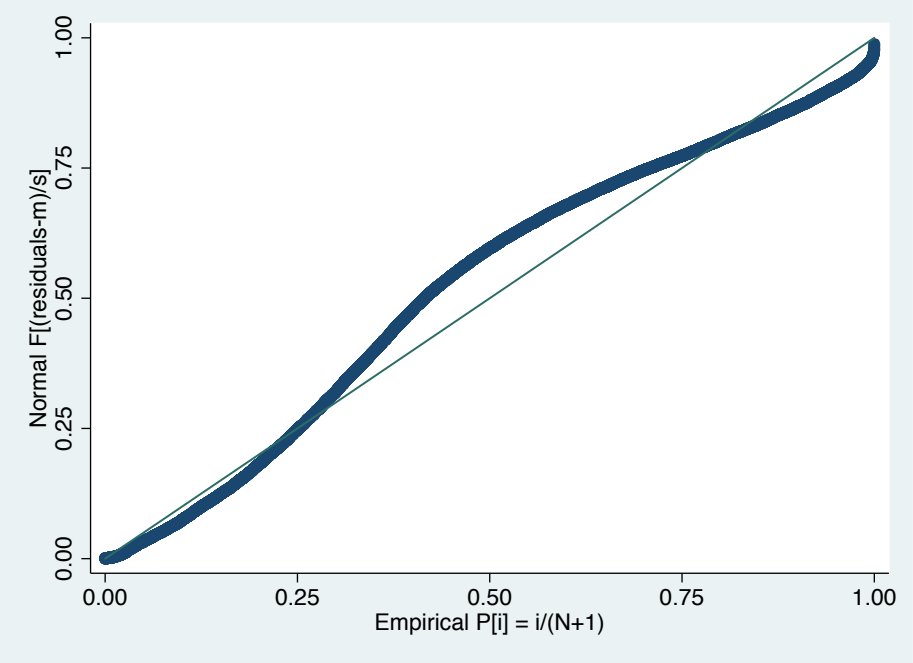
Table 1 - continued

Correlation matrix

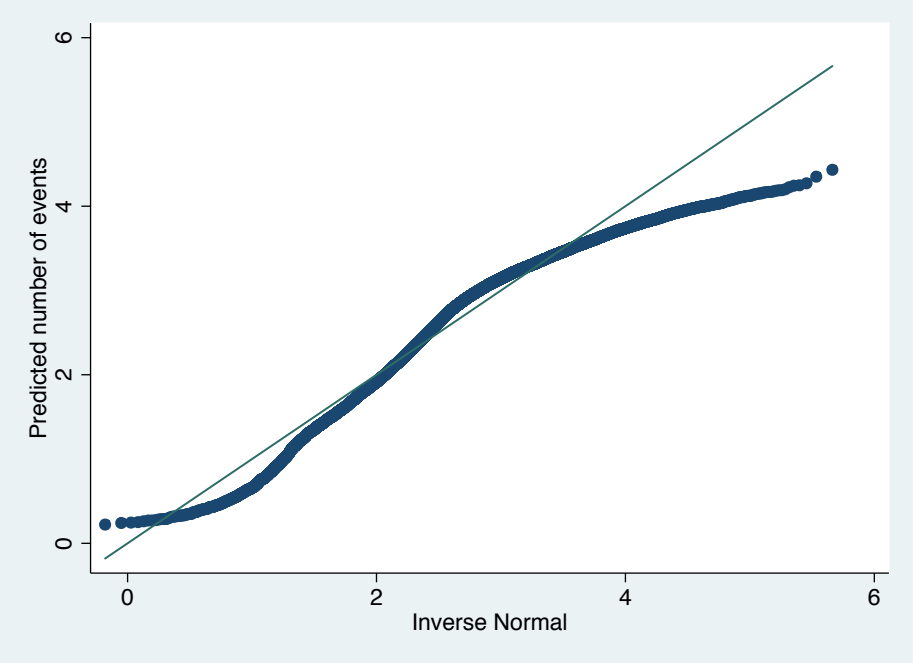
	Weight	Income	Age	Age squared	Satisfaction with partner	Education
Weight	1.0000					
Income	0.1911	1.0000				
	0.0000					
Age	0.1968	0.2761	1.0000			
	0.0000	0.0000				
Age squared	0.1800	0.2486	0.9906	1.0000		
	0.0000	0.0000	0.0000			
Satisfaction with partner	-0.0025	0.0434	-0.1137	-0.1171	1.0000	
	0.6947	0.0000	0.0000	0.0000		
Education	-0.0437	-0.3838	-0.3335	-0.2923	-0.0389	1.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	

Normality

In order to check the normality of residuals, first the standardized normal probability (P-P) plot was looked at. The P-P plot does show minor signs of non-normalities.



Secondly, the plot of the quantiles of a variable against the quantiles of a normal distribution was analyzed. This plot also shows minor signs of non-normalities.



As the above plots are inconclusive with respect to the absence of non-normalities, numerical tests for testing normality are used to give more clarity. First, the inter-quartile range, which assumes the symmetry

of the distribution, was analyzed. In this test severe outliers consist of those points that are either three inter-quartile-ranges below the first quartile or three inter-quartile-ranges above the third quartile. The presence of any severe outliers should be sufficient evidence to reject normality at a 5% significance level. Mild outliers are common in samples of any size.

From the inter-quartile range (table 2) it can be concluded that there are no severe outliers and the distribution seems fairly symmetric. The residuals have an approximately normal distribution.

Table 2
Inter-quartile range

	low	high
inner fences	0.6131	4.921
# mild outliers	162	0
% mild outliers	0.84%	0.00%
outer fences	-1.003	6.537
# severe outliers	0	0
% severe outliers	0.00%	0.00%

Finally, the Shapiro Wilk test for normality (table 3) shows a very low p-value, which indicates that the residuals are not normally distributed.

Table 3
Shapiro Wilk test for normality

Variable	W	p-value
r	0.953	0.000

However, due to the fact that there are no severe outliers in the inter-quartile range and the sample size is large enough, the non-normality of the residuals will not cause any problems for our model.

Multicollinearity

The test for multicollinearity was done through the variance inflation factor (VIF). A variable whose VIF values are greater than 10 may merit further investigation. A tolerance level, defined as 1/VIF, lower than 0.1 is comparable to a VIF of 10.

Table 1

Variance inflation factor - multicollinearity test

Variable	VIF	1/VIF
Self-employed	1.05	0.9497
Marital Status	1.38	0.7269
Health	1.16	0.8632
Height	2.09	0.4779
Weight	1.52	0.6594
Income	1.32	0.7558
Age	34.51	0.0290
Age squared	32.91	0.0304
Satisfaction with partner	1.06	0.9459
Education	1.18	0.8492
Mean VIF	7.29	

Looking at table 1, we only have any problems with multicollinearity for the variables Age and Age squared.