Chapter 3

The Estimation of the Health Functioning Production Function for Brazil

Abstract: This paper aims to model and estimate the health functioning production function as a relation that conveys to what extent people are able to convert private and public resources into the achievement of the specific functioning "being healthy". This conversion process is affected by a set of internal and external conversion factors identified by exogenous individual, social and environmental characteristics. The estimation of this function has been made by employing Brazilian data. By applying probit and ordered probit regression models, we find that Brazilian young people are the most vulnerable group that convert resources less efficiently into the achieved functioning. Moreover, women are the most relevant policyholder for the Brazilian public health services. We conclude that our empirical findings might be relevant for policy making once a more comprehensive approach of assessing individual well-being is accepted.

3.1 Introduction

The aim of this paper is to construct and assess the health functioning production function. The health functioning production function defines the relationship between the achievement of the functioning "being healthy" and a set of private and public resources needed to achieve this specific functioning controlling for a set of exogenous characteristics.

The definition and estimation of the functioning production functions can be considered a valuable technique for assessing individual well-being in the context of the capability approach developed by Amartya Sen.

In fact, by adopting the Senian framework, the well-being of a person can be conceptualized by a set of achieved functionings, where these functionings are beings or doings that a person manages to achieve, such as being well nourished, being well sheltered, being educated, or living in a safe and healthy environment.

If the achievement of functionings is determined by a set of available resources subject to individual, social and environmental characteristics, we can conceive this relationship as a functionings-resources conversion process. Indeed, the individual, social and environmental characteristics might be viewed as internal and external conversion factors that affect the conversion process. The estimation of the functionings-resources conversion process conveys to what extent a person is able to convert her or his set of resources in order to achieve functionings.

The first conceptualization of the conversion process as a tool for assessing individual well-being was given by Sen (1985). After that, little has been done to deepen the analysis of the functionings-resources conversion process from both the theoretical and empirical perspectives.

Kuklys's (2005) book is the main contribution that aims to investigate if the capability approach is more comprehensive than standard welfare economics in assessing individual well-being. Kuklys' contribution is a pioneer work in the econometric estimation of a functioning production function.

Starting from these previous studies, we define and construct a functioning production function for the specific functioning "being healthy". In our perspective, the achievement of the health functioning is determined by private resources, given by an indicator of wealth, as well as public resources, identified by an index of public services, and controlled for a set of internal and external conversion factors. In order to construct the model, we exploit the conceptual analysis for modelling individual well-being provided by Chiappero-Martinetti et al (2007).

To the best of our knowledge, this paper is the first study that aims to model and compute the impact of both private and public resources on health functioning achievement in the context of the capability approach.

Understanding the functionings-resources conversion process might provide valuable results for policy purposes. The policy maker might indeed be interested to know how individuals are able to convert their resources into achieved functionings.

If the estimation of this function conveys to what extent people convert their resources, by aggregating the population into specific sub-groups we are able to estimate the ability of each population sub-group to achieve functionings.

Hence the estimation of the conversion process by population sub-groups is equally relevant for the policy maker because it helps in understanding which population-sub-groups can be considered more efficient in converting resources or more vulnerable in that well-being process. It is undoubtedly a more comprehensive way to look at individual well-being and it might be supportive in defining policy interventions.

The estimations of the health functioning production function are made by employing the Brazilian household survey, *Pesquisa Nacional por Amostra do Domicilios* (PNAD), and a specific regional dataset on Brazilian public health services, *Datasus*, for 2003. The econometric methodologies applied depend on the nature of the variables that identify the health functioning. We estimate the health functioning production function by applying both probit and ordered probit regression models. The computations have been made for

the entire Brazilian sample and by population sub-groups, recognizing the relevance of our empirical findings in terms of policy implications.
When the health functioning is identified by the self-reported morbidity index, public resources are more relevant in the health functioning achievement process. White people are the least efficient in using public resources. On the other hand, when a health status indicator identifies the health functioning, private resources become predominant. White men are generally the most efficient in employing their private resources in order to achieve better health conditions.
Looking at our empirical results, Brazilian black people might be considered a vulnerable group. The Brazilian policy maker should protect this part of the population that demonstrate a lower ability to convert their private resources and a higher efficiency in using public resources. Another interesting result is the fact that women record a greater impact of public resources while for men private resources are more relevant. The Brazilian policy maker should protect these weaker sub-groups of the population. A possible policy intervention might be to promote black-targeted public provision of medical assistance and prevention. Moreover, the public health services should be aware of the fact that the highest portion of its policyholders is female.

The paper is structured as follows. Section 3.2 presents a review of the previous literature. Section 3.3 describes our economic conceptualization of the functioning production function. Data and variables are explained in section 3.4, while section 3.5 explicates the econometric methodologies employed. Section 3.6 proposes empirical results. Final remarks and conclusions are provided in section 3.7.

3.2 Previous contributions

Sen's (1985) book "Commodities and Capabilities" is considered the first theoretical contribution of personal well-being assessment in the context of the capability approach.

From a capability perspective the well-being of a person can be defined by a set of a person's functionings. The concept of functionings is a more comprehensive way of identifying personal well-being with respect to a traditional money-metric approach. Functionings is defined by what a person manages to do or to be. It thus embodies the state of a person not as a mere possessor of goods or utility.[1] Focusing on functionings means to pay attention to what a person succeeds in doing or being with the resources that she or he is able to command.

Sen conceptualizes this process analytically through the "utilization function" $f_i(\cdot)$ with the set of functioning b_i of a person i given by

$$b_i = f_i(c(x_i)) \tag{1}$$

where x_i is the commodities vector of person i and $c(\cdot)$ is the function that converts the commodities vector into the characteristics vector.

The utilization function is indeed a function that conveys how a set of commodities, particularly the characteristics of these commodities, are employed by the person i in order to achieve functionings.

Sen defines a more general construction of the previous formula that considers not only a particular set of functionings, but various combinations of them. The capabilities set $Q_i(X_i)$ represents the space of all possible functionings that a person values to do or to be and the general formula of $Q_i(X_i)$ of a person i is given by

$$Q_i(X_i) = [b_i | b_i = f_i(c(x_i)), \text{ for some } f_i \subset F_i \text{ and for some } x_i \subset X_i] \tag{2}$$

where x_i is the commodities vector selected from a given group of commodities X_i and f_i is the utilization function chosen from a given set of possible utilization functions F_i.

This more general reformulation tells how each person is able to achieve a combination of functionings b_i that she or he values from a capabilities set

[1] In his book of 1985, Sen considers three different approaches: utility, opulence and functionings. Formal economists have adopted a unique measure of person's state and interests called utility, reflected by satisfaction, happiness or desire-fulfilment. The opulent approach focuses on good possession as a more commodities-fetishist view. The well-being evaluation based on functionings aims looks at commodity-commands of a person.

$Q_i(X_i)$ given a bounded set of commodities x_i and a particular utilization function f_i that is affected by her or his personal attributes.

The conversion process of commodities into functionings is subject to the availability of commodities and to the type of the utilization function which largely depends on what Sen defines as personal and social factors (Sen, 1985). Examples of personal and social factors are respectively age, activity levels, health conditions, and the role within the family or the social conventions and rules.

After Sen's (1985) fundamental contribution little has been done in order to define and to estimate the conversion process between commodities and functionings. Some studies embracing the capability approach highlight the intricacy of translating the complex Senian conceptual framework into empirical applications.[2]

Robeyns (2003, 2005) redefines the importance of this conversion process from goods in order to achieve functionings. Goods represent means to achieve functionings while capabilities, i.e. different combinations of functioning that a person values, represent the freedom to achieve functionings. She stresses the crucial role played by conversion factors in this goods-functionings conversion process. Conversion factors are personal, social and environmental characteristics that inevitably affect person's ability to achieve functionings. The utilization function introduced by Sen (1985) has been redefined "conversion function" by Robeyns and Kyklys (2004) in order to value the conversion process of commodities into functionings or, more generally, into capabilities. In the same study, they refresh the role of conversion factors in affecting conversion processes.

[2] For more on the complexity of the operationalization of the capability approach, see Chiappero-Martinetti (2000), Robeyns (2000) and Comin (2001). Chiappero-Martinetti (2000) highlights the fact that this approach is more challenging because of the greater need of information with respect to standard approaches in assessing well-being. This could be the reason for the relatively low number of empirical applications in the context of the capability approach. Robeyns (2000) stresses several key difficulties related to theoretical and empirical applications and again underlines the lack of empirical works embracing this approach. Comin (2001) defines the concept of operationalizing Sen's capability approach and suggests possible alternatives that can be considered as operationalization strategies. Also Comin claims the absence of studies by citing the papers of Chiappero-Martinetti (2000) and Robeyns (2000).

In 2005, Kuklys wrote an insightful book whose aim was to contribute to the well-being assessment by connecting welfare economics to the capability approach literature and to understand whether the capability perspective is more informative and comprehensive than the standard approach. In this book, the novelty of the conversion function with respect to the utilization function is the inclusion of conversion factors in the analytical formulation as follow

$$b_i = f_i\left(c(x_i)\right)\left|z_i, z_s, z_e\right. \tag{3}$$

where z_i, z_s and z_e are the set of individual, social and environmental conversion factors.

Subsequently, Kuklys (2005) provides a regression approach to model and measure the achievement of functionings. The statistical formulation of the conversion function is given by the so-called "functioning production function" where the achievement of functioning is subject to resources employed and a set of conversion factors. The functioning production function is given by

$$b_i = f\left(y_h, z_i, z_s, z_e\right) + \varepsilon_i \tag{4}$$

where the achieved functionings vector b_i of person i is a function of the household income y_h and the conversion factors z_i, z_s and z_e. It is important to point out that the household income is taken as a proxy for the available resources that are otherwise difficult to quantify and the conversion factors are personal, social and environmental characteristics that simply enter in the regression function as exogenous variables.

Kuklys' estimation of the functionings production function is the pioneering study in applying regression methodology to estimate the achievement of functionings by proposing a structural equation model as an alternative. Thus it provides an important contribution in the quantification and estimation of conversion process between commodities and functionings. On the other hand, although she refers to x_i as a vector of market and non-market goods and services, namely both private and public resources, she employs household income as unique proxy of resources that can be exploited in the conversion process. We can imagine that in the personal well-being

assessment, the functioning achievement is subject to a wider set of resources such as goods and services that are available on the free market as well as available publicly. Household income is a reasonable proxy for all private resources. However the accessibility of public resources is independent to household income level and hence income cannot be a reliable proxy for all resources indispensable for functionings achievement.

Chiappero-Martinetti et al (2007) offer a more complex conceptual framework that explains well-being assessment generating from private and public resources. In their work, they explain how the conversion process toward functioning achievement depends to an initial asset of resources that are partially available on the market and partially are public. In line with previous studies explaining conversion processes, once again the conversion factors are considered crucial in these processes. Chiappero-Martinetti et al (2007) essentially distinguished into internal factors that are more related to personal characteristic of each person and external factors that are instead depending on the social and institutional context where each individual operates.

3.3 The economic framework

The main contribution of this study is to model and to estimate a functioning production function for the functioning "being healthy". The health functioning production function is a relation where the achievement of a good health status is explained by a set of private and public resources controlling for conversion factors, say personal, social and environmental characteristics. The estimation of this function indeed conveys the impact of these private and public resources in determining the achievement of a specific functioning given a set of exogenous characteristics.

If the estimation of this function can provide the extent to which each individual can convert resources into functionings, then disaggregating the population into specific groups can tell how much the ability of converting resources into the functioning "being healthy" varies across several groups.

In a policy maker's perspective it might be useful to know which population groups are more or less efficient in converting their available resources into functionings achievement. An example can clarify the issue. Imagine to consider "being healthy" as the selected achieved functioning and to aggregate the female population by geographical location as well as by age. We might find out that in achieving a good health status two women of the same age living in the same place differ in their ability of converting their set of resources, because the woman with a higher level of education is more efficient in converting her set of private and public goods than the other. This example is too reductive because it avoids considering other important observed determinants, but it gives a bit of flavour of the influence of this estimation.

As already said, the functioning production function refers to the utilization function introduced by Sen (1985) that reflects the way by which each individual uses commodities in order to generate functionings. However in defining the health functioning production function, some of Sen's assumptions have been dropped.

First the function that transforms commodities into characteristics is not considered. We simply suppose to take directly goods' characteristics instead of the goods themselves in order to avoid defining this function as well. The reason for dropping the fundamental assumption that individuals use goods only for the characteristics that goods embodies is a simple practical reason, although we agree that considering the function transforming goods into characteristics of goods is crucial if one wants to embrace the functioning approach rather than a hedonistic or utilitarian approach[3].

Second the problem of the choice of the functioning among a set of possible functionings is not taken into account. We define the functioning production function for the specific functioning "being healthy". The opportunity to choose functionings into a capability set is fundamental in the capability approach framework, but this study aims to measure the achievement of the health functioning instead to analyse the capability set.

[3] *Ibidem* 1.

Bearing in mind these restrictions on Sen's assumptions, we adopt Kuklys' formulation of conversion function for the health functioning rewritten as follows

$$H_i = f_i\left(x_i | z_i, z_s, z_e\right) \qquad \forall f_i \subset F_i \text{ and } \forall x_i \subset X_i \tag{5}$$

where H_i is the vector of health functioning for person i, x_i is a generic vector of all resources that might be exploited to achieve a good health status given the conversion factors z_i, z_s, z_e.

The statistical representation of the previous conversion function is the health functioning production function given by

$$H_{ij} = f_i\left(W_{ij}, G_j | z_{ij}, z_j\right) + \varepsilon_{ij} \tag{6}$$

where H_{ij} is the achievement of the health functioning for person i living in the geographical area j. This health functioning achievement is given by employing the wealth indicator W_{ij} of a person i living in the geographical area j, as a proxy for goods and services available on the market, and an index for public goods and services G_j located in the geographical area j. The estimation of the achievement of the functioning via private and public resources is controlled for internal conversion factors z_{ij} related to person i living in the geographical area j and external conversion factors z_j related to the geographical area j.

Formally, we model the health functioning production function following the simplification introduced on Sen's assumptions, including conversion factors as Kuklys' approach and, particularly, adding a specific variable for public resources in line with the more comprehensive conceptual framework provided by Chiappero-Martinetti et al (2007).

In health economics literature many studies define and model the individual and social determinants of health and estimate the impact of these personal, households and community characteristics on individual health.[4]

[4] In general, the literature on health economics refers to "Social Determinants of Health" SDH to identify all social and economic factors that might have an impact on health and health inequalities (Marmot and Wilkinson, 2006). In their report, Wilkinson and Marmot (2003) discuss the social gradient of health and analyze psychological and social determinants of

Other empirical studies assess the impact of public policies, public interventions and health-care utilization on health status.[5] However, to the best of our knowledge, this is the first study aiming to estimate the impact of both private and public resources on health conditions in the context of the capability approach.

A very interesting work by Martin (2006) models individual and collective resources and their impact on women's health in Morocco. This study differs to our model substantially in two assumptions. First it models the impact of public goods and services only through private resources that are represented by an assent index and the educational level attainment. Second, the capability perspective is employed only to identify education as an instrumental capacity in the conversion process of private and public resources into health.

Finally, some clarifications need to be added on the concept of conversion factors. In the already quoted Sen's (1985) book, by introducing the utilization function concept he writes that "the conversion of commodity-characteristics into personal achievements of functionings depends on a variety of factors". He sets the general outline without revealing how factors should be analytically conceptualized. Other studies we already cited generally refer to conversion factors as some personal, social and environmental characteristics which affect the conversion process between resources and functionings.

Robeyns (2005) says that "the relation between a good and the functionings to achieve certain beings and doings is influenced by three groups of conversion factors [...] personal, [...] social and [...] environmental conversion factors". In the same line Kuklys (2005) writes that "the achievement of these functionings depends on resources at the disposal of the

---

longevity and physical health. Wagstaff (2002) reflect upon the relationship between poverty and health and analyze the possible determinants of health disparities. Healtzman et al (1994) claim the need for a broad conceptual framework in the investigation of heterogeneities in population health status and they sketch possible sources of heterogeneity. Finally, Frenk et al (1994) provide a comprehensive analysis of the determinants of health.

[5] For example, Rivera (2001) employs an ordered probit model to assess the impact of public health spending on health status using Spanish data. Earlier, Thomas et al (1996) study how health services and facilities are able to improve child health in Côte d'Ivoire.

individual, such as her income or education, as well as conversion factors, such as age, marital status and region of living".

Thus conversion factors are identified by exogenous characteristics and Kuklys (2005) has econometrically estimated the achievement of functionings considering these variables in the regression models and quantifying the impact of them on the estimated functioning.

This study wants to highlight that the focus in conversion processes has clearly to be on the role played by conversion factors not for themselves, but rather in affecting the impact of resources on functionings achievement given conversion factors. In other words, the focus has to be on the rates of conversion rather than on the conversion factors.[6]

Estimating the health functioning production function means assessing to what extent people are able to convert their resources into a good health status subject to their internal and external characteristics. Consequentially, looking at the health functioning production function will quantify the rates of conversion of private and public resources specified in the regression equation controlling for other exogenous variables identifying conversion factors.

3.3.1 Modelling Issues

The representation of conversion process between resources and functioning into an econometric estimation of the functioning production function can be viewed as comparable to estimating a reduced-form demand equation.

Ruggeri Laderchi (1999) highlights the essential advantage in adopting a reduced-form demand function by stressing that "such relation reduces responses of the household to depend only on the exogenous or predetermined variable and parameter from the point of view of the household".

Referring to Schultz (1984), it is possible either to estimate a reduced-form equation between health and its determinants that are assumed as

[6] On these aspects, see also the working paper by Chiappero-Martinetti and Salardi (2007) that aims at developing the same conceptual and methodological framework to the study of three different functionings, say "being healthy", "being educated" and "living in a safe and healthy environmental", applied to the Italian reality.

exogenous or to estimate simultaneously a demand equation for health inputs and a production function that is a relation between health outcomes and inputs. The estimation of parameters in the health production function is demanding of data since information on inputs, outputs and related instruments, namely prices are needed. For this reason, reduced-form demand functions have been applied often in the health economics literature.[7] As already said, these functions are derived from models where the household utility function is maximized subject to both the total budget constraint (including time constraint) and the health production function.

The most important and pioneering contribution on the demand and production of health has been provided by Grossman (1972). Following the traditional model of household behaviour of Becker (1965), this model proposes to maximize household utility constrained to resources consumption and time and resources allocation as well as to the best utilization of household endowment, namely economic and biological endowment. From this utility-maximization and its constraints a reduced-form demand function is derived and depends on exogenous variables, proxies of prices, income and preferences.

Since the functioning production function proposed in this study is derived from a model that estimates the health functioning with respect to individual and household characteristics as well as to monetary resources, we are able to assimilate our functioning production function to a reduced-form health demand equation.

3.4 Data and Variables Description

Our main data source is the annual Brazilian households survey, *Pesquisa Nacional por Amostra do Domicilios* (PNAD), for 2003 collected by the *Instituto Brasileiro de Geografia e Estatistica* (IBGE). The PNAD is based on

[7] Examples for studies in the economic literature that present this typology of models are Lavy et al (1996); Thomas et al (1991), Schultz (1984) and Rosenzweig and Schultz (1982, 1983).

a nationally representative random sample of households. The household survey consists of two sections, *Archivo de Domicílios* and *Archivo de Pessoas*. The first section contains information at the household level, such as characteristics of the dwellings and the geographical locations of the households. The second section provides data at the individual level, focusing more on the characteristics of household members. Particularly for 2003 the PNAD devotes an entire section to health conditions at individual level. This special section includes information on health status, presence of chronic diseases, availability of health services, health-care utilization, degrees of satisfaction in health-care provision, health insurance coverage and financial assistance in health-care utilization.

The sample used includes 128,028 Brazilians and is based on individuals aged from 10 to 65 years that have self-reported their health conditions.[8]

This Brazilian household survey has been integrated with regional data on public health services coming from the so-called *Datasus* dataset provided by the Brazilian Minister of Health.[9] The *Datasus* is a specific dataset provided by the Brazilian Government that offers geographically aggregated information related to the Brazilian public health services, the health conditions of Brazilian population and financial aspects of public health-care system.

3.4.1 The dependent variable

The functioning "being healthy" is measured by exploiting two different indicators on heath conditions.

First, we construct an index of self-reported morbidity (SRMI). This index accounts for twelve chronic diseases: vertebral column dysfunctions, arthritis and rheumatisms, cancer, diabetes, chronic bronchitis and bronchial asthma, hypertension, hearth dysfunctions, chronic kidney diseases, depression,

[8] It means that people whose health conditions have been reported by other respondents have been dropped from the sample. The underlining reason is to assure the reliability of the reported health conditions.

[9] Source: Ministério da Saúde - CGRH-SUS/SIRH (2006) available on the website http://w3.datasus.gov.br/datasus/datasus.php.

tuberculosis, tendinitis and cirrhosis. Moreover the extent of these chronic diseases is matched with the information on invaliding consequences that lead to inactivity. The SRMI is a dummy variable that takes value 1 if individuals suffer of one of these chronic diseases and this sufferance involves invalidity.
Second, we create an indicator of subjective health status (SHSI). We consider the question "Value your health status from your personal point of view" where the possible answers are "very good", "good", "fair", "bad" and "very bad". By aggregating these answers we construct the categorical variable SHSI that takes value 1 if the health status is considered bad or very bad, 2 if the health status is considered fair and finally 3 if the health status is considered good or very good.

Table 3.1: Frequencies for SRMI and SHSI

	SRMI		
SHSI	0	1	Total
1	3,351	1,955	5,306
2	25,854	3,721	29,575
3	92,226	1,685	93,911
Total	121,431	7,361	128,792

Table 3.1 reports the frequencies for both SRMI and SHSI. The incidence of chronic diseases has more observations where the health status is subjectively judged as bad or fair. On the other hand who is not affected by chronic disease is more likely to values her or his health conditions as fair or good.

Referring to the SRMI, 5.7% of the sample is affected by chronic and invalidating illnesses and among them 73.5% are women where women account for 65.8% of the entire sample. Individuals affected by chronic and invalidating disease are for 45.6% aged between 30 and 50 and for 37.5% aged over 50. Comparing SRMI across different level of educational attainment there is a negative relationship between chronic disease incidence and education: if 10% of individuals with primary education are affected by chronic and invalidating illnesses, only 4.5% of individuals with graduate education report the same. 56.7% of ill individuals live in the North-East and

South-East of Brazil which are the most populated regions and also the most numerous ones in our sample. Looking at the occupational levels, 68% of ill people are blue-collars while only 5.2% are professionals.

The SHSI reveals that 4.1% of the sample judges their health status as "bad" or "very bad" while 23% as "fair". The majority, say 72.9% of the sample, considers their health status "good" or "very good".

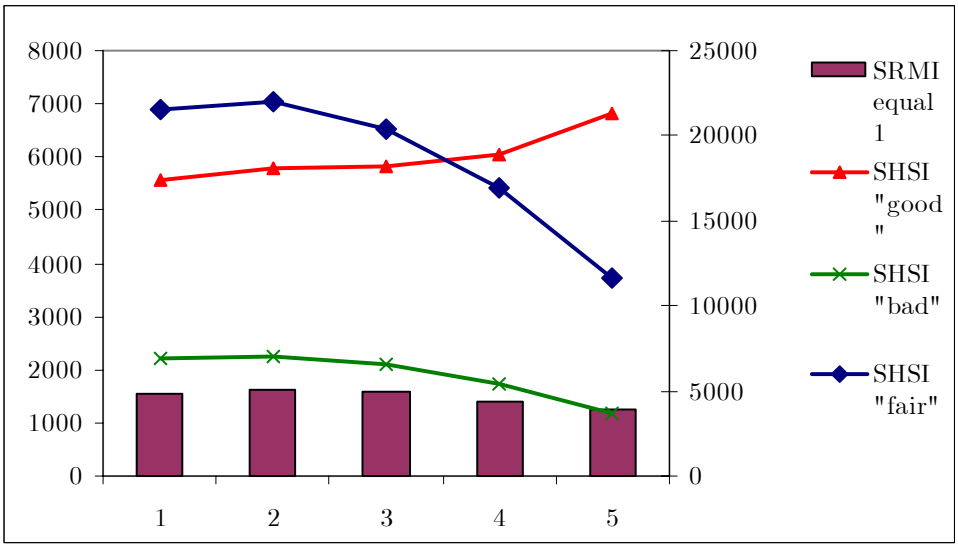
As for the SRMI, women are the majority of the sample across all three categories of the SHSI, but their relative share changes. In particular, if women that judge their health status as bad and fair count respectively for 69.6% and 71.5% of the category, their share reduces to 63.3% in the good health status category. As regarding to age groups, the incidence in the bad health status category increases moving to elderly people. Looking at the levels of attained education, individuals with good health status are likely to be more educated than individuals judging their health status as bad or very bad. Again, the distribution across three occupational levels is interesting and follows the pattern shown in the SRMI. Professionals and intermediates are the minority across all SHSI categories, but their relative shares increase moving to better health status. The relationship between occupational stratification and health indicators shows a pattern very similar to the one drawn by the educational attainment. [10]

Analyzing the distribution of both SRMI and SHSI across income quintiles, an interesting pattern emerges that can be easily understood by looking at the following graph.

In Figure 3.1, people affected by chronic and invalidating diseases for which the SRMI take value 1 are represented by the columns across quintiles. Although moving from the first to the second quintile, the self-reported morbidity index slightly raises, after the second quintile the index decrease as we move to higher income quintiles.

[10] The computations are available on request from the Author.

Figure 3.1: The incidence of SRMI and SHSI



The three categories of SHSI are instead plotted via lines. It is clear how the two lowest categories, namely "bad" and "fair", decrease while the "good health status" category noticeably increases as soon as we move to the top of the income distribution.

The pattern of both indexes, SRMI and SHSI, with respect to income quintiles testifies a clear relationship between income and health, usually well-known as the income-health gradient.

Both SRMI and SHSI are employed in our regression analysis as dependent variables and, due to the nature of these variables, we need to apply a qualitative dependent variable regression models. In particular as we already have seen, SRMI is a dichotomous variable while SHSI has a categorical character. With regard to the category variable, the temptation is either to ignore the problem by adopting a linear regression model, but this can bring in heteroscedasticity, or to dichotomize it by setting a critical threshold upon which health conditions are judged good. The latter technique reduces the difficulties of the model since a binary model for discrete choice is more intuitive than an ordinal probability model. However the loss of information might be relevant especially in the context of the capability perspective where a dichotomist approach excludes the existence of some kind

of complexity and fuzziness central for this field of research (Chiappero-Martinetti, 2004). Moreover the choice of the cut-off point above which health status might be considered good is subject to the critique of excessive arbitrariness.

Moreover, it should be reminded that the standard OLS method cannot be used unless a cardinalisation of the dependent variable is applied. Basically, the cardinalisation of a categorical variable implies the assumption that this variable is a latent variable with a standard lognormal distribution and then a score is assigned to each category.[11]

A final remark is needed on the intrinsic nature of these two variables identifying the health functioning. SRMI provides information on individual morbidity that has been self-reported by each respondent; indeed neither doctors nor professional personnel have checked for these diseases. SHSI conveys opinions given by each individual to its own health conditions. Both variables are thus subjective indicators of health and might be criticized. First, the employment of a mortality index instead of a morbidity index is preferred following the epidemiological literature (Sen, 1998), because it gives more reliable information related to the level of health and illness of a population at the aggregate level. Nevertheless the core of this study is to assess the individual health functioning achievement that exemplifies the concept of being able to be healthy. Hence indicators on morbidity or health status might be more suitable at individual level with respect to a mortality index.

Second, it might be claimed that even if adopting a morbidity index it should not be self-reported. In fact the self-reporting nature of an indicator increases the degree of subjectivity. The internal assessment of health status generally differs from the external view provided by medical experts (Sen, 2002). A person's evaluation of her or his own health situation is clearly affected by her or his social experience. People's awareness on health and

[11] An example of cardinalisation of a self-assessed health variable is provided in Wagstaff et al (2001). This study follows a previous study by Wagstaff and Van Doorslaer (1994) that proposes a methodology to construct a latent variable to overcome some limits of health studies using multiple-category morbidity indicators.

illness diverges across different social context and is highly associated to their medical understanding and the presence of health-care services systems. Sen's case study on Kerala[12] is clarifying. In India the State of Kerala reports higher rates of self-assessed morbidity in comparison to other states such as Bihar and Uttar Pradesh where there is a low life expectancy. Better health conditions in Kerala make people's perception of illness much higher and, as a consequence, the comparison of morbidity levels across these Indian states is mistaken. However the unreliability of the health assessment subsists much more in the illusion of low rates of morbidity in Bihar and Uttar Pradesh rather than in erroneous estimations in Kerala.

Following Sen's 1993 debate on the adoption of subjective or objective indicators,[13] we argue that our health indicators should be viewed as not subjective, but positionally objective indicators. If subjectivity is generally perceived as a rejection of objectivity, positional objectivity asserts objectivity of perceptions and understandings from a certain position (Sen, 1993).

The subjectivism should be kept separated from the notion of positional objectivity. Sen (1993) embraces Nagel's notion of objectivity, however he claims that "this conception of objectivity is in some tension with the inescapable positionality of observation". And he remarks that the role of positionality plays a crucial role in identifying illusions or misunderstanding in socio-economic investigations, as Kerala case study shows.

We accept this view claiming that subjective assessment can be explicated by specification of the positional constraints affecting her or his understanding. By applying this approach the demands of objectivity of values can be reinterpreted.

3.4.2 Wealth and public goods

The health functioning production function investigates the relationship between health functioning and the resources employed in the conversion

[12] Several Sen's publications (1993, 1998 and 2002) explain the case study on Kerala morbidity and the different problem related to the self-perception of health conditions.
[13] See Sen (1993).

process. As already mentioned, in our model we consider two main types of resources, private and public.

Following Kuklys' methodological choice, we take income as a proxy for all private resources, i.e. all commodities and services that are available on the private market. The relationship between health and income is well-known in the economics and health economics literature and it generally called "gradient" because it better exemplifies the gradual relationship existing between health status and income levels. Moving to the top of the income distribution health status is usually improving.

Strauss and Thomas (1995) provide a review on the interrelationships between health/nutrition and income/productivity by mentioning empirical works that estimate the effects of income on nutrient intakes and, conversely, how nutrition affects income and labour productivity.

The first original empirical study reporting the existence of a socio-economic gradient is the Whitehall study conducted among British male civil servants (Marmot and Shilpey, 1996).

The existence of a reverse causal relationship between health and income is well explained in an empirical work by Case (2000). In particular, Case stresses different channels through which money provides health: medical care, water and sanitation, nutrition and psychosocial stress. Deaton (2002) reports an exhaustive analysis of the gradient health-income. He claims that the gradient is affected by health-related behaviour and that it changes considering different pathologies and different access to medical care. Moreover Deaton argues that not only income, but also socioeconomic status (SES) is intimately correlated to health. Following our conceptual framework, other variables that determine socioeconomic status except income are considered personal characteristics and enter in the model as conversion factors.

In spite of the wide literature on the positive relationship between income and health, the reversal causality is subject to controversy. Nevertheless the reverse causal relationship between health and income might cause endogeneity problem in our regression model. The application of a two-stage

procedure helps in overcoming this problem. In her study of 1996, Ettner estimates the impact of income on health status both with ordinary and instrumental variables (IV) estimates. Conversely it seems difficult to find the right instruments where the residuals are not correlated to the health variable. For this reason we decide to construct a long-run indicator of wealth to substitute the income variable because a long-run wealth index is less exposed to reversal causality with health conditions.[14]

The wealth indicator has been constructing using the principal components analysis.[15] In order to construct the wealth indicator we exploit variables regarding to housing characteristics, facilities access and durables ownership. Table 3.2 reports the scoring factors from the principal components analysis that are used to compute the wealth indicator.

Table 3.2: Scoring factors and summary statistics for variables entering in the computation of the first principal component for computing the wealth indicator

	Scoring factors	Mean	SD
Having good walls	0,0478	0,8696	0,3367
Number of Rooms	0,0784	5,8020	2,1995
Number of Bedrooms	0,0272	2,0900	0,6035
Garage	0,0825	0,4588	0,4983
House property	0,0825	0,6957	0,4601
Piped water	0,1217	0,8708	0,3355
Well water	-0,0837	0,0510	0,2204
Flush toilet	0,1084	0,9340	0,2483
Garbage collection	0,0968	0,7480	0,4342
Electricity as energy source	0,0940	0,9655	0,1825
Gas as energy source	0,1197	0,8876	0,3159
Wood as energy source	-0,0994	0,8336	0,2764
Coal as energy source	-0,0469	0,0171	0,1295

[14] Martin (2006) also adopt a wealth indicator to solve the endogeneity problem in estimating their health production function. They also underline that the introduction of a morbidity variable as covariate allow them to partially control for endogeneity.

[15] To apply the principal component analysis in constructing the wealth indicator we refer to the relevant literature on this topic, such as Filmer and Pritchett (2001), Montgomery (2003), Montgomery et al. (2000) and Sahn and Stifel (2000, 2003).

Kitchen (one cooker)	-0,0685	0,0139	0,1171
Kitchen (more cookers)	0,0785	0,9743	0,1582
Own Telephone	0,1092	0,4745	0,4994
Own Water Filter	0,0398	0,5053	0,5000
Own Radio	0,0525	0,8705	0,3357
Own Colour Television	0,1169	0,8520	0,3551
Own Black/white Television	-0,0568	0,0457	0,2089
Own Fridge	0,1196	0,8573	0,3498
Own Freezer	0,0568	0,1707	0,3762
Own Washing Machine	0,0901	0,3004	0,4584
Own Computer	0,0796	0,1378	0,3447
Own Internet Access	0,0734	0,1010	0,3014

Each scoring factor gives its contribution in determining the wealth indicator. The check for the robustness of the wealth index constructed by using principal components procedure can be done by comparing this index with another one constructed using a different procedure for deriving weights. We obtain a 0.9931 Spearman rank correlation between our wealth indicator and a similar one developed by applying factor analysis. This result conveys that the constructed wealth indicator is robust. Finally in order to ensure that the wealth indicator can substitute the income variable in our regression analysis we compute the Spearman rank correlation between wealth and income: the values of 0. 6372 is good in comparison with the results in the relevant literature (Sahn & Stifel, 2003).

The use of a wealth indicator as a proxy for private goods instead of income might be viewed as a more comprehensive and appropriate variable because it is a long-run indicator and embodies more information that is able to determine health conditions. Furthermore we think the reversal causality is weaker between health and wealth than health and income since detrimental health conditions are more likely to affect income levels in the short-run rather than long-run wealth.

Public resources are the second type of resources we consider in the conversion process to health functioning achievement. As specified above, data

referring to public goods and services at local level are drawn from *Datasus* dataset. We decide to consider the number of doctors, nurses and hospital beds available at local level plus the per capita public expenditure in health-care imputed by geographical area. We aggregate these four variables by constructing an indicator of availability of public resources via principal component analysis as shown in table 3.3. The constructed variable representing public resources has a geographical variability and has been merged with the individual dataset by adopting a geographical criterion.

Table 3.3: Scoring factors and summary statistics for variables entering in the computation of the first principal component for computing the public resources index

	Scoring factors	Mean	SD
Number of Doctors	0,3686	1,2697	0,6847
Number of Nurses	0,3711	0,5419	0,2094
Number of Beds	0,1483	0,8612	0,3142
Per capita public expenditure in health care	0,3902	268,0110	61,2206

The main purpose of modelling the conversion process from resources to functioning is to estimate the impact that the wealth indicator and the public resources index have on health conditions controlling for conversion factors. Referring to equation (6) the conversion process is conceptualized as a production function, where these two variables W_{ij} and G_j enter into the conversion processes as production factors subject to z_{ij} and z_j. We might be interested not only in how these factors singularly contribute to the conversion process, but also in the effect of the interaction of these resources. The individual impact of the wealth indicator as well as the public resources index in achieving health functioning can be shown through a simple mathematical expression as follow

$$\frac{\partial H_{ij}}{\partial W_{ij}} = f\left(\partial z_{ij}, \partial z_j, \varepsilon_{ij}\right) \tag{7}$$

$$\text{and } \frac{\partial H_{ij}}{\partial G_j} = f\left(\partial z_{ij}, \partial z_j, \varepsilon_{ij}\right). \tag{8}$$

In equations (7) and (8), the impact of the wealth and public goods is given by the first derivatives with respect to these variables where the function is a function of conversion factors as well.

In order to investigate the interactions occurring among private and public resources, second-order derivatives provide the joint impact of these resources. Hence the sign of these second-order derivates conveys in which relationship these resources jointly determine the health functioning achievement. If the first derivative is positive and

$$\frac{\partial H_{ij}^2}{\partial W_{ij} \partial G_j} > 0 \quad \text{then the private and public resources are complements;} \tag{9}$$

$$\frac{\partial H_{ij}^2}{\partial W_{ij} \partial G_j} < 0 \quad \text{then the private and public resources are substitute.} \tag{10}$$

When the first derivative is negative, the reverse is true. Hence private and public resources are complements if the second derivative is negative and they are substitute if the second derivative is positive.

3.4.3 Individual characteristics

The estimation of the health functioning production function aims to quantify the impact of private and public resources in the functioning achievement subject to so-called conversion factors.

Conversion factors are individual, social and environmental characteristics that unavoidably enter into the conversion process. Indeed the specification of the set of these characteristic is clearly crucial.

In our model, we identify two sets of conversion factors, z_{ij} and z_j. As we have already explained, the first set of internal conversion factors consists of characteristics for individual *i* living in the *j-th* geographical area, while the set of external conversion factors is a group of community characteristics of the *j-th* geographical area.

In order to identify individual and community characteristics, we refer to previous studies in health economics aiming to classify the determinants of health outcomes.

Frenk et al (1994) provide a clear diagram where health status is affected by proximate, structural and basic determinants. Basic determinants have a systemic character and refer to population genome, environment and social organization. Structural determinants have a more societal attribute and look at the level of wealth, social stratification and occupational structure as well as the redistribution mechanisms. Proximate determinants are institutional or household factors that directly affect health status such as working and living conditions, the health care system as well as individual life-style.

Hertzman et al (1994) stress the importance of a comprehensive framework to analyze health outcomes and reject the analysis of the health of a population only explained by individual characteristics. They highlight that the heterogeneity in health conditions depends on life cycle stages, individual characteristics and other sources of heterogeneity. The individual characteristics involve socioeconomic status, ethnicity, migration status, geography and gender. Other sources of heterogeneity might be the individual life-style, physical and social environmental and differences in access to health care services.

Referring to Wagstaff (2002), the main determinants of health outcomes are grouped into three groups: households and community factors, health system and government policies. In particular the households and community factors are household actions and risk factors, such as utilization of health services, sanitary, sexual practices, dietary and lifestyle, household assets, namely human, physical and financial, and community factors like social capital, environment, infrastructure, cultural norms and community institutions.

Bearing in mind all possible determinants of health status, at this stage of our empirical analysis we consider only individual characteristics, particularly personal characteristics such as gender, race or education, labour market characteristics and geographical characteristics.

Table 3.4: Summary statistics for individual characteristics

Variable	Mean or Percentage in the Category	Std. Dev
Personal characteristics		
Male	0.3409	0.474
White	0.4687	0.499
Age group:[a]		
Mature people	38.8835	5.6640
Elderly people	56.6904	4.5828
Educational attainment:[b]		
Primary school	0.1538	0.3607
Secondary school	0.549	0.4975
College	0.0665	0.2492
Post-graduate	0.0035	0.0597
Labour market characteristics		
Farmer	0.1198	0.3248
Occupational level:[c]		
Intermediate	0.2882	0.4529
Blue collar	0.6454	0.4783
Formal sector	0.1968	0.3976
Geographical characteristics		
Region:[d]		
North-East	0.3278	0.4694
South-East	0.2872	0.4524
South	0.1598	0.3665
Central-West	0.1177	0.3222
Urban	0.8468	0.3601
Brasilia	0.0282	0.1657
São Paulo	0.1087	0.3113
Roraima	0.0044	0.0667
Acre	0.0071	0.0841

(a) For the category variable Age group, the base category are your people;
(b) For the category variable Educational attainment, the base category is illiterate;
(c) For the category variable Occupational level, the base category is professional/technician;
(d) For the category variable Region, the base category is the North.

Table 3.4 reports summary statistics for individual characteristics that were selected and employed in our regression analysis. Personal characteristics embrace *male*, *white*, *age group* and *educational attainment*. The majority of our sample is female and black. The black category is the majority because it also covers brown people and mulattos. The sample considers only people aged from 10 to 65 because children generally do not report their health status by

themselves and this is also true for very elderly people. Moreover at the tails of age distribution is more likely to find outliers. The population has been divided in three age groups: your people aged from 10 to 29, mature people aged from 30 to 49 and elderly people aged from 50 to 65. We decide to adopt the maximum level of educational attainment instead of the years of education because it is usually considered a more informative variable on the real level of education achieved.

In the set of personal characteristics we also include a selection of variables related to the labour market. In particular *farmer* identifies people who work as farmers; and *occupational level* groups individuals into three categories: professional/technician, intermediate and blue collar. The variable *formal* classifies people as working in the formal sector when they own a work card.[16]

Finally with the geographical characteristics we control for geographical differences in health status and health provision. It is important to remind that Brazil is a country with huge geographical disparities. We control for *region*, where Brazil is divided into five regions: North, North-East, South-East, South and Central-West. The dummy variable *urban* identifies people who lives in an urban area where wealth tends to be higher and health care provision better. Finally, some metropolises showing particular trends[17] with respect to the wealth indicator and the public resources index are added into the geographical controls.

3.5 Econometric methodologies

The econometric estimation methodology depends on the distribution of the indicator adopted.[18] The self-assessed morbidity index is estimated as a

[16] The possession of the work card guarantees legal rights through labour legislation. Hence the definition of formal and informal sector used to construct this dummy variable refers to the state regulation of work as indicated by social security payment.
[17] Brasilia and São Paulo have very high levels for the wealth indicator, while Roraima and Acre are very poor cities placed in the North region. They show particular bad performances in term of health provision.
[18] See Maddala (2001).

probit model, while the subjective health status indicator as an ordered probit model.

In the probit model, the binary dependent variable y_i is replaced by a latent continuous dependent variable y_i^* such that if $y_i^* \geq 0$ then $y_i = 1$ and if $y_i^* \leq 0$ then $y_i = 0$. In other words, in the first case the event occurs, while in the latter not. We assume the following regression model in matrix form

$$y_i^* = x_i'\beta + u_i \qquad \text{with } i=1,\ldots,n \tag{11}$$

where $u_i \approx N(0,\sigma^2)$ and $y_i^* \approx N(x_i'\beta,\sigma^2)$.

Then, the probability that the event occurs is

$$prob[y_i = 1] = prob[y_i^* \geq 0] = prob\left[\frac{u_i}{\sigma} \leq \frac{x_i'\beta}{\sigma}\right] \tag{12}$$

Equation (12) shows the probability that the cumulated probabilities from -∞ to the point delineated by $\frac{x_i'\beta}{\sigma}$. We can rewrite equation (12) as follow

$$prob(y_i = 1) = \Phi(x_i'\beta) \tag{13}$$

where $\Phi(\cdot)$ is the cumulative distribution function for a standard normal random variable.

In order to interpret the regressor's impact on the probability of an event occurring, we need to compute marginal effects if the regressor is a continuous variable or impact effects if the regressor is a binary variable.

Instead of using the matrix expression of the index, we use the following simple expression

$$x_i^*\beta = \alpha + \beta X_i + \delta D_i \tag{14}$$

where the index contains a constant term, a continuous regressor X_i and a dummy variable D_i. We can express the model as follow

$$prob[y_i = 1] = P_i = \Phi(\alpha + \beta X_i + \delta D_i). \tag{15}$$

The marginal effect is then given by

$$\frac{\partial P}{\partial X_i} = \phi(\alpha + \beta X_i + \delta D_i) \times \beta \tag{16}$$

The impact effect is given by

$$\Delta = \Phi(\alpha + \beta X_i + \delta) - \Phi(\alpha + \beta X_i). \tag{17}$$

The ordered probit model is an extension to the binary probit model that provides a way of modelling ordered discrete data. We express again the model following equation (14). In this model, the latent continuous dependent variable y_i^* replaces the ordinal variable in the following way:

$$y_i = \begin{cases} 1 & if \quad y_i^* \le \theta_1 \\ 2 & if \quad \theta_1 < y_i^* \le \theta_2 \\ . & \\ . & \\ M & if \quad \theta_{M-1} \le y_i^* \end{cases} \tag{18}$$

where M represents the number of alternatives where j=1,…,m and θ_j are the cut-off points between alternatives.

Then, the probability of observing y_i is given by

$$\begin{aligned} prob[y_i = j] &= prob[\theta_{j-1} < \alpha + \beta X_i + \delta D_i + u_{ii} \le \theta_j] \\ &= \Phi[\theta_j - (\alpha + \beta X_i + \delta D_i)] - \Phi[\theta_{j-1} - (\alpha + \beta X_i + \delta D_i)] \end{aligned} \tag{19}$$

where $\Phi(\cdot)$ has a normal distribution.

If the ordered dependent variable has three categories, marginal effects are computed as follow

$$\frac{\partial prob[y_i = 1]}{\partial X_i} = -\phi(\alpha + \beta X_i + \delta D_i) \times \beta \tag{20}$$

$$\frac{\partial prob[y_i = 2]}{\partial X_i} = \phi(-(\alpha + \beta X_i + \delta D_i)) \times \beta - \phi(\theta_1 - (\alpha + \beta X_i + \delta D_i)) \times \beta \tag{21}$$

$$\frac{\partial prob[y_i = 3]}{\partial X_i} = \phi(\theta_1 - (\alpha + \beta X_i + \delta D_i)) \times \beta \tag{22}$$

Finally, the impact effects are given by

$$\Delta = prob[y_i = j | D = 1] - prob[y_i = j | D = 0]. \tag{23}$$

3.6 Empirical results

The estimations of the health functioning production function are provided in Tables 3.5 and 3.6. The econometric model implemented depends on the nature of the dependent variable. When the self-reported morbidity index (SRMI) is the variable used as health functioning, due to the binary nature of this variable, the health functioning achievement is estimated as a probit model. When the health functioning is specified by the indicator of subjective health status (SHSI), the ordinal categorical nature of the health status imposes the utilization of an ordered probit model.

Table 3.5 in the appendix shows the marginal effects from the probit estimates employing four different models. In particular, the first model estimates only the impact of the private resources, identified by the wealth indicator, on the health functioning achievement controlling for a set of individual characteristics The second model provides only the impact of the public resources, namely the public resources index, again controlling for a set of individual characteristics. The third model considers simultaneously private and public resources and estimates the conversion of these two resources into health functioning achievement. Finally, the fourth model is the most comprehensive because it considers not only both resources, but also the interaction between them.

The same model specifications, except for the last one, are applied for the ordered probit model and results are presented in Table 3.6.[19]

Some clarifications might be useful in interpreting the results of our estimations. First, we adopt two different variables for identifying the dependent variable. SRMI takes value 1 when the respondent is affected by an invalidating and chronic illness and 0 if not. Hence the estimates of the resources-functioning conversion process should be negative: the more we employ private and public resources in the converting process, it should be less likely to get an invalidating and chronic disease. On the other hand, SHSI evaluates health status from 1 to 3 and the best health status is associated

[19] Marginal effects from the ordered probit models are provided by the Author on request.

with the higher categorical value, i.e. when SHSI takes value 3. In this case the estimated conversion rates from the health functioning achievement process should be positive.

Second, the impact of private and public resources in the achievement of functioning is given by the estimated coefficients of the wealth indicator and the public resources index. The interpretation of these coefficients is not straightforward as in the case of the individual characteristics used as controls that are binary or continuous variables.

In fact the wealth indicator and the public resources index are variables constructed using the principal component analysis. The procedure involves scoring the factors and retaining the first score as the latent common factor. Both the wealth indicator and the public resources index are expressed in terms of standard deviation and consequently in order to assess the impact of these variables we should consider the effect of one standard deviation increase of these two indexes.

In order to be able to interpret these impacts in a more intuitive way, we employ the five quantiles of the wealth index distribution instead of the wealth index itself. Thus we can directly understand the effect of being in a specific part of the wealth index distribution on the dependent variable. For the public resources index we construct a dummy variable that takes value 1 when these index shows a value that lies in the highest fifth quantile of its distribution, say when people benefit of the highest level of public resources in the health sector.

Looking at Table 3.5 we can see that the impact of private and public resources in reducing the probability of contracting an invalidating and chronic illness is statistically significant across four different models.

When we take private or public resources separately, public resources seem to have a greater impact: having a good access to public resources decreases the probability of getting ill by 2.4 percentage points, *ceteris paribus*. The impact of the private resources is greater as soon as we move to the highest quantiles of the wealth index distribution. Indeed, being in the second quantile of the wealth distribution decreases the probability of getting ill by 0.7 percentage

points with respect to the first quantile, while in the highest quantile the probability diminishes on average by 2.1 percentage points, *ceteris paribus*. Once both resources are simultaneously considered in the regression, their effects do not vary significantly. The fourth model is the most complete because it adds the interaction terms between wealth quantiles and the dummy variable for the good level of public resources. These interaction terms are crucial in order to understand whether private and public resources are substitutes or complements in the health functioning achievement process. Giving the negative sign of the first derivative for both resources, the negative interaction terms allow us to infer that private and public resources are complements in reducing the probability of contracting an invalidating and chronic disease. In particular, public resources have a greater impact than private resources in reducing the probability of contracting invalidating and chronic diseases at the bottom of the wealth index distribution, i.e. for the least wealthy part of the population.

Personal, labour market and geographical characteristics enter into our model as individual conversion factors affecting the resource-functioning conversion process. Nonetheless it is interesting to analyze how these variables influence the process. Since the impact of these variables is similar across model specifications, we comment on results from the last and most complete model specification from Table 3.5. Considering personal characteristics we find that being male decreases the probability of getting ill by 1.9 percentage points, while being white increases the probability by 0.3, *ceteris paribus*. As a consequence, we can infer that white people are more likely to report invalidating and chronic diseases although it is less clear whether whites are actually more likely to contracting illness. Age is robustly statistically significant and increases the probability of getting ill. Being elderly increases the probability by 9 percentage points, while for mature people the probability increases by 4.2 percentage point taking young people as reference group. The maximum attained educational level is an interesting variable. Only secondary school and college are statistically significant and decrease the probability of getting ill by respectively 0.8 and 0.9 percentage points, *ceteris paribus*. It

means that primary school is not sufficient to acquire those standards of living and life-styles able to prevent invalidating and chronic diseases. On the other hand, postgraduate education is no more functional than college education, since it is not statistically significant.

Among labour market characteristics, being a blue collar worker is statistically significant and increases the probability of contracting illness by 0.6 percentage points with respect to working as a professional or technician, *ceteris paribus*.

The geographical characteristics involve dummy variables for regions, for living in an urban area and four specific dummies for the "Unidade de Federação" of Brasilia, São Paulo, Roraima and Acre. Living in an urban area raises the probability of being chronically ill by 1.6 percentage points, *ceteris paribus*. Regional dummies are not statistically significant or particularly informative, while the dummies for some "Unidade de Federação" are interesting. Living in some of these geographical areas increases the probability of getting invalidating and chronic diseases, in particular by 3.5 percentage points in Brasilia as well as in Roraima and 7.6 percentage points in Acre, *ceteris paribus*. On the other hand, in São Paolo the probability shrinks by 0.6 percentage points, *ceteris paribus*.

Table 3.6 illustrates the estimated impact of private and public resources on SHSI controlling for the same set of individual characteristics and with the same model specifications as that of the probit estimations, but employing an ordered probit model due to the ordered categorical nature of the health status variable. As said earlier, the model with interaction terms is not applied due to their statistical insignificance.

The analysis of ordered probit estimations is less intuitive than a binary model and to quantify the impact of each covariate we should refer to the marginal effects.

Nonetheless by looking at the estimated coefficients in Table 3.6 we find some interesting patterns. The impact of private and public resources is strongly statistically significant across different model specifications. On the contrary of estimated coefficients for SRMI, the private resources have a

greater impact on health status than public resources. In fact the impact of having good public service is greater only than the impact of the second and the third quantile of wealth taking the first quantile as reference group. It means that at the top of wealth distribution private resources are more effective than public resources in increasing the probability of having a good health status.

The effects of individual characteristics are analyzed by considering only the third model specification provided in Table 3.6.

Generally speaking the estimated coefficients for individual characteristics from ordered probit models are all in line with the probit estimates. Male individuals are more likely to judge their health status as good or very good. White people are more likely to judge their health status as bad or very bad. Age is negatively associated with good health status.

All categories related to the maximum attained educational level with illiterate people as the reference category are statically significant. Having a college degree has the greatest impact on the probability of having a good health status followed by the postgraduate degree and the secondary school degree. Having attended primary school affects negatively the achievement of a good health status with respect to being illiterate as a reference group. Although this result could appear atypical, apparent better health conditions of illiterate people compared to people who attend primary education might reflect a lack of awareness by illiterate people in reporting their health status.

Moving to labour market conditions, being a farmer increases the probability of reporting good health conditions. The previous remark referring to those who have attended only primary school can help in interpreting the estimated coefficient of this dummy variable. In fact, this might mean that farmers are less likely to report bad health status rather than being effectively healthier than people working in other economic sectors.

Looking at the occupation levels, intermediates and blue collars are less likely to report good health status with respect to professionals. The last labour market characteristic, namely *formal*, tells us that working in the formal

sector, i.e. owing a working card, increases the probability of having good health status probably due to better guaranteed working conditions.
Finally, with regard to geographical characteristics, the South region seems to be the region where individuals are more likely to report better health status. Living in an urban area decreases the probability of having good health and in particular living in the districts of Roraima and Acre has the worst impact. Again this result is in line with the ones obtained from the previous probit analysis. The fact that people living in metropolitan areas are likely to report worse health conditions might be due to a more conscious perception of their health and, more in general, to a greater awareness of the health-care system as we have already explained for *primary school* and *farmer* variables.

3.6.1 Aggregating by race

Tables 3.5 and 3.6 provide probit and ordered probit estimates considering the entire Brazilian sample. We have already highlighted that the main purpose of this econometric analysis is to assess the health functioning achievement in order to understand to what extent individuals are able to convert private and public resources into health functioning achievement.
We might also be interested in understanding how this ability to convert resources into functioning might vary across population sub-groups. Policy makers might be interested in understanding which population sub-groups are more "efficient" in converting their available resources and which ones are more vulnerable and which factors might affect the conversion process more.
To do that, our Brazilian sample has been aggregated into four different population sub-groups by gender and race: white women, white men, black women and black men. Before proceeding with the estimation, we check whether the model allows for an intercept shift for gender and race but not other gender-race effects. In other words, we test whether the separation by gender-race is supported by our data and we conclude that there are some gender-race differentials in the effect of covariates on the two dependent variables.

Tables 3.7 and 3.8 again in the appendix present results of the probit and ordered probit estimations across the four population sub-groups by employing the last model specification of both regression models.[20]

For probit estimates, Table 3.7 provides the marginal effects.

White women show a statistically significant impact of private resources only at the top end of the wealth distribution, while among black women all wealth quantiles have a statistically significant impact on decreasing the probability of getting ill.

White men show the highest impact of wealth in reducing the probability of getting ill across wealth quantiles. For both white women and men, being in the highest wealth quantile decreases the probability of getting ill by 1.9 percentage points, *ceteris paribus*.

At the bottom of wealth distribution black people have a higher impact of wealth on the probability of getting ill, in particular black women show a higher impact than black men across all wealth quantiles.

The impact of having good public resources is statistically significant only for black women and decreases the probability of getting ill by 2.9 percentage points, ceteris paribus.

If for black women having good public resources show an intercept shift and does not permit for other effects given by interaction terms, for black men interaction terms are statistically significant and it means that they benefit by the interaction of public and private resources.

Among white people public resources affect only women through their interaction with the highest quantile of wealth, while men do not show any impact of public resources.

Ordered probit estimates provided in Table 3.8 show the crucial role played by the private resources in improving the health status.[21] Across all population

[20] For the probit regression Table 3.7 already reports the marginal effects. The model specification adopted for the probit model across population sub-groups is the one that takes into account both private and public resources and their interaction terms, while for the ordered probit model it is the one that considers both private and public resources but not their interaction terms.

[21] To do that we compare the marginal effects of ordered probit estimations with the marginal effects of probit estimates provided with table 3.7. In this work we show only ordered probit

sub-groups wealth quantiles have a greater impact in comparison with having good public resources except for the lowest quantile.

Amongst women, black women show a greater impact of private resources than white women in lowest wealth quantiles while white women perform better at the top of the wealth distribution. In general, moving to the highest quantile of wealth distribution across all regression estimations white people show greater effect of private resources than black people.

Similarly to the results of the previous table, white men benefit from the highest impact of private resources in reaching a good health status, but not from the access to good public resources. In fact black people show a higher impact of having good public resources in improving their health status than white people.

Again, we infer that if white people benefit from a greater impact of private resources, black people show a greater effect in having good public resources. Across race black people perform better in lower wealth quantiles while white people in higher ones. Finally, women seem to benefit less from private resources, although it is not true at the top of wealth distribution especially among white people.

3.7 Final remarks and conclusions

Our probit and ordered probit regression estimations provide interesting patterns about the ability of the Brazilian population in converting private and public resources into the achievement of the health functioning.

When the self-reported morbidity index (SRMI) is employed, public resources seem to have a greater impact than private resources in reducing the probability of contracting an invalidating and chronic disease. Once interactions between private and public resources are added, the effect of private resources in the process is strengthened by the role played by public

estimates and we decide to omit tables with the related marginal effects due to the unnecessary amount of information.

resources. The interaction terms also tell us that these resources are complementary in achieving health functioning.

When examining the role played by conversion factors, among personal characteristics, we notice that men are less likely in getting ill and that whites generally display higher probability of getting ill. Age obviously increases the probability as well. Achieving a college degree seems to be a fundamental determinant in lowering the probability of contracting an invalidating and chronic disease. In fact, working as blue collar increases the probability of getting ill. Among geographical characteristics, living in an urban area has the greatest effect on the probability of poor health. The fact that the urban population is subject to more illnesses than rural people might not be entirely true. As we have already highlighted, the urban population might be more aware of their own health conditions as a consequence of living in an environment where health-care provision is dispensed more.

The utilization of the subjective indicator of health status (SHSI) gives different results. Private resources have a more relevant role in achieving health functioning with respect to public resources. When the health functioning is measured with health status rather than a morbidity index, the strong positive relationship between wealth and health status is even more clearly noticeable. Looking at the personal, labour market and geographical characteristics we control for, a pattern similar to the one for SRMI emerges. In particular, we want to focus on two noticeable differences: the negative impact of having a primary school education compared to being illiterate and the positive effect of being a farmer. Both cases might be misinterpreted. It is difficult to believe that illiterate people are effectively healthier than Brazilians who have attended primary school or that farmers are in better health than the urban population. It is easier to accept that the illiterate population and those who live in rural areas are less informed about health and health services and, consequentially, have a different perception about their health conditions. The perception of illness varies with what people experience and with their knowledge about health and medical provision. As

for the urban variable with SRMI, the evaluation of their own health status depends on the Brazilian population's understanding of health.

Having analyzed the resources-functioning process for the entire sample, we estimate the effect of private and public resources by aggregating the Brazilian population into four sub-groups.

We employ again both dependent variables, namely SMRI and SHSI. With the self-reported morbidity index and considering white people, men are more efficient in converting private resources than women. In particular, for white women private resources have an impact in lowering the probability to get ill only in the highest quantile. White men are also more efficient than black men. In general, at the top of wealth distribution white people are more efficient than black people.

With regard to having good public resources, when statistically significant they have greater impact than private resources in health functioning achievement. Black people are more efficient in converting public resources in lowering the probability to get ill. Among white people, only white women are able to convert public resources, but exclusively at the top of the wealth distribution.

As highlighted by the results for the entire sample, the use of the subjective health status indicator highlights the significant impact of private resources on the health functioning. Across all population sub-groups private resources have a greater effect than public resources.

White men are again the most efficient group in converting private resources in health functioning achievement, but at the top of wealth distribution white women show a greater impact of private resources in achieving a good health status. Across both races, black people are more efficient in lower wealth quantiles while white people are more efficient as we move to the top of the wealth distribution. Public resources show greater impact again for black people than for white people.

To summarize, by identifying the health functioning with the self-reported morbidity index, public resources are more crucial in the health functioning achievement process. White people are the least efficient in using

public resources. On the other hand, when the health status indicator is used to identify the health functioning, the role played by private resources becomes predominant. White men are generally the most efficient in employing their private resources in order to achieve better health conditions.

These econometric estimations of the health functioning production function aim to assess the extent to which Brazilians are able to convert a set of private and public resources into the health functioning, controlling for individual characteristics. Moreover, we think that the definition of population sub-groups and the estimation of conversion processes for each sub-group might be of considerable interest for policy making because it helps in identifying population categories that are more or less efficient in exploiting private and public resources.

Looking at our empirical results, black people might be considered a vulnerable group. The Brazilian policy maker should protect this part of the population that records the lower ability into converting their private resources and good efficiency in using public resources. Possible directions of intervention might be to promote black-targeted public provision of medical assistance and prevention considering that private resources of black people are on average more limited. Another interesting result that might affect policy makers is the fact that across race, women record a greater impact of public resources while for men private resources are more relevant. A possible explanation might be the weaker power of the women in managing private resources of the household that pushes women in exploiting more efficiently public services. Indeed the public health services should be aware of the fact that the highest portion of its policyholders is female and thus the creation of more female-centric policies may help to most efficiently improve health functioning.

Modelling and quantifying the resources-functioning conversion process is the main purpose of this paper. With our empirical analysis we want to focus on the conversion process not to define and estimate the variable identifying the health functioning, but to assess the conversion process for itself giving the health functioning, the private and public resources and the

conversion factors, i.e. personal, labour market and geographical characteristics.

Little has been done in order to operationalize the capability approach and this study might be considered a contribution to assessing individual well-being in the Senian context of capabilities and functionings.

We want to conclude by listing some fundamental remarks that need to be solved in order to forward the operationalization of the capability approach.

First, the definition of the variable that can best identify the functioning is important, but problematic. In our paper we analyze the functioning "being healthy" and we adopt two different variables to identify this functioning: a morbidity index and an indicator of health status. Furthermore the investigation should go deeper and handle the definition and measurement of other functionings, such as "being educated" or "living in a safe and healthy environment". Nevertheless the lack of statistical data constrains empirical applications of well-being assessment that wish to employ the concepts of capabilities and functionings in their analysis.

Second, our functioning production function conceives the functioning achievement as a production of the health functioning where private and public resources are the main resources that identify production factors. However the definition of which type of resources can be considered in the model is open to discussion. We take the wealth indicator as proxy of income where income is a proxy of all goods freely acquirable from the market. Martin (2006) considers not only a long-term indicator of wealth, but also education as resources that can be employed in the well-being production.

Thirdly, the resources-functioning conversion process is controlled by a set of individual characteristics that we have called internal conversion factors. We consider several characteristics, namely personal, labour market and geographical characteristics, but the extension of the set of conversion factors we control for is a needed step toward a more precise estimation of the conversion process. Although we try to classify exogenous characteristics that might affect the functionings achievement, there are several factors not easy to quantify or to add into regression equations, such as genetic background.

Moreover there are differences in norms and expectations that affect the functioning "being healthy" and related to self-reported and subjective indicator of health status that are ignored.[22] Generally speaking, the problem of the omitted variables tends to overestimate the model.

Finally, the estimation of the health production function has been made by employing a probit and an ordered probit regression model. The potential endogeneity problem related to the reversal causality existing between health and income has been partially overcome by substituting income with a long-term indicator of wealth, the wealth indicator. However, using a two-stage instrumental variables estimation might be more consistent. Ettner (1996) estimates the effect of income on self-assessed health status by applying both ordinary and IV estimates. She highlights that this method is reliable as long as the instruments for income are valid. She uses unemployment rate, work experience, parental education and spouse characteristics as potential instruments for household income. We question, however, whether or not these are valid instruments and if IV estimation procedure is able to control for endogeneity problem better than using a long-term indicator of wealth instead of income and, hence, if it is judged more appropriate.

A study of the identification of the variables, the definition of the model and the improvement of the econometric strategies as well as to explore different functioning and their interactions in order to assess individual well-being in the context of the capability approach would be the major contribution to the existing literature.

[22] Hildebrand and Van Kerm (2005) remark that the problems related to the omitted variable and to the differences in norms and expectations are partially controlled by the adoption of panel data since it control for the effects of unobservable fixed effects in the income-health relationship.

References 3

Becker, G. S., (1965), "A Theory of the Allocation of Time", *The Economic Journal*, Vol. 75, No. 299, pp. 493-517.

Case, A., (2002), "Health, Income, and Economic Development", *Annual World Bank Conference on Development Economics, 2001/2002,* pp. 221-241.

Chiappero-Martinetti, E., (2000), "A Multidimensional assessment of well-being based on Sen's Functioning Approach", *Rivista Internazionale di Scienze Sociali*, No. 2.

Chiappero-Martinetti, E., (2007), "Complexity and vagueness in the capability approach: strengths or weaknesses?", in S. Alkire, F. Comin, M. Qizilbalsh, (Eds.), The capability approach in human development: concepts, applications and measurement, Cambridge: CUP.

Chiappero-Martinetti, E., M. Grasso, and S. Pareglio, (2007), "La qualità della vita nelle società avanzate: linee di ricerca per un modello basato sull'approccio delle capacità di Amartya Sen", *Economia e Politica Industriale*, Vol. 34, No. 1.

Chiappero-Martinetti, E., P. Salardi, (2007), "Well-being process and conversion factors: an estimation of the micro-side of the well-being process", *HDCP-IRC Working paper*, Paper presented at the 2007 International Conference of the Capability Approach "Ideas Changing History", September 17-20, New York City.

Comin, F., (2001), "Operationalizing Sen's Capability Approach", paper prepared for the Conference Justice and Poverty: examining Sen's Capability Approach, Cambridge 5-7 June 2001.

Deaton, A., (2002), "Policy Implications Of The Gradient Of Health And Wealth", *Health Affairs*, Vol. 21, No.2.

Ettner, S. L., (1996), "New Evidence on the relationship between income and health", *Journal of Health Economics*, Vol. 15, pp. 67-85.

Filmer, D., and L. H. Pritchett, (2001), "Estimating Wealth Effect without Expenditure Data or Tears: An Application to Educational Enrolments in State of India, *Demography*, Vol. 38, No. 1, pp. 115-132.

Frenk, J., J. L. Bobadilla, C. Stern, T. Frejka, and R. Lozano, (1994), "Elements for a theory of the health transition", in: L. C. Chen, A. Kleinman, N. C. Ware (Eds.), Health and social change in international perspective, Harvard Series on population and international health, Harvard: Harvard University Press.

Grossman, M. (1972), "The demand for health: A theoretical and empirical investigation", *National Bureau of Economic Research, Occasional paper 11.*

Healtzman, C., J. Frank, and R. G. Evans, (1994), "Heterogeneities in Health Status and the Determinants of Population Health", in R. G. Evans (Ed.), Why are some People Healthy and Others Not, Berlin-New York: Walter de Gruyter.

Hildebrand, V., and P. Van Kerm, (2005), "Income Inequality and Self-rated Health Status: Evidence from the European Community Household Panel", *IRISS Working Paper*, No. 2005-01.

Kuklys, W. (2005), *"Amartya Sen's Capability Approach: Theoretical Insights and Empirical Applications"*, Berlin: Springer Verlag.

Lavy, V., J. Strauss, D. Thomas, and P. de Vreyer, (1996), "Quality of care, survival and health outcomes in Ghana", *Journal of Health Economics*, Vol. 15, No. 3, pp. 333-357.

Marmot, M., and M. Shilpey, (1996), "Do Socio-Economic Differences Persist after Retirement? 25 Year Follow-up of Civil Servants from the First Whitehall Study", *British Medical Journal*, Vol. 313, pp. 1177-1180.

Marmot, M., and R. Wilkinson, eds (2006), "*Social Determinants of Health"*, Oxford: Oxford University Press.

Martin, M.-C., (2006), "Individual and collective resources and women's health in Morocco", paper prepared for the 7th HD-CA Conference in Groeningen.

Montgomery, M.R. (2003), "Measuring living standards: household consumption and wealth indices", Quantitative Techniques for Health Equity Analysis, Technical Note No. 4.

Montgomery, M.R., M. Gragnolati, K. A. Burke, and E. Paredes, (2000), "Measuring living standards with proxy variables", *Demography*, Vol. 37, No. 2, pp. 155-174.

Rivera, B., (2001), "The effects of public health spending on self-assessed health status: an ordered probit model", *Applied Economics*, Vol. 33, pp. 1313-1319.

Robeyns, I., (2000), "An unworkable idea or a promising alternative? Sen's capability approach re-examined", Discussion paper 00.30, Center for Economic Studies, University of Leuven.

Robeyns, I., (2003), "The Capability Approach: An Interdisciplinary Introduction", paper written for the Training Course preceding the 3rd International Conference on the Capability Approach on 6 September, Pavia, Italy.

Robeyns, I., (2005), "The Capability Approach: A Theoretical Survey", *Journal of Human Development*, Vol. 6, No. 1, pp. 93-114.

Robeyns, I., and W. Kuklys, (2004), "Sen's capability approach to welfare economics", *Cambridge Working Papers in Economics* 0415.

Rosenzweig, M. R., and T. P. Schultz, (1982), "The Behaviour of Mothers as Inputs to Child Health: The Determinants of Birth Weight, Gestation, and Rate of Fetal Growth", in V. Fuchs (Ed.), Economic Aspects of Health, Chicago: The University of Chicago Press.

Rosenzweig, M. R., and T. P. Schultz, (1983), "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and Their

Effects on Birth Weight", *The Journal of Political Economy*, Vol. 91, No. 5, pp. 723-746.

Ruggeri Laderchi, C., (1999), "The Many Dimensions of Deprivation in Peru: Theoretical Debates and Empirical Evidence", QEH Working Paper Series 29.

Sahn, D., and D. Stifel, (2000), "Poverty comparisons over time and across countries in Africa", *World Development*, Vol. 28, No. 12, pp. 2123-2155.

Sahn, D., and D. Stifel, (2003), "Exploring alternative measures of welfare in the absence of expenditure data", *Review of Income and Wealth*, Vol. 49, No. 4.

Schultz, T. P., (1984), "Studying the Impact of Household Economic and Community Variables on Child Mortality", *Population and Development Review*, Vol. 10, Child Survival: Strategies for Research, pp. 215-235.

Sen, A., (1985), "*Commodities and Capabilities"*, New Delhi: Oxford University Press.

Sen, A., (1993), "Positional Objectivity", *Philosophy and Public Affairs*, Vol. 22, No. 2, pp. 126-145.

Sen, A., (1998), "Mortality as an Indicator of Economic Success and Failure", *The Economic Journal*, Vol. 108, No. 446, pp. 1-25.

Sen, A., (2002), "Health: perception versus observation. Self reported morbidity has severe limitations and can be extremely misleading"*, British Medical Journal,* Vol. 324, pp. 860–1.

Strauss, J., and D. Thomas, (1995), "Human resources: Empirical modelling of household and family decisions", in: J. Behrman, T. N. Srinivasan (Eds.), Handbook of Development Economics, Vol. 3A, Amsterdam: Elsevier.

Thomas, D., J. Strauss, and M. H. Henriques, (1991), "How Does Mother's Education affect Child Height?", *The Journal of Human Resources*, Vol. 26, No. 2, pp. 183-211.

Thomas, D., V. Lavy, and J. Strauss, (1996), "Public policy and anthropometric outcomes in the Côte d'Ivoire", *Journal of Public Economics,* Vol. 61, pp. 155-192.

Wagstaff, A., (2002), "Poverty and health sector inequalities", *Bulletin of the World Health Organization*, Vol. 80 No. 2.

Wagstaff, A., and E. Van Doorslaer, (1994), "Measuring inequalities in health in the presence of multiple-category morbidity indicators", *Health Economics*, Vol. 3, pp. 281-291.

Wagstaff, A., P. Paci, and H. Joshi, (2001), "Causes of inequality in health: Who you are? Where you live? Or who your parents were?", *World Bank Working Paper 2713*, Washington, D.C.: World Bank.

Wilkinson, R., and M. Marmot, eds (2003), "*Social Determinants of Health: the Solid Facts"*, (2nd edition), Copenhagen: WHO Europe.

Appendix 3

Table 3.5: Marginal effects of Probit estimates using SRMI

	(1)	(2)	(3)	(4)
Private and public resources				
Wealth2	-0.007		-0.006	-0.006
	(0.002)***		(0.003)**	(0.003)**
Wealth3	-0.010		-0.009	-0.008
	(0.003)***		(0.003)***	(0.003)***
Wealth4	-0.015		-0.015	-0.015
	(0.002)***		(0.002)***	(0.002)***
Wealth5	-0.021		-0.020	-0.020
	(0.004)***		(0.004)***	(0.004)***
Public		-0.024	-0.023	-0.014
		(0.002)***	(0.002)***	(0.005)***
Wealth2*Public				-0.013
				(0.005)**
Wealth3*Public				-0.013
				(0.005)***
Wealth4*Public				-0.009
				(0.006)
Wealth5*Public				-0.011
				(0.007)
Personal characteristics				
Male	-0.019	-0.019	-0.019	-0.019
	(0.002)***	(0.001)***	(0.002)***	(0.002)***
White	0.003	0.005	0.003	0.003
	(0.001)***	(0.001)***	(0.001)**	(0.001)**
Mature people	0.041	0.041	0.042	0.042
	(0.003)***	(0.002)***	(0.002)***	(0.002)***
Elderly people	0.089	0.086	0.090	0.090
	(0.005)***	(0.004)***	(0.004)***	(0.004)***
Primary school	0.008	0.009	0.008	0.008
	(0.002)***	(0.002)***	(0.002)***	(0.002)***
Secondary school	-0.008	-0.008	-0.008	-0.008
	(0.001)***	(0.001)***	(0.001)***	(0.001)***
College	-0.009	-0.014	-0.009	-0.009
	(0.003)***	(0.002)***	(0.003)***	(0.003)***
Post-graduate	-0.009	-0.014	-0.009	-0.009
	(0.009)	(0.009)	(0.009)	(0.009)
Labour market characteristics				
Farmer	-0.002	0.000	-0.003	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Intermediate level	0.000	0.004	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
Blue collar level	0.006	0.010	0.006	0.006
	(0.003)**	(0.003)***	(0.003)**	(0.003)**
Formal	0.002	0.001	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Geographical characteristics				

North-East	-0.015	-0.015	-0.015	-0.015
	(0.008)*	(0.008)*	(0.008)*	(0.008)*
South-East	-0.012	-0.008	-0.004	-0.004
	(0.010)	(0.008)	(0.008)	(0.008)
South	-0.002	-0.006	-0.002	-0.002
	(0.008)	(0.008)	(0.008)	(0.008)
Central-West	-0.002	-0.004	-0.002	-0.002
	(0.008)	(0.008)	(0.008)	(0.008)
Urban	0.016	0.011	0.016	0.016
	(0.003)***	(0.002)***	(0.002)***	(0.002)***
Brasilia	0.001	0.032	0.035	0.035
	(0.003)	(0.004)***	(0.005)***	(0.005)***
São Paolo	0.003	-0.007	-0.006	-0.006
	(0.008)	(0.002)***	(0.002)**	(0.002)**
Roraima	0.002	0.037	0.037	0.035
	(0.008)	(0.013)***	(0.012)***	(0.013)***
Acre	0.034	0.088	0.083	0.076
	(0.012)***	(0.018)***	(0.017)***	(0.017)***
Observations	128,028	128,028	128,028	128,028
Pseudo-R^2	0.0436	0.0431	0.0449	0.0450

Robust standard errors adjusted for clustering on *Unidade de Federacão* in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.6: Ordered probit estimates using SHSI

	(1)	(2)	(3)
Private and public resources			
Wealth2	0.071		0.067
	(0.021)***		(0.019)***
Wealth3	0.165		0.161
	(0.026)***		(0.026)***
Wealth4	0.275		0.271
	(0.024)***		(0.024)***
Wealth5	0.513		0.508
	(0.024)***		(0.025)***
Public		0.244	0.226
		(0.031)***	(0.032)***
Personal characteristics			
Male	0.201	0.195	0.201
	(0.010)***	(0.010)***	(0.010)***
White	-0.081	-0.122	-0.077
	(0.016)***	(0.018)***	(0.016)***
Mature people	-0.542	-0.517	-0.545
	(0.020)***	(0.019)***	(0.020)***
Elderly people	-0.996	-0.941	-1.001
	(0.027)***	(0.026)***	(0.027)***
Primary school	-0.267	-0.285	-0.266
	(0.018)***	(0.019)***	(0.018)***
Secondary school	0.028	0.037	0.028
	(0.014)**	(0.015)**	(0.014)**
College	0.350	0.491	0.347
	(0.036)***	(0.035)***	(0.037)***
Post-graduate	0.345	0.507	0.341

	(0.083)***	(0.086)***	(0.084)***
Labour market characteristics			
Farmer	0.045	0.002	0.053
	(0.027)	(0.029)	(0.026)**
Intermediate level	-0.144	-0.229	-0.146
	(0.017)***	(0.016)***	(0.017)***
Blue collar level	-0.217	-0.307	-0.219
	(0.021)***	(0.021)***	(0.021)***
Formal	0.149	0.166	0.150
	(0.014)***	(0.015)***	(0.014)***
Geographical characteristics			
North-East	0.046	0.057	0.045
	(0.102)	(0.105)	(0.102)
South-East	0.199	0.200	0.127
	(0.113)*	(0.102)*	(0.098)
South	0.160	0.243	0.163
	(0.104)	(0.108)**	(0.104)
Central-West	0.027	0.083	0.028
	(0.095)	(0.099)	(0.096)
Urban	-0.083	0.021	-0.085
	(0.024)***	(0.021)	(0.024)***
Brasilia	-0.048	-0.211	-0.271
	(0.022)**	(0.033)***	(0.036)***
São Paolo	0.001	0.112	0.077
	(0.060)	(0.031)***	(0.033)**
Roraima	-0.234	-0.454	-0.459
	(0.094)**	(0.103)***	(0.100)***
Acre	-0.220	-0.478	-0.446
	(0.094)**	(0.103)***	(0.100)***
/Cut1	-2.365	-2.525	-2.367
	0.105	0.108	0.105
/Cut2	-1.098	-1.27	-1.099
	0.109	0.111	0.109
Observations	128,028	128,028	128,028
Pseudo-R^2	0.0977	0.0908	0.0984

Robust standard errors adjusted for clustering on *Unidade de Federacão* in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.7: Marginal effect of Probit estimates with SRMI by race

	(1)White women	(2)White men	(3)Black women	(4)Black men
Private and public resources				
Wealth2	-0.001	-0.006	-0.005	-0.009
	(0.007)	(0.005)	(0.003)*	(0.004)***
Wealth3	-0.002	-0.013	-0.010	-0.007
	(0.005)	(0.006)**	(0.004)**	(0.003)**
Wealth4	-0.009	-0.018	-0.017	-0.014
	(0.006)	(0.004)***	(0.003)***	(0.004)***
Wealth5	-0.019	-0.019	-0.017	-0.017
	(0.006)***	(0.006)***	(0.005)***	(0.005)***
Public	-0.005	-0.006	-0.029	-0.004
	(0.016)	(0.020)	(0.010)***	(0.010)
Wealth2*Public	-0.023	-0.015	-0.005	-0.013
	(0.015)	(0.013)	(0.012)	(0.010)
Wealth3*Public	-0.014	-0.011	-0.008	-0.024
	(0.014)	(0.018)	(0.012)	(0.007)***
Wealth4*Public	-0.018	-0.000	0.007	-0.026
	(0.013)	(0.024)	(0.018)	(0.005)***
Wealth5*Public	-0.022	-0.013	-0.002	-0.012
	(0.013)*	(0.018)	(0.018)	(0.009)
Personal characteristics				
Mature people	0.035	0.031	0.050	0.045
	(0.003)***	(0.004)***	(0.004)***	(0.005)***
Elderly people	0.082	0.061	0.105	0.098
	(0.005)***	(0.008)***	(0.007)***	(0.008)***
Primary school	0.011	0.008	0.009	0.003
	(0.004)***	(0.005)*	(0.004)**	(0.003)
Secondary school	-0.005	-0.006	-0.009	-0.008
	(0.003)	(0.004)	(0.003)***	(0.002)***
College	-0.009	-0.005	-0.013	0.006
	(0.005)*	(0.005)	(0.005)**	(0.007)
Post-graduate	-0.016	-0.012	0.018	0.025
	(0.013)	(0.009)	(0.034)	(0.035)
Personal characteristics				
Farmer	0.001	-0.013	0.002	-0.008
	(0.006)	(0.004)***	(0.005)	(0.004)*
Intermediate level	0.002	0.003	-0.014	-0.000
	(0.004)	(0.004)	(0.007)*	(0.005)
Blue collar level	0.010	0.016	-0.019	0.014
	(0.004)**	(0.004)***	(0.010)*	(0.004)***
Formal	0.005	0.006	-0.004	-0.001
	(0.005)	(0.003)**	(0.005)	(0.004)
Geographical characteristics				
North-East	-0.013	-0.016	-0.018	-0.010
	(0.011)	(0.007)**	(0.010)*	(0.006)*
South-East	-0.005	-0.010	-0.004	-0.002
	(0.011)	(0.008)	(0.009)	(0.006)
South	0.001	-0.011	-0.004	-0.003
	(0.012)	(0.007)	(0.009)	(0.006)
Central-West	-0.002	-0.016	0.003	0.001

	(0.012)	(0.006)**	(0.010)	(0.006)
Urban	0.021	0.006	0.020	0.008
	(0.004)***	(0.004)	(0.004)***	(0.005)
Brasilia	0.039	0.014	0.052	0.024
	(0.006)***	(0.007)*	(0.009)***	(0.004)***
São Paolo	-0.009	-0.001	-0.002	-0.004
	(0.001)***	(0.005)	(0.003)	(0.002)
Roraima	0.066	-0.023	0.063	0.012
	(0.021)***	(0.005)***	(0.016)***	(0.008)
Acre	0.075	0.036	0.110	0.060
	(0.022)***	(0.022)	(0.023)***	(0.014)***
Observations	39,857	20,144	44,519	23,508
Pseudo-R^2	0.0357	0.0398	0.0455	0.0627

Robust standard errors adjusted for clustering on *Unidade de Federacão* in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3.8: Ordered probit estimates using SHSI by race

	(1)White women	(2)White men	(3)Black women	(4)Black men
Private and public resources				
Wealth2	0.045	0.103	0.067	0.105
	(0.033)	(0.032)***	(0.021)***	(0.032)***
Wealth3	0.134	0.237	0.156	0.205
	(0.043)***	(0.047)***	(0.030)***	(0.036)***
Wealth4	0.277	0.319	0.255	0.289
	(0.044)***	(0.033)***	(0.029)***	(0.035)***
Wealth5	0.546	0.536	0.444	0.451
	(0.041)***	(0.039)***	(0.033)***	(0.044)***
Public	0.172	0.110	0.279	0.369
	(0.024)***	(0.045)**	(0.035)***	(0.026)***
Personal characteristics				
Mature people	-0.536	-0.570	-0.534	-0.564
	(0.023)***	(0.036)***	(0.028)***	(0.030)***
Elderly people	-0.993	-0.957	-0.998	-1.060
	(0.035)***	(0.036)***	(0.038)***	(0.032)***
Primary school	-0.279	-0.394	-0.255	-0.171
	(0.025)***	(0.037)***	(0.027)***	(0.029)***
Secondary school	0.048	-0.050	0.029	0.046
	(0.022)**	(0.037)	(0.014)**	(0.027)*
College	0.420	0.234	0.297	0.233
	(0.030)***	(0.066)***	(0.066)***	(0.072)***
Post-graduate	0.409	0.229	0.270	0.167
	(0.120)***	(0.163)	(0.283)	(0.279)
Personal characteristics				
Farmer	-0.046	0.139	0.024	0.147
	(0.026)*	(0.043)***	(0.038)	(0.048)***
Intermediate level	-0.141	-0.090	-0.133	-0.200
	(0.031)***	(0.037)**	(0.044)***	(0.037)***
Blue collar level	-0.226	-0.258	-0.183	-0.263
	(0.035)***	(0.033)***	(0.040)***	(0.043)***
Formal	0.122	0.187	0.126	0.181
	(0.028)***	(0.026)***	(0.021)***	(0.022)***

Geographical characteristics				
North-East	0.040	0.053	0.049	0.019
	(0.123)	(0.097)	(0.103)	(0.098)
South-East	0.168	0.156	0.133	0.052
	(0.110)	(0.103)	(0.098)	(0.094)
South	0.206	0.169	0.136	0.141
	(0.113)*	(0.099)*	(0.116)	(0.119)
Central-West	0.069	0.042	-0.000	0.027
	(0.108)	(0.102)	(0.095)	(0.092)
Urban	-0.076	-0.050	-0.118	-0.063
	(0.028)***	(0.062)	(0.033)***	(0.040)
Brasilia	-0.257	0.035	-0.353	-0.358
	(0.027)***	(0.058)	(0.042)***	(0.025)***
São Paolo	0.095	0.068	0.023	0.019
	(0.025)***	(0.044)	(0.036)	(0.026)
Roraima	-0.529	-0.322	-0.530	-0.526
	(0.113)***	(0.104)***	(0.100)***	(0.096)***
Acre	-0.390	-0.163	-0.522	-0.587
	(0.113)***	(0.106)	(0.099)***	(0.096)***
/Cut1	-2.279	-2.386	-2.262	-2.356
	0.121	0.120	0.105	0.102
/Cut2	-0.984	-1.216	-0.944	-1.173
	0.121	0.113	0.112	0.106
Observations	39,857	20,144	44,519	23,508
Pseudo-R^2	0.1075	0.1113	0.0792	0.0884

Robust standard errors adjusted for clustering on *Unidade de Federacão* in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%