Borradores de ECONOMÍA

Health Status and Labor Force Participation: Evidence for Urban Low and Middle Income Individuals in Colombia

Por: Ana María Iregui-Bohórquez,
Ligia Alba Melo-Becerra,
María Teresa Ramírez-Giraldo

Núm. 851I
2014

BANCO DE LA REPÚBLICA
COLOMBIA

Health Status and Labor Force Participation: Evidence for Urban Low and Middle Income Individuals in Colombia[♣]

Ana María Iregui-Bohórquez[♠] aireguibo@banrep.gov.co

Ligia Alba Melo-Becerra[♦] lmelobec@banrep.gov.co

María Teresa Ramírez-Giraldo[•] mramirgi@banrep.gov.co

Abstract

This paper uses the first wave of the Colombian Longitudinal Survey (ELCA) to analyze the relationship between individual health status and labor force participation. The empirical modeling strategy accounts for the presence of potential endogeneity between these two variables. The results show that there is a positive relationship between health and labor force participation in both directions, indicating that better health is likely to lead to a higher probability of participation in the labor market, and also that those who are in the labor market are more likely to report better health. Moreover, interesting differences arise when the database is further divided by gender and/or age groups. Our findings highlight the importance of public policy to guarantee good health conditions of the population which could also have a positive impact on labor productivity and consequently on long-run economic growth.

Key words: Health status, labor force participation, endogeneity, Colombia
JEL Classification: *C35, C36, I10, J21*

[♣] We want to thank Ximena Cadena, Director of the ELCA Project, for the information about the survey. We are also grateful to Luis Eduardo Arango, Jesús Otero, Rainer Winkelmann, and Héctor Zárate for their comments and suggestions. We also wish to thank Carmen Cecilia Delgado, Helena González, and Sonia Salazar for their excellent research assistance. The opinions expressed herein are those of the authors and do not necessarily reflect the views of Banco de la República or its Board of Directors.
[♠] Banco de la República, Bogotá, Colombia.
[♦] Banco de la República, Bogotá, Colombia.
[•] Banco de la República, Bogotá, Colombia.

Estado de salud y participación laboral: Evidencia para Colombia

Resumen

En este trabajo se analiza la relación entre el estado de salud de los individuos y su participación laboral en Colombia, utilizando la primera etapa de la Encuesta Longitudinal Colombiana (ELCA). Para abordar la posible endogeneidad entre las dos variables, el análisis se lleva a cabo utilizando variables instrumentales y mínimos cuadrados en dos etapas. Los resultados muestran que existe una relación positiva entre salud y participación laboral en los dos sentidos, indicando que un buen estado de salud aumenta la probabilidad de participación en la fuerza laboral, y que aquellos que están en el mercado laboral tienen una mayor probabilidad de reportar un mejor estado de salud. Sin embargo, hay algunas diferencias por género y edad. Los resultados sugieren que es esencial que las políticas públicas garanticen buenas condiciones de salud de la población lo cual también podría tener un impacto positivo sobre la productividad laboral y en consecuencia sobre el crecimiento económico de largo plazo.

Palabras claves: Estado de salud, participación laboral, endogenidad, Colombia
Clasificación JEL: *C35, C36, I10, J21*

I. Introduction

Health, like education, is an important component of human capital that plays a crucial role in economic growth as a determinant of labor supply (Becker, 1964; Strauss and Thomas, 1998; Weil, 2014). Poor health conditions could negatively affect labor productivity and, consequently, long run economic growth. Thus, the study of the relationship between individuals' health and labor market outcomes is important because of the cost, in terms of lost production and earnings, of a reduction in labor force participation due to the health condition of individuals.

The relationship between health status and labor force participation has been empirically studied by several authors, who have paid a great deal of attention to the potential endogeneity issues associated with unobserved characteristics of individuals as well as with the possible simultaneous determination between these two variables (e.g., Stern, 1989; Cai and Kalb, 2006; Laplagne et al., 2007). In addition, these studies have also focused on the choice of the individual health indicator and the measurement issues related to them.

Although there is a large literature on the determinants of labor force participation in Colombia (e.g., Arango and Posada, 2005; Amador et al., 2013; González, Daza and Garavito, 2014), health has not been included in the analyses. The purpose of this paper is to further our understanding of the relationship between health status and labor force participation in Colombia. For this, we use data for urban low and middle income individuals as collected in the first wave of the Colombian Longitudinal Survey (ELCA). The analysis is carried out by gender and age groups. We believe that the study of this topic is important for a middle-income country such as Colombia, given that the estimation of the impact between these two variables could shed light on public policies aimed at improving the health of individuals and the consequent effect on the labor market.

In general terms, the results show that there is a positive relationship between health and labor force participation in both directions, indicating that better health is likely to lead to a higher probability of participation in the labor force, and that those who are in the labor

market are more likely to report better health. However, there are interesting differences when the individuals are studied according to their gender and/or age group.

This paper is divided into six sections, besides the introduction. The second section contains a brief literature review. In the third section we present an overview of the model used in the estimations. Section four provides information about the data used in the analysis. In the fifth section, we discuss the empirical strategy and the results. The final section presents the main conclusions.

II. Literature Review

Theoretical studies relating human capital and labor market date back to Schultz (1961), Becker (1964), and Grossman (1972). According to these authors, education and health are the most important factors in determining the stock of human capital of individuals, and to this extent they are crucial in their decision to work. Following these earlier theoretical studies, there has been a growing interest in assessing the relationship between health and labor market participation. For example, Currie and Madrian (1999) present a detailed review of the literature relating health and labor market outcomes, concluding that poor health reduces labor participation, productivity, and wages.

This relationship had been specifically studied for the United States by Bartel and Taubman (1979), who estimated the effects of specific diseases on wage rates and hours worked for white, veteran, male twins. They found a strong negative effect on earnings and labor supply for those with some chronic diseases, although the impact depends on the specific disease. Also for the United States, Stern (1989) estimated the impact of different measures of disability on labor market participation and found that each measure of disability explained an important amount of variation in labor participation.

More recently, Cai and Kalb (2006), Laplagne et al. (2007), and Cai (2010) examined the effect of self-assessed health on labor force participation in Australia, finding a positive relationship between good health and labor force participation, although with some differences by gender and age. Also, for this country Harris (2009), Zhang et al. (2009), and

Forbes et al. (2010) analyzed the impact of chronic diseases on labor market outcomes, concluding that the reduction in the incidence of chronic diseases is associated with higher levels of labor participation and productivity. Similar results were found for New Zealand by Holt (2010) and Carter et al. (2013). For Germany, Jäckle and Himmler (2010) showed that good health leads to higher wages for men, and for Canada, Campolieti (2002) found that disability has a negative effect on the labor force participation of older males.

Moreover, Handa and Neitzert (1998), Mete and Schultz (2002), Pandey (2009), and van Gameren (2010) have studied the relationship between health and labor force participation for elderly men and women in Jamaica, Taiwan, India and Mexico, respectively. The authors have found that health has a significant and positive impact on labor participation, especially for older men.

Regarding Latin America, the Inter-American Development Bank presented a collection of papers in which several authors analyzed the relationship between health and wages for different countries (Savedoff and Schultz, 2000). For Mexico, Parker (2000) examined this relationship for the elderly. For Peru, Murrugarra and Valdivia (2000) analyzed the returns to health across the wage distribution for adults, while Cortez (2000) estimated the relationship between health and productivity. Similarly, for Nicaragua, Espinosa, Hernandez, and Savedoff (2000) assessed the relationship between productivity and health status. Finally, for Colombia, Ribero and Nuñez (2000) analyzed the impact of two health indicators, days of disability and stature, on labor productivity and wages. In general, all papers concluded that health has a significant impact on individual earnings.

It is worth mentioning that the effect of factors associated with individuals´ health on the labor market has not been sufficiently analyzed in Colombia. Besides the paper by Ribero and Nuñez (2000), Ribero (2000) studies the determinants of individual good health and its effect on productivity in urban and rural areas by gender. She estimates Mincer equations, including health indicators as additional regressors and finds that days of disability have a weak correlation with income, while there is a positive correlation between stature and income. Other research has mainly focused on assessing institutional aspects of the health

sector (see for example Bernal and Gutierrez (2012) and Guerrero, Gallego, Becerril-Montekio, and Vásquez (2011)).

Lastly, although there is a large literature on labor participation in Colombia, so far health status has not been considered as a determinant (see for example, López, 1995; Tenjo and Ribero, 1998; Santa María, 2001; Arango, Posada, and Charry, 2003; Arango and Posada, 2005; González, Daza and Garavito, 2014). Some authors have focused specifically on female labor force participation without considering health; see for instance, Arango and Posada (2007), Robbins et al. (2009), Alvis-Guzman et al. (2010), Castro, García and Badillo (2011), Amador et al. (2013) and Martinez (2013).

III. Overview of the Model

The model used in this paper follows Stern (1989), Cai and Kalb (2006), and Laplagne, et al. (2007). This model relates labor force participation and health status, taking into account the potential endogeneity between these two variables. In particular, these authors identify three causes that could explain the endogeneity: i) unobservable characteristics of individuals (for example, motivation, innate ability or preferences); ii) rationalizing behavior, which may occur when individuals justify their non-participation in the labor force reporting a poor health status, when using self-assessed health as an indicator of health; and iii) the simultaneous determination of health and labor force participation. According to these authors, causality between health and labor participation could run in both directions. Health may be endogenous to labor supply, since to improve or maintain a given health status individuals need to invest in health, which requires resources. The availability of resources may depend on the individual's labor participation. In turn, activities in the labor market may also have a direct impact on individual health.

The model relates labor force participation and health by means of three equations.[1] The first equation determines labor force participation based on a latent measure of true health and a set of exogenous variables:

[1] We follow closely Cai and Kalb's (2006) notation.

$$p_i^* = \gamma_1 h_i^{**} + \beta_1 X_{p,i} + \varepsilon_{1,i} \quad (1)$$

where p_i^* is the latent value of labor force status for individual *i*; h_i^{**} is the latent true health for individual *i*; $X_{p,i}$ is a set of exogenous characteristics of individual *i*; and $\varepsilon_{1,i}$ is the error term which is assumed to be normally distributed. The second equation describes the determination of latent true health (h_i^{**}) conditional on labor force participation and a set of exogenous variables:

$$h_i^{**} = \gamma_2 p_i^* + \beta_2 X_{h,i} + \varepsilon_{2,i} \quad (2)$$

where $X_{h,i}$ is a set of exogenous individual characteristics and $\varepsilon_{2,i}$ is the error term which is assumed to be normally distributed. $X_{p,i}$ and $X_{h,i}$ may have some variables in common. And the third equation associates true health and reported self-assessed health (h_i^*), since the former is not observed. In this case, the variable h_i^* depends on the true health and labor force participation:

$$h_i^* = h_i^{**} + \alpha p_i^* + \mu_i \quad (3)$$

Where μ_i is the error term, which is assumed to be normally distributed. Substituting equation (2) in equation (3) we get:

$$h_i^* = \theta_h p_i^* + \beta_h X_{h,i} + \varepsilon_{h,i} \quad (4)$$

where $\theta_h = \gamma_2 + \alpha$; and $\varepsilon_{h,i} = \varepsilon_{2,i} + \mu_i$. From (3), it follows that $h_i^{**} = h_i^* - \alpha p_i^* - \mu_i$, and replacing this in equation (1), yields:

$$p_i^* = \theta_p h_i^* + \beta_p X_{p,i} + \varepsilon_{p,i} \quad (5)$$

where $\theta_p = \frac{\gamma_1}{1-\gamma_1\alpha}$; $\beta_p = \frac{\beta_1}{1-\gamma_1\alpha}$; and $\varepsilon_{p,i} = \frac{\varepsilon_{1,i}-\gamma_1\mu_i}{1-\gamma_1\alpha}$. As Cai and Kalb (2006) mention, $\varepsilon_{h,i}$ and $\varepsilon_{p,i}$ are correlated through μ_i even if $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ are assumed to be independent. However, it is very likely that $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ are correlated due to the presence of unobservable variables that may affect both health and labor force participation.

Equations (4) and (5) constitute a system of simultaneous equations and the parameters to be estimated are θ_h, β_h, θ_p, β_p. The reduced forms of equations (4) and (5) can be written as:

$$h_i^* = \left[\frac{1}{1-\theta_h\theta_p}\right]\left[\theta_h\beta_p X_{p,i} + \beta_h X_{h,i} + \left(\varepsilon_{h,i} + \theta_h\varepsilon_{p,i}\right)\right] \quad (6)$$

and

$$p_i^* = \left[\frac{1}{1-\theta_h\theta_p}\right]\left[\theta_p\beta_h X_{h,i} + \beta_p X_{p,i} + \left(\varepsilon_{p,i} + \theta_p\varepsilon_{h,i}\right)\right] \quad (7)$$

where, $\varepsilon_{p,i}$ and $\varepsilon_{h,i}$ are assumed to follow a standard normal bivariate distribution with a correlation coefficient ρ.

IV. Data

The data used in this paper come from the first wave of the Colombian Longitudinal Survey of the Universidad de los Andes (ELCA) which collects detailed information about employment, income, consumption, education, health, household composition, and social capital. Other available surveys, such as the Encuesta de Calidad de Vida (from the National Department of Statistics), have good socioeconomic information, but the module on health is rather narrow. At the other end of the spectrum, the Encuesta Nacional de Salud (from the Ministry of Health) is specialized in health, but the information on labor market is quite limited.

The ELCA survey was conducted during the first semester of 2010 and applied to 10,800 households (6,000 in urban areas and 4,800 in rural areas). The empirical analysis focuses on the urban sample, which is representative of households in the first four socioeconomic strata

in the following five regions of the country: Bogotá, Central, Eastern, Atlantic and Pacific.[2] We concentrated on the answers of the head of the household and the spouse, older than 12 and younger than 66 years of age, obtaining a total sample of 8,574 working-age individuals. The sample was further divided by gender and age groups, that is, males and females aged 13-40 and males and females aged between 41 and 65.

In particular, the ELCA survey contains comprehensive information on individuals' labor participation and health status. Regarding the former, individuals were asked whether during the previous week she/he had worked for at least one hour in a wage-earning job, worked as unpaid family worker for at least one hour, did not work but had a job for at least one hour, worked for at least one hour and looked for a job, was permanently disabled for work, or none of the above. If the individual answered affirmatively any of the first four statements, it is considered that he/she participates in the labor force and the variable takes the value of 1; if the individual answered affirmatively any of the last two statements, it is considered that he/she does not participate in the labor force and the variable takes the value of 0. In this sample, 70% of the individuals participate in the labor market.

Regarding the health variable, it is worth mentioning that the literature identifies two types of health indicators: objective and subjective (Currie and Madrian, 1999). In general, there is no consensus as to what measure is the most appropriate; the choice largely depends on the availability of information. Some examples of the most commonly used indicators are: i) self-assessed health; ii) limitations on the ability to work or perform everyday activities; iii) presence of diseases (specific and / or chronic diseases); iv) use of health insurance; v) presence of poor health habits (alcohol, drugs, smoking, etc.); and vi) nutritional status, such as weight, height or body mass index. In this paper, we use the self-assessed health status included in the survey.

Specifically, individuals were asked to rate, on a scale from 0 to 100, their current health status. In this scale, 100 corresponds to the best health condition and 0 to the worst. Based on

[2] Strata one to four include low and middle income households. The survey excludes strata five and six, which correspond to the highest socioeconomic strata.

the distribution of the answers to this question, we created a categorical variable to indicate individual health perception.[3] This variable contains four categories: excellent = 3 (for answers between 90 and 100); good = 2 (for answers between 79 and 89); fair = 1 (for answers between 50 and 69); and poor = 0 (for answers less than 50). Within this sample, 48% of the individuals report excellent health, 34% good health, 15% fair health, and 3% poor health. Moreover, both younger males and females report better health than older ones. For instance, while 61% of young males report excellent health, 44% of older males do so; for females, these percentages are 51% and 38%, respectively.

Table 1 presents labor force participation by self-assessed health status for the complete sample as well as for each of the groups defined above. The results indicate that for all groups the percentage of people in the labor force increases with better health. For instance, in the complete sample, while 44% of individuals that reported poor health are not in the labor market, only 27% of individuals with excellent health are not. In general, for all self-assessed health categories males participate more than females, and for both males and females older individuals participate less than younger ones.

Allowing for the possible endogeneity discussed above, we estimated a simultaneous equations model.[4] More specifically, we consider an equation for labor participation and another one for health status. Although both equations share some of the explanatory variables, a different set of regressors is included in each equation to guarantee the identification of the parameters in the model (See Appendix B for a description of the variables and their descriptive statistics).

The labor force participation equation includes the traditional variables considered in the literature, such as age, age squared, marital status, educational attainment (technical, technological, university, postgraduate), income different from labor income, and children under the age of 5. We also control for the region where the household lives, for whether the

[3] It is important to point out that self-assessed health could be used to rationalize labor force participation. Cai and Kalb (2006) state that rationalization could make the health variable endogenous and its effect could be overestimated. In addition, it is important to bear in mind that this measure of health could suffer from measurement errors in the answers of respondents.

[4] See for example, Cai and Kalb (2006) and Zhang, Zhao and Harris (2009).

spouse is in the labor force, and whether the household is beneficiary of the "familias en accion" program. Lastly, since one of the main objectives of this paper is to test if health affects labor force participation, the variable for self-assessed health status of the individual was included as an additional regressor.

Table 1
Cross tabulations of labor force participation and self-assessed health

Labor force	Self-assessed health				Total
	Excellent (3)	Good (2)	Fair (1)	Poor (0)	
Complete sample					
Participate	73.1%	70.7%	63.5%	56.4%	70.3%
Do not participate	26.9%	29.3%	36.5%	43.6%	29.7%
Males					
Participate	92.4%	87.9%	85.6%	74.7%	89.6%
Do not participate	7.6%	12.1%	14.4%	25.3%	10.4%
Males aged 13-40					
Participate	94.9%	92.3%	94.3%	88.5%	94.0%
Do not participate	5.1%	7.7%	5.7%	11.5%	6.0%
Males aged 41-65					
Participate	89.4%	85.0%	81.8%	68.9%	85.9%
Do not participate	10.6%	15.0%	18.2%	31.1%	14.1%
Females					
Participate	56.5%	58.2%	51.4%	48.2%	55.8%
Do not participate	43.5%	41.8%	48.6%	51.8%	44.2%
Females aged 13-40					
Participate	56.9%	59.7%	56.4%	51.3%	57.6%
Do not participate	43.1%	40.3%	43.6%	48.8%	42.4%
Females aged 41-65					
Participate	55.9%	56.7%	48.2%	46.0%	54.1%
Do not participate	44.1%	43.3%	51.8%	54.0%	45.9%

Source: Calculations based on Appendix A.

Regarding the health equation, besides the set of common variables (age, marital status, educational attainment, and the geographical location of the household), we consider the ethnic group of the individual and the socioeconomic stratum of the household. In order to

take into account genetic factors we included two dummy variables that indicate whether the father/mother had/has a chronic disease. In addition, to account for the impact of the social security regime, we consider if the individual is affiliated to the contributory health social security regime. In Colombia the social health system consists of three main regimes, each with different health services: Contributory, non-contributory (subsidized), and special (e.g., Armed Forces and National Police).[5] In the sample used in this paper, 56.4% of the individuals are affiliated to the contributory regime, 39.4% to the subsidized regime, and 4.2% to the special regime. Similarly, to assess the effect of government programs on the improvement of health, we include the program "Familias en acción"; in this case, a dummy variable was included to indicate whether the household is a beneficiary of the program.[6] Moreover, we consider that risky factors associated to the house where the family lives could affect the individual's health; specifically, if the residence is located near hazardous places (e.g., factories, dumps, slaughterhouses, power plants, sewage pipes), and if the dwelling has been affected by natural disasters (e.g., floods, avalanches, swells of rivers, earthquakes). Finally, to account for the possible endogeneity between health and labor force, in this equation we included the variable labor participation.

V. Empirical Strategy and Results

According to the theoretical specification of the model, simultaneity is an important feature in our estimation. It is worth noting that in the labor force participation equation the dependent variable is binary, whereas in the health equation the dependent variable is ordinal (4 categories). If we simplify the model and set aside the ordered part, then we essentially have a bivariate probit type model with full simultaneity, which is "logically inconsistent";

[5] The contributory regime operates as an insurance system that offers a basic health plan. It covers workers with a work contract, pensioners and freelancers. The non-contributory or subsidized regime covers the poorest and most vulnerable people in the country and is funded with public resources (Melo and Ramos, 2010).

[6] "Familias en acción" is a government program addressed to families in poverty and vulnerability, which delivers conditional monetary transfers in order to supplement incomes and improve health and education for children under 18.

see, for example, Maddala (1983, p. 119) and Winkelmann and Boes (2006). Hence, linear probability models and two-stage least squares are our preferred methods of estimation.[7]

Specifically, we estimate the effects of health and labor market outcomes of individuals through instrumental variables and two-stage least squares (IV-2SLS) to address the potential endogeneity between these variables (Laplagne et al., 2007; Cai and Kalb, 2006; Cai, 2010; Bartel and Taubman, 1979). Failure to do so yields biased and inconsistent estimates. In this method of estimation, each equation is separately estimated and all exogenous variables are used as instruments (see Wooldridge, 2006).

We test for the endogeneity of the health variable in the labor participation equation and for the endogeneity of the labor force participation variable in the health equation in order to determine the appropriateness of the estimation method.[8] If the health variable is not endogenous, we estimate a probit model for labor force participation. In turn, if the labor participation variable is not endogenous, we estimate an ordered probit model for health, given that the health status variable has four ordered outcomes, namely poor (0), fair (1), good (2), and excellent (3). The model is estimated for the complete sample of individuals and for four different groups: females aged 13-40, males aged 13-40, females aged 41-65 and males aged 41-65. In all cases, the identification conditions (order and rank) indicate that both equations are overidentified.

Table 2 presents the results of the estimations for the complete sample. Before we describe our main findings, it is worth mentioning that the endogeneity tests for both equations show that the exogeneity hypothesis is rejected.[9] Therefore, estimation through IV-2SLS is

[7] Another method of estimation could be the bivariate probit. However, this method does not allow us to consider neither full simultaneity nor the four categories in the health status variable. Nevertheless, we estimated bivariate probit models assuming two categories of health (good and poor). These results are not reported here but are available upon request. In addition, an alternative method could be three-stage least squares. However, given that estimators are inconsistent when errors are heteroskedastic, we decided against this estimation method.

[8] Before we test for endogeneity, we test for the joint significance of the instruments used to fit the model. Next, we use two tests for endogeneity, the Wooldridge´ score test and a regression-based test of exogeneity, which tolerate heteroskedastic and autocorrelated errors. For more details see Wooldridge (2006), chapter 15, pp.532.

[9] Appendix C presents the tests for the joint significance of the instruments as well as the tests for endogeneity.

appropriate. First, let us consider the labor force participation equation. The effect of health on labor participation is positive and highly significant, indicating that better health increases participation in accordance with the human capital theory. According to the coefficients of age and age squared, labor participation increases with age up to 43 years when it starts to decline. From the point of view of the firms, hiring individuals older than that age could turn out to be more expensive due to the difficulties associated with the deterioration of health that arise during the mature age. As a result, firms offer lower wages which is perceived by the worker, and therefore leads to lower labor participation.

The probability of labor participation of married individuals or couples on a common law marriage is ten percentage points higher than that of the reference category (single, widowed or divorced). The effect of education is positive and statistically significant; the higher the educational degree the higher the probability of participation. We also included other sources of income different from wage income. The availability of this type of income in the household reduces the probability of participating in the labor force. Similarly, this probability decreases if the spouse is in the labor force. Finally, regarding the location of the households, the probability of participation is higher in Bogota, the reference region, than in other parts of the country.

Regarding the health equation, we find that the effect of labor participation on health is positive and significant, suggesting that individuals who participate report a better health status. However, this positive sign may also reflect rationalizing behavior due to the use of the self-assessed health measure as explained by Cai and Kalb (2006) and Laplagne et al. (2007).

Table 2
Results for the complete sample
(IV – 2SLS estimations)

Explanatory variables	Labor force participation equation	Robust standard errors	Health equation	Robust standard errors
Labor force participation			0.2734***	(0.077)
Health	0.1505***	(0.042)		
Age	0.0519***	(0.003)	-0.0134***	(0.000)
Age squared	-0.0006***	(0.000)		
Marital status	0.1064***	(0.015)	0.0295	(0.023)
Technical education (with degree)	0.0546***	(0.021)	0.0251	(0.038)
Technological education (with degree)	0.0607*	(0.033)	0.1502***	(0.052)
University education (with degree)	0.1246***	(0.021)	0.1540***	(0.035)
Postgraduate education (with degree)	0.2091***	(0.029)	0.1010*	(0.060)
Atlantic region	-0.0850***	(0.017)	0.1636***	(0.031)
Eastern region	0.0046	(0.016)	-0.0083	(0.030)
Central region	-0.1398***	(0.018)	0.2466***	(0.029)
Pacific region	-0.0540***	(0.016)	0.0385	(0.030)
Ln(other income)	-0.0030*	(0.001)		
Spouse in labor force	-0.1637***	(0.012)		
Child 0-5	-0.0171	(0.012)		
Ethnic group			0.0169	(0.033)
Socioeconomic stratum			0.0481***	(0.012)
Chronic disease father			-0.1025***	(0.019)
Chronic disease mother			-0.0910***	(0.018)
Contributory health regime			0.1512***	(0.020)
Dwelling location near risky places			-0.0432**	(0.019)
Dwelling affected by natural disasters			-0.0099	(0.030)
"Familias en accion" program	-0.0019	(0.016)	0.1109***	(0.026)
Constant	-0.5495***	(0.121)	2.1931***	(0.095)
Number of observations	8.363		8.363	

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors' calculations.

As to the impact of the exogenous variables on health, we find that, in general, the statistically significant coefficients have the expected sign. More educated people have better health compared with the reference category (less than high school). Education could improve health behaviors in different ways (see for example, Grossman, 2006; Cutler and Lleras-Muney, 2010; Cawley and Ruhm, 2012). People with more education may be better

informed about the negative health consequences of risky behaviors, such as smoking or drinking. Education could also influence these behaviors through the income level and socioeconomic conditions of individuals.

In addition, the socioeconomic stratum, as a proxy for income, has a positive impact on health status, given that individuals with more resources could have access to better health services. Also, those affiliated to the contributory health social security regime have better health compared to those affiliated to the non-contributory (subsidized) regime, which could be due to the difference in the health plans. Similarly, being a beneficiary of the government program "Familias en acción" has a positive impact on health. On the contrary, hereditary factors, such as the presence of chronic diseases in the parents of those surveyed and the location of the residence near hazardous places have a negative effect on health. Lastly, as expected, health deteriorates with age.

Next, we split the sample by gender and age groups; we expect labor force participation and health status to differ among these groups. Table 3 present the results for the labor force participation equations for females 13-40 and females aged 41-65; Table 4 shows the results for males aged 13-40 and males 41-65.[10]

Initially, the estimations were carried out using instrumental variables and two-stage least squares for all groups. Then, endogeneity tests for the health status were performed and the null hypothesis of exogeneity was not rejected for all groups, but for females aged 13-40 (see Appendix C). Thus, in the case of females aged 13-40, health is endogenous to labor participation, indicating that to improve or maintain health status they require resources that depend on their participation in the labor market. This endogeneity could be related to the childbearing age of this group, or could be the result of unobserved characteristics. For example, the desire of having a career can increase the probability of participation, but also make them more vulnerable to health problems related to stress in trying to combine the demands of a career and family responsibilities (Cai and Kalb, 2006). Furthermore, for this

[10] Appendix D presents the marginal effects for the probit estimations.

group, the coefficient indicates that better health increases the probability of labor participation.

Table 3
Females' labor force participation equation by age group

Variables	Females 13-40		Females 41-65	
	IV-2SLS	Robust stand. error	Probit	Robust stand. error
Health	0.2064**	(0.092)		
Fair health (1)			0.1443	(0.140)
Good health (2)			0.2872**	(0.136)
Excellent health (3)			0.2490*	(0.136)
Age	0.0632***	(0.016)	0.2151***	(0.071)
Age squared	-0.0008***	(0.000)	-0.0026***	(0.000)
Marital status	-0.1304**	(0.053)	-0.2768**	(0.110)
Female head of household	0.0554	(0.036)	0.2630***	(0.092)
Technical education (with degree)	0.0624	(0.041)	0.3558***	(0.137)
Technological education (with degree)	-0.0102	(0.065)	0.7923***	(0.221)
University education (with degree)	0.1740***	(0.049)	0.8889***	(0.140)
Postgraduate education (with degree)	0.2049**	(0.089)	0.9617***	(0.209)
Atlantic region	-0.1677***	(0.033)	-0.2979***	(0.092)
Eastern region	-0.0108	(0.032)	-0.0530	(0.091)
Central region	-0.1612***	(0.037)	-0.5047***	(0.084)
Pacific region	-0.1117***	(0.032)	-0.2152**	(0.091)
Ln other income	-0.0073	(0.005)	-0.0086	(0.008)
Spouse in labor force	-0.0297	(0.047)	0.1208	(0.086)
Child 0-5	-0.0856***	(0.022)	-0.1943	(0.133)
"Familias en accion" program	0.0137	(0.029)	0.0573	(0.076)
Constant	-0.8413***	(0.307)	-4.3242**	(1.822)
Number of observations	2429		2415	

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors' calculations.

Table 4
Males' labor force participation equation by age group

Variables	Males 13-40		Males 41-65	
	Probit	Robust stand. error	Probit	Robust stand. Error
Fair health (1)	0.2255	(0.392)	0.4408**	(0.193)
Good health (2)	0.1064	(0.363)	0.5540***	(0.185)
Excellent health (3)	0.3024	(0.361)	0.6681***	(0.186)
Age	0.2485***	(0.084)	0.1684*	(0.086)
Age squared	-0.0039***	(0.001)	-0.0020**	(0.000)
Marital status	0.5932***	(0.160)	0.1510	(0.140)
Technical education (with degree)	0.4340	(0.302)	0.1885	(0.192)
Technological education (with degree)	-0.0728	(0.363)	0.2682	(0.275)
University education (with degree)	-0.2537	(0.209)	0.4028**	(0.185)
Atlantic region	-0.0906	(0.162)	0.1576	(0.126)
Eastern region	0.1662	(0.167)	0.1572	(0.123)
Central region	0.0364	(0.173)	-0.0425	(0.118)
Pacific region	0.0140	(0.163)	0.1117	(0.123)
Ln other income	-0.0270	(0.017)	-0.0267***	(0.009)
Spouse in labor force	-0.1862*	(0.113)	0.1146	(0.079)
Child 0-5	0.1829*	(0.106)	0.1516	(0.140)
"Familias en accion" program	0.0065	(0.130)	-0.0700	(0.106)
Constant	-3.0386**	(1.282)	-2.1907	(2.268)
Number of observations	1676		1919	

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors' calculations.

For the other groups, the exogeneity of health suggests that an individual's health status is independent of participating or not in the labor force. This result could be explained in part by the fact that in 2010 health coverage for the population was almost universal. In the cases where the health variable is exogenous to labor participation (females aged 41-61 and males aged 13-40 and 41-65) we used probit models. For these groups we also present some selected conditional probabilities of labor participation (Table 5).

Table 5
Selected predicted conditional probabilities of labor force participation*

	Females 41-65	Males 13-40	Males 41-65
Health status			
Poor (0)	0.4014	0.6135	0.7091
Fair (1)	0.4393	0.6503	0.8338
Good (2)	0.4973	0.6935	0.8663
Excellent (3)	0.4725	0.7912	0.8894
% change poor to excellent health	17.7%		25.4%
Married	0.4435	0.7587	0.8785
Not married	0.5988	0.6127	0.8189
Children under 5	0.3898	0.9239	0.8946
Without children under 5	0.5089	0.6479	0.8553
University degree	0.7724	0.6812	0.9381
Without university degree	0.4572	0.7333	0.8631
Spouse in labor force	0.4664	0.7798	0.8894
Spouse not in labor force	0.4825	0.6677	0.8384
Married and university degree	0.7518	0.7024	0.9453
Married and without university degree	0.4268	0.7618	0.8748
Married and with children under 5	0.3760	0.9301	0.9002
Married and without children under 5	0.4770	0.6729	0.8677
With children under 5 and university degree	0.7308	0.8758	0.9618
With children under 5 and without university degree	0.3706	0.9267	0.8908
Excellent health and university degree	0.7685	0.7347	0.9468
Excellent health and without university degree	0.4520	0.7952	0.8854

*Note: Predicted conditional probabilities were calculated for those significant variables in the probit estimations.
Source: Authors' calculations.

In general, the effects of the exogenous variables on labor participation when the sample is split by gender and age groups are very similar to those obtained for the complete sample. It is worth highlighting that the positive effect of education on labor participation is more important for females than for males for both age groups: the higher the educational degree, the higher the probability of participation. In particular, for older females and males, the difference in the probability of participation between those with a university degree and those

without it is higher for women (32 percentage points) than for men (8 percentage points) (see Table 5).

The presence of children under the age of 5 in the household does not have an effect on labor participation for males and females over the age of 40. One interesting result is that for younger females having children under the age of five decreases the probability of participation by eight percentage points, compared to those without small children (Table 3), whereas for younger males the presence of children under the age of five increases the probability of labor participation (Table 4). In fact, the difference in the probability of participation for younger males with and without children under five is about 28 percentage points (Table 5). These results could be explained by cultural factors, such as traditional gender attitudes still rooted in several Latin American countries (see for example Contreras and Plaza (2010) for the case of Chile). In particular, the preferences associated with child rearing and the lack of childcare facilities could explain the negative impact on female labor participation, whereas the positive effect on younger males' participation could be explained by the fact that in most households men might be the main breadwinners.

Similarly, the negative impact on female labor participation of being married indicates that the probability of participation reduces with the presence of a partner in the household. On the contrary, the probability of participation in the case of younger males is positive for those married or in a common-law marriage.[11] Furthermore, in the case of older women, being the head of the household has a positive impact on their participation. These results could be also associated to cultural aspects.

Regarding health status, as expected, better health increases the probability of labor participation. Specifically, for females and males aged 41-65 an improvement of health status from poor to excellent increases the probability of participation in about 18% and 25%,

[11] The results for younger males differ from those obtained by Cai and Kalb (2006) for Australia. In particular, while the presence of small children affects the probability of participation negatively in Australia, in Colombia the impact is positive. In addition, for this group, both education and health have a positive effect on labor participation in Australia, whereas neither education nor health has a significant impact on labor participation in Colombia. These results could indicate differences in the labor market as well as cultural factors.

respectively (Table 5). Additionally, for all health status the probability of participation is larger for older males than for older females.

Later, we performed the estimations of the health equations for females and males aged 13-40 and older than 40 years old, respectively (Tables 6 and 7).[12] As in the labor participation equations, we used instrumental variables and two-stage least squares for all groups. The endogeneity tests for labor force participation were performed and the null hypothesis of exogeneity was not rejected for females aged 13-40 and males aged 41-65 (see Appendix C). In these cases we used ordered probit models given that the health variable consists of four categories.[13] Table 8 presents some conditional probabilities of health status.

The endogeneity of labor force participation in the health equation for males aged 13-40 and females aged 41-65 could be the result of rationalization endogeneity and/or unobserved characteristics, as mentioned. Nevertheless, while for males aged 13-40 the positive and significant coefficient could indicate rationalizing behavior, for females aged 40-65 the negative coefficient indicates that if rationalizing behavior exists, it is small, and that bad working conditions and stress associated with the employment offset the possible positive effects of participation. This result is not surprising since older women are less prone to social pressure to attribute non-participation to health problems, as explained by Cai and Kalb (2006).[14] For older males, where labor participation is exogenous to the health status, the probability of having excellent health is higher for those who participate compared to those that do not (Table 8).

[12] Appendix E presents the marginal effects for the ordered probit estimations.

[13] The threshold parameters estimated in all the models are statistically different from one another; therefore, we maintained the four categories for the dependent variables in all the models. A Wald test was used to test the difference among the threshold parameters. The results of the tests, as well as the marginal effects for all models, may be obtained from the authors upon request.

[14] For Australia, Cai and Kalb (2006) find a positive relationship between being in the labor force and self-assessed health for older women, indicating different working conditions between the two countries.

Table 6
Females' health equation by age group

Variables	Females 13-40		Females 41-65	
	Oprobit	Robust stand. error	IV-2SLS	Robust stand. error
Labor force participation	0.0086	(0.050)	-0.6345*	(0.383)
Age	-0.0200***	(0.004)	-0.0261***	(0.007)
Marital status	0.0610	(0.056)	-0.1654**	(0.067)
Technical education (with degree)	0.1176	(0.088)	0.0565	(0.1103)
Technological education (with degree)	0.3630**	(0.151)	0.4566***	(0.134)
University education (with degree)	0.4362***	(0.118)	0.3964***	(0.130)
Graduate education (with degree)	0.3025	(0.241)	0.2895*	(0.165)
Atlantic region	0.1088	(0.080)	0.2079***	(0.078)
Eastern region	-0.0590	(0.074)	0.0239	(0.066)
Central region	0.2564***	(0.084)	0.1798**	(0.088)
Pacific region	0.0235	(0.077)	0.0304	(0.075)
Ethnic group	0.0928	(0.087)	-0.0113	(0.073)
Socioeconomic stratum	0.0341	(0.035)	0.0948***	(0.026)
Chronic disease father	-0.1957***	(0.049)	-0.0233	(0.040)
Chronic disease mother	-0.1145**	(0.049)	-0.0737*	(0.039)
Contributory health regime	0.1837***	(0.051)	0.1392***	(0.043)
Dwelling location near risky places	-0.0279	(0.049)	-0.0917**	(0.040)
Dwelling affected by natural disasters	-0.0280	(0.075)	0.0187	(0.064)
"Familias en accion" program	0.1314**	(0.061)	0.0831	(0.061)
Constant			3.3569***	(0.639)
Number of observations	2430		2363	

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors' calculations.

The effects of the exogenous variables on health status when the sample is split by gender and age groups are very similar to those obtained for the complete sample, with some differences among groups. It is worth mentioning that the positive effect of education on health is more important for females than for males. Moreover, from the ordered probit estimations, the conditional probabilities of having excellent health is about 20 percentage points higher for those with a university degree compared with those without a degree in the case of females aged 13-40 and males aged 41-65 (Table 8).

Table 7
Males' health equation by age group

Variables	Males 13-40		Males 41-65	
	IV-2SLS	Robust stand. error	Oprobit	Robust stand. error
Labor force participation	1.4696*	(0.795)	0.2655***	(0.076)
Age	-0.0116***	(0.003)	-0.0259***	(0.003)
Marital status	-0.1391	(0.106)	-0.1266	(0.104)
Technical education (with degree)	0.0153	(0.077)	-0.0025	(0.134)
Technological education (with degree)	0.0179	(0.126)	0.2522	(0.198)
University education (with degree)	0.1086	(0.080)	0.3295***	(0.105)
Graduate education (with degree)	0.1582	(0.120)	0.2438	(0.151)
Atlantic region	0.0911	(0.065)	0.1770**	(0.090)
Eastern region	-0.0586	(0.062)	-0.0071	(0.088)
Central region	0.1682***	(0.059)	0.3516***	(0.084)
Pacific region	-0.0649	(0.065)	0.0286	(0.087)
Ethnic group	-0.0780	(0.081)	-0.0490	(0.091)
Socioeconomic stratum	0.0199	(0.025)	0.0695*	(0.035)
Chronic disease father	-0.1269***	(0.043)	-0.1755***	(0.052)
Chronic disease mother	-0.0890**	(0.040)	-0.1344**	(0.053)
Contributory health regime	0.1546***	(0.043)	0.2895***	(0.057)
Dwelling location near risky places	-0.0207	(0.039)	-0.0500	(0.056)
Dwelling affected by natural disasters	-0.0431	(0.067)	-0.0003	(0.087)
"Familias en acción" program	0.1074*	(0.054)	0.2552***	(0.077)
Constant	1.4249**	(0.663)		
Number of observations	1659		1916	

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors' calculations.

The socioeconomic stratum in which the household resides has a positive impact on the health of older males and females. Also, being a beneficiary of the government program "Familias en acción" has a positive impact on health for all groups except for females older than 40, since they are less likely to have school-aged children. Similarly, those affiliated to the contributory health social security regime have better health compared to those in the reference group. In contrast, health deteriorates with age in all groups, and so does the presence of chronic diseases in the parents of those surveyed. In particular, for females aged 13-40 and males aged 41-65, the probability of having excellent health is about ten percentage points lower for those whose father or mother have a chronic disease (Table 8).

Table 8
Selected predicted conditional probabilities of health status*

	Females 13-40, health status				Males 41-65, health status			
	Poor (0)	Fair (1)	Good (2)	Excellent (3)	Poor (0)	Fair (1)	Good (2)	Excellent (3)
Participation					0.0162	0.1123	0.3205	0.5510
Non participation					0.0332	0.1709	0.3664	0.4296
University degree	0.0154	0.0871	0.2759	0.6215	0.0053	0.0568	0.2409	0.6970
Without university degree	0.0505	0.1738	0.3504	0.4253	0.0224	0.1348	0.3405	0.5023
Chronic disease father	0.0646	0.1998	0.3615	0.3741	0.0291	0.1582	0.3599	0.4528
Without chronic disease father	0.0378	0.1483	0.3360	0.4779	0.0163	0.1116	0.3179	0.5542
Chronic disease mother	0.0588	0.1900	0.3583	0.3928	0.0272	0.1529	0.3571	0.4628
Without chronic disease mother	0.0379	0.1474	0.3340	0.4807	0.0155	0.1073	0.3121	0.5651
Contributory regime	0.0378	0.1473	0.3341	0.4809	0.0135	0.1003	0.3066	0.5796
Non contributory	0.0602	0.1924	0.3595	0.3879	0.0302	0.1635	0.3658	0.4405

*Note: Predicted conditional probabilities were calculated for those significant variables in the ordered probit estimations.
Source: Authors' calculations.

Moreover, an unexpected result for older women is that being married (or in a common-law marriage) affects their health negatively compared to the reference group. This is surprising since the literature has recognized several advantages of being married on individual health (see for example Hahn (1993) and Pandey (2009)).

VI. Conclusions

This paper analyses the relationship between health status and labor force participation for low and middle income individuals in Colombia by using information from the first wave of the Colombian Longitudinal Survey. To address the potential endogeneity between the two

variables, the analysis is carried out using instrumental variables and two-stage least squares; when endogeneity is rejected, probit and ordered probit models were used instead. The estimations are conducted for the complete sample and, in order to evaluate possible differences due to gender and age, separately for males aged 13-40, males aged 41- 65, females aged 13-40, and females 41-61.

For the complete sample of individuals, the results indicate that there is a positive relationship between health and labor force participation that runs in both directions; in other words, better health status leads to a higher probability of participation in the labor force, and that those who are in the labor market are more likely to report better health.

When the sample is split into different groups according to age and/or gender interesting differences can be uncovered. For example, the results show that in the labor participation equation health is endogenous for females aged 13-40. This endogeneity could be related to the childbearing age of this group, or it could be the result of unobserved characteristics. This group, unlike the others, might face more health issues related to the stress in trying to combine the demands of starting a professional career along with the responsibilities of family life.

For younger females, health status, university and postgraduate education affect the probability of labor participation positively, whereas having children under the age of 5 and being married reduce their probability of participation. These results highlight the importance of education and suggest that traditional gender attitudes could be still prevalent in the Colombian society. On the contrary, for younger males, neither education nor health status affects labor participation. However, for this group, having children under the age of 5 and being married are the most important variables explaining their probability of participation, since in most households, for cultural reasons, men are the main breadwinners. For females and males aged 41-65, both health status and a university degree positively affect their probability of labor participation. The presence of children under 5 is not significant for these groups. In the case of older women, being the head of the household has a positive impact on their participation.

In turn, in the health equation, labor force is endogenous for females 41-65 and males 13-40. In the case of males the endogeneity could be due to rationalizing behavior. For older women, endogeneity and the negative sign of the coefficient suggest that this group is under less social pressure to attribute non-participation to health issues, and that bad working conditions and job-related stress could offset the positive effects of participation. In the case of males aged 41-65, where labor participation is exogenous to health status, those who participate report better health compared to those that do not.

Regarding the impact of other variables, education is significant for all groups except for younger males, indicating the importance of education in improving healthy behaviors and consequently on the overall health status. The socioeconomic stratum, as a proxy for income, is important for older males and females, indicating that for these age groups, individuals with more resources could have access to better health services. Similarly, those affiliated to the contributory regime report better health, compared to those affiliated to the subsidized regime, which could be the result of different health plans. The recently-adopted policy to equalize these plans is a step towards improving the health service. Moreover, it is worth mentioning that the presence of chronic diseases of both father and mother has negative impact on health in all groups.

The evidence presented above suggests that it is essential for public policy to guarantee good health conditions of the population. Good health conditions could also have a positive effect on labor productivity and consequently on long-run economic growth. Moreover, with an ageing population and the possibility of increasing the age of retirement, it is important to guarantee that these individuals have good health in order to participate in a productive way and reduce the burden of social security expenditure to society.

In addition, our results show that education is not only an important determinant of labor participation, as has been traditionally recognized in the literature, but also a significant factor in explaining health status. This result is especially strong for women, suggesting that the greater the human capital, the greater the probability that women will participate in the labor market.

The difference in the results between younger males and females in the labor force participation equation with regard to the presence of children under 5 and marital status (being married or in a common law marriage) suggests the importance of public policies towards women in order to contribute to greater female labor participation and to encourage them to remain in the labor market. These policies, together with a better education, could include a wider availability of childcare facilities and greater labor flexibility.

References

Alvis-Guzmán, N.; Yánez-Contreras, M.; Quejada-Pérez, R.; Acevedo-González, K. and Del Río-Carrasquilla, F. (2010). Fecundidad y participación de la mujer en el mercado laboral en la Costa Caribe y en Colombia, *Revista Gerencia y Políticas de Salud*, vol. 9, num. 19, pp. 90-107.

Amador, D.; Bernal, R. and Peña, X. (2013). The rise in female participation in Colombia: Fertility, marital status or education?, *Ensayos sobre Política Económica*, vol. 31, num. 71, pp. 54-63.

Arango, L. E. and Posada, C. E. (2005). Labour Participation in Colombia, *Applied Economics*, vol. 37, num. 16, pp. 1829-1838.

Arango, L. E. and Posada, C. E. (2007). Labor Participation of Married Women in Colombia, *Revista Desarrollo y Sociedad*, No. 60, pp. 93-126.

Arango, L. E., Posada, C. E., and Charry, A. (2003). La participación laboral en Colombia según la nueva encuesta: ¿cambian sus determinantes?, Banco de la República, Borradores de Economía num. 250.

Bartel, A.; and Taubman, P. (1979). Health and Labor Market Success: The Role of Various Diseases, *The Review of Economics and Statistics*, vol. 61, num. 1, pp. 1-8.

Becker, G.S. (1964). *Human Capital*. Columbia University Press, Nueva York.

Bernal, O.; and Gutiérrez, C. (2012). *La salud en Colombia: logros, retos y recomendaciones*. Universidad de los Andes, Escuela de Gobierno, Ediciones Uniandes, Bogotá.

Cai, L. (2010). The relationship between health and labour force participation: Evidence from a panel data simultaneous equation model, *Labour Economics*, vol. 17, num. 1, pp. 77–90.

Cai, L.; and Kalb, G. (2006). Health Status and Labour Force Participation: Evidence from Australia, *Health Economics*, vol. 15, num. 3, pp. 241-261.

Campolieti, M. (2002). Disability and the labor force participation of older men in Canada, *Labour Economics*, vol. 9, num. 3, pp- 405–432.

Carter, K. N.; Gunasekara, F. I.; Blakely, T.; and Richardson, K. (2013). Health shocks adversely impact participation in the labour force in a working age population: a longitudinal

analysis. *Australian and New Zealand Journal of Public Health*, vol. 37, num. 3, pp. 257-263.

Castro, E.; García, G., and Badillo, E. (2011). La participación laboral de la mujer casada y su cónyuge en Colombia: Un enfoque de decisiones relacionadas, *Lecturas de Economía*, num. 74, pp. 171-201.

Cawley, J. and Ruhm, C. (2012). The Economics of Risky Health Behaviors. In: T. G. McGuire; M. V. Pauly, and P. Pita Barros (eds), Handbook of Health Economics, vol. 2, pp. 95-199, Elsevier: New York.

Contreras, D. and Plaza, G. (2010). Cultural Factors in Women's Labor Force Participation in Chile, *Feminist Economics*, vol. 16, num. 2, pp. 27–46.

Cortez, R. (2000). Health and Productivity in Peru: Estimates by Gender and Region. In: W.D. Savedoff and T.P. Schultz (eds.). *Wealth from Health: Linking Social Investments to Earnings in Latin America*. Inter-American Development Bank, Washington D.C, pp. 189-217.

Currie, J.; and Madrian, B. C. (1999). Health, health insurance and the labor market. In: O. Ashenfelter and D. Card (eds.), Handbook of Labor Economics, edition 1, volume 3, chapter 50, pages 3309-3416, Elsevier.

Cutler, D.A. and Lleras-Muney, A. (2010). Understanding differences in health behaviors by education, *Journal of Health Economics*, vol. 29, num. 1 , pp. 1–28.

Espinosa-Ferrando, J.; Hernandez-Alvarez, C.; and Savedoff, W.D. (2000). Productivity and Health Status in Nicaragua. In: W.D. Savedoff and T.P. Schultz (eds.). *Wealth from Health: Linking Social Investments to Earnings in Latin America*. Inter-American Development Bank, Washington D.C, pp. 219-245.

Forbes, M.; Barker, A.; and Turner, S. (2010). The Effects of Education and Health on Wages and Productivity. Productivity Commission Staff Working Paper, Melbourne. Available at: http://www.pc.gov.au/__data/assets/pdf_file/0009/95778/education-health-effects-wages.pdf (accessed November 28, 2013).

Gonzalez-Quintero, N.; Daza-Baez, N. and Garavito-Calderon, N. (2014). "Determinantes y perfiles de la participación laboral en Colombia: 2002-2013", Archivos de Economía num. 415. Departamento Nacional de Planeación. Bogotá.

Grossman, M. (1972). The Demand for Health. National Bureau of Economic Research, Occasional Paper No. 119. New York: Columbia University Press.

Grossman, M. (2006). Education and nonmarket outcomes. In: E. A. Hanushek and F. Welch (eds.). Handbook of the Economics of Education, vol. 1, pp. 577-633, Elsevier.

Guerrero, R.; Gallego, A. I.; Becerril-Montekio, V.; and Vásquez, J. (2011). Sistema de salud de Colombia. *Salud Pública de México*, vol. 53, num. 2, pp. 144-155.

Hahn, B.A. (1993). Marital Status and Women's Health: The Effect of Economic Marital Acquisitions, *Journal of Marriage and Family*, vol. 55, num. 2, pp. 495-504.

Handa, S. and Neitzert, M. (1998). Chronic Illness and Retirement in Jamaica. Living Standards Measurement Study Working Paper No.131, The World Bank, Washington DC. Available at: http://elibrary.worldbank.org/doi/pdf/10.1596/0-8213-4087-5 (accessed September 11, 2014)

Harris, A. (2009). Diabetes, Cardiovascular Disease and Labour Force Participation in Australia: An Endogenous Multivariate Probit Analysis of Clinical Prevalence Data, *The Economic Record*, vol. 85, num. 271, pp. 472–484.

Holt, H. (2010). Health and Labour Force Participation. New Zealand Treasury Working Paper 10/03. Available at: http://www.treasury.govt.nz/publications/research-policy/wp/2010/10-03/twp10-03.pdf (November 29, 2013).

Jäckle, R. and Himmler, O. (2010). Health and Wages: Panel Data Estimates Considering Selection and Endogeneity, *Journal of Human Resources*, vol. 45, num. 2, pp. 364-406.

Laplagne, P.; Glover, M.; and Shomos, A. (2007). Effects of Health and Education on Labour Force Participation. Productivity Commission Staff Working Paper, Melbourne. Available at: http://www.pc.gov.au/__data/assets/pdf_file/0019/63190/healthandeducation.pdf (accessed November 13, 2013).

López, Hugo (1995). Participación laboral y desempleo en las cuatro principales ciudades: un modelo econométrico. In: Hugo López (ed.), Ensayos sobre Economía Laboral Colombiana, FONADE and Carlos Valencia Editores. pp. 36-44.

Maddala, G.S. (1983). *Limited-dependent and qualitative variables in econometrics*. Econometric Society Monographs No. 3, Cambridge University Press, Cambridge.

Martinez, C. (2013). Descenso de la fecundidad, participación laboral de la mujer y reducción de la pobreza en Colombia, 1990 – 2010, *Serie de Estudios a Profundidad ENDS 1990 – 2010,* Bogotá.

Melo, L. and Ramos, J. (2010). Algunos aspectos fiscales y financieros del sistema de salud en Colombia. Banco de la República, Borradores de Economía No. 624.

Mete, C. and Schultz, T. P. (2002). Health and labor force participation of the elderly in Taiwan. Yale University Economic Growth Center Discussion Paper No. 846. Available at: http://www.econ.yale.edu/growth_pdf/cdp846.pdf (accessed September 11, 2014).

Murrugarra, E. and Valdivia, M. (2000). The Returns to Health for Peruvian Urban Adults by Gender, Age, and across the Wage Distribution. In: W.D. Savedoff and T.P. Schultz (eds.). *Wealth from Health: Linking Social Investments to Earnings in Latin America*. Inter-American Development Bank, Washington D.C, pp. 151-187.

Pandey, M.K. (2009). Labor Force Participation among Indian Elderly: Does Health Matter?. ASARC working paper series no. 2009/11, Australia South Asia Research Centre, Australian National University, Canberra, Australia. Available at: https://taxpolicy.crawford.anu.edu.au/acde/asarc/pdf/papers/2009/WP2009_11.pdf (accessed September 11, 2014).

Parker, S. W. (2000). Elderly Health and Salaries in the Mexican Labor Market. In: W.D. Savedoff and T.P. Schultz (eds.). *Wealth from Health: Linking Social Investments to Earnings in Latin America*. Inter-American Development Bank, Washington D.C, pp. 71-109.

Ribero, R. (2000). Salud y productividad laboral en Colombia, *Revista Desarrollo y Sociedad* núm. 45, pp. 1-30.

Ribero, R.; and Nuñez, J. (2000). Productivity and Household Investment in Health - The Case of Colombia. In: W.D. Savedoff and T.P. Schultz (eds.). Wealth from Health: Linking Social Investments to Earnings in Latin America. Inter-American Development Bank, Washington D.C.

Robbins, D.; Salinas, D.; and Manco, A. (2009). La oferta laboral femenina y sus determinantes: evidencia para Colombia con estimativas de cohortes sintéticas, *Lecturas de Economía*, vol. 70, pp. 137-163.

Santamaría, M. and Rojas, N. (2001). La participación laboral: ¿qué ha pasado y qué podemos esperar?, *Planeación y Desarrollo*, vol. 32, pp. 5-34.

Savedoff, W.D. and Schultz, T.P. (eds.) (2000). Wealth from Health: Linking Social Investments to Earnings in Latin America. Inter-American Development Bank, Washington D.C.

Schultz, T.W. (1961). Investment in human capital, *The American Economic Review*, vol. 51, num. 1, pp. 1-17.

Stern, S. (1989). Measuring the Effect of Disability on Labor Force Participation, *The Journal of Human Resources*, vol. 24, num. 3, pp. 361-395.

Strauss, J. and Thomas, D. (1998). Health, Nutrition, and Economic Development, *Journal of Economic Literature*, vol. 36, num. 2, pp. 766-817.

Tenjo, J. and Ribero, R. (1998). Participación, desempleo y mercados laborales en Colombia, Archivos de Macroeconomía num. 81, Departamento Nacional de Planeación, Bogotá.

van Gameren, E. (2010). Labor Force Participation by the Elderly in Mexico. Serie documentos de trabajo, Centro de Estudios Económicos, El Colegio de México, Documento de trabajo 2010-06. Available at: http://cee.colmex.mx/documentos/documentos-de-trabajo/2010/dt20106.pdf (accessed September 11, 2014).

Weil, D.N. (2014). Health and Economic Growth. In P. Aghion and S. N. Durlauf (eds.), Handbook of Economic Growth, Volume 2B, Elsevier, Amsterdam, pp. 623-682.

Winkelmann, R. and Boes, S. (2006). *Analysis of Microdata*. Springer, Berlin.

Wooldridge, J.M. (2006). *Introductory Econometrics: A Modern Approach*. Thomson South-Western, Third Edition. Mason, Ohio.

Zhang, X.; Zhaoa, X.; and Harris, A. (2009). Chronic diseases and labour force participation in Australia. *Journal of Health Economics*, vol. 28, num. 1, pp. 91–108.

Appendix A

Cross tabulations of labor force participation and self-assessed health

	Excellent (3)	Good (2)	Fair (1)	Poor (0)	Total
Complete sample					
In labor force	2986	2047	834	158	6025
Not in labor force	1098	849	480	122	2549
Observations	4084	2896	1314	280	8574
Male					
In labor force	1746	1071	398	65	3280
Not in labor force	143	147	67	22	379
Observations	1889	1218	465	87	3659
Male aged 13-40					
In labor force	977	455	133	23	1588
Not in labor force	52	38	8	3	101
Observations	1029	493	141	26	1689
Male aged 41-65					
In labor force	769	616	265	42	1692
Not in labor force	91	109	59	19	278
Observations	860	725	324	61	1970
Female					
In labor force	1240	976	436	93	2745
Not in labor force	955	702	413	100	2170
Observations	2195	1678	849	193	4915
Female aged 13-40					
In labor force	725	485	186	41	1437
Not in labor force	549	327	144	39	1059
Observations	1274	812	330	80	2496
Female aged 41-65					
In labor force	515	491	250	52	1308
Not in labor force	406	375	269	61	1111
Observations	921	866	519	113	2419

Source: Colombian Longitudinal Survey of the Universidad de los Andes (ELCA); authors' calculations.

Appendix B
Variables used in the model

Table B1
Description of Variables

Variables	Description
Endogenous variables	
Labor force participation	1 if the individual participates in the labor market 0 otherwise
Health status	Self-assessed health status 0 = poor health 1 = fair health 2 = good health 3 = excellent health
Explanatory variables	
Age	Individual's age in years at the time of the survey
Marital Status	1 if married or on a common-law marriage 0 otherwise
Woman head of household	1 if a woman is the head of the household 0 otherwise
Technical education (with degree)	1 if individual completed a technical degree 0 otherwise
Technological education (with degree)	1 if individual completed a technological degree 0 otherwise
University education (with degree)	1 if individual completed a university degree 0 otherwise
Postgraduate education (with degree)	1 if individual completed a postgraduate degree 0 otherwise
Atlantic Region	1 if household is located in the Atlantic region 0 otherwise
Eastern Region	1 if household is located in the Eastern region 0 otherwise
Central Region	1 if household is located in the Central region 0 otherwise
Pacific Region	1 if household is located in the Pacific region 0 otherwise
Bogota	1 if household is located in Bogota 0 otherwise
Ln(other income)	Logarithm of other sources of income, different from labor income. It includes income from renting property, interests or dividends.

Table B1
Description of Variables (Cont.)

Variables	Description
Spouse in labor force	1 if spouse participates in the labor force 0 otherwise
Child 0-5	1 if the household has children under the age of 5 0 otherwise
Ethnic group	1 if the individual does not consider himself / herself *raizal* from the archipelago, gypsy, indigenous, *palenquero*, black, and mulatto (Afro-descendants). 0 otherwise
Socioeconomic strata	Takes values 1, 2, 3, and 4. The survey excludes strata 5 and 6. Where level 1 corresponds to the lowest socioeconomic stratum and 6 to the highest stratum.
Chronic disease father	1 if the father had/has a chronic disease 0 otherwise
Chronic disease mother	1 if the mother had/has a chronic disease 0 otherwise
Contributory health regime	1 if the individual is affiliated to the contributory health social security regime 0 otherwise
Dwelling location near risky places	1 if the dwelling is close to factories or industries, dumps, marketplaces or slaughterhouses, bus terminals, airports, sewage pipes, sewage treatment plants, hydrocarbon transportation routes (pipelines), and high voltage power lines (power plants) 0 otherwise
Dwelling affected by natural disasters	1 if the dwelling has been effected by floods; avalanches, landslides or mudslides; overflows, swells of rivers, streams; land subsidence; tremors or earthquakes 0 otherwise
"Familias en acción" program[1/]	1 if the household receives or was beneficiary of the program 0 otherwise

[1/] "Familias en acción" is a government program addressed to families in poverty and vulnerability, which delivers conditional monetary transfers in order to supplement incomes and improve health and education of children under 18.

Table B2
Summary of descriptive statistics

	Males 13-40		Females 13-40		Males 41-65		Females 41-65		Total sample	
Variables	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Labor force participation	0.940	0.237	0.576	0.494	0.859	0.348	0.541	0.498	0.703	0.457
Health	2.210	0.825	2.314	0.820	2.210	0.825	2.073	0.882	2.258	0.833
Age	31.7	5.6	30.7	6.1	50.8	6.6	50.1	6.4	41.0	11.5
Marital Status	0.915	0.279	0.777	0.416	0.927	0.260	0.665	0.472	0.807	0.395
Woman head of household	0.000	0.000	0.318	0.466	0.000	0.000	0.438	0.496	0.216	0.412
Technical education (with degree)	0.053	0.225	0.073	0.259	0.039	0.193	0.042	0.200	0.052	0.223
Technological education(with degree)	0.021	0.142	0.028	0.164	0.021	0.144	0.019	0.137	0.022	0.148
University education (with degree)	0.050	0.217	0.046	0.211	0.061	0.239	0.052	0.221	0.052	0.222
Graduate education (with degree)	0.008	0.087	0.010	0.100	0.024	0.153	0.023	0.149	0.016	0.127
Atlantic Region	0.227	0.419	0.225	0.418	0.223	0.416	0.199	0.400	0.218	0.413
Eastern Region	0.218	0.413	0.222	0.416	0.190	0.392	0.190	0.392	0.205	0.404
Central Region	0.169	0.375	0.163	0.369	0.214	0.410	0.255	0.436	0.202	0.401
Pacific Region	0.213	0.410	0.218	0.413	0.197	0.398	0.179	0.384	0.201	0.401
Bogota	0.172	0.378	0.172	0.378	0.176	0.381	0.177	0.381	0.174	0.379
Ln (other income)	0.468	2.407	0.392	2.175	1.224	3.754	1.032	3.451	0.778	3.039
Spouse in labor force	0.475	0.500	0.718	0.450	0.475	0.499	0.532	0.499	0.562	0.496
Child 0-5	0.543	0.498	0.520	0.500	0.115	0.319	0.044	0.206	0.297	0.457
Ethnic group	0.917	0.276	0.916	0.278	0.909	0.288	0.919	0.274	0.915	0.279
Socioeconomic stratum	1.988	0.833	2.006	0.826	2.162	0.882	2.222	0.874	2.099	0.860
Chronic disease father	0.308	0.462	0.342	0.474	0.429	0.495	0.461	0.499	0.389	0.488
Chronic disease mother	0.397	0.489	0.434	0.496	0.530	0.499	0.585	0.493	0.491	0.500
Contributory health regime	0.557	0.497	0.485	0.500	0.547	0.498	0.550	0.498	0.532	0.499
Dwelling location near risky places	0.395	0.489	0.399	0.490	0.394	0.489	0.390	0.488	0.395	0.489
Dwelling affected by natural disasters	0.120	0.325	0.123	0.329	0.106	0.308	0.105	0.306	0.113	0.317
“Familias en acción” program	1.772	0.420	1.751	0.433	1.823	0.382	1.840	0.366	1.797	0.402
No. of observations	1689		2496		1970		2419		8574	

Source: Colombian Longitudinal Survey of the Universidad de los Andes (ELCA); authors’ calculations.

Appendix C

Tests for the joint significance of instruments and endogeneity

	Labor force participation equation		Health equation
Complete sample			
First stage test for the joint significance of instruments			
F Robust(7, 8340)	25.95	F Robust(4, 8340)	147.23
Prob > F	0.0000	Prob > F	0.0000
Tests of endogeneity (Ho: variables are exogenous) [1/]			
Robust Score Chi2(1)	7.48	Robust Score Chi2(1)	3.80
P value	0.0062	P value	0.0513
Robust regression F(1, 8345)	7.48	Robust regression F(1, 8342)	3.80
P value	0.0062	P value	0.0512
Females 13-40			
First stage test for the joint significance of instruments			
F Robust(7, 2405)	6.26	F Robust(5, 2405)	7.60
Prob > F	0.0000	Prob > F	0.0000
Tests of endogeneity (Ho: variables are exogenous) [1/]			
Robust Score Chi2(1)	5.32	Robust Score Chi2(1)	0.20
P value	0.0210	P value	0.6557
Robust regression F(1, 2410)	5.3176	Robust regression F(1, 2408)	0.20
P value	0.0212	P value	0.6571
Females 41-65			
First stage test for the joint significance of instruments			
F Robust(7, 2339)	6.60	F Robust(5, 2339)	5.21
Prob > F	0.0000	Prob > F	0.0001
Tests of endogeneity (Ho: variables are exogenous) [1/]			
Robust Score Chi2(1)	0.01	Robust Score Chi2(1)	3.92
P value	0.9067	P value	0.0476
Robust regression F(1, 2344)	0.01	Robust regression F(1, 2342)	3.91
P value	0.9070	P value	0.0482

Appendix C (Cont.)

Tests for the joint significance of instruments and endogeneity

	Labor force participation equation		Health equation
Males 13-40			
First stage test for the joint significance of instruments			
F Robust(7, 1636)	5.77	F Robust(4, 1636)	3.53
Prob > F	0.0000	Prob > F	0.0071
Tests of endogeneity (Ho: variables are exogenous) [1/]			
Robust Score Chi2(1)	0.21	Robust Score Chi2(1)	3.59
P value	0.6442	P value	0.0582
Robust regression F(1, 1641)	0.21	Robust regression F(1, 1638)	3.61
P value	0.6460	P value	0.0578
Males 41-65			
First stage test for the joint significance of instruments			
F Robust(7, 1889)	8.03	F Robust(4, 1889)	6.08
Prob > F	0.0000	Prob > F	0.0001
Tests of endogeneity (Ho: variables are exogenous) [1/]			
Robust Score Chi2(1)	0.06	Robust Score Chi2(1)	0.25
P value	0.8122	P value	0.6158
Robust regression F(1, 1894)	0.06	Robust regression F(1, 1891)	0.25
P value	0.8131	P value	0.6173

[1/]The endogeneity tests correspond to the Wooldridge´ score test and a regression-based test of exogeneity.

Appendix D
Marginal effects probit estimations

Table D1
Labor force participation equations
Marginal effects at means by gender and age group

Variables	Females 41-65		Males 13-40		Males 41 - 65	
	dy/dx	Standard error	dy/dx	Standard error	dy/dx	Standard error
Fair health (1)	0.058	0.056	0.029	0.056	0.127**	0.062
Good health (2)	0.114**	0.054	0.015	0.054	0.152**	0.060
Excellent health (3)	0.099*	0.054	0.037	0.054	0.174***	0.060
Age	0.085***	0.028	0.026***	0.009	0.035*	0.018
Age squared	-0.001***	0.000	-0.000***	0.000	-0.000**	0.000
Marital status	-0.110**	0.043	0.062***	0.017	0.031	0.029
Female head of household	0.104***	0.036				
Technical education (with degree)	0.141***	0.054	0.046	0.032	0.039	0.040
Technological education (with degree)	0.314***	0.088	-0.008	0.038	0.055	0.057
University education (with degree)	0.352***	0.055	-0.027	0.022	0.083**	0.038
Postgraduate education (with degree)	0.381***	0.083				
Atlantic region	-0.118***	0.036	-0.010	0.017	0.032	0.026
Eastern region	-0.021	0.036	0.018	0.018	0.032	0.025
Central region	-0.200***	0.033	0.004	0.018	-0.009	0.024
Pacific region	-0.085**	0.036	0.002	0.017	0.023	0.025
Ln other income	-0.003	0.003	-0.003	0.002	-0.006***	0.002
Spouse in labor force	0.048	0.034	-0.020*	0.012	0.024	0.016
Child 0-5	-0.077	0.053	0.019*	0.011	0.031	0.029
“Familias en accion” program	0.023	0.030	0.001	0.014	-0.014	0.022

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors’ calculations.

Appendix E
Marginal effects ordered probit estimations

Table E1
Females 13-40 health equation
Marginal effects at means by health status category

Variables	Poor health (0)		Fair health (1)		Good health (2)		Excellent health (3)	
	dy/dx	Standard error	dy/dx	Standard error	dy/dx	Standard error	dy/dx	Standard error
Labor force participation	-0.001	0.003	-0.002	0.009	-0.001	0.007	0.003	0.019
Age	0.001***	0.000	0.003***	0.001	0.003***	0.001	-0.008***	0.002
Marital status	-0.004	0.004	-0.010	0.010	-0.009	0.008	0.023	0.022
Technical education (with degree)	-0.008	0.006	-0.020	0.015	-0.017	0.013	0.045	0.034
Technological education (with degree)	-0.024**	0.010	-0.062**	0.026	-0.053**	0.022	0.139**	0.058
University education (with degree)	-0.029***	0.009	-0.074***	0.020	-0.063***	0.017	0.167***	0.045
Graduate education (with degree)	-0.020	0.016	-0.052	0.041	-0.044	0.035	0.116	0.092
Atlantic region	-0.007	0.005	-0.019	0.014	-0.016	0.012	0.042	0.031
Eastern region	0.004	0.005	0.010	0.013	0.009	0.011	-0.023	0.028
Central region	-0.017***	0.006	-0.044***	0.015	-0.037***	0.012	0.099***	0.032
Pacific region	-0.002	0.005	-0.004	0.013	-0.003	0.011	0.009	0.030
Ethnic group	-0.006	0.006	-0.016	0.015	-0.013	0.013	0.036	0.033
Socioeconomic stratum	-0.002	0.002	-0.006	0.006	-0.005	0.005	0.013	0.014
Chronic disease father	0.013***	0.004	0.033***	0.008	0.028***	0.007	-0.075***	0.019
Chronic disease mother	0.008**	0.003	0.020**	0.008	0.017**	0.007	-0.044**	0.019
Contributory health regime	-0.012***	0.004	-0.031***	0.009	-0.027***	0.008	0.070***	0.020
Dwelling location near risky places	0.002	0.003	0.005	0.008	0.004	0.007	-0.011	0.019
Dwelling affected by natural disasters	0.002	0.005	0.005	0.013	0.004	0.011	-0.011	0.029
"Familias en accion" program	-0.009**	0.004	-0.022**	0.011	-0.019**	0.009	0.050**	0.024

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors' calculations.

Table E2
Males 41-65 health equation
Marginal effects at means by health status category

Variables	Poor health (0)		Fair health (1)		Good health (2)		Excellent health (3)	
	dy/dx	Standard error	dy/dx	Standard error	dy/dx	Standard error	dy/dx	Standard error
Labor force participation	-0.017***	0.005	-0.052***	0.015	-0.029***	0.009	0.098***	0.028
Age	0.002***	0.000	0.005***	0.001	0.003***	0.000	-0.010***	0.001
Marital status	0.008	0.007	0.025	0.020	0.014	0.012	-0.047	0.038
Technical education (with degree)	0.000	0.009	0.000	0.026	0.000	0.015	-0.001	0.050
Technological education (with degree)	-0.016	0.013	-0.049	0.039	-0.028	0.022	0.093	0.073
University education (with degree)	-0.021***	0.007	-0.064***	0.021	-0.036***	0.012	0.121***	0.039
Graduate education (with degree)	-0.016	0.010	-0.047	0.030	-0.027	0.017	0.090	0.056
Atlantic region	-0.011*	0.006	-0.034**	0.018	-0.020*	0.010	0.065**	0.033
Eastern region	0.000	0.006	0.001	0.017	0.001	0.010	-0.003	0.033
Central region	-0.022***	0.006	-0.068***	0.017	-0.039***	0.009	0.130***	0.031
Pacific region	-0.003	0.006	-0.006	0.017	-0.003	0.010	0.011	0.032
Ethnic group	0.003	0.006	0.010	0.018	0.005	0.010	-0.018	0.034
Socioeconomic stratum	-0.004*	0.002	-0.014*	0.007	-0.008*	0.004	0.026*	0.013
Chronic disease father	0.011***	0.004	0.034***	0.010	0.019***	0.006	-0.065***	0.019
Chronic disease mother	0.009**	0.003	0.026**	0.011	0.015**	0.006	-0.050**	0.020
Contributory health regime	-0.018***	0.004	-0.056***	0.011	-0.032***	0.006	0.107***	0.021
Dwelling location near risky places	0.003	0.004	0.010	0.011	0.006	0.006	-0.018	0.021
Dwelling affected by natural disasters	0.000	0.006	0.000	0.017	0.000	0.010	-0.000	0.032
"Familias en accion" program	-0.016***	0.005	-0.050***	0.015	-0.028***	0.009	0.094***	0.028

*** p<0.01. ** p<0.05. * p<0.1.
Source: Authors' calculations.