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Marriage as an argument for energy poverty reduction: the moderating role of financial inclusion

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Marriage as an argument for energy poverty reduction: the moderating role of financial inclusion

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Abstract

The present research extends the extant literature by investigating the hypothesis on whether marriage can be a substitute for financial inclusion in energy poverty reduction in Ghana. Pooled data and two stage least squares techniques are used in the estimation process and the validity of the tested hypothesis (i.e., that marriage is a substitute for financial inclusion in energy poverty mitigation) is based on two main criteria: (i) a positive interactive effect relative to the negative unconditional effect of marriage; (ii) a marriage net effect lower in magnitude compared to the unconditional effect of marriage and (iii) an insignificant interactive effect when both unconditional effects are negative. The investigated hypothesis is not valid in the full sample, urban sub-sample and female sub-sample while it is valid in the rural and male sub-samples. Policy implications are discussed.

Keywords: Energy poverty; financial inclusion; consumption poverty; education; household income
JEL Classification: D03; D12; D14; I32; Q41

1. Introduction

The present research is founded on two main elements of motivation in the extant scholarly and policy literature, notably: (i) the importance of energy poverty in sustainable development goals (SDGs) and (ii) gaps in the extant literature. In what follows, these points are expanded in the same order as highlighted.

First, energy poverty is a fundamental concern in the achievement of the United Nations' SDGs and Agenda 2063 of the African Union. This issue applies to individual countries such as Ghana as well as to sub-regions such as sub-Saharan Africa given that low economic growth and corresponding negatively externalities on economic development are partly attributed to poor access to energy. In the light of the attendant literature, sub-Saharan Africa is host to about 75% of the current one billion of the World's poor who lack access to modern forms of energy like electricity (Anuga & Njenga, 2022). Hence, it is imperative for countries in SSA to address concerns pertaining to energy poverty which have been documented to be associated with negative political, economic and social consequences (Asongu & Odhiambo, 2020a, 2020b; Koomson & Danquah, 2021). The first objective focuses on the importance of marriage in reducing energy poverty owing to an apparent gap in the extant energy poverty and marriage literature.

Second, the extant literature on the nexus between energy poverty, marriage and socio-economic outcomes can be summarized in two main strands: one on the nexus between energy poverty and development outcomes and the other on the connection between marriage and socio-economic development. The first strand of literature focusing on energy poverty has largely been concerned with, among others: (i) the nexus between financial inclusion and the reduction of energy poverty (Boutabba *et al*., 2020; Koomson & Danquah, 2021) and (ii) the importance of inclusive finance in outcomes of economic and inclusive development (Sarma & Pais, 2011; Kuri & Laha, 2011 ; Sharma, 2016; Danquah *et al*., 2017; Li, 2018 ; Koomson & Ibrahim, 2018 ; Park & Mercado, 2018; Stein & Yannelis, 2019; Matekenya *et al*., 2020 ; Omar & Inaba, 2020). Furthermore, in the extant strand of studies on the nexus between energy poverty and inclusive development, Baah-Boateng (2015) has argued that in Ghana, unemployment rises with increasing education and declining age which is why higher unemployment rates are less apparent among old people compared to young people. Canagarajah *et al*. (2001) have posited that income distribution in Ghana is contingent on a plethora of factors including those considered in this study such as

financial inclusion and household characteristics (which include marital status). The underlying factors have also been engaged by Koomson and Danquah (2021) in the Ghanaian economy and the authors have concluded that financial inclusion mitigates energy poverty in the sampled country. Furthermore, Allen *et al*. (2016) posit that the probability of having a bank account within a financial institution is positively correlated with age in the light of the perspective that older people turn to borrow comparatively more from the attendant institutions.

In the second strand, the extant literature on marriage, family and wellbeing, has largely focused on; (i) family relationships and well-being (Allen *et al*., 2022; Chiang & Bai, 2022; Don *et al*., 2022); (ii) nexuses between ethnicity, race and family support (Taylor *et al*., 2022; Amorim & Deming, 2022); (ii) family and violence (Kong & Goldberg, 2022; Giordano *et al*., 2022); (iii) family variability and children's behaviors (Mollborn *et al*., 2022; Nilsen *et al*., 2022) and (iv) contextual influence on marriage and fertility (Ohlsson-Wijk, 2022; Wright, 2022). Of these studies that are critically discussed in Section 2, the closest stream to the present research is that focusing on the contextual influence on marriage and fertility. The present study departs from the attendant stream by focusing on the importance of marriage in energy poverty reduction.

The policy relevance of energy poverty reduction is consistent with United Nations agenda on sustainable development goals (SDGs), not least, because energy poverty is a dimension of poverty that has been established to be a critical obstacle in the achievement of poverty and inequality related SDGs. It is worthwhile to articulate that consistent with some post-2015 studies focusing on SDGs, countries in SSA are not likely to achieve most SDGs targets unless concerns related to poverty and inequality are addressed (Bicaba *et al*., 2017; Asongu & Odhiambo, 2018). A focus on energy poverty is a step in the underlying policy direction of extreme poverty mitigation. Moreover, the contingency of the investigated nexus between marriage and energy poverty reduction on financial inclusion is also based on the relevance of financial inclusion in the achievement of SDGs. Accordingly, the moderating variable of financial inclusion used in the present study has been documented to be fundamental in the achievement of most poverty and inequality-related SDGs (UNCDF, 2022). It follows that, understanding substitutes of financial inclusion as argued in the present study is a means of providing policy makers and scholars with alternative policy frameworks through which extreme poverty can be mitigated in the sampled country and by extension, other poor and developing economies in Africa.

The closest study in the literature to the present exposition is Koomson and Danquah (2021) who have focused on the direct nexus between financial inclusion and energy poverty. In the present study, the effect of marriage on energy poverty is examined contingent on financial inclusion. In other words, financial inclusion is interacted with marital status within a nonlinear framework to assess the overall incidence of marriage on energy poverty such that the overall effect of marriage on energy poverty is contingent on the moderating role of financial inclusion. Moreover, contrary to Koomson and Danquah (2021) in which the validity of how financial inclusion affects energy poverty rests on the significance and sign on the financial inclusion estimated coefficient, in the light of the nonlinear modeling approach employed in the present study, the validity of the tested hypothesis (i.e., that marriage is a substitute for financial inclusion in energy poverty mitigation) is based on three main criteria: (i) a positive interactive effect relative to the negative unconditional effect of marriage, (ii) a marriage net effect lower in magnitude compared to the unconditional effect of marriage and (iii) an insignificant interactive effect when both unconditional effects are negative. It follows that the main research question motivating the present exposition is the following: Is marriage a substitute of financial inclusion in energy poverty reduction?

The rest of the paper is structured in the following manner. The data and methodology are provided in Section 3 while the empirical results are disclosed in Section 4. Section 5 concludes with implications and future research directions.

2. Theoretical underpinnings, hypotheses development and conceptual framework

This section is discussed in three main strands, especially in relation to: (i) conceptual clarifications, (ii) theoretical underpinnings and hypotheses development and (iii) conceptual framework. Regarding the first strand on conceptual clarification, it is relevant to clarify, *inter alia*: the concepts of energy poverty and financial inclusion on the one hand and on the other hand, discuss features of energy poverty in Ghana in the light of other sub-Saharan African countries. How the underlying poverty features can be compared with the situation in more developed countries such that those in the European Union (EU) is highlighted as specificities of energy poverty in Ghana are discussed in this strand.

Financial inclusion in this study defined in terms of a household financial deprivation score while energy poverty is also defined in terms of household energy deprivation score, as apparent in

Appendix 1. The energy poverty and financial inclusion situation in Ghana is not very different from those in many African countries, compared to more developed regions like countries in the EU where financial inclusion and energy poverty are limited (Khan et al., 2023; Oyewole et al., 2024).

With regard to the specifics of Ghana, in order to fully comprehend the reason behind the study, it is also beneficial to add to this strand some knowledge about Ghana's energy mix and the Multidimensional Poverty Index (MPI). In line with previously published research (Asongu & Odhiambo, 2024), Ghana's energy mix is both straightforward and difficult. According to the corresponding literature, in order to meet the demands of businesses and households, the nation is dependent on gas, power, charcoal/biomass, and crude oil (which includes petroleum products). For instance, the main energy sources in 2015 were, natural gas (12.38%), hydroelectricity (5.27%), and biomass (37.87%). The insights show that although the country's population has historically relied on waste and biomass, particularly when it comes to firewood and charcoal, the proportion of biomass in the nation's energy mix has been steadily declining as the country's use of fossil fuels has increased. In addition, there is a greater demand for electricity than there is supply, which leads to unpredictable distribution of electricity, particularly when load shedding and/or rationing are implemented (Asongu & Odhiambo, 2024).

Regarding the MPI in the nation, the current policy and academic literature (Asongu & Odhiambo, 2024) indicate that 45.6% of the population is impoverished from a multidimensional perspective. The MPI is based on twelve indicators and three broad dimensions (health, education, and living standard). Constituents of the underlying multidimensional poverty include undernutrition, tardiness in school, lack of health insurance, and the educational background of household members. According to the associated poverty intensity of 51.7%, over 50% of weighted deprivations are experienced by those living in poverty. The product of the intensity and incidence of poverty is the MPI, which is 0.236. A 22.2% discrepancy may be seen when the 45.6% incidence of multidimensional poverty in the nation is compared to the 23.4% incidence of poverty in consumer expenditures. A more thorough examination of the two estimates reveals that: 19.3% of the population is poor from both multidimensional and consumption perspectives; 26.3% of people are not affected by consumption poverty but are multidimensionally poor; and 4.1% of people are

not MPI poor but are low in terms of consumption expenditure. Based on the fundamental analysis, approximately 82.3% of the impoverished people are also impoverished from an MPI perspective. Furthermore, according to Asongu and Odhiambo (2024), 26.3% of people who are multidimensionally poor do not exhibit financial poverty.

In the second strand on theoretical underpinnings, it is relevant to clarify that the foundation of marriage enrichment is based on the human potential hypothesis which holds that all people and relationships have a vast amount of untapped potential that can be developed, as well as a lot of strengths and resources (Mace & Mace, 1975; Otto, 1976). In essence, two main theoretical strands underlying the link between financial inclusion and energy poverty on the one hand and on the other between marriage and energy poverty are discussed in the first stand.

First, the primary stream of theoretical literature motivating the nexus between financial inclusion and energy poverty can be understood within the of interactive and extensive margin theoretical underpinning (Owen & Pereira, 2018; Tchamyou et al., 2019). According to the corresponding literature, for the intensive margin theory, existing customers within a financial institution or financial institutions are provided with more financial access opportunities. Conversely, the extensive margin theory applies when financial access opportunities are provided to the population beyond the remit of existing client or customers of financial institutions. In this latter framework, potential clients are considered and involved more financially, especially as it pertains to customers that did not previously have access to bank accounts (Owen & Pereira, 2018; Tchamyou et al., 2019). Some instruments by which the intensive and extensive margin theoretical underpinnings can be consolidated in view of achieving inclusive development outcomes such as reduction of poverty include: ownership of bank account, loan/credit access, insurance ownership and use of mobile money innovations to receive financial remittances. Accordingly, the attendant financial inclusion instruments which have been documented in the extant literature (Ngono, 2021) to reduce dynamics of poverty (i.e., entailing energy poverty used as the outcome variable in the present study) are employed in the present study as apparent in the narrative in the data section. The underlying theoretical underpinnings motivate the following testable hypothesis:

Hypothesis 1: Financial inclusion decreases energy poverty.

The second stream of theoretical literature in this strand speaks to how marriage is relevant in alleviating dynamics of poverty such as energy poverty. The main theoretical underpinning underlying the nexus between marriage and development outcomes is the Mariage Enrichment or Enhancement Theory (MET) which postulates for positive outcome in terms of inclusive development (Stempky, 1985). According to the underlying theory, the significant issues that modern marriages face have given rise to the marriage enrichment movement. A precautionary and educational strategy for improving relationships is marriage enrichment. The phrase describes a wide range of programs in addition to the philosophy and methodology of this approach (Stempky, 1985). According to the narrative, marriage is theoretically designed to achieve one of the following goals, *inter alia*: (i) to raise each partner's level of self-awareness about themselves and their mate, with a focus on the good traits, assets, and room for improvement of both the marriage and the person. (ii) To encourage the partner to explore and reveal more of their own thoughts and feelings. (iii) To improve intimacy and empathy amongst people. (iv) To cultivate and promote the application of the abilities required by the partners for efficient problem-solving, communication, and conflict resolution (Hof & Miller, 1981; Stempky, 1985).

"Development of marriage and individual potential while maintaining a consistent and primary focus on the relationship of the couple" is how Otto (1976, p. 14) describes marriage enrichment. According to Otto's description, most marriage enrichment programs aim to strike a balance between individual and marital development and relational and marital progress (Stempky, 1985). The intention behind marital enrichment's preventative approach is to stop interpersonal dysfunction from starting, growing, or happening again (Guerney, 1977; Mace & Mace, 1975; Otto, 1976; Stempky, 1985). It is thought that progress and happiness can happen by working with marriages that are essentially functional and by maximizing the potential and strengths that already exist. The relationship can be stopped or avoided from deteriorating as long as a positive, growth-oriented base is established. The couples can learn how to handle change and disagreement as well as how to identify issues early on. In addition to the focus on prevention, there is a primary focus on enhancing emotional and interpersonal fulfillment as well as fortifying marital and family life (Hof & Miller, 1981; Stempky, 1985). Accordingly, the documented marriage objectives, include reduction in energy levels. The underlying theoretical underpinnings motivate the following testable hypothesis:

Hypothesis 2: Mariage decreases energy poverty.

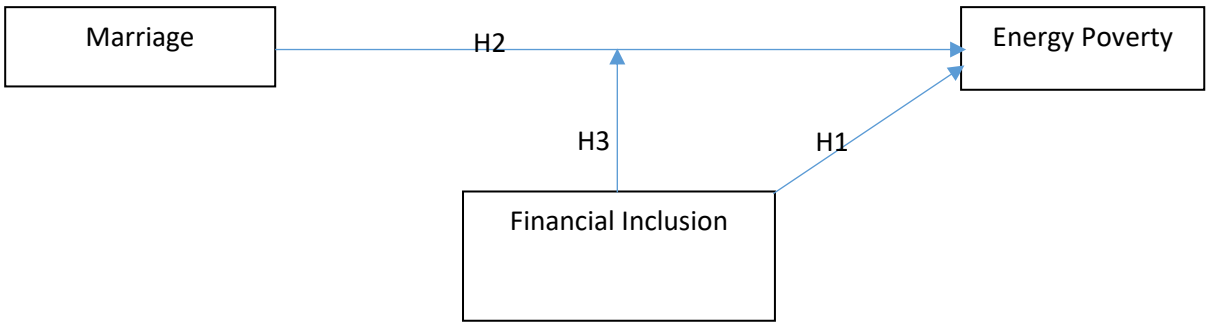
When *Hypothesis* 1 and *Hypothesis* 2 are collectively, considered, *Hypothesis* 3 ensues as follows:

Hypothesis 3: Marriage is a substitute of financial inclusion in reducing energy poverty.

While the assessment of *Hypothesis* 1 and *Hypothesis* 2 is based respectively on the unconditional effects of financial inclusion and marriage within the remit of interactive regressions, *Hypothesis* 3 is assessed by examining how financial inclusion moderates the incidence of marriage on energy poverty. In a situation where net negative effects are not computed from which negative synergies are apparent, *Hypothesis* 3 is valid. It is worthwhile to note that, in accordance with the relevant interactive regression literature, a negative synergy is apparent when interactive and unconditional effects have the same negative sign (Asongu & Nwachukwu, 2017; Diop et al., 2024).

Third, the above theoretical underpinnings and testable hypotheses motivate the following conceptual model in Figure 1 in which the three corresponding hypotheses are further articulated in order to enhance readability and flow. As apparent in Figure 1: (i) Financial inclusion directly affects energy poverty and the anticipated effect is negative in order to validate *Hypothesis* 1 (i.e., H1); (ii) Marriage also directly influences energy poverty and the expected incidence should be negative in order to validate *Hypothesis* 2 (i.e., H2) and (iii) Financial inclusion moderates the incidence of marriage on energy poverty and the moderating effect does not have to be significant in order for Hypothesis 3 (i.e., H3) to be valid. In order words, for marriage to be a substitute for financial inclusion in energy poverty mitigation, the following information criteria may also be fulfilled: (i) a positive interactive effect relative to the negative unconditional effect of marriage, (ii) a marriage net effect lower in magnitude compared to the unconditional effect of marriage and (iii) an insignificant interactive effect when both unconditional effects are negative.

Figure 1: The moderating effect of financial inclusion on the relationship between marriage and energy poverty



3. Data and methodology

3.1 Data

Information on variables used in this section is obtained from Koomson and Danquah (2021) and the primary sources are the 6th (GLSS6) and 7th (GLSS7) rounds of the Ghana Living Standards Survey (GSS, 2014; 2019) that were collected by the Ghana Statistical Service (GSS) for ten regions in the country. It is relevant to clarify that the GLSS7 (GLSS6) was gathered in 2016/2017 (2012/2013). In accordance with the attendant study, the corresponding survey is focused on a two-stage approach to probability sampling and reflects a number of dimensions such as fuel use and housing, demography and housing conditions, sanitation and water, health, insurance, employment, financial access, agriculture, governance, non-farm activities and migration. The main reason for using the GLSS6 and GLSS7 is based on data availability constraints at the time of the study. Furthermore, the corresponding survey rounds engender variables that have been used in the literature on energy poverty (Bouzarovski & Petrova, 2015; Boutabba *et al*., 2020; Churchill & Marisetty, 2020; Koomson & Danquah, 2021), especially within the remit of appreciating features that reflect the instrumental variables, indexes and corresponding explanatory indicators.

It is imperative to articulate that 18, 000 (15, 000) households are covered by the GLSS6 (GLSS7) with a response rate of 93.2% (93.4%). Building on these insights, the most updated sample for the GLSS7 (GLSS6) is 14,009 (16,772). After combining the file/section constituting the variable of interest, the attendant sample size is a bit diminished to a total pool of 30, 606 which consists of 16,760 (13,846) for GLSS6(GLSS7). Furthermore, given the missing information, the attendant regression analysis entails 6,545 (16,169) for GLSS7 (GLSS6) and engender a pool data of 22,714 households. The considerable reduction in the total number of observations after the estimation exercise is traceable to the perspective that 6,910 observations are not apparent from GLSS7 as a result of non-responses related to measurements that make up the index. Appendix 1 provides insights into the descriptive statistics of the variables.

3.1 Energy Poverty

In line with the attendant literature on energy poverty (Koomson & Danquah, 2021), both subjective and objective measures are employed in this study. On the one hand, we respect to the objective measure, the energy expenditure-income framework is articulated in relation to energy

poverty (% of household income) which is allocated to energy and fuel. Consistent with both contemporary and non-contemporary literature (Boardman, 2013; Churchill & Smyth, 2020), the existing energy poverty level is a positive function of the proportion of the measurement of energy. Another objective framework of secondary dimension is to engage about 10% of expenses in energy as the critical mass in the expenditure income approach in order to appreciate or define households that are energy poor as households which allocate about 10% of their income on fuel and energy (Boardman, 2013; Bouzarovski & Petrova, 2015; Koomson & Danquah, 2021). On the other hand, in line with the subjective front, energy poverty can be appreciated in terms of deprivation in material conditions, especially when the weather is cold. As documented in Churchill and Smyth (2020), the indicator for the most part, takes a value of 1 in a situation in which a household is unable to be heated owing to lack of funds and a corresponding value of 0, if the situation is otherwise. It is important to note that, the attendant measures are largely employed in studies that have focused on developing countries due to the absence of comprehensive data on concerns related to household expenditure on energy and fuel as well as heating.

An indicator that entails both objective and subjective indicators of energy poverty is understood within the framework of a multidimensional poverty index (MEPI). The corresponding indicator is for the most part, used in developing countries given its conceptualization and how such relates to initial economic conditions and the adoption rate of clean energy (Nussbaumer *et al*., 2013; Churchill & Smyth, 2020). Consistent with the relevant literature focused on developing countries (Adusah-Poku & Takeuchi, 2019; Nussbaumer *et al*., 2013; Crentsil *et al*., 2019), this study adopts and employs the MEPI indicator in the light constraints in data availability, especially as it concerns the measurement of poverty from the GLSS.

Following the underlying literature (Nussbaumer et al., 2013; Adusah-Poku & Takeuchi, 2019; Crentsil *et al*., 2019; Koomson & Danquah, 2021), as shown in Appendix 2, five main dimensions that are captured by the indicators constitute the MEPI, notably: communication, cooking, lighting, connected household appliances and education/entertainment. Moreover, consistent with the corresponding literature (Alkire & Foster, 2011), the MEPI has been established as a comprehensive multidimensional poverty index from the Oxford Poverty and Human Development Initiative which is based on, the contribution of Amartya Sen within the remit capabilities and deprivations literature. As argued by Koomson and Danquah (2021), the

underlying five dimensions can equally be weighted using an attendant weight of 0.20 which is assigned to each of the dimensions. Irrespective of this underlying, the cooking and lighting dimensions are assigned additional weights relative to the remaining three dimensions, essentially owing to the comparative relevance of poverty in energy in accordance with the attendant literature (Nussbaumer *et al*., 2013; Adusah-Poku & Takeuchi, 2019). Furthermore, upon comparing light and cooking, more weight is assigned to cooking given the premise that it represents a more critical household energy need in developing nations. On this fundamental, the two measures in the dimension have respective weights of 0.205 while a weight of 0.200 is assigned to the dimension of lighting. Of these three dimensions that are remaining, a 0.13 weight is attributed each of them. Appendix 2 entails three corresponding indicators that equally reflect comparative deprivation and by extension, are used to calculate the corresponding indicators that mirror deprivations that are relative and thus, are used to calculate the energy deprivation scores. For every underlying household, the score on deprivation is measured as the total of deprivations that range from 0 to 1 and captured as follows in Equation (1):

$$d_i = w_1 I_1 + w_2 I_2 + \cdots + w_n I_n \tag{1}$$

where d_i denotes the score on household energy deprivation, $I_i = 1$ in a scenario where the household is deprived in indicator i and $I_i = 0$ if otherwise. w_i reflects the weight linked to indicator i with $\sum_{i=1}^{d} w_i = 1$. Consistent with Nussbaumer *et al*. (2013), a cut off critical mass of 0.33 is used and is an indication that a household which is characterized with an energy deprivation score of at least 0.33 is an energy-poor household.

3.2 Financial inclusion (FI)

In the light of Koomson and Danquah (2021), the present research uses a multidimensional proxy for financial inclusion, in accordance with the attendant literature on energy poverty (Zhang & Posso, 2019; Churchill *et al*., 2020; Churchill & Marisetty, 2020). Accordingly, the four dimensions of the attendant FI measure are: ownership of bank account, loan/credit access, insurance ownership and use of mobile money innovations to receive financial remittances. These underlying measures of FI which are consistent with Koomson and Danquah (2021) are disclosed in Appendix 3. As far as the distribution is concerned, a weight of 0.25 is attributed to each of the

dimensions in order to calculate the household score on deprivation in Equation (1). Following the same consistency with the attendant study, the present research employs a critical mass of 0.50 and a value of 1 is provided to households which are connected with a deprivation score of below 0.50 and the corresponding value of 0 is employed for households which are characterized by a deprivation score that is above 0.50.

3.2. Methodology

Consistent with Koomson and Danquah (2021), the present research employs the linear probability model (LPM) which is tailored such that, both financial inclusion and marriage are the independent variables of interest. It is worthwhile to put emphasis on the fact, in line with the attendant literature, a pooled ordinary least squares (OLS) approach is used contrary to the random effects and fixed effects models, not least, because of the nature of the data that is collected from the GLSS7 and GLSS6 as repeated cross sections that do not involve a panel data structure. Accordingly, in accordance with prior research focusing on energy poverty (Koomson *et al*., 2020; Churchill & Marisetty, 2020), the simultaneity or reserve causality issue of endogeneity is tackled by means of an instrumental variable approach that is summarized in Equations (2) and (3). In the considered Equations, whereas financial inclusion is presented as the independent variable of interest for simplicity, two main independent variables of interest are employed in the analysis, such that the marriage independent variable of interest proxy is captured in the set of control variables. The concern about reverse causality is founded on the view that: (i) energy poverty is mitigated by financial inclusion and marriage and (ii) energy poverty is a condition that can motivate households to consider marriage or create a bank account with a formal financial establishment in order to create enabling conditions for the potential establishment of good relations with the attendant financial institutions that can boost the possibilities of creating a bank account and receiving credit facilities in view of addressing energy poverty concerns.

The first and second stages of the instrumental variable regressions process are disclosed in Equation (2) and Equation (3), respectively.

Reduced form equation (stage 1)

$$FI_{it} = \delta + \gamma Dist_{it} + \eta X_{it} + \vartheta_r + \mu_t + \varepsilon_{it} \quad (2)$$

Structural equation (stage 2)

$$EPov_{it} = \alpha + \beta\widehat{FI}_{it} + \lambda X_{it} + \vartheta_r + \mu_t + \nu_{it} \quad (3)$$

The corresponding interactive regression model associated with Hypothesis 3 is presented as follows in Equation (4):

$$EPov_{it} = \alpha + \beta FI_{it} + \partial M_{it} + \emptyset(FI * M)_{it} + \lambda X_{it} + \vartheta_r + \mu_t + \nu_{it} \quad (4)$$

where $EPov_{it}$ shows the status of energy poverty of a household i at time t, with time reflecting the period of each GLSS round; FI_{it} denotes an i household's status of financial inclusion at time t; M represents the marital status while whereas FI*M is the interaction between financial inclusion and marital status. X is a vector of covariates that are documented in the previously discussed energy poverty literature, namely: marital status (which is used an as independent variable of interest), gender, age, location, education, household size, employment status of head of household.δ and α respectively, represent constant values; ϑ_r and μ_t denote regional and GLSS fixed effects, respectively whereas ε and ν are the random error terms.

Note should be taken of the fact that, as argued by Koomson and Danquah (2021), 'distance to the nearest bank' (i.e. $Dist$) in Equation (2) is employed as an instrument for financial inclusion. There is an abundant supply of literature supporting the use of this instrument in the extant studies involving financial inclusion and poverty (Churchill *et al*., 2020; Koomson *et al.*, 2020; Churchill & Marisetty, 2020). In line with the corresponding literature, inclusive finance is linked to the distance to the nearest bank, essentially owing to the premise that households that are not far away from the bank have less access to financial services, compared to households that are near the bank. Such a positive association is due to less associated cost in financial access (Kunt & Klapper, 2012; Churchill *et al*., 2020; Koomson *et al*., 2020). Furthermore, the attendant instrument is assumed to exclusively affect energy poverty, via the marriage channel and the validity of the attendant instrument has been confirmed in the corresponding literature focusing on microfinance operations and financial institutions in both rural and urban areas (Reiter & Peprah, 2015; Churchill & Marisetty, 2020; Churchill *et al*., 2020; Koomson & Danquah, 2021; Koomson *et al*., 2020). Moreover, sub-sample analysis provides more insights for policy implications because the responsiveness of energy poverty to the considered independent variables of interest may be

contingent on some heterogeneities which have used in the extant literature (Koomson & Danquah, 2021). Such heterogeneities include the gender of the household head (i.e., male versus female household head) and location of the household (i.e., rural versus urban household).

4. Empirical results

The findings are reported in this section in Tables 1-5. Table 1, Table 2, Table 3, Table 4 and Table 5 respectively; focus on the full sample, rural sub-sample, urban sub-sample, male sub-sample and female sub-sample. Each table is characterized by three main specifications: the first is a pooled regression in the first column while the second and third respectively, are concerned with GLSS6 and GLSS7. The considered approach that is employed in presenting the findings is in line with Koomson and Danquah (2021) who have exclusively focused on the direct nexus between financial inclusion and energy poverty. It is worthwhile to note that in this study, the effect of marriage on energy poverty is assessed contingent on financial inclusion. In other words, marital status is interacted with financial inclusion to influence energy poverty such that the overall effect of marital status on energy poverty is contingent on the moderating role of financial inclusion. As previously highlighted, the validity of the tested hypothesis that marriage is a substitute for financial inclusion in energy poverty mitigation is based on three main criteria: (i) a positive interactive effect relative to the negative unconditional effect of marriage, (ii) a marriage net effect lower in magnitude compared to the unconditional effect of marriage and (iii) an insignificant interactive effect when both unconditional effects are negative.

In the light of the above, in order to assess the validity of the tested hypothesis, net effects of marriage are computed in the full sample and attendant sub-samples. This computation of net effect is consistent with the nonlinear empirical framework of the present study and thus, the estimated coefficients are not interpreted as in linear additive models, as done by Koomson and Danquah (2021). Moreover, the computation of net effect in order to avoid pitfalls of interactive regressions documented by Brambor *et al*. (2006) is consistent with contemporary literature on interactive regressions (Nchofoung *et al*., 2021, 2022; Nchofoung & Asongu, 2022a, 2022b). To put this computation into more perspective, the net effect of marriage on energy poverty in the first specification of Table 2 is -0.004 = ([0.028 × 0.38] + [-0.015]). In the corresponding computation,

0.38 is the average value of financial inclusion, -0.015 is the unconditional incidence of marriage on energy poverty while 0.028 is the conditional or interactive incidence of marriage with financial inclusion on energy poverty.

In the light of the information criteria for the validity of investigated hypothesis highlighted earlier, the tested hypothesis is not valid in the full sample, urban sub-sample and female sub-sample while it is valid in the rural and male sub-samples. Variables in the conditioning information set have signs that are broadly consistent with Koomson and Danquah (2021). Moreover revisiting the signs and significance of variables in the conditioning information set does not substantially add to the extant literature because they have been documented and discussed in Koomson and Danquah (2021).

Table 1: Full sample

Dependent variable: Energy Poverty			
	(1)	(2)	(3)
Variables	Pooled	GLSS6	GLSS7
age	0.001***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)
	0.061	0.064	0.053
female	-0.015**	-0.016**	-0.013
	(0.006)	(0.007)	(0.011)
	-0.017	-0.019	-0.016
married	-0.031***	-0.026***	-0.045***
	(0.006)	(0.007)	(0.012)
	-0.040	-0.034	-0.057
edu	-0.160***	-0.149***	-0.186***
	(0.005)	(0.006)	(0.009)
	-0.208	-0.194	-0.241
hhsize	0.012***	0.011***	0.013***
	(0.001)	(0.001)	(0.001)
	0.086	0.082	0.097
rural	0.193***	0.193***	0.189***
	(0.005)	(0.006)	(0.010)
	0.249	0.250	0.242
1.empstat	-0.036***	-0.023	-0.047***
	(0.012)	(0.018)	(0.017)
	-0.027	-0.016	-0.039
2.empstat	-0.133***	-0.123***	-0.134***
	(0.012)	(0.017)	(0.018)
	-0.142	-0.130	-0.145
3.empstat	0.020**	0.038**	0.002
	(0.010)	(0.015)	(0.013)
	0.025	0.046	0.002
rounds	-0.008		
	(0.005)		
	-0.009		
FI_mpi	-0.071***	-0.081***	-0.048***
	(0.008)	(0.010)	(0.015)
	-0.089	-0.102	-0.059
finclusion_married	0.010	0.015	-0.003
	(0.010)	(0.012)	(0.019)
	0.011	0.016	-0.003
Constant	0.734***	0.711***	0.756***
	(0.014)	(0.019)	(0.022)
Net effect of marriage	na	na	na
Observations	22,706	16,161	6,545
R-squared	0.272	0.277	0.263

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Age=Age of household head, FI_mpi=financial inclusion, female=female-headed household, married, edu=educated, hhsize=household size, rural=rural area, 1.empstat=retired/inactive, 2.empstat=employee, 3.empstat=self-employment, finclusion_married=financial inclusion*married. The mean value of financial inclusion is 0.38.

Table 2: Rural sample

Dependent variable: Energy Poverty			
	(1)	(2)	(3)
Variables	Pooled	GLSS6	GLSS7
age	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
	0.055	0.062	0.045
female	-0.016***	-0.019***	-0.009
	(0.005)	(0.006)	(0.010)
	-0.033	-0.041	-0.018
married	-0.015***	-0.014***	-0.018*
	(0.005)	(0.005)	(0.010)
	-0.033	-0.033	-0.038
edu	-0.067***	-0.058***	-0.089***
	(0.004)	(0.005)	(0.009)
	-0.149	-0.136	-0.178
hhsize	0.005***	0.005***	0.007***
	(0.000)	(0.001)	(0.001)
	0.076	0.067	0.092
1.empstat	-0.015	-0.014	-0.013
	(0.009)	(0.015)	(0.011)
	-0.019	-0.016	-0.018
2.empstat	-0.150***	-0.118***	-0.189***
	(0.013)	(0.017)	(0.020)
	-0.222	-0.174	-0.276
3.empstat	0.012*	0.025**	0.006
	(0.007)	(0.011)	(0.009)
	0.024	0.047	0.012
rounds	-0.008*		
	(0.004)		
	-0.017		
FI_mpi	-0.054***	-0.059***	-0.046***
	(0.009)	(0.010)	(0.015)
	-0.113	-0.129	-0.089
finclusion_married	0.028***	0.030**	0.020
	(0.010)	(0.012)	(0.019)
	0.050	0.057	0.032
Constant	0.950***	0.936***	0.952***
	(0.010)	(0.014)	(0.016)
Net effect of marriage	-0.004	-0.013	na
Observations	12,966	9,143	3,823
R-squared	0.137	0.117	0.180

Robust standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1 Age=Age of household head, FI_mpi=financial inclusion, female=female-headed household, married, edu=educated, hhsize=household size, rural=rural area, 1.empstat=retired/inactive, 2.empstat=employee, 3.empstat=self-employment, finclusion_married=financial inclusion*married. The mean value of financial inclusion is 0.38.

Table 3: Urban sample

Dependent variable: Energy Poverty			
	(1)	(2)	(3)
Variables	Pooled	GLSS6	GLSS7
age	0.003***	0.003***	0.002***
	(0.000)	(0.000)	(0.001)
	0.079	0.083	0.069
female	-0.026**	-0.030**	-0.016
	(0.011)	(0.013)	(0.021)
	-0.026	-0.030	-0.016
married	-0.054***	-0.047***	-0.069***
	(0.013)	(0.016)	(0.025)
	-0.057	-0.049	-0.072
edu	-0.286***	-0.277***	-0.305***
	(0.009)	(0.011)	(0.018)
	-0.284	-0.273	-0.309
hhsize	0.027***	0.028***	0.027***
	(0.002)	(0.002)	(0.004)
	0.135	0.137	0.131
1.empstat	-0.079***	-0.063*	-0.107***
	(0.025)	(0.035)	(0.039)
	-0.050	-0.039	-0.070
2.empstat	-0.131***	-0.135***	-0.109***
	(0.022)	(0.032)	(0.032)
	-0.130	-0.133	-0.108
3.empstat	0.001	0.015	-0.027
	(0.021)	(0.031)	(0.029)
	0.001	0.016	-0.028
rounds	-0.015		
	(0.010)		
	-0.015		
FI_mpi	-0.090***	-0.104***	-0.048*
	(0.013)	(0.015)	(0.025)
	-0.093	-0.109	-0.049
finclusion_married	-0.021	-0.019	-0.036
	(0.018)	(0.021)	(0.034)
	-0.020	-0.017	-0.032
Constant	0.758***	0.740***	0.772***
	(0.028)	(0.037)	(0.045)
Net effect of marriage	na	na	na
Observations	9,740	7,018	2,722
R-squared	0.185	0.192	0.171

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Age=Age of household head, FI_mpi=financial inclusion, female=female-headed household, married, edu=educated, hhsize=household size, rural=rural area, 1.empstat=retired/inactive, 2.empstat=employee, 3.empstat=self-employment, finclusion_married=financial inclusion*married. The mean value of financial inclusion is 0.38.

Table 4: Male sample

Dependent variable: Energy Poverty			
	(1)	(2)	(3)
Variables	Pooled	GLSS6	GLSS7
age	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
	0.050	0.051	0.050
married	-0.035***	-0.033***	-0.046***
	(0.007)	(0.008)	(0.015)
	-0.040	-0.037	-0.051
edu	-0.135***	-0.123***	-0.163***
	(0.005)	(0.006)	(0.011)
	-0.176	-0.162	-0.210
hhsize	0.011***	0.011***	0.013***
	(0.001)	(0.001)	(0.002)
	0.088	0.083	0.101
rural	0.216***	0.216***	0.213***
	(0.007)	(0.008)	(0.013)
	0.275	0.277	0.266
1.empstat	-0.036**	-0.037	-0.031
	(0.016)	(0.023)	(0.021)
	-0.024	-0.022	-0.024
2.empstat	-0.117***	-0.112***	-0.110***
	(0.014)	(0.020)	(0.022)
	-0.132	-0.126	-0.124
3.empstat	0.022*	0.037**	0.005
	(0.012)	(0.017)	(0.016)
	0.028	0.045	0.007
rounds	-0.013**		
	(0.006)		
	-0.015		
FI_mpi	-0.108***	-0.118***	-0.081***
	(0.014)	(0.016)	(0.027)
	-0.134	-0.148	-0.097
finclusion_married	0.047***	0.052***	0.031
	(0.015)	(0.017)	(0.029)
	0.054	0.061	0.035
Constant	0.721***	0.706***	0.723***
	(0.017)	(0.022)	(0.028)
Net effect of marriage	-0.017	-0.013	na
Observations	15,905	11,499	4,406
R-squared	0.281	0.289	0.263

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Age=Age of household head, FI_mpi=financial inclusion, female=female-headed household, married, edu=educated, hhsize=household size, rural=rural area, 1.empstat=retired/inactive, 2.empstat=employee, 3.empstat=self-employment, finclusion_married=financial inclusion*married. The mean value of financial inclusion is 0.38.

Table 5: Female sample

Dependent variable: Energy Poverty			
	(1)	(2)	(3)
Variables	Pooled	GLSS6	GLSS7
age	0.002***	0.002***	0.001**
	(0.000)	(0.000)	(0.000)
	0.070	0.082	0.045
married	-0.016	-0.007	-0.037*
	(0.012)	(0.014)	(0.021)
	-0.018	-0.007	-0.041
edu	-0.212***	-0.203***	-0.232***
	(0.011)	(0.013)	(0.019)
	-0.269	-0.256	-0.296
hhsize	0.014***	0.015***	0.012***
	(0.002)	(0.002)	(0.003)
	0.076	0.078	0.070
rural	0.150***	0.148***	0.151***
	(0.008)	(0.010)	(0.014)
	0.196	0.191	0.202
1.empstat	-0.043**	-0.017	-0.070***
	(0.020)	(0.031)	(0.027)
	-0.039	-0.015	-0.068
2.empstat	-0.186***	-0.170***	-0.197***
	(0.023)	(0.034)	(0.033)
	-0.160	-0.142	-0.181
3.empstat	0.009	0.030	-0.010
	(0.017)	(0.028)	(0.022)
	0.012	0.035	-0.014
rounds	0.005		
	(0.009)		
	0.006		
FI_mpi	-0.041***	-0.049***	-0.024
	(0.010)	(0.012)	(0.017)
	-0.052	-0.062	-0.031
finclusion_married	-0.037*	-0.034	-0.042
	(0.021)	(0.025)	(0.036)
	-0.028	-0.025	-0.033
Constant	0.746***	0.707***	0.808***
	(0.024)	(0.034)	(0.033)
Net effect of marriage	na	na	na
Observations	6,801	4,662	2,139
R-squared	0.267	0.265	0.275

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Age=Age of household head, FI_mpi=financial inclusion, female=female-headed household, married, edu=educated, hhsize=household size, rural=rural area, 1.empstat=retired/inactive, 2.empstat=employee, 3.empstat=self-employment, finclusion_married=financial inclusion*married. The mean value of financial inclusion is 0.38.

In discussing the established findings, it is first of all worthwhile to clarify the importance of repositioning the study closest to the study in the extant literature. Accordingly, Koomson and Danquah (2021) have established that financial inclusion reduces energy poverty. The departure of the present study from Koomson and Danquah (2021) has been clarified in terms of positioning and empirical results in the previous paragraph. Hence, the findings in this study further confirm both the scholarly and policy relevance of replicating studies in the extant contemporary literature (Pridemore *et al*., 2018; Asongu *et al*., 2020, 2021).

In the light of the above, the established findings have complemented the extant contemporary literature on the negative nexus between financial inclusion and energy poverty (Boutabba *et al*., 2020; Koomson & Danquah, 2021) by showing that marriage can be a substitute for financial inclusion, not least, because marriage provides partners with opportunities of risk diversification, especially as it pertains to financial access concerns on the one hand and on the other, leveraging on financial access to address poverty concerns such as energy poverty. Hence, by engaging financial inclusion within the framework of interactive regressions, this study also extends a strand of literature on the importance of interacting macroeconomic and microeconomic variables for microeconomic and macroeconomic outcomes with enhanced policy avenues (Alesina & Zhuravskaya, 2011; Churchill & Smyth, 2020).

It is relevant to further discuss the findings in the light of the extant theoretical literature on the subject, especially as it pertains to the financial inclusion theory on the one hand and the marriage enrichment theory on the other hand. Accordingly, the established findings are consistent with both theoretical underpinnings, not least, because unconditional effects of both financial inclusion and marriage, respectively, reduce energy poverty. It follows that the established findings are inline with the extensive and intensive margin theories of financial inclusion (Owen & Pereira, 2018; Tchamyou et al., 2019; Ngono, 2021). The established results are also in accordance with the positive externalities from marriage (Otto, 1976; Hof & Miller, 1981; Stempky, 1985), especially within the remit of reduced energy poverty in households as a result of a marriage engagement.

It follows from the above that the theoretical relevance of marriage in improving the socio-economic outcome of the household, withstands empirical scrutiny in this study within the remit of reduced energy poverty. Inter alia, a reason for the negative incidence of marriage on energy poverty can be traceable to the perspective that marriage is also tailored to strike a delicate balance between the improvement of the married couple as well as collective benefits from other favorable externalities such as reduction in energy poverty (Mace & Mace, 1975; Otto, 1976; Guerney, 1977; Hof & Miller, 1981; Stempky, 1985). In summary, the findings are also broadly consistent with the extant contemporary literature on the benefits of marriage in family wellbeing (Allen *et al*., 2022; Chiang & Bai, 2022; Don *et al*., 2022).

5. Concluding implications and future research directions

The present research has extended the extant literature by investigating the hypothesis on whether marriage can be a substitute for financial inclusion in energy poverty reduction in Ghana. Pooled data and two stage least squares techniques are used in the estimation process and the validity of the tested hypothesis that marriage is a substitute for financial inclusion in energy poverty mitigation is based on three main criteria: (i) a positive interactive effect relative to the negative unconditional effect of marriage, (ii) a marriage net effect lower in magnitude compared to the unconditional effect of marriage (iii) an insignificant interactive effect when both unconditional effects are negative. The investigated hypothesis is not valid in the full sample, urban sub-sample and female sub-sample while it is valid in the rural and male sub-samples.

In the light of the above, the main policy implications are centered on how marriage can be improved/promoted which according to Kante (2010) should be consistent with the steps recommended by the Successful Strategic Alliance (and Marriages), notably that present and potential marriage partners should: (i) court carefully and be open to romance; (ii) understand mutual strengths and weaknesses in romance; (iii) seek values compatibility; (iv) respectfully engage with the extended family; (v) mutually vow to work together; (vi) build organizational bridges; (vii) respect individual differences and (viii) teach one another and be opened to learning and adjusting to change.

Future studies focusing on energy poverty can extend this study by considering other policy channels and variables by which the outcome of energy poverty can be favorably influenced in

order to provide more insights for policy makers and concerned scholars on the subject. Moreover, reconsidering the empirical framework in other countries and regions as more data become available is also a worthwhile future research endeavor. Another limitation of the study that should be taken into account is the perspective that marriage is also endogenous as financial inclusion. However, the potential endogeneity of marriage is not corrected because it is measured as a dummy variable in the study. Hence, future studies attempting to extend the present exposition should consider a measurement of marriage that can be corrected for the simultaneity dimension of endogeneity by means of instrumental variables.

5.Declaration

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Appendices

Appendix 1: Definition of variables and summary statistics

Variable	Description	Mean	SD
Energy poverty	Dummy variable equals 1 if household's energy deprivation score exceeds 0.33	0.81	0.39
Financial inclusion	Dummy variable equals 1 if household financial deprivation score is less than 0.5	0.38	0.49
Age of head	Age of the household head	46.9	14.11
Female household head	Binary variable equals 1 if household head is female	0.26	0.44
Married head	Binary variable equals 1 if household head is married	0.68	0.47
Educated head	Binary variable equals 1 if household head is educated	0.52	0.5
Household size	Number of persons in the household	5.74	3.12
Household size squared	Number of persons in the household squared	42.7	53.46
Rural	Binary variable equals 1 if household is located in a rural area	0.5	0.5
Unemployed	Binary variable equals 1 if household head is unemployed	0.04	0.19
Retired/inactive	Binary variable equals 1 if household head is retired/inactive	0.07	0.26
Employee	Binary variable equals 1 if household head is an employee	0.22	0.42
Self-employed	Binary variable equals 1 if household head is self-employed	0.67	0.47
Distance to the nearest bank	Average distance to the nearest bank measured in kilometres	13.11	6.62
Energy Poor	Household with an energy deprivation score of at least 0.33	0.24	0.43
Net income	Continuous variable for household's total net income	155.0648	546083.9
Exp on education	Continuous variable for household's total expenditure on children's basic and secondary education	756.3471	1799.569
Account	Binary variable equals 1 if household head owns a bank or mobile money account	0.56	0.5
Insurance	Binary variable equals 1 if household head owns an insurance product	0.31	0.46
Credit	Binary variable equals 1 if household head has access to credit	0.13	0.33
Remittance	Binary variable equals 1 if household received financial remittance from financial institution or through mobile money	0.26	0.44

Source: Koomson and Danquah (2021).

Appendix 2: Dimensions, indicators and weights for multidimension energy poverty

Dimensions	**Indicators (weights)**	**Variables**	**Deprivation cut-off (energy poor if….)**
Cooking	Modern cooking fuel (0.205)	Type of cooking fuel	Any fuel used beside electricity, LPG, Kerosene, natural gas and biogas.
	Indoor pollution (0.205)	Food cooked on stove or open fire (no hood/chimney), indoor, if using any fuel beside electricity, LPG, natural gas or biogas	True
Lighting	Electricity access (0.200)	Has access to electricity	False
Services provided by means of household appliances	Household appliance ownership (0.13)	Has a fridge	False
Entertainment/education	Entertainment/education appliance ownership (0.13)	Has a radio or television	False
Communication	Telecommunication means (0.13)	Has a phone landline or mobile phone	False

Source: Adopted from: (Nussbaumer et al., 2012) and Koomson and Danquah (2021).

Appendix 3: Dimensions, indicators and weights for multidimensional financial inclusion

Dimension (weight)	
Bank account (1/4)	Household does not have a bank account (bank account includes savings, current, fixed deposit or microfinance account) or mobile money account
Loan/Credit (1/4)	Household does not have access to loan/credit from bank, microfinance institution or other formal institution
Insurance (1/4)	Household does not have access to medical, life, property, unemployment/income or family insurance
Financial remittance (1/4)	Household does not receive financial remittance from the bank, money transfer service provider or through mobile money

Source: Koomson and Danquah (2021).