JOURNAL OF ECONOMIC DEVELOPMENT 1
Volume 47, Number 3, September 2022

HUMAN CAPITAL AND WOMEN'S INFORMAL WORK: THEORY AND EVIDENCE *

JEAN-LOUIS BAGO [a], WAMADINI DITE MINATA SOURATIÉ [b], ERNEST OUÉDRAOGO [c] AND PAM ZAHONOGO [d]

[a] *Governement of Quebec, Canada*
[b] *University of Dedougou, Burkina Faso*
[c] *Laval University, Canada*
[d] *University Ouaga II, Burkina Faso*

Informal employment among developing countries' women continues to impair their emancipation from chronic poverty, although there has been progress in recent decades. In sub-Saharan Africa, not only do women lag behind men in educational attainments, they are also overrepresented in low-paid informal employments. In the literature, marriage and childbearing are seen to be the cause of both low educational attainments and high prevalence of informal employment among sub-Saharan African women. However, this prediction ignores the significance of human capital as a determinant of employability in the formal sector. In this paper, we use micro-level data from Niger in combination with the instrumental variables approach to analyze the causal effect of a female's level of education - a proxy for human capital - on the likelihood of informal employment. A theoretical job-search model highlighting the mechanism driving this causal effect guides our empirical analysis. We find that an additional year of schooling completed lowers the probability that a female is informally employed by 3.99% to 6.12%. Our theoretical model explains this relationship by the fact that, in informal employments, the opportunity cost of leisure and childbearing rises with a female education, due to the flexibility of hours worked for this type of employment.

Keywords: Women, Human Capital, Education, Informal Employment, Job-search
JEL Classification: J24, J46, O17

* We would like to thank Sylvain Dessy and Bernard Fortin from University Laval, Luca Tiberti from University of Florence, Sonia Lazzlo from McGill University and the three anonymous referees for their helpful comments on previous versions of this paper.

1. INTRODUCTION

Informal employment is an important source of livelihoods for both women and men in developing countries, but in sub-Saharan Africa, more than in any other region of the world, women are overrepresented in this category of employment (McCaig and Pavcnik, 2015; Ulrichs, 2016; Carré and Chen, 2021). For instance, in Liberia, the gap between the rate of women's participation in non-agricultural informal employment (72%) and men's participation (47.4%) is nearly 25 percentage points. The corresponding gaps for Zimbabwe, Zambia, Mali, and Madagascar are respectively 23.2, 17.2, 15, and 14.2 percentage points, respectively (UN, 2015). More importantly, not only are average earnings in informal employments lower than in formal employments (Carré and Chen, 2021), but also, within informal employments themself, women participants are concentrated predominantly in the more disadvantaged, vulnerable, lowest paid, categories of employment, including domestic workers, piece-rate home-based workers, and assistants in small family Enterprises (UN, 2015). As informal employments are usually unregulated, any hope of improving the economic prospects of sub-Saharan African women in relation to the timely completion of UN's sustainable development goals (SDGs) 1 and 5 may, therefore, lie with policy actions most likely to pool them out of informal, and into formal, employments. However, the predominant view in the literature on female labor force participation in sub-Saharan Africa is that women's time and mobility are constrained by social and cultural norms that assign the primary responsibility for social reproduction to women (Chen, 2001). These family responsibilities tend to discourage female participation in formal employments, which are usually characterized by inflexible work hours. If indeed, marriage and childbearing are the drivers of women's overrepresentation in informal employments, then, to the extent that women yearn for marriage and family, any public policy action aimed at pulling them out of informal employments may drive a wedge between marriage and female career aspirations, and thus may not win political support from these women themselves.

From, an empirical point of view, casual evidence from Niger - the setting of our empirical analysis - appears to support marriage and childbearing as important determinants of female participation in informal employments. For instance, 96% of Niger's married women with children under the age of five are informally employed. However, this figure hides a significant heterogeneity in the impact these factors have on the likelihood that a woman is informally employed in Niger. First, among all married women with children under the age of five, those with no education have the highest participation rate in the informal employments at 99.76%. By contrast, for those with secondary education or higher, the participation rate in informal employments falls to 50%. To the extent that schooling is a source of human capital needed to find a job in the formal employment, this disparity in participation rates by levels of education among married women with children under the age of five raises the question of whether lack of human capital may be an important factor trapping women in the low-income informal employments. This paper addresses this issue by analyzing the causal effect of human

capital on the likelihood that a woman is informally employed.

We start with a simple theoretical model of job search based on McCall (1970) and Kolm and Larsen (2016) to motivate our empirical analysis. The framework features heterogeneous female job seekers who search for both formal and informal employments. Time allocated to search for a formal employment trade off time allocated to search for an informal employment. An important difference between formal and informal employments is that, in the latter, unlike in the former, each worker can choose the time she allocates between paid work and leisure, both of which trade off time allocated to childcare if any. Each female job seeker determines her optimal allocation of search time between the two types of employments to maximize her overall probability of employment.

Comparative statics yields three related predictions with respect to the effect of a female job seeker's human capital level. First, having more human capital increase the utility premium from working in formal employment. This result stems from the operation of two mechanisms. The first works through the negative effect human capital has on the payoff to informal employment. Indeed, we show that for an informally employed female, having more human capital increases the opportunity cost of leisure. As a result, hours worked in informal employment increase with a female's human capital (P1). This trade-off thus causes a female worker's human capital to have a negative effect on her payoff to informal employment. The second mechanism works through the positive effect human capital has a female payoff to formal employment. The key to this mechanism is the assumption that hours worked in formal employment are invariant to a female's human capital (P2). This assumption implies that human capital does alter the trade-off between work and leisure for a formally employed female, unlike for her informally employed counterpart. As a result, her payoff to formal employment rises with her human capital, due to the positive effect human capital has on earned income. Second, for otherwise identical female job seekers, those with more human capital allocate lower levels of search effort to finding informal jobs. This prediction is a direct implication of the contrasting effect human capital has on the payoff to formal and to informal employments. Third, for otherwise identical female job seekers, those with more human capital have lower probabilities of being informally employed (P3), because search time influences the probability of finding a job in the sector in which search is conducted.

The main goal our empirical analysis is to test for P3 above, along with the underlying mechanisms as described by P1 and P2 also above. Our empirical analysis is based on Niger's National Survey on Household Living Conditions and Agriculture (NSHLCA) 2011/2014. The main challenge confronting our analysis of the causal effect a female's human capital has on the probability that she is informally employed stems from the fact that a female human capital is unmeasured in our database. As a result, we follow the labor literature by using years of schooling completed as a proxy for human capital. Indeed, the questionnaire in the Niger's NSHLCA includes questions on workers levels of education, including female workers.

As part of our empirical strategy, we start by providing observational evidence on Niger women's overrepresentation in informal employments. More importantly, we also provide observational evidence on the negative association between the rate of participation in informal employments and females' levels of education. We note a sharp decline in participation rates for female workers with secondary or tertiary education. These two pieces of evidence motivate our formal analysis of the effect of a female's human capital on the likelihood that she is informally employed.

Our estimation results are the outcome of an identification strategy that combines Ordinary Least Square (OLS) and IV estimates. Our OLS estimates, which comprise our baseline strategy, suffer from potential endogeneity issues arising from three possible sources. In particular, a female's level of education is potentially a endogenous regressor. Indeed, since education is an imperfect proxy of human capital, it becomes a source of measurement error. For, identification therefore, we use instrumental variables approach to estimate the causal effect of education on a woman's probability to be informally employed.

We instrument a female worker's level of education with tree different variables, including her mother's, and her father's, level of education, and her status with respect to in utero exposure to the rainy season. For the first two instruments, the relevance of the first stage regression draws from an extensive literature linking a child's schooling achievement to his family background including paternal and maternal education (Hertz et al., 2007; Heineck and Riphahn, 2009).

The motivation behind the third instrument, namely a female worker's status with respect to intrauterine exposure to the rainy season stems from available evidence showing that weather conditions around a critical stage of fetal development is associated with neonates' long-run human capital outcomes (Buckles and Hungerman, 2013; Wilde et al., 2017]. In the context of a Sahelian African country like Niger, there is evidence showing that the rainy season is often accompanied by severe floods, as the level of the Niger River rises. Episodes of floods are reported to cause the destruction of homes, loss of food crops, as well as major cholera outbreaks, and an increased incidence of malaria in the entire flood affected areas. These health factors when associated with pregnant women are known by the World Health Organization to have adverse effects birth weight and child morbidity.

OLS estimates show that an additional year of schooling reduces the probability that a female is informally employed by 3.04% – 4.01%. We also find that being married (2.9%) increase this probability. IV estimates fare even better. The negative effect of a female's level of education ranges from a low of 3.99% when we use only the trimester of in utero exposure to rainy season to instrument female's education, to a high of 6.12% when the instruments for female education are her mother's and father's education. When we use all three instruments of a female's education simultaneously, we find that an additional year of schooling completed reduces the probability that a female is informally employed by 6.01%, which quite higher than the OLS' upper bound.

The literature on informal employment in developing countries is large. However

most contributions focus on barriers to formalization (Bosch and Esteban-Pretel, 2012; Bosch and Campos-Vazquez, 2014), or on public policies to reduce the size of the informal sector (Meghir et al., 2015; Kolm and Larsen, 2016; Tondini, 2017). None of these works focuses specifically on women participation in informal employments. Our paper contributes to this literature by focusing specifically on human capital as a determinant of women's participation in informal employments in a developing country context.

The remainder of this paper is structured as follows. Section 2 presents a parsimonious job-search model to guide our empirical analysis. Section 3 describes the empirical strategy. Section 4 presents the estimation results, and section 5 concludes the paper.

2. THEORETICAL MODEL

In the section we develop a parsimonious model of female choice of the type of employment (formal or informal). We use this model as a guide to our empirical analysis of the causal effect of human capital on the probability that a woman is informally employed.

2.1. Set up

The structure of our model is adapted from McCall (1970) and Kolm and Larsen (2016). There is a measure N of female job seekers. Each female job-seeker is endowed with a level of human capital H, has K_5 children under the age of five, and a marital status M. A female job-seeker with a marital status $M = 0$ is single while one with a marital status $M = 1$ is married. Let R be a vector representing the female job-seeker other characteristics. Hereafter, we index each woman with her level of human capital and refer to her simply as female H. There are two periods in this economy. The first period is entirely allocated to job search. If search is successful, then employment takes place in the second and last period, otherwise the job-seeker remains unemployed through this last period. In each of these two periods, each female has one unit of time. In the first period time effort is allocated between searching for informal jobs ($s = 0$) and searching for formal jobs (s=1). We denote as zs, the total time a female job-seeker allocates to searching for a job of type $s \in \{0,1\}$, with

$$z_0 + z_1 = 1. \tag{1}$$

Search yields one of two possible outcomes: success or failure. We denote as $\Phi^s(z^s, H, K_5, M, R)$ the probability of success in finding a job of type s, implying that the contrapositive probability of failure is $1 - \Phi^s(z^s, H, K_5, M, R)$. We make the following assumption to parameterize these success functions:

Assumption 1 *Given* (z^s, H, K_5, R),

$$\Phi^s(z^s, H, K_5, R) = \Psi^s(K_5, M, R)H^{\alpha_s}z^{s1-\alpha_s} + \mu_s,$$

where $\alpha_s \in (0,1)$ all $s \in \{0,1\}$.

The term μ_s is a random factor capturing the fact that a female without human capital ($H = 0$), or who didn't search for a job ($z^s = 0$) can still receive a job offer of type $s \in \{0,1\}$, as may be the case if she has a relative who owns a business.

2.2. Payoff Functions

At the beginning of the second period, each female H learns her employment status. If she is unemployed, she has a realized present value of unemployment $U_H \geq 0$. If she got a job offer by the end of the first period, then at the start of the second period, she must allocate her time between leisure, childcare for under five children, if any, and work. In the second period, the time use constraint for an employed female is given by

$$L_s + \ell + \nu K_5 = 1, \tag{2}$$

where L_s denotes work time in the employment s, ℓ, leisure time, $\nu \in (0,1)$, the per child time requirement for child care, and $K_5 \geq 0$, the number of children under five. Denote as $W^s(\ell, H, L_s)$ the present value of earnings from having an employment of type s for a female H who allocates ℓ units of her time endowment to leisure, and L_s units a job of type s. Given (ℓ, H, L_s), the present value of earnings from having job of type $s \in \{0,1\}$ in the second period is given by:

$$W^s(\ell, H, L_s) = H^{\lambda_s}(L_s)^{1-\lambda_s} + \gamma\ell, \tag{3}$$

where $\lambda_s \in (0,1)$ all $s \in \{0,1\}$.

Under Assumption (1), and given expression (3) above, we can define the expected present value of employment of type $s \in \{0,1\}$ as follows:

$$\begin{aligned} V^s(z_s, H, K_5, L_s, M, R) := {} & [\Psi^s(K_5, M, R)H^{\alpha_s}(z_s)^{1-\alpha_s} + \mu_s]\left[H^{\lambda_s}(L_s)^{1-\lambda_s} + \gamma\ell\right] \\ & + [1 - \Phi^s(z, H, K_5, R)]U_H, \end{aligned} \tag{4}$$

as the expected value from having job of type $s \in \{0,1\}$ in the second and last period.

Assumption 2 *For all formally employed females, the number of hours worked is exogenously given:* $L_1 = \bar{L} \in (0,1)$.

This assumption reflects the fact that in virtually all workplace environments,

formally employed agents tend to work fixed hours, as determined by the contractual agreement.

Consider an informally employed female H. This female's problem is how much time to allocate to work outside home, given her marital status $M \in \{0,1\}$, and the number of children under the age of five she may have K_5. Her problem thus is to solve:

$$\max\{H^{\lambda_s}(L_s)^{1-\lambda_s} + \gamma\ell\} \quad \text{s.t. (2).}$$

The interior solution to this problem is

$$\ell^* = 1 - \nu K_5 - H\left(\frac{1-\lambda_0}{\gamma}\right)^{\frac{1}{\lambda_0}} \equiv \zeta(H, K_5), \tag{5}$$

$$L_0^* = \left(\frac{1-\lambda_0}{\gamma}\right)^{\frac{1}{\lambda_0}} H, \tag{6}$$

which in turn implies that

$$V^0(z_0, H, K_5, L_0^*, M, R) = [\Psi^0(K_5, M, R)H^{\alpha_0}(z_0)^{1-\alpha_0} + \mu_s]\left[H^{\lambda_0}(L_0^*)^{1-\lambda_0} + \gamma\zeta(H, K_5)\right] + [1 - \Phi^0(z_0, H, K_5, R)]U_H. \tag{7}$$

Define the total expected value of being employed in the second period as follows:

$$T(z, H, K_5, L_s^*, M, R) = V^0(z, H, K_5, L_0^*, M, R) + V^1(1 - z, H, K_5, \bar{L}, M, R),$$

where $z_0 = z$ and $z_1 = 1 - z$, owing to the time allocation constraint in (1).

Next, without loss of generality, let $U_H = 0$. Then, using (4) and (7), we have that

$$T(z, H, K_5, M, R) = [\Psi^0(K_5, M, R)H^{\alpha_0}(z)^{1-\alpha_0} + \mu_s]\left[\lambda_0 H\left(\frac{1-\lambda_0}{\gamma}\right)^{\frac{1-\lambda_0}{\lambda_0}} + \gamma(1 - \nu K_5)\right] + [\Psi^1(K_5, M, R)H^{\alpha_1}(1-z)^{1-\alpha_1} + \mu_1]\left[H^{\lambda_1}(\bar{L})^{1-\lambda_1} + \gamma(1 - \nu K_5 - \bar{L})\right].$$

Each female H chooses the allocation of search time across the two types of employments $(z, 1-z)$ so as to maximize her total expected value from working in the second period $T(z, H, K_5, M, R)$.

2.3. Optimal Allocation of Search Efforts

At the start of the first period, a job-seeking female H chooses z to solve:

$$\max_{z} T(z, H, K_5, M, R).$$

The first order necessary and sufficient condition for this maximum is characterized by:

$$F(z_s, M) := \frac{(1-z)^{\alpha_1}}{z^{\alpha_0}} - H^{\alpha_1-\alpha_0}\Gamma(K_5, M, R)\xi(H, K_5) = 0, \tag{8}$$

where

$$\xi(H, K_5) := \frac{\left[(\bar{L})^{1-\lambda_1}H^{\lambda_1}+\gamma(1-\nu K_5-\bar{L})\right]}{\left[\bar{\lambda}H+\gamma(1-\nu K_5)\right]}, \tag{9}$$

$$\Gamma(K_5, M, R) := \frac{\Psi^1(K_5,M,R)}{\Psi^0(K_5,M,R)}\frac{1-\gamma}{1-\alpha}, \tag{10}$$

$$\bar{\lambda} = \lambda_0\left(\frac{1-\lambda_0}{\gamma}\right)^{\frac{1-\lambda_0}{\lambda_0}}. \tag{11}$$

The term $\xi(H, K_5)$ can be interpreted as the *utility premium* of being a formally employed. It measures the extent to which the utility of being formally employed exceeds that of being informally employed. Of course such a premium exists only for a female worker with a level of human capital H that satisfies: $\xi(H, K_5) > 1$. For a female with a level of human capital H that satisfies $\xi(H, K_5) < 1$, there is no premium for being formally employed.

Observe that partial differentiation of (8) yields the following effect with respect to z_s and H.

$$F_{z_s} = -\frac{(1-z_s)^{\alpha_1}}{z_s^{\alpha_0}}\frac{\alpha_1 z_s+\alpha_0(1-z_s)}{z_s(1-z_s)} < 0, \tag{12}$$

$$F_H = \frac{\xi(H,K_5)}{H^{1-\alpha_1+\alpha_0}}\left[\alpha_1 - \alpha_0 + \xi_H\frac{H}{\xi(H,K_5)}\right], \tag{13}$$

where

$$\xi_H = \frac{\gamma\left[\lambda_1(1-\nu K_5)\left(\frac{\bar{L}}{H}\right)^{1-\lambda_1} - \lambda_0(1-\nu K_5-\bar{L})\left(\frac{1-\lambda_0}{\gamma}\right)^{\frac{1-\lambda_0}{\lambda_0}}\right]}{\left[\bar{\lambda}H+\gamma(1-\nu K_5)\right]^2}. \tag{14}$$

as we let

$$(1-\lambda_1)\bar{\lambda} \to 0, \tag{15}$$

without loss of generality. The term ξ_H denotes the marginal effect of increasing a female worker's level of human capital on her utility premium from being formally

employed. We have just established the following result:

Proposition 2.1 *Let condition (15) holds. If for all* H,

$$\frac{\lambda_1}{\lambda_0}\left(\frac{\bar{L}}{H}\right)^{1-\lambda_1}\left(\frac{\gamma}{1-\lambda_0}\right)^{\frac{1-\lambda_0}{\lambda_0}} > \frac{1-\nu K_5-\bar{L}}{1-\nu K_5}, \tag{16}$$

then, the utility premium from being formally employed rises with the worker's human capital H: i.e., $\xi_H > 0$.

Condition (16) states that the relative pecuniary gain from being formally employed exceeds the relative loss in leisure time due to the time demands of formal employment. When this condition holds, the utility premium from being formally employed will be higher, the higher the worker's level of human capital H.

With Proposition (2.1) in hand, we can now return to expression (13) whose sign is ambiguous. Observe then that since $\xi_H > 0$, by Proposition (2.1), for all H, and given K_5, we can define $\epsilon_{\xi/H} := \xi_H \frac{H}{\xi(H,K_5)}$ as the elasticity of a female job-seeker's utility premium from being formally employed, with respect to her level of human capital H. Expression (13) thus can be rewritten as follows:

$$F_H = \left[\alpha_1 - \alpha_0 + \epsilon_{\xi/H}\right]\frac{\xi(H,K_5)}{H^{1-\alpha_1+\alpha_0}}, \tag{17}$$

whose sign is strictly positive if and only if

$$\epsilon_{\xi/H} > \alpha_0 - \alpha_1. \tag{18}$$

Condition (18) states that the elasticity of the utility premium from formal employment, with respect to human capital H, is sufficiently high. In other words, a female job-seeker's human capital must have a sufficiently strong positive effect on the utility premium from formal employment. Hence, the following Lemma:

Lemma 2.2 *Let conditions (15) and (16) hold simultaneously.* Then, $F_H > 0$ if and only if condition (18) also holds.

On the basis of Lemma (2.2), we have just established the existence of an interior solution to Equation (8) above. Indeed, the optimal allocation of job search effort for a female job seeker with socioeconomic characteristics (H, K_5, M, R) is thus given as follows:

$$z_0^* \equiv Z_0(H, K_5, M, R), \tag{19}$$

$$z_1^* = 1 - z_0^* \equiv Z^1(H, K_5, M, R). \tag{20}$$

We are particularly interested in the term $\partial z_0^*/\partial H$ representing the marginal effect a female job-seeker's human capital has on the effort she directs towards finding an informal job. This marginal effect can be derived implicitly as follows, using Equation (8) above, along with expressions (12) and (17):

$$\frac{\partial z_0^*}{\partial H} = -\frac{[\alpha_1 - \alpha_0 + \epsilon_{\xi/H}]z(1-z)\xi(H,K_5)}{[\alpha_1 z + \alpha_0(1-z)]H^{1-\alpha_1+\alpha_0}}\frac{z^{\alpha_0}}{(1-z)^{\alpha_1}}.$$

Hence the following result which obtains as an implication of Lemma (2.2).

Proposition 2.3 *Let conditions (15) and (16) hold simultaneously. Then, having more human capital reduces the search effort a female job-seeker directs towards finding an informal job (i.e., $\partial z_0^*/\partial H < 0$), if and only if (18) also holds.*

Proposition (2.3) gives necessary and sufficient conditions for a female job-seeker's level of human capital to have a negative effect on the search effort she directs towards finding informal employment. Recall from expression (4), that the search time z_0 is a determinant of the probability that a female job seeker finds an informal job. Since z_0 is endogenous, any exogenous factor that influences its level will have an effect on that probability. In what follows, we analyze the implications of Proposition (2.3) for the probability that a female job-seeker finds an informal job.

2.4. Optimal Probability of being Employed in the Informal Sector

In this sub-section, we characterize the determinants of the optimal probability that a female with individual characteristics (H, K_5, M, R) is informally employed, in which case she optimally allocates a number of hours worked L_0^*, as characterized in (6) above. Using Assumption 1 in combination with (19), we obtain the optimal level of this probability as follows:

$$\Phi_0^* = \Psi^0(K_5, M, R)H^{\alpha_0}[Z^0(H, K_5, M, R)]^{1-\alpha_0} + \mu_0. \tag{21}$$

Expression (21) clearly shows that a female job-seeker's human capital H has two opposite effects on the probability that she is informally employed Φ_0^*. One is a direct positive effect working through the effect human capital has on ability and productivity; and the other is an indirect negative effect working through the negative effect human capital has on a female job-seeker's incentive to direct search effort towards finding an informal job. We characterize the net effect of human capital on this probability as follows, making use of Proposition (2.3) above:

$$\frac{\partial \Phi_0^*}{\partial H} = \left[\alpha_0 - (1-\alpha_0)\epsilon_{z_0^*/H}\right]\left(\frac{z_0^*}{H}\right)^{1-\alpha_0} \Psi^0(K_5, M, R),$$

where $\epsilon_{z_0^*/H} = -\frac{\partial z_0^*}{\partial H}\frac{H}{z_0^*}$ denotes the elasticity of the search effort directed at finding an informal job with respect to a female job-seeker's human capital H. Hence the following result:

Proposition 2.4 *Let conditions (15), (16), and (18) hold simultaneously. Then, having more human capital has a negative effect on the probability that a female job-seeker finds an informal job (i.e.,* $\partial \Phi_0^*/\partial H < 0$*), if and only if*

$$\epsilon_{z_0^*/H} > \frac{\alpha_0}{1-\alpha_0}. \tag{22}$$

Condition (22) states that the elasticity of the search effort directed at finding an informal job with respect to a female job-seeker's human capital is sufficiently high. On the basis of Proposition (2.4), it follows that there are three necessary and sufficient conditions for human capital to have a negative effect on the probability that a female job-seeker finds an informal job. First, since formal employment tends to be rigid in terms of hours worked, such jobs will be attractive to female job-seekers only to the extent that the relative pecuniary gain from formally employed exceeds the relative loss in leisure time due to an inflexible work schedule for formal employment (i.e., condition (16) must hold). Second, a female job-seeker's utility premium from being formally employed must be sufficiently responsive to her human capital, in terms of raising the level of this utility premium (i.e., condition (18) must hold). Finally, a female job-seeker's incentive to direct search effort towards finding an informal job must be sufficiently responsive to her human capital, in terms of significantly reducing this incentive (i.e., condition (22) must hold).

Our empirical analysis to follow aims to provide evidence on the existence of a causal relationship between a female job-seeker's human capital and the likelihood that she is informally employed. It the builds on the premise that human capital H is a complex phenomenon that is very difficult to measure. This leads us to proxy a female job-seeker's human capital H by her level of education.

3. DATA AND BACKGROUND

This paper uses data from Niger's *National Survey on Household Living Conditions and Agriculture* 2011/2014 to identify the causal effect of human capital on the likelihood that a woman is informally employed. This database contains information about individuals, their demographic and socioeconomic characteristics (education, employment, age, ethnic group,

affiliation..) and their household characteristics (household size, number of children), their parents characteristics, their geographic location (area of residence, region of residence...). For employment, the database contains a specific question on whether the worker has a formal job contract and/or social protection (housing allowance, pension benefit, travel allowance, schooling allowance for children). Informal work by definition is work with no access to social protection.

As defined by UN (2015), informal work is associated with the lack of social protection, labour legislation and protective measures in the workplace. With respect to this definition, we define a formal worker as one whose employment provides her with one or several of these aforementioned advantages; otherwise her job is considered informal. We use this information to define a dummy variable equals to 1 if a woman is informally employed, and 0 otherwise. Focusing on working women over the age of fifteen, we exclude from our sample non working females, such as students or girls under the age of fifteen. We also exclude from our sample, women over 65 years to focus our attention to only females considered to still be in the active stage of their lives. This restricts our sample size to 5580 female respondents.

Table 1. Summary Statistics

	Men		Women	
	Mean	Sd	Mean	Sd
Informal Employment	0.813	0.390	0.933	0.250
Education				
Average years of schooling	3.415	4.641	1.765	3.469
Age	34.57	14.43	33.96	13.31
Number of kids under 5	1.073	1.090	1.153	1.174
Married	0.602	0.490	0.714	0.452
Father's Education				
No education	0.909	0.287	0.916	0.278
Primary	0.039	0.194	0.0387	0.193
Secondary	0.037	0.189	0.0334	0.180
Higher	0.014	0.119	0.0121	0.109
Mother's Education				
No education	0.954	0.210	0.954	0.210
Primary	0.029	0.168	0.0298	0.170
Secondary	0.016	0.128	0.0153	0.123
Higher	0.001	0.026	0.0011	0.033
Ethno-linguistic group				
No nigerien	0.020	0.141	0.0142	0.118
Haoussa	0.394	0.489	0.407	0.491
Djerma/Songhai	0.269	0.444	0.270	0.444
Touareg	0.150	0.357	0.147	0.354
Others	0.167	0.373	0.162	0.368
Place of residence				
Urban	0.425	0.494	0.393	0.489
Rural	0.575	0.494	0.607	0.489

The choice of Niger as the setting of our empirical analysis is appropriate because this country is one of the poorest developing country in the world. The country has been consistently one of the lowest-ranked in the United Nations' *Human Development Index* (HDI). For instance, it was ranked 187th out of 188 countries in 2016. According to the *CIA World Factbook*, in 2015 Niger has an unemployment rate of 5.1% and ranks 45th in the world, which is surprisingly lower than that of many rich countries. Moreover, agriculture is a source of livelihood for 87% of the labour force, but only contributes to 36.5% of Niger's GDP. This sector creates employment in a context where the formal economy cannot provide jobs for the majority of people especially women.

Table 1 presents summary statistics. A note worthy feature of employment among female respondents to the survey is that more than 93% percent of them are informally employed. This rate of informal employment is nearly twenty percentage points higher than the corresponding average for female workers in sub-Saharan Africa which stands at 74.2% (ILO, 2016). Furthermore, 71.4% of female workers in our sample are married. They have each between 0 and 7 children under the age of five, for an average of 1.153 children under the age of five per female worker. Both figures (on marital status and number of children under the age of five) tend to support evidence showing that marriage and child bearing push female workers into the informal sector (Agüero et al., 2012; Chen, 2005) due to the influence patriarchal gender norms have on the within-household division of labor. However, female workers in our sample also have, on average, less than two years of schooling, implying that female workers in our sample may suffer from a deficiency in human capital. Therefore, to the extent that formal employment requires human capital, we cannot exclude the possibility that lack of human capital raises the probability of being informally employed.

Human capital is a complex phenomenon encompassing skills, experience, and other competencies embodied in an individual, and as such, is very difficult to measure. In this paper, we proxy a woman's human capital by her level of education, on the account that schooling is an important mechanism for accumulating human capital.

4. ECONOMETRIC MODEL

We use two identification methods to estimate the effect of a woman's education on the likelihood that she is informally employed. First, we rely on a baseline strategy that uses least squares regressions. Then, we apply the instrumental variables approach as a second identification strategy. We complement the analysis with a series of sensitivity analyses and robustness checks to account for heterogeneity in ecological factors that may affect the likelihood that a woman participates in the informal work.

4.1. One Equation Model

We begin by estimating the following one-equation model using a standard Ordinary

Least Square (OLS) apporach:

$$Y_{ir} = \beta_0 + \phi_r + \beta_1 H_{ir} + \beta_2 X_{ir} + \mu_{ir},$$

where Y_{ir} is dummy variable equals to 1 if a woman i, living in region r is informally employed and 0 otherwise; H_{ir} is human capital and X_{ir}, a vector of controls, including woman i's marital status, the number of children under five that she may have, her age group, her household size, her ethnic group of affiliation, area and region of residence. However, human capital is not measured in our data set. Our solution to this problem is to proxy human capital with the level of education. This assumption is justified based on empirical evidence showing that an individual's level of education is positively correlated with his level of human capital (Schultz,1961 ; Becker,1994). Becker(1994) argues that education and training are the most important investments in human capital.

The adjusted model thus is the following:

$$Y_{ir} = a_0 + \Psi_r + a_1 S_{ir} + a_2 X_{ir} + \varepsilon_{ir}, \quad (23)$$

where S_{ir} is a woman's level of education measured in years of schooling completed. To deal with the potential clustering of observations when estimating the model at the neighbourhood level, we estimate heteroskedasticity robust standard errors.

4.2. Instrumental Variables Approach

The main challenges in using OLS to estimate the effect of human capital on the employment status is the presence of potential endogeneity issues. In our setting, a woman's level of education S_i is a potentially endogenous regressor. First, since education is an imperfect measure of human capital, its use as a proxy for unobservable human capital thus is prone to measurement error, which may lead to an attenuation bias. In fact, during surveys, females are likely to misreport (voluntarily or not) their level of education. Second, as mentioned above, a female number of years of schooling completed is an imperfect measure of his human capital level, because it ignores other aspects of human capital such as skills, experience, health, for example. This measurement error can lead to an attenuation bias as well. Finally, as the labor economics literature shows, education and employment decision are potentially jointly determined in the data, thus leading to a simultaneity bias. To address these potential endogeneity issues, we use the IV approach.

This method involves estimating a two-stage model in which the second stage consists of estimating equation (23), while the first stage consists of estimating the following equation:

$$S_{ir} = \alpha_0 + \psi_r + \alpha_1 Z_{ir} + \alpha_2 X_{ir} + \epsilon_{ir}, \quad (24)$$

where Z_{ir} is a vector of instruments and X_{ir} is the vector of controls identical to those of Equation (23).

We instrument a female worker's level of education with tree different variables. The first two instruments are her mother's and her father's level of education. The third instrument is her status with respect to *in utero exposure* to the rainy season.

Maternal and Paternal levels of education as instrument for a female worker's educational attainment

It is widely acknowledged that family background, parents' education in particular, affects the academic achievements of their children. Several studies reveal that when parents are more educated, their children tend to receive more schooling as well (Plug, 2004; Hertz et al., 2007; Heineck and Riphahn, 2009). Haveman and Wolfe (1995), in particular, argue that the education of parents is probably the most fundamental factor in explaining the child's success in school. Differents paths of influence have been analyzed in the literature. One path is the intergenerationnal transmission of cognitive abilities, for example through an intra-uterine process (Blanden et al., 2007; Black et al., 2009) which plays a substantial role for a child's schooling achievement (Heckman and Vytlacil, 2001). Anger and Heineck (2010) suggest that an individual's cognitive skills are positively related to his parents' abilities and educationnal attainment. Another path is parental investment in child education. This literature shows that parents with higher levels of education are more likely to be involved in their children's schools, and thus affect positively their children academic achievements (Cunha and Heckman, 2007; Stewart, 2008) This is especially true in developing countries were educated parents are more likely to send their girls to school and to invest in their daughters education compared to uneducated parent's. However, parents's education could also affect their children employment status through their own employment status. To account for this fact, we control for parents works and found no relationship between parents works and the women informality.

In our database, the mother's and the father's education variables are categorical variables taking the value 0 if the mother (the father) has no education, 1 if she (he) has attained primary level, 2 if she (he) has achieved secondary level and 3 if she (he) has attained higher education.The descriptive statistics from our data shows a positive relationship between a woman's average years of schooling completed, and her mother's education. In other words, women whose mothers are not educated have in average the lowest number of years of schooling completed (1.2 years of schooling in average). Those whose mothers have completed primary school displays an average of 4.1 years of schooling completed. This increases to 8.3 and 5 years respectively, for those whose mother have a secondary and higher education, respectively. Likewise, the descriptive statistics also shows a strong positive relationship between a woman's years of schooling and her father's level of education. In fact, females whose fathers are not educated have barely 0.97 years of schooling while those with a higher educated father

averaged 11 years of schooling.

In Utero Exposure to the Rainy Season as instrument of education

The literature on the impact of the *in utero* exposure to seasons on long-run life outcomes suggests that seasonal shocks during conception and early pregnancy affect long-run human capital outcomes (Buckles and Hungerman, 2013; Wilde et al., 2017).

In fact the in utero exposure to seasonal shocks is credited with several risk factors for newborn that may have irreversible long run effects on their human capital, when adult. The first one is the climate shocks. The literature on the effect of climate shocks during conception and early pregnancy on later life outcomes show that rainy season phenomena, like rainfall, low temperature, and windstorms can have adverse long run effect on human capital (Maccini and Yang, 2006; Wilde et al., 2017).

The second risk factor -and potentially the most important in our analysis- is the mother's undernourishment (de Rooij et al., 2010; Scholte et al., 2015) during the rainy season. In developing countries where a large proportion of the population draws its livelihood from agriculture, the rainy season coincide often with the onset of hunger and famine episodes, due to lack of food or purchasing power (Vaitla et al., 2009). This situa- tion may expose pregnant women to malnutrition, particularly among the poor, with the likelihood of adverse effects on newborns' BMI and stunting status–two factors known to determine an individual's cognitive ability (Wilde et al., 2017). In developing countries, there is evidence that a drop in food consumption during the rainy season is an important predictor of undernourishment (Dostie et al., 2002). Further, this effect is magnified by the increase in food prices during the rainy season, as a result of supply shortage (Vaitla et al., 2009). Using data from Madagascar, Dostie et al. (2002) show that food shortages during the rainy season increase the rates of malnutrition and child mortality leading to a greater prevalence of diarrhea and other infant diseases. This literature suggests that pregnant woman's under-nutrition if occurring during a critical phase of foetal development, can imprint adult life in the form of poor human capital prospects.

The third risk factor is the risks of mother's morbidity that will affect the foetal cogni- tive development. In fact the rainy season in developing countries is prone to infectious disease prevalence or virulence (such as malaria, ebola or influenza) and health damaging physicals works for women in agricultural works. In fact studies on the effect of in utero exposure to illness on human capital exist. For instance, analyzing the impact of in utero exposure to the 1918 influenza pandemic on human capital in adulthood among those born in the U.S, Almond (2006) finds that individuals exposed in utero completed fewer years of education, have lower income, poorer socioeconomic status and are more likely to have physical disabilities.

Our dataset contains the birthday of each individual. In Niger the rainy season lasts from June to September. To identify the trimester when the rainy season overlaps the conception, we first estimate the months of conception using the month of birth. We

follow the literature (Buckles and Hungerman, 2013; Almond et al., 2015) in assuming that every individual had a normal gestation length of approximately 9 months. We then calculate the month of conception as the month of birth imputed by 9. Using this variable, we generate a categorical variable that takes the value of 1 if the rainy season overlaps with the first trimester of pregnancy; the value of 2 if the overlap occurs during the second trimester; the value of 3 if the overlap occurs during the third trimester of pregnancy.

The descriptive statistics from our data also suggest that early *in utero exposure* to the rainy season during pregnancy affects the level of education. Indeed, we observe that individuals exposed to the rainy season during the first trimester of pregnancy, on average, have 3.4 years of education, compared to 5 and 4.2 years of education for those exposed during the second and third trimester, respectively.

5. RESULTS

5.1. OLS Estimates

We report the OLS estimates of Equation () in table (2). Column (OLS1) controls only for the female education. These results suggest that each additional year of schooling for a female reduces the probability that she is informally employed by 4.01 percentage points. In column (OLS2), we include the others characteristics such as the marital status, the age group, the number of children under 5 and the household size. ethnic group. We find that the effect of education reduces to 3.91 percentage points, which is smaller than the effect reported in column (OLS1). Nevertheless, this effect remains statistically significant as in column (OLS1). Moreover, being married increases the probability of being an informal worker by 4.38 percentage points. Childcare (each supplementary child under five) increases this probability by 1.07 percentage points. The results also suggest that age reduce the probability to be in an informal job. In column (OLS3) we include the ethnic group dummies and we find, in contrast that ethnicity does not affect the probability of being informally employed. Finally, the results reported in column (OLS4) show that when we control for geographic location (area of residence and the region of residence) each additional year of education reduces the probability that the female is informally employed by 3.04 percentage points. However, as suggested in the last section, these results might be biased because of education and hours worked are endogenous. To correct for this endogeneity, we instrument both variables.

Table 2. OLS Estimates

Dependent Variable is Informal employment (0/1)				
Variables	(OLS1)	OLS2	OLS3	OLS4
Years of schooling	-0.0401***	-0.0391***	-0.0392***	-0.0304***
	(0.0101)	(0.0100)	(0.00980)	(0.0109)
Married		0.0438***	0.0459***	0.0290**
		(0.0142)	(0.0145)	(0.0120)
Children under five		0.0107**	0.0111**	0.00561
		(0.00423)	(0.00435)	(0.00378)
Age group				
25-34 years		-0.0445***	-0.0434***	-0.0239**
		(0.0145)	(0.0144)	(0.0108)
35-44 years		-0.0372***	-0.0365***	-0.00725
		(0.0139)	(0.0139)	(0.0130)
Over 45 years old		-0.0359***	-0.0341***	-0.0109
		(0.0119)	(0.0119)	(0.0130)
Household size		0.000743	0.000915	0.00113
		(0.00117)	(0.00122)	(0.00131)
Ethno-linguistic group				
Haoussa			-0.0740	-0.194**
			(0.0760)	(0.0949)
Djerma/Songhai			-0.0804	-0.188*
			(0.0803)	(0.0982)
Touareg			-0.0450	-0.168*
			(0.0714)	(0.0917)
Others			-0.0792	-0.206**
			(0.0761)	(0.101)
Rural resident				0.0618
				(0.0398)
Region of residence				Yes
Constant	0.988***	0.967***	1.033***	1.091***
	(0.0148)	(0.0234)	(0.0668)	(0.0694)
Observations	2,681	2,681	2,681	2,681
R-squared	0.369	0.380	0.383	0.427

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.2. IV Estimates

Table 4 reports the IV estimates. The endogeneity test shows that the OLS estimates previously discussed are subject to endogeneity bias. The robust identification stactistic in the table is the kleibergen-paap rk wald F statistic which is 15.115 in the model (IV1), 8.407 in the model(IV2) and 10.76 in the model (IV3). These numbers are above the Stock and Yogo critical value suggesting that intruments are not weak. The underidentification test of Kleibergen-Paap rk LM statistic statistics also indicates no concerns about underidentification. Finally, the first regression estimation results (Table 3) shows a strong relationship between our instruments and the endogenous variable. These results support the use of IV approach to identify the effect of a female's education on her probability to be informally employed.

Table 3. IV First-Stage Estimation Results

First-Stage regression: Dependent variable is Education: in single years of schooling			
	Model (IV1)	Model (IV2)	Model (IV3)
Instruments	Mother's Education Father's Education	Rainy season exposure	Mother's Education Father's Education Rainy season exposure
Father's Education			
Primary	1.786*** (0..48723)	-	1.977** (08307)
Secondary	2.781*** (0.61024)	-	1.454* (0.7864)
Higher	6.157*** (1.2340)	-	5.864*** (1.2576)
Mother's Education			
Primary	0.4857 (.50152)	-	.65641 (0 .74557)
Secondary	2.2211* (1.24450)	-	0 2.1234 (1.2941)
Higher	-3.9089*** (1.2737)	-	-4.9374*** (1.5043)
Rainy season exposure			
Trimester 2	-	2.0926*** (0.7060)	2.198*** (0.6893)
Trimester 3	-	2.2188*** (.7070)	2.057*** (0.7777)
All baseline controls	Yes	Yes	Yes
Observations	2,362	497	469
F-test of excluded instruments			
F statistic	15.12	8.25	10.29
Prob>F	0.000	0.000	0.000

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. IV Estimates: Second-Stage Regression Results

First-Stage regression: Dependent variable is Informal employment (0/1)			
	Model (IV1)	Model (IV2)	Model (IV3)
Instruments	Mother's Education Father's Education	Rainy season exposure	Mother's Education Father's Education Rainy season exposure
Years of schooling	-0.0612***	-0.0399*	-0.0601***
	(0.00951)	(0.0234)	(0.0131)
Household size	-0.00168	0.00222	-0.000553
	(0.00133)	(0.00682)	(0.00554)
Married	0.0189	0.0347	0.00437
	(0.0143)	(0.0453)	(0.0451)
Children under five	0.00679*	0.0168	0.0142
	(0.00378)	(0.0201)	(0.0203)
Age group (Base=15-24)			
25-34	-0.0238**	0.0364	-0.00900
	(0.0120)	(0.0590)	(0.0571)
35-44	-0.0236	0.0345	-0.0408
	(0.0146)	(0.0755)	(0.0638)
45 and +	-0.0337**	0.0301	-0.0446
	(0.0148)	(0.0730)	(0.0666)
Ethno-linguistic group			
Haoussa	-0.0407	-0.141	-0.102
	(0.0726)	(0.0871)	(0.0860)
Djerma/Songhai	-0.0348	-0.116	-0.0803
	(0.0749)	(0.0989)	(0.0920)
Touareg	-0.0310	-0.00966	0.0155
	(0.0720)	(0.0947)	(0.0965)
Others	-0.0320	-0.131	-0.0647
	(0.0752)	(0.115)	(0.103)
Father's Employment			
Skilled worker	-0.0114	-0.0198	0.00601
	(0.0206)	(0.0870)	(0.0755)
Unskilled worker	0.000512	-0.0911	-0.0203
	(0.0372)	(0.137)	(0.0965)
Mother's Employment			
Qualified	-0.00660	0.0246	0.00866
	(0.00820)	(0.0440)	(0.0406)
Non-qualified	0.0125	0.00873	0.00707
	(0.0251)	(0.0513)	(0.0486)
Rural resident	-0.0324	0.0222	-0.0110
	(0.0283)	(0.0577)	(0.0532)
Region dummy	Yes	Yes	Yes
Constant	1.112***	0.993***	1.108***
	(0.0804)	(0.145)	(0.134)
Observations	2,362	497	469
R-squared	0.448	0.423	0.451
Underidentification statistics	53.870	15.360	38.736
χ^2 p-value	0.000	0.000	0.000
Endogeneity test	2.067	0.459	0.659
p-value of endogeneity test	0.1505	0.4981	0.4169
Weak identification statistic	15.115	8.407	10.76
Stock-Yogo weak ID test			
critical value (20%)	11.72	8.75	12.48
critical value (25%)	9.38	7.25	9.93

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Father's and Mother's Employment based = self-employment

The results of the second stage regressions in Table 4 presents the IV estimates with tree models. In the first one, Model (IV1), the instruments for female education is her mother's and father's education. We find that each additional year of schooling decreases the probability that a female is informally employed by 6.12 percentage points, which is quite higher than the OLS estimates. In Model (IV2), we use the trimester of in utero exposure to rainy season to instrument female's education. The results show that the effect of education on the likelihood of being an informal worker is 3.99 percentage points, which is slightly weaker than the OLS estimates. In Model (IV3), we use all our instruments simultaneously. We find that one year of education reduces the probability of being an informal worker by 6.01 percentage points, which is definitively higher the OLS estimates. These results suggest that IV estimates fare even better than OLS since IV estimates are all higher that the OLS estimates.

5.3. Sensitivity Analysis

In this section, we conduct sensitivity analyses and robustness checks for the effect of education level on a female's informal work likelihood .

Table 5. Sensitivity to Area of Residence

Intra-sample Robustness check: Dependent variable is Informal work(0/1)			
	Model (IV1)	Model (IV2)	Model (IV3)
Instruments	Mother's Education Father's Education	Rainy season exposure	Mother's Education Father's Education Rainy season exposure
URBAN			
Years of schooling	-0.0571***	-0.0440*	-0.0548***
	(0.0125)	(0.0238)	(0.0140)
All baseline controls	Yes	Yes	Yes
Observations	510	373	347
R-squared	0.429	0.411	0.439
RURAL			
Years of schooling	-0.0822***	0.0935	-0.0667**
	(0.0160)	(0.0717)	(0.0304)
All baseline controls	Yes	Yes	Yes
Observations	1,852	124	122
R-squared	-1.970	-0.959	0.222

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

First, we test for the robustness of our estimates for rural resident and urban residence. To control for regional effect, we estimate the effect of education on the likelihood of being informally employed using the sub-sample of rural resident and the

sub-sample of urban resident separately. The IV estimates are reported in Table (5). As shown, the negative effect of education on the probability of working in the informal sector remains significant. This result confirms that the estimated effect of human capital on the probability of women informal work hold for both urban and rural resident females.

Subsequently, we estimate this effect for different age groups. We first separate our sample in two age groups using the median age equals to 33 years. We estimate the effect of education for the sub-sample of females under 33 and the sub-sample of females equal or over 33. The Table (6) presents the IV estimates. It shows that the effect is consistent with the age groups.

Table 6. Sensitivity to Age Groups

Intra-sample Robustness check: Dependent variable is Informal work (0/1)			
	Model (IV1)	Model (IV2)	Model (IV3)
Instruments	Mother's Education Father's Education	Rainy season exposure	Mother's Education Father's Education Rainy season exposure
Age<Median=33			
Years of schooling	-0.0773***	0.0436	-0.0741***
	(0.0164)	(0.103)	(0.0246)
All baseline controls	Yes	Yes	Yes
Observations	989	179	167
R-squared	0.303	-0.196	0.513
Age>=Median=33			
Years of schooling	-0.0496***	-0.0627***	-0.0546***
	(0.0109)	(0.0230)	(0.0115)
All baseline controls	Yes	Yes	Yes
Observations	1,852	124	122
R-squared	-1.970	-0.959	0.222

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.4. Empirical Evidence in Support of the Mechanisms P1 and P2

This section provides empirical evidence in support of the mechanism underlying the effect of human capital on the probability of being informally employed through the relationship between hours worked and human capital. Just to recall, two testable mechanisms have been highlighted in our model to explain why, for otherwise identical female job seekers, those with more human capital have lower probabilities of being informally employed. The first one is the prediction that hours worked in the informal employment increase with a female's human capital (P1). The second one is the

assumption that hours worked in formal employment are invariant to a female worker's human capital (P2).

Table 7. Testing mechanisms (P1) and (P2)

The dependant variable is hours worked				
	Informal (P1)		Formal (P2)	
Variables	(1)	(2)	(3)	(4)
Education level *(Base= No education)*				
Primary	0.751***	0.695***	0.661	0.519
	(0.191)	(0.191)	(0.793)	(0.814)
Secondary and Higher	1.081***	1.062***	-0.0930	-0.183
	(0.320)	(0.318)	(0.675)	(0.636)
Children under five		-0.112***		0.108
		(0.0414)		(0.165)
Married		-0.644***		-0.240
		(0.144)		(0.309)
Age		0.0681***		0.0315
		(0.0257)		(0.0919)
Age square		-0.000815**		-0.000414
		(0.000340)		(0.00118)
Constant	5.048***	4.444***	7.714***	7.320***
	(0.0516)	(0.431)	(0.663)	(1.997)
Observations	2,474	2,474	207	207
R-squared	0.016	0.031	0.018	0.025

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To formally test these mechanisms, we regress hours worked on the level of education, and control for other individual characteristics, such as the number of children under the age of five, the marital status, age and age square. The results are presented in Table (7). Columns (1) and (2) report the results for the test for $P1$, while columns (3) and (4) reports those for the test for $P2$. In columns (1) and (3), we include only the level of education as a explanatory variable for hours worked in each employment status. We find that education increases the number of hours worked in informal employment (0.75 hour for primary and 1.08 hours for secondary and higher education). This effect is statistically significant.In contrast, the effect of a female's education on the number of hours worked in formal employments is not statistically significant. In columns (2) and (4), we control for the number of children under the age of five, the marital status, age and age square. For informal employment, we find that the

positive effect of a female's education on the number of hours worked persists and is significant. Moreover, we find that marriage and childcare reduce a female worker's number of hours worked. Age has a positive decreasing effect on hours worked in informal employments. Interestingly, we find that hours worked in the formal employment are not affected by any of these controls including the level of education. These results support the prediction that the number of hours worked in informal employments increases with a female's human capital (P1), as well as the assumption that her hours worked are invariant to her human capital in formal employments (P2).

6. CONCLUSION

Women are overrepresented in low-paid informal employments throughout sub-Saharan Africa. The existing literature points to marriage and childcare in combination with the inflexibility of worked hours in formal employments as the cause of this phenomenon (Clark et al., 2017). There are two issues with this predictions. First, if childcare is a binding constraint on women's participation in formal employments, then availability of kinship support in the form of unpaid childcare from older children or children's grand-parents (as is often the case through-out sub-Saharan Africa) should allow those who have access to it to engage in formal employment. Second, having access to formal employments requires that a worker first build human capital, for example, through completion of primary and secondary education. Yet women in sub-Saharan Africa still lag behind men in educational attainments. It is therefore not clear which, of lack of education, or childcare responsibilities, is the main reason why sub-Saharan Africa's working women are overrepresented in low-paid informal employments.

In this paper, we analyze the causal effect of human capital on the probability that a female is informally employed. We first address this issue using a model of job-search in which female job-seekers optimally allocate search effort between finding a formal employment, and finding an informal one instead. Human capital is an input into both formal and informal employments. However, because participation in informal employments allow a female worker to choose her work hours, having more human capital raises the opportunity cost of leisure for an informally employed female. This effect does not obtain for a formally employed female, whose hours worked are exogenously determined. As a result, having more human capital increase the utility premium from being formally employed. This, in turn, increases the incentive for a female with more human capital to allocate more search effort to finding a formal employment, at the expense of search effort directed at finding an informal employment. Ultimately, our model predicts that having more human capital reduces the probability that a female job seeker ends up being an informal worker.

Our empirical analysis test this prediction using micro-level data from Niger in

combination with an instrumental variables approach. This approach allows us to essentially correct for the mismeasurement of human capital, which, in our study, is proxied by completed years of schooling. Both OLS and IV estimates show a negative effect of education on the probability that a female is informally employed, but as expected IV estimates fare even better. According to these estimates, having an additional year of schooling completed reduces the probability that a female is informally employed by 3.99% - 6.12%. Our study contributes to the literature linking women's characteristics to their labor market outcomes (Aguero and Marks, 2008, 2011; Clark et al., 2019).

In this socioeconomic context, women's informal work is driven primarily by low educational attainment, our study suggests that building women's human capital and skills through increased access to primary and secondary schooling can wean them off chronic dependence on low-paid informal employments. Thus, our findings suggest that public policy aimed at pulling developing countries' women out of low-paid informal work should prioritize girls' education. More importantly, building women's human capital can achieve this objective in two ways. First, by providing women with the skills needed to thrive in formal employments. Second, by reducing their fertility rate, which, in turn, will lessen the burden of family responsibilities that raise the opportunity cost of formal employment.

REFERENCES

Agüero, J., M. Marks, and N. Raykar (2012), "The Wage Penalty for Motherhood in Developing Countries," Technical Report, Working Paper. Riverside, California: University of California, Riverside.

Aguero, J.M. and M.S. Marks (2008), "Motherhood and Female Labor Force Participation: Evidence from Infertility Shocks," *American Economic Review*, 98(2), 500-504.

_____ (2011), "Motherhood and Female Labor Supply in the Developing World Evidence from Infertility Shocks," *Journal of Human Resources*, 46(4), 800-826.

Almond, D. (2006), "Is the 1918 Influenza Pandemic Over? Long-Term Effects of in Utero Influenza Exposure in the post-1940 Us Population," *Journal of Political Economy*, 114(4), 672-712.

Almond, D., B. Mazumder and R. Ewijk (2015), "In Utero Ramadan Exposure and Children's Academic Performance," *Economic Journal*, 125(589), 1501-1533.

Anger, S. and G. Heineck (2010), "Do Smart Parents Raise Smart Children? The Intergenerational Transmission of Cognitive Abilities," *Journal of Population Economics*, 23(3), 1105-1132.

Becker, G.S. (1994), "Human Capital Revisited," in *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education* (3rd Edition), pp. 15-28, University of Chicago Press.

Black, S.E., P.J. Devereux and K.G. Salvanes (2009), "Like Father, Like Son? A Note on the Intergenerational Transmission of IQ Scores," *Economics Letters*, 105(1), 138-140.

Blanden, J., P. Gregg and L. Macmillan (2007), "Accounting for Intergenerational Income Persistence: Noncognitive Skills, Ability and Education," *Economic Journal*, 117(519).

Bosch, M. and R.M. Campos-Vazquez (2014), "The Trade-offs of Welfare Policies in Labor Markets with Informal Jobs: The Case of the "Seguro Popular" Program in Mexico," *American Economic Journal: Economic Policy*, 6(4), 71-99.

Bosch, M. and J. Esteban-Pretel (2012), "Job Creation and Job Destruction in the Presence of Informal Markets," *Journal of Development Economics*, 98(2), 270-286.

Buckles, K.S. and D.M. Hungerman (2013), "Season of Birth and Later Outcomes: Old Questions, New Answers," *Review of Economics and Statistics*, 95(3), 711-724.

Carré, F. and M. Chen (2021), "Informal Women Workers in the Global South: Policies and Practices for the Formalisation of Women's Employment in Developing Economies," UK and New York: Routledge, 2117, pp. 44-95.

Chen, M. (2005), *Progress of the World's Women 2005: Women, Work and Poverty*, United Nations Publications.

Chen, M.A. (2001), "Women and Informality: A Global Picture, the Global Movement," *Sais Review*, 21(1), 71-82.

Clark, S., C.W. Kabiru, S. Laszlo and S. Muthuri (2019), "The Impact of Childcare on Poor Urban Women's Economic Empowerment in Africa," *Demography*, 56(4), 1247-1272.

_____ (2017), "Can Subsidized Early Child Care Promote Women's Employment?: Evidence from Kenya," Grow Research Series - Policy Brief .

Cunha, F. and J. Heckman (2007), "The Technology of Skill Formation," Technical Report, National Bureau of Economic Research.

de Rooij, S.R., H. Wouters, J.E. Yonker, R.C. Painter and T.J. Roseboom (2010), "Prenatal Undernutrition and Cognitive Function in Late Adulthood," *Proceedings of the National Academy of Sciences*, 107(39), 16881–16886.

Dostie, B., S. Haggblade and J. Randriamamonjy (2002), "Seasonal Poverty in Madagascar: Magnitude and Solutions," *Food Policy*, 27(5), 493-518.

Haveman, R. and B. Wolfe (1995), "The Determinants of Children's Attainments: A Review of Methods and Findings," *Journal of Economic Literature*, 33(4), 1829-1878.

Heckman, J. and E. Vytlacil (2001), "Identifying the Role of Cognitive Ability in Explaining the Level of and Change in the Return to Schooling," *Review of Economics and Statistics*, 83(1), 1-12.

Heineck, G. and R.T. Riphahn (2009), "Intergenerational Transmission of Educational Attainment in Germany: The Last Five Decades," *Jahrbücher für Nationalökonomie und Statistik*, 229(1), 36-60.

Hertz, T., T. Jayasundera, P. Piraino, S. Selcuk, N. Smith and A. Verashchagina (2007), "The Inheritance of Educational Inequality: International Comparisons and Fifty-Year Trends," *BE Journal of Economic Analysis and Policy*, 7(2).

Kolm, A.S. and B. Larsen (2016), "Informal Unemployment and Education," *IZA Journal of Labor Economics*, 5(1), 8.

Maccini, S. and D. Yang (2006), "Under the Weather: Health, Sschooling and Socioeconomic Consequences of Early-Life Rain," Ph.D. thesis, MS thesis, Department of Economics Ann Arbor, Michigan.

McCaig, B. and N. Pavcnik (2015), "Informal Employment in a Growing and Globalizing Low-Income Country," *American Economic Review*, 105(5), 545-550.

McCall, J.J. (1970), "Economics of Information and Job Search," *Quarterly Journal of Economics*, 113-126.

Meghir, C., R. Narita and J.M. Robin (2015), "Wages and Informality in Developing Countries," *American Economic Review*, 105(4), 1509-1546.

Oxaal, Z. (1997), *Education and Poverty: A Gender Analysis*, Volume 53, Institute of Development Studies at the University of Sussex, Sussex.

Plug, E. (2004), "Estimating the Effect of Mother's Schooling on Children's Schooling Using a Sample of Adoptees," *American Economic Review*, 94(1), 358-368.

Scholte, R.S., G.J. Van den Berg and M. Lindeboom (2015), "Long-run Effects of Gestation during the Dutch Hunger Winter Famine on Labor Market and Hospitalization Outcomes," *Journal of Health Economics*, 39, 17-30.

Schultz, T.W. (1961), "Investment in Human Capital," *American Economic Review*, 51(1), 1-17.

Stewart, E.B. (2008), "School Structural Characteristics, Student Effort, Peer Associations, and Parental Involvement: The Influence of School-and Individual-Level Factors on Academic Achievement," *Education and Urban Society* 40(2), 179-204.

Tondini, A. (2017), "The Impact of Unconditional Cash Transfers on Informality: Evidence from South Africa's Child Support Grant," Working Paper, Paris School of Economics.

Ulrichs, M. (2016), "Informality, Women and Social Protection: Identifying Barriers to Provide Effective Coverage," ODI Working Paper, London: ODI.

Vaitla, B., S. Devereux and S.H. Swan (2009), "Seasonal Hunger: A Neglected Problem with Proven Solutions," *PLOS Medicine*, 6(6), e1000101.

Wilde, J., B.H. Apouey and T. Jung (2017), "The Effect of Ambient Temperature Shocks During Conception and Early Pregnancy on Later Life Outcomes," *European Economic Review*, 97, 87-107.

Mailing Address: Jean-Louis Bago, Revenu Québec, 3800, rue de Marly, secteur 4-4-4, G1X4A5 Quebec (QC), Canada, E-mail: jean-louis.bago.1@ulaval.ca

Received January 09, 2021, Revised March 04, 2022, Accepted March 30, 2022.