INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY STUDIES ON MANAGEMENT, BUSINESS, AND ECONOMY

VOLUME 6, ISSUE 2, 2023, 88 – 118

Print ISSN 2735-5438

Online ISSN 2735-5446

Returns to Health Improvement: The Impact on Wages in Egypt's Private Sector

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Abstract

Health is hypothesised to positively affect wages of individuals through an enhancement of their productivity levels. Using a self-perceived measure of health, which rates an individual's own health state from excellent to very bad, based on the postulated positive relationship between better health and productivity improvements, and Egypt's labour market data for the years 2012 and 2018 and utilising a Maximum Likelihood Estimation method, we address two issues, the endogeneity of health in the estimation of wages and a sample selection bias. Our findings indicate the great value that better health has in enhancing wage levels in Egypt's private sector. Also, we find that overlooking the endogeneity of health under-estimates its effect on wages, but the effect of the sample selection bias seems insignificant. Thus, the improvement of health states is likely to be beneficial in improving labour market outcomes, in terms of wages as well as labour productivity, in Egypt.

Keywords: Labour productivity; wages; health; endogeneity; sample selection.
JEL: I10; J01; J24;

1. Introduction

The impact of health on wages, through labour productivity, is important in the context of labour markets. It is especially so in Egypt due to the low levels of labour productivity, which represents an obstacle to Egypt's economic growth and prosperity (Morsy et al., 2015). Moreover, examining the determinants of wages, which are likely the primary reason individuals choose to engage in labour market activities, tends to be useful in determining ways to improve labour market outcomes. Yet, this is usually difficult, with respect to individual labour productivity, which is often unobservable. One potential way to overcome this difficulty is to inspect individuals' health. This choice is based on health's link to

productivity. Specifically, healthier individuals are expected to exert more effort and be more productive in the labour market, a relationship verified by a wide range of studies (Grossman, 1972; Grossman & Benham, 1974; Bloom & Canning, 2000; Cole & Neumayer, 2006; Glick & Sahn, 1998). Thus, we use data from the Egypt Labour Market Panel Survey (ELMPS) to address the following research question, what is the impact of better health on wages in Egypt's private sector? This allows drawing inferences regarding labour productivity's impact on wages.

There are three notes to make at this stage. First, we focus on Egypt's private sector as it is relatively more competitive and market-oriented than other sectors (Assaad, 1997), thus we expect this health—labour productivity—wages link to exist only in this particular sector. Second, we address two biases, sample selection and endogeneity. The sample selection bias is due to the non-random sample resulting from individuals who experience extreme bad health conditions, and thus opt out of the labour force altogether and are unobservable in our analysis of wages. The endogeneity bias is due to the reverse causality resulting from better health allowing more earnings by improving performance and productivity levels, while simultaneously higher income allowing more investment in healthcare and maintaining a better state of health, feeding back into productivity and wages. In order to eliminate both biases, we utilise a simultaneous system of estimation technique, namely a Maximum Likelihood Estimation (MLE). Third, we expand on previous research (Shemeis, 2018) that used the ELMPS cross-sectional data, by utilising the ELMPS panel data, allowing us to capture the impact of individual heterogeneity.

Plenty of reasons render the significance of this topic. For instance, low wages represent a critical problem in Egypt (Kandil & Helmy, 2012), which is likely to represent a significant detriment to the Egyptian population's well-being. This issue becomes even more substantial seeing that waged and salaried workers represented 68.6% of total employed labour in Egypt in 2019 (World Bank, 2022), implying that wages influence the lives of a large share of the Egyptian population. Similarly, focusing on the private sector is valuable, as it employs a large share of Egypt's labour force, based on the nationally-representative sample of the ELMPS (Economic Research Forum [ERF] and Central Agency for Public Mobilisation and Statistics [CAPMAS], 2019). On a larger scale, inadequate income may have significant drawbacks in terms of the instability of the economy, as Egypt had witnessed during the 2011 revolution. Finally, the results of the impact of health may be used to proxy for labour productivity, which has seldom been addressed in the context of Egypt's wage determination literature (Assaad, 1997; Said, 2007; 2015; El-Ghamrawy & Amer, 2011), due to the hypothesised relationship between health and labour productivity.

The rest of this paper is structured as follows. Section (2) reviews the relevant literature, while section (3) introduces the econometric model. Sections (4) and (5) then outline the method and data utilised in our analysis, respectively. Thereafter, section (6) illustrates and discusses our model's results, and section (7) concludes the paper.

2. Literature Review

A large body of literature addressed the relationship between health and wages. Earlier literature (Hadley & Osei, 1982; Duleep, 1986; Ettner, 1996) largely focused on the impact of wages on health. As the health factor increased in popularity, the general wage determination literature expanded to explicitly consider the impact of improved health states on wages, similar to our research question, across many countries and by using a wide range of samples (Flores et al., 2020; Contoyannis & Rice, 2001; Gambin, 2004; 2005; Hsieh et al., 2012; Kedir, 2008; Thomas & Strauss, 1997; Cai, 2009; Lye & Hirschberg, 2007; Lee, 1982; Haveman et al., 1994; Berkowitz et al., 1983; Gao & Smyth, 2010; Alcan & Özsoy, 2020; Sabia & Rees, 2012; Pelkowski & Berger, 2004).

A challenge that confronts authors addressing this topic is the choice of the health measure to use. Various authors (Alcan & Özsoy, 2020; Ettner, 1996; Contoyannis & Rice, 2001; Cai, 2009; Gambin, 2004; 2005; Hsieh et al., 2012) used a scale-measure of self-perceived health states. Likewise, Jäckle and Himmler (2010) used a scale-measure of health satisfaction. Still, some authors used measures of height and weight (Kedir, 2008; Thomas & Strauss, 1997; Sabia & Rees, 2012; Gao & Smyth, 2010), mortality rates (Hadley & Osei, 1982; Duleep, 1986), disability measures (Baldwin & Johnson, 1994; Walker & Thompson, 1996), or even alcoholism (Lye & Hirschberg, 2007; Mullahy & Sindelar, 1995; Ettner, 1996; Barrett, 2002).

Although all health measures have a logical basis for their choice, they are all equally criticised. For instance, disabilities represent a special case of health, which is governed by numerous rules and laws to ensure fairness in the workplace, and disabled people may not be less effective on the job if their disability does not interfere with their work tasks. Hence, earnings may not be affected by disabilities, which Walker and Thompson (1996) verified in their analysis. Yet, a counterargument is that disabilities might deter a person's accessibility to higher-paying jobs. Jäckle and Himmler (2010) have criticised the self-perceived health measure, stating that it may not be entirely representative of actual health and may result in a measurement error. Thus, determining the health measure to use is challenging and requires a number of assumptions.

The endogeneity of health in the estimation of wages, which results from reverse causality and the lagged effect of health (Jäckle & Himmler, 2010), renders

single equation models, such as Ordinary Least Squares (OLS), biased. This shortcoming was pronounced in a number of researches (Contoyannis & Rice, 2001; Hsieh et al., 2012). Consequently, several authors (Grossman & Benham, 1974; Lee, 1982; Haveman et al., 1994; Goldsmith et al., 2000) utilised simultaneous equation frameworks to deal with this endogeneity. For instance, Goldsmith et al. (2000) estimated a wage and effort equations simultaneously using a Two-Stage Least Squares (2SLS) method. Similarly, Gao and Smyth (2009) used 2SLS and compared its results to those of an OLS model. A challenge with this type of models is the instrumentation of health by factors that affect health, but not wages, to adhere to the exclusion restrictions. Cai (2009), Thomas and Strauss (1997), Contoyannis and Rice (2001), and Jäckle and Himmler (2010) instrumented the relevant health measures in order to deal with the endogeneity and measurement biases. Another method to correct for endogeneity as well as other unobserved factors' biases and unobserved heterogeneity is by using panel data (Gambin, 2005; Jäckle & Himmler, 2010; Forbes et al., 2010).

Although most studies confirmed a significantly positive relationship between health and wages, the magnitude of health's impact on wages relevant to other factors has varied. Additionally, studies utilising simultaneous models find that overlooking the endogeneity of health underestimates its effect on wages (Gao & Smyth, 2009). Moreover, Swamy (1997) criticised the disregard of the value of health in wage determination and productivity studies.

3. Econometric Model

This section demonstrates the wage and health equations, which are utilised to answer our research question, as well as the selection equation utilised to address sample selection.

3.1. Wage Equation

Our main equation of interest is an extended form of a linear Mincer-type wage equation (Mincer, 1974), where the logarithm of hourly wages is regressed on factors that we expect to affect wages. This equation is identified as follows:

$$\boldsymbol{LOG(w_i) = a + \beta_1(H_i) + \beta_2(X_i) + \beta_3(C_i) + \beta_4(J_i) + \mu_i} \quad \textbf{(EQ.I)}$$

Where,

$LOG(w_i)$ – Logarithm of hourly wages of individual *i*
H_i – Self-perceived health state of individual *i*
X_i – Individual characteristics of individual *i*
C_i – Human capital characteristics of individual *i*
J_i – Job characteristics of individual *i*
β – Coefficients
a – Constant term
μ – Error terms

The dependent variable of EQ.I is the individuals' logarithm of hourly wages [$LOG(w_i)$], which we use in this form to minimise the impact of outliers on the results, and the main independent variable of interest is the individuals' self-perceived health states (H). Additionally, we control for individual (X), human capital (C), and job (J) characteristics.

3.2. Health Equation

To address health's endogeneity in the wage equation, we use a health equation, identified as,

$$\boldsymbol{H_i = \beta_1(X_i) + \beta_2(C_i) + \beta_3(Z_i) + \mu_i} \qquad \textbf{(EQ.II)}$$

Where,

Z_i – Health instruments of individual *i*

EQ.II, which is non-linear due to the discrete ordered nature of the dependent variable, regresses the individuals' self-perceived health states (H) on the individual (X) and human capital (C) characteristics, and the health instruments (Z), factors likely to impact health but not wages.

3.3. Selection Equation

Finally, we identify a selection equation, to address the sample selection bias, as follows,

$$\boldsymbol{Pr(y_i = 1|x_i) = Pr[(a + \beta_1(X_i) + \beta_2(C_i) + \beta_3(L_i) + \mu_i]} \qquad \textbf{(EQ.III)}$$

Where,

$y_i = 1$ – Participation into the labour force for individual *i*

L_i – Selection instruments of individual *i*

EQ.III is also non-linear, however, the dependent variable is binary, representing the probability of labour force participation, based on the standard market definition. We regress that over individual (X) and human capital (C) characteristics as well as the selection instruments (L). Like EQ.II, these instruments should significantly impact participation, but not wages or health.

4. Methodology

We begin this section by reviewing the methodological issues, sample selection and endogeneity. Thereafter, we illustrate our method of estimation, MLE.

4.1. Sample Selection Bias

The sample selection bias arises from disregarding a proportion of the sample, for which our dependent variable of interest is unobservable. Specifically, individuals suffering from extreme bad health may opt out of the labour market completely, and hence their wages are unobservable, and unaccounted for in EQ.I. Since unobservable factors affecting the choice to join the labour market may also affect wages earned, we need to correct for any resulting bias from selection.

4.2. Endogeneity Bias

Better health, reflected in productivity improvements, may improve wages received by labour. Meanwhile, higher-earning individuals are likely to invest more in healthcare and maintain better health. Consequently, this reverse causality may bias EQ.I's estimates. Also, workers' awareness of the effect of better health on wages may lead rational individuals to increase their investment in health (Jäckle & Himmler, 2010). Thus, we instrument health to correct for this endogeneity.

4.3. Estimation Method

Our equations of interest are mixed in nature, EQ.I is linear whereas EQ.II and EQ.III are non-linear. Thus, we need to utilise an estimation method that takes this distinction into account. Therefore, we estimate a simultaneous system of equations, using Maximum Likelihood Estimation (MLE).

Specifically, we use a Conditional Mixed Process (CMP) estimator to estimate a multi-equation mixed system, whereby endogenous variables can appear on the right side of other equations and their errors can be correlated. The possibility of mixing processes, where different equations are allowed to have different types of dependent variables, offers more flexibility in the model's construction and increases its efficiency (Roodman, 2015). This model requires determining the method to be used to estimate each equation. We specify EQ.I to utilise a linear approach, EQ.II to utilise an Ordered Probit method, and EQ.III to utilise a Probit method. CMP's simultaneous estimation of the equations prevents any further adjustments or corrections.

On a final note, wages are only observed if participation > 0, and thus only a subset of the sample is used in the estimation of EQ.I and EQ.II, however, EQ.III's estimation utilises the complete sample. CMP allows this kind of flexibility, since equations can vary by observations.

5. Data

As previously-mentioned, our main dataset is the ELMPS. This is a rich source of data covering various labour factors. The ELMPS comprises four rounds, 1988, 2006, 2012, and 2018, however, we are confined to the 2012 and 2018 rounds, as the health variable appears in these two rounds only. Note that we also extract some data from Egypt's 'Statistical Year Book' (Central Agency for Public Mobilisation

and Statistics [CAPMAS], 2017; 2021), which Krafft et al. (2019) explained, are consistent with the ELMPS data and samples.

5.1. Sample

We limit our sample to individuals within the official working age, which is 15 to 65 (CAPMAS, 2021). Furthermore, we drop any workers besides the waged ones, since wages represent our main variable of interest. We also restrict our sample to private sector workers, as previously-explained, due to the wage-setting mechanisms of other sectors that are not determined by the market forces. Finally, we drop any observations with missing information. This leaves us with an unbalanced panel, which includes 32,343 observations. Out of the complete sample, 10,280 observations have appeared in both rounds of the ELMPS and 9,347 are waged employed workers.

5.2. Dependent Variables

The ELMPS provides an hourly wage measure, EQ.I's dependent variable, which is calculated by dividing the previous three months' total monthly wages over the same period's usual hours spent in market work (ERF & CAPMAS, 2019). Our sample's average hourly wage is 10 Egyptian Pounds (ERF & CAPMAS, 2019).

Regarding the self-perceived health measure, EQ.II's dependent variable, individuals were asked "How is your health in general?" and answers were given according to a 4-point scale. "1" represents very bad health, while "4" represents excellent/very good health (See table A1 in the appendix). 50% and 40% of our sample have reported their health states as good and very good/excellent, respectively (ERF & CAPMAS, 2019), implying a general state of good health.

The last dependent variable, that of EQ.III, is the probability of labour force participation. Only 38% of our sample are participating in the labour force, implying the low level of participation in the Egyptian labour market (ERF & CAPMAS, 2019).

5.3. Explanatory Variables

We control for various explanatory variables, which are divided into individual, human capital, and job characteristics. Table A1 in the appendix lists these variables and their descriptions.

Individual characteristics include age, age squared, gender, marital status, region, and parents' educational attainment, whose descriptive statistics are shown in table 1. As previously-stated, we restrict our sample to individuals between the ages of 15 and 65 years old. We find that our sample's average age is 32 years old (ERF & CAPMAS, 2019). In terms of gender, the number of women slightly exceeds that of men. Also, we find that the majority of our sample are married, living in rural regions, and have parents with less than an intermediate educational degree.

Table 1: Individual Variables – Sample Distributions:

Variable	Sample Distribution
Gender:	
MALE	14,879
FEMALE	17,464
Marital Status:	
SINGLE	10,960
MARRIED	19,587
DIVORCED	474
WIDOWED(ER)	1,322
Region of Residence:	
CAIRO	3,633
ALEXANDRIA/SUEZCANAL	2,561
URBAN-LOWER	3,496
URBAN-UPPER	4,244
RURAL-LOWER	8,420
RURAL-UPPER	9,989
Parents' Education:	
EDUCATED FATHER	7,744
NON-EDUCATED FATHER	24,599
EDUCATED MOTHER	5,309
NON-EDUCATED MOTHER	27,034

Source: ERF & CAPMAS *(2019)*

With respect to the human capital characteristics (See table 2), we control for individuals' educational attainment and whether they have received any training other than formal education. We find that a large proportion of our sample are either illiterate or have a vocational secondary degree. Furthermore, post-graduate and university degree holders make up less than 1% and 12% of our sample, respectively. This implies the low level of educational attainment among our sample. Similarly, we find a very small proportion of our sample have received training other than formal education. Thus, human capital is a factor that requires attention in Egypt, however, we do not delve into the discussion of this issue as it goes beyond the scope of our analysis.

Table 2: Human Capital Variables – Sample Distributions:

Variable	Sample Distribution
Education:	
ILLITERATE	6,932
LITERATE, NO DIPLOMA	1,512
PRIMARY SCHOOL	3,409
MIDDLE SCHOOL	4,242
GENERAL HIGH SCHOOL	2,638
VOCATIONAL HIGH SCHOOL	8,976
POST-SECONDARY	741
DEGREE	3,778
UNIVERSITY	115
POST-GRADUATE	
TRAINING	254
NO-TRAINING	9,980

Source: ERF & CAPMAS *(2019)*

Finally, we state the descriptive statistics for a variety of job aspects (See table 3), and these include tenure, tenure squared, occupations, job stability, formality, union membership, supervisory roles, working night-time, and firm size. Our sample's average tenure is 10 years (ERF & CAPMAS, 2019), indicating low mobility across jobs. In terms of occupations, we find that higher-status jobs, such as managers, constitute a small proportion of our sample, while the largest proportion are craft and related trades workers. Similarly, we find that only a small proportion are union members or have supervisory roles, while a significant proportion works night-time. Furthermore, our sample is mainly permanently-employed or casually-employed, and informally-employed. These statistics imply that job quality and stability are two issues in Egypt. Finally, the majority of our sample are employed in firms employing less than 50 workers.

Table 3: Job Variables – Sample Distributions:

Variable	Sample Distribution
Occupation:	
MANAGERS	117
PROFESSIONAL	669
TECHNICIANS	380
CLERICAL	295
SERVICE/SALES	1,732
	1,843

AGRICULTURE/FORESTRY/FIS	3,109
HERY	1,445
CRAFT/TRADES	563
PLANT/MACHINE OPERATORS	
ELEMENTARY WORKERS	
Job Stability:	
PERMANENT	4,480
TEMPORARY	1,864
SEASONAL	273
CASUAL	3,373
FORMAL	1,896
INFORMAL	8,082
UNION	598
NON-UNION	9,374
SUPERVISOR	750
NON-SUPERVISOR	9,322
NIGHT	4,596
NO-NIGHTS	5,449
Firm Size:	
SMALL	8,015
MEDIUM	318
LARGE	1,234
UNKNOWN	413

Source: ERF & CAPMAS *(2019)*

5.4. Instrumental Variables

Instrumental variables are those we use to identify the equation of an endogenous variable. Thus, the health instruments identify EQ.II to deal with endogeneity in the estimation of EQ.I, while the selection instruments identify EQ.III to deal with sample selection.

5.4.1. Health Instruments

Health instruments include the size of the household as well as the incidence of a work injury and dead siblings. These are expected to significantly affect health but not wages.

Table 4: Health Instruments (Work Injuries and Dead Siblings) – Sample Distributions:

Variable	Sample Distribution
INJURY	459
NO-INJURY	9,741
DEAD SIBLING	7,292
NO-DEAD SIBLING	23,574

Source: ERF & CAPMAS *(2019)*

Household size may impact an individual's health by putting more pressure and increasing housework or income demands but unlikely to impact wages as employers do not consider this factor relevant to jobs or wages. Our sample's average household size is roughly 5 people (ERF & CAPMAS, 2019), implying a relatively large household. Also, work injuries imply hazardous working conditions that are likely to impact an individual's views of health and result in worse perspectives of health states. Conversely, this factor is unlikely to affect the wages an individual is offered, as work injuries are likely to have been compensated at the time of the incident but unlikely to result in a pay rise. Only a minor proportion of our sample have experienced a work injury (See table 4). Similarly, having a dead sibling is likely to implicate individuals' views of their health states, especially if that sibling has died at a younger age or due to a health condition. Contrarywise, employers are unlikely to compensate workers through their wages for such an incidence. These individuals represent a more significant proportion of our sample (See table 4).

5.4.2. Selection Instruments

The selection equation, EQ.III, is identified by whether individuals are heads of households as well as the number of males in the official working age and the number of children, those younger than 15 years old, in the household. These variables are listed in table A3 in the appendix and their descriptive statistics are demonstrated in table 5 below.

Table 5: Selection Instruments (Head of Household) – Sample Distributions:

Variable	Sample Distribution
HEAD	9,645
NON-HEAD	22,698

Source: ERF & CAPMAS *(2019)*

We expect all of the selection instruments to affect the decision to participate in the labour force but not wages received. Specifically, heads of the household are likely to be financially-responsible to provide for those in the household. Thus, such individuals are expected to have a higher probability of participation. According to the statistics of our sample, we find that less than third of the sample are heads of households. On the contrary, having more males in the household within the working age may mean less pressure to participate in the labour force, as there is likely an alternative source of income. The majority our sample, specifically 63%, have one male in the working age in the household. The effect of having children in the household may differ according to the individuals' genders due to the differing gender roles in the household, especially in a Middle Eastern society like Egypt. Men with more children in the household may have to participate in the labour force to provide for these children and their needs, similar to the effect of being a household head. On the other hand, women are usually the caretakers of children in the household. Thus, more children may lower their probability of participation in the labour force.

6. Results and Analysis

We focus our following discussion on the results of the selection instruments, the health instruments, and the impact of health on wages, while we only briefly review the rest of the results.

6.1. Probability of Labour Force Participation

The selection equation identifies the effect of the various factors on the probability of labour force participation. Note that this equation utilises the complete sample available to us. We find that all of our selection instruments have a significant impact on the individuals' probability of labour force participation. Moreover, our results confirm the predicted relationships (See table 6). Specifically, we find that heads of a household significantly increase probability of participation, while the opposite is true for individuals having more males in the working age in the household.

Table 6: Selection Equation (EQ.III) – Selection Instruments Results (MLE Model):

Variable[1]	Coefficients *(Standard Deviations)*
HEAD	0.844*** *(0.035)*
ACTIVE-AGE MALE	-0.097*** *(0.014)*
Number of Children:	
MALE*CHILD	0.078*** *(0.026)*
FEMALE*CHILD	-0.148*** *(0.019)*
N	***32,343***

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

Regarding the number of children in the household, we do indeed find a difference between men and women. Precisely, men's probability of labour force participation increases as number of children increases, while the opposite is true for women, confirming our earlier postulations.

With respect to the rest of the results (See table A4 in the appendix), we find that the probability of participation increases with age at a decreasing rate. It is sensible that younger individuals participate more than older ones, who may be more experienced in the labour market, and thus more selective. In addition, older individuals may have other factors to consider, such as health conditions or savings and other sources of income. Also, we confirm the often-cited problem of low female labour force participation, as we find men to have a much higher probability of participation compared to women. Furthermore, we find that education is highly important in the Egyptian context, since the probability of labour force participation considerably increases with higher educational degrees. Finally, we find that singles participate more than individuals of other marital statuses as do those residing in Cairo compared to other regions. Conversely, individuals whose parents have at least attained an intermediate educational degree have a lower participation probability than others. While we cannot explain this result, as it goes beyond the scope of our research, it may be the result of correlation with other variables, such as education.

6.2. Health Equation Results

Again, we find that all our health instruments are highly significant in determining health (See table 7), which implies their suitability. We find that individuals who have experienced a work injury or have a dead sibling are likely to rate their health

[1] Control variables include: age, age squared, male, marital status dummies (4), region of residence dummies (6), educated fathers, educated mothers, and education dummies (9).

lower than others. Also, the larger the household, the lower the health state reported by individuals. This follows the logic of our earlier postulations, where larger households imply more demands on a person's health. Thus, we can confirm that the health instruments serve their purpose of properly identifying health and should allow us to reach more viable conclusions concerning the impact of health on wages.

Table 7: Health Equation (EQ.II) – Health Instruments Results (MLE Model):

Variable[2]	Coefficients *(Standard Deviations)*
INJURY	-0.486*** *(0.054)*
DEAD SIBLING	-0.179*** *(0.028)*
HOUSEHOLD SIZE	-0.012* *(0.007)*
N	***9,830***

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

With respect to the rest of the results (See table A5 in the appendix), we find that most variables are actually insignificant in the determination of health. The only exceptions are region and education. Specifically, we find that residing in any region other than Cairo actually improves the individuals' health states. This is likely due to the hectic lifestyle of people residing in Cairo, where there is always a lot of traffic, pollution, and high costs. Also, we identify that education improves reported health states, especially among the vocational high school, post-secondary, and university degree-holders compared to illiterate individuals. This may be based on the higher level of awareness and knowledge of the former categories of maintaining their health states.

6.3. The Effect of Health on Wages

The wage equation results are probably the most important part in our analysis. It shows the impact of various labour factors on the wages an individual earns. Table 8 below focuses on the results of health. Note that we also run an OLS model of the wage equation to compare its results with that of MLE and identify any differences resulting from addressing the endogeneity of health. This equation uses a subset of the sample, which includes individuals with observable hourly wages.

While the OLS model shows that health has a significant impact on wages received in Egypt's labour market, it also shows that this impact is considerably under-estimated. Specifically, we find that the OLS model estimates wages to increase by 9.3% as health states improves one point, while the MLE estimates a

[2] Control variables include: age, age squared, male, marital status dummies (4), region of residence dummies (6), educated fathers, educated mothers, and education dummies (9).

39.5% increase in wages. This is a huge difference in magnitude. Also, this is perhaps the most valuable enhancement to our estimations and reinforces the importance of addressing the endogeneity of health to achieve more accurate results.

Table 8: Wage Equation (EQ.I) – Health Results:

Variable[3]	MLE Model	OLS Model
HEALTH	0.395*** *(0.052)*	0.093*** *(0.012)*
N	***9,347***	

Standard deviations in brackets
**** p<0.01, ** p<0.05, * p<0.1*

Consequently, we reject the OLS model and accept the MLE. In Egypt's context, the MLE results imply that health plays a major role in determining wages. Thus, better health, representing productivity as postulated, is likely to improve productivity contributions and wages earned, indicating great benefits to redeem in terms of labour market outcomes. In comparison with findings for other countries in the literature, health seems to have a larger and more significant impact on wages in Egypt's labour market. For instance, Jäckle and Himmler (2010) reported very small coefficients for German labour, albeit still positive and significant. These distinctions could be linked to a variety of factors, such as the heavy reliance on manual labour in numerous of Egypt's sectors and industries. While technological advancements are occurring, they lag much behind the level of technology commonly found in more advanced economies. Thus, enhancing productivity is perhaps most possible by improving workers' health states. In addition, poor health services exacerbate the situation, and hence healthier individuals may be preferred by employers in order to cut costs, especially when medical insurance is involved with the job.

The rest of the results show that wages increase with age, having educated parents, formality, supervisory roles, as well as tenure, but at a decreasing rate. That is the longer individuals remain in the same job, the lower the increase in their wages. Also, literacy and vocational high school degrees earn more compared with illiterate individuals. An important finding is the existence of a significant gender wage-gap in favour of men, which may explain the low level of female labour participation identified earlier. Also, we find that residents of Cairo earn the highest wages

[3] Control variables include: age, age squared, male, marital status dummies (4), region of residence dummies (6), educated fathers, educated mothers, education dummies (9), training, occupation dummies (9), tenure, tenure squared, job stability dummies (4), formality, union membership, supervisory roles, night-time work, and firm size dummies (4).

compared to other regions, which may explain why moving to Cairo for work is so popular in Egypt. Similarly, seasonal and casual workers earn more than permanent workers, which implies that workers may have to be compensated higher for the instability of their jobs. In terms of occupations, we find that managers earn more compared to service/sales and elementary workers. It is worth noting that service/sales workers are often offered low basic wages, as they mainly rely on commissions that might increase their total pay to a great extent. Finally, night-time workers earn less than others.

7. Conclusion

To conclude, our research has addressed the impact of productivity on the Egyptian private sector's wages. Due to the unavailability of individual labour productivity measures, we used health as a proxy. This rests on the assumption that healthier individuals are more likely to exert more effort and perform better on the job, an issue that has been addressed and confirmed by various studies.

In modelling wages, we expected two biases due to selection into participation in the labour force and the endogeneity of health. For this purpose, we utilised the MLE approach. We found that correcting for the biases notably influences the results. Specifically, better health is found to significantly contribute to wages. Furthermore, we found that the impact of health on wages is substantially under-estimated in the OLS model compared to the MLE model, implying the importance of addressing the endogeneity bias in particular. Furthermore, health as a proxy for productivity means this effect of health is of even higher value, especially given Egypt's high reliance on manual labour, poor health-care services, and the ease of diseases spreading.

Thus, health should be viewed and evaluated from two angles (Cai, 2009). Health is an end in itself, as improving the population's health is crucial for their well-being. In addition, health also plays an instrumental role in labour markets. Egyptian policy-makers and officials therefore need to review the role of health in economic development and labour markets.

Declarations

Ethics Approval and Consent to Participate:
Not applicable.

Consent for Publication:
Not applicable.

Availability of Data and Materials:
The datasets analysed during the current study are available in the "Economic Research Forum" and the "Central Agency for Public Mobilisation and Statistics" repositories:
http://www.erfdataportal.com/index.php/catalog/157
https://www.capmas.gov.eg/Pages/StaticPages.aspx?page_id=5034

Competing Interests:
The author declares that they have no competing interests.

Funding:
Not applicable.

Authors' Contributions:
Not applicable.

Acknowledgments:
Not applicable.

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Appendix

Table A1: Explanatory Variables' Descriptions:

Variable	Description
HEALTH	**An ordered discrete variable, individuals asked, "How is your health in general?" and answers given on a 4-point scale as follows:** 1-Very bad/bad health state 2-Fair health state 3-Good health state 4-Excellent/very good health state
Individual Characteristics	
AGE	Respondent's age (in years)
AGE SQUARE	Respondent's age (in years) squared
Gender: **MALE** ***Reference***	**A dummy variable for gender,** 1 if male, 0 otherwise ***Omitted: females***
Marital Status: **MARRIED** **DIVORCED** **WIDOWED(ER)** ***Reference***	**A dummy variable for marital status,** 1 if married, 0 otherwise 1 if divorced, 0 otherwise 1 if widowed(er), 0 otherwise ***Omitted: less than minimum age, never married, contractually married***
Region of Residence: **ALXEXANDRIA/SUEZCANAL** **URBAN-LOWER** **URBAN-UPPER** **RURAL-LOWER** **RURAL -UPPER** ***Reference***	**A categorical variable for region of residence,** 1 if Alexandria or Suez Canal region, 0 otherwise 1 if urban lower region, 0 otherwise 1 if urban upper region, 0 otherwise 1 if rural lower region, 0 otherwise 1 if rural upper region, 0 otherwise ***Omitted: Greater Cairo region***
Parents' Education: **EDUCATED FATHER** ***Reference*** **EDUCATED MOTHER** ***Reference***	**A dummy variable for parents' educational level,** 1 if father has an intermediate or higher degree, 0 otherwise ***Omitted: fathers with less than intermediate degree***

	1 if mother has an intermediate or higher degree, 0 otherwise ***Omitted: mothers with less than intermediate degree***
Human Capital Characteristics	
Education: **LITERATE, NO DIPLOMA** **PRIMARY SCHOOL** **MIDDLE SCHOOL** **GENERAL HIGH SCHOOL** **VOCATIONAL HIGH SCHOOL** **POST-SECONDARY DEGREE** **UNIVERSITY** **POST-GRADUATE** ***Reference***	**A categorical variable for educational attainment level of respondent,** 1 if literature with no diploma, 0 otherwise 1 if primary school degree, 0 otherwise 1 if middle school degree, 0 otherwise 1 if general high school degree, 0 otherwise 1 if vocational high school degree, 0 otherwise 1 if post-secondary degree, 0 otherwise 1 if university degree, 0 otherwise 1 if post-graduate degree, 0 otherwise ***Omitted: illiterates***

Table A1: Explanatory Variables' Descriptions - *Continued*:

Variable	Description
TRAINING ***Reference***	**A dummy variable for whether respondent received training other than formal education,** 1 if received training, 0 otherwise ***Omitted: no training received***
Job Characteristics	
Occupation: **PROFESSIONAL** **TECHNICIANS** **CLERICAL** **SERVICE/SALES** **AGRICULTURE/FORESTRY/FISHERY** **CRAFT/TRADES** **PLANT/MACHINE OPERATORS** **ELEMENTARY WORKERS** ***Reference***	**A categorical variable for stability of job,** 1 if professional, 0 otherwise 1 if technician/associate professional occupation, 0 otherwise 1 if clerical support worker, 0 otherwise 1 if service/sales worker, 0 otherwise 1 if agricultural/forestry/fishery occupation, 0 otherwise 1 if craft/trade worker, 0 otherwise 1 if plant/machine operator, 0 otherwise 1 if elementary occupation, 0 otherwise ***Omitted: managers***
TENURE	The length of employment at current job (in years)
TENURE SQUARE	The length of employment at current job (in years) squared
Job Stability: **TEMPORARY** **SEASONAL** **CASUAL** ***Reference***	**A categorical variable for stability of job,** 1 if temporary worker, 0 otherwise 1 if seasonal worker, 0 otherwise 1 if casual worker, 0 otherwise ***Omitted: permanent workers***
FORMAL ***Reference***	**A dummy variable for formality of job,** 1 if job is formal, 0 otherwise ***Omitted: informal workers***

UNION ***Reference***	**A dummy variable for union membership,** 1 if member in union, 0 otherwise ***Omitted: non-union member***
SUPERVISOR ***Reference***	**A dummy variable for supervisory roles,** 1 if respondent is a supervisor, 0 otherwise ***Omitted: non-supervisors***
NIGHT ***Reference***	**A dummy variable for working nights (after 7 p.m.),** 1 if works nights, 0 otherwise ***Omitted: no night work***
Firm Size: **MEDIUM** **LARGE** **UNKNOWN** ***Reference***	**A categorical variable for size of firm,** 1 if firm has 50-99 workers, 0 otherwise 1 if firm has more than 100 workers, 0 otherwise 1 if firm size is unknown, 0 otherwise ***Omitted: if firm has 1-49 workers***

Table A2: Instrumental Variables' Descriptions – Health Equation (EQ.II):

Variable	Description
INJURY ***Reference***	**A dummy variable for incidence of work injury,** 1 if injury exists, 0 otherwise ***Omitted: no injury***
DEAD SIBLING ***Reference***	**A dummy variable for incidence of dead sibling,** 1 if has dead sibling, 0 otherwise ***Omitted: no dead sibling***
HOUSEHOLD SIZE	Household size

Table A3: Instrumental Variables' Descriptions – Selection Equation (EQ.III):

Variable	Description
HEAD ***Reference***	**A dummy variable for head of household,** 1 if respondent is head of household, 0 otherwise ***Omitted: not head of household***
ACTIVE-AGE MALE	The number of males in the labour age (15-65 years old) in household
Number of Children: **MALE*CHILD** **FEMALE*CHILD**	**An interaction variable for gender*number of children in household,** Number of children (below 15 years old) in household for males Number of children (below 15 years old) in household for females

Table A4: Selection Equation (EQ.III) – Complete Results (MLE Model):

Variable	Coefficients *(Standard Deviations)*
Selection Instruments	
HEAD	0.844*** *(0.035)*
ACTIVE-AGE MALE	-0.097*** *(0.014)*
Number of Children:	
MALE*CHILD	0.078*** *(0.026)*
FEMALE*CHILD	-0.148*** *(0.019)*
Individual Characteristics	
AGE	0.248*** *(0.005)*
AGE SQUARE	-0.003*** *(0.0001)*
MALE	1.734*** *(0.032)*
Marital Status:	
MARRIED	-0.305*** *(0.033)*
DIVORCED	-0.163** *(0.077)*
WIDOWED(ER)	-0.670*** *(0.079)*
Region of Residence:	
ALEXANDRIA/SUEZCANAL	-0.107** *(0.044)*
URBAN-LOWER	-0.005 *(0.040)*
URBAN-UPPER	-0.112*** *(0.039)*
RURAL-LOWER	-0.001 *(0.035)*
RURAL-UPPER	-0.142*** *(0.035)*
Parents' Education:	
EDUCATED FATHER	-0.216*** *(0.029)*
EDUCATED MOTHER	-0.116*** *(0.034)*
Human Capital Characteristics	
Education:	
LITERATE, NO DIPLOMA	0.056 *(0.050)*
PRIMARY SCHOOL	-0.095** *(0.039)*
MIDDLE SCHOOL	-0.375*** *(0.039)*
GENERAL HIGH SCHOOL	-0.810*** *(0.047)*
VOCATIONAL HIGH SCHOOL	0.209*** *(0.030)*
POST-SECONDARY	0.406*** *(0.062)*
DEGREE	0.615*** *(0.038)*
UNIVERSITY	0.849*** *(0.136)*
POST-GRADUATE	
Constant	-4.834*** *(0.106)*

N	***32,343***

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

Table A5: Health Equation (EQ.II) – Complete Results (MLE Model):

Variable	Coefficients *(Standard Deviations)*
Health Instruments	
INJURY	-0.486*** *(0.054)*
DEAD SIBLING	-0.179*** *(0.028)*
HOUSEHOLD SIZE	-0.012* *(0.007)*
Individual Characteristics	
AGE	-0.008 *(0.014)*
AGE SQUARE	-0.0003 *(0.0002)*
MALE	0.139 *(0.114)*
Marital Status:	
MARRIED	-0.039 *(0.036)*
DIVORCED	-0.167 *(0.109)*
WIDOWED(ER)	-0.147 *(0.139)*
Region of Residence:	
ALEXANDRIA/SUEZCANAL	0.518*** *(0.057)*
URBAN-LOWER	0.539*** *(0.051)*
URBAN-UPPER	0.550*** *(0.050)*
RURAL-LOWER	0.506*** *(0.043)*
RURAL-UPPER	0.485*** *(0.044)*
Parents' Education:	
EDUCATED FATHER	-0.001 *(0.042)*
EDUCATED MOTHER	0.026 *(0.052)*
Human Capital Characteristics	
Education:	
LITERATE, NO DIPLOMA	-0.0003 *(0.053)*
PRIMARY SCHOOL	0.001 *(0.046)*
MIDDLE SCHOOL	0.086 *(0.054)*
GENERAL HIGH SCHOOL	0.089 *(0.082)*
VOCATIONAL HIGH SCHOOL	0.169*** *(0.035)*
POST-SECONDARY	0.234*** *(0.080)*
DEGREE	0.261*** *(0.051)*
UNIVERSITY	0.231 *(0.201)*
POST-GRADUATE	

N	***9,830***

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

Table A6: Wage Equation (EQ.I) – Complete Results:

Variable	MLE Model	OLS Model
HEALTH	0.395***	0.093***
	(0.052)	*(0.012)*
Individual Characteristics		
AGE	0.023***	0.023***
	(0.008)	*(0.005)*
AGE SQUARE	-0.0001	-0.0002***
	(0.0001)	*(0.0001)*
MALE	0.349***	0.366***
	(0.065)	*(0.031)*
Marital Status:		
MARRIED	0.076***	0.075***
DIVORCED	*(0.023)*	*(0.022)*
WIDOWED(ER)	0.205***	0.184***
	(0.073)	*(0.071)*
	0.131 *(0.099)*	0.115 *(0.097)*
Region of Residence:		
ALEXANDRIA/SUEZCANAL	-0.279***	-0.196***
URBAN-LOWER	*(0.041)*	*(0.037)*
URBAN-UPPER	-0.315***	-0.234***
RURAL-LOWER	*(0.037)*	*(0.034)*
RURAL-UPPER	-0.287***	-0.203***
	(0.036)	*(0.032)*
	-0.212***	-0.139***
	(0.032)	*(0.028)*
	-0.103***	-0.030 *(0.029)*
	(0.032)	
Parents' Education:		
EDUCATED FATHER	0.071** *(0.028)*	0.071***
EDUCATED MOTHER	0.172***	*(0.027)*
	(0.034)	0.179***
		(0.033)
Human Capital Characteristics		
Education:		
LITERATE, NO DIPLOMA		

PRIMARY SCHOOL	0.131***	0.132***
MIDDLE SCHOOL	*(0.036)*	*(0.035)*
GENERAL HIGH SCHOOL	0.022 *(0.031)*	0.025 *(0.030)*
VOCATIONAL HIGH SCHOOL	0.052 *(0.035)*	0.074** *(0.033)*
POST-SECONDARY DEGREE	0.022 *(0.052)*	0.044 *(0.047)*
UNIVERSITY	0.079***	0.110***
POST-GRADUATE	*(0.025)*	*(0.023)*
	0.014 *(0.054)*	0.054 *(0.052)*
	0.060 *(0.039)*	0.108***
	0.033 *(0.138)*	*(0.036)*
		0.060 *(0.134)*
TRAINING	0.012 *(0.051)*	0.011 *(0.051)*
Job Characteristics		
Occupation:		
PROFESSIONAL	-0.027 *(0.082)*	-0.024 *(0.083)*
TECHNICIANS	-0.061 *(0.086)*	-0.064 *(0.086)*
CLERICAL	0.041 *(0.090)*	0.031 *(0.090)*
SERVICE/SALES	-0.225***	-0.227***
AGRICULTURE/FORESTRY/FISHERY	*(0.081)*	*(0.081)*
CRAFT/TRADES	-0.106 *(0.083)*	-0.108 *(0.083)*
PLANT/MACHINE OPERATORS	-0.037 *(0.081)*	-0.041 *(0.081)*
ELEMENTARY WORKERS	-0.075 *(0.081)*	-0.081 *(0.082)*
	-0.189**	-0.192**
	(0.085)	*(0.086)*
TENURE	0.008***	0.008***
	(0.002)	*(0.002)*
TENURE SQUARE	-0.0002***	-0.0002***
	(0.0001)	*(0.0001)*

Table A6: Wage Equation (EQ.I) – Complete Results - *Continued*:

Variable	Coefficients *(Standard Deviations)*	
Job Stability:		
TEMPORARY	0.030 *(0.021)*	0.028 *(0.021)*
SEASONAL	0.509*** *(0.048)*	0.508*** *(0.048)*
CASUAL	0.185*** *(0.019)*	0.182*** *(0.019)*
FORMAL	0.137*** *(0.025)*	0.138*** *(0.025)*
UNION	0.035 *(0.037)*	0.032 *(0.037)*
SUPERVISOR	0.094*** *(0.031)*	0.092*** *(0.032)*

NIGHT	-0.083*** *(0.016)*	-0.083*** *(0.016)*
Firm Size:		
MEDIUM	0.017 *(0.044)*	0.015 *(0.045)*
LARGE	0.023 *(0.026)*	0.023 *(0.026)*
UNKNOWN	0.019 *(0.038)*	0.020 *(0.039)*
Constant	-0.291 *(0.274)*	0.686*** *(0.131)*
N	***9,347***	

Standard deviations in brackets
**** p<0.01, ** p<0.05, * p<0.1*