Are Women Happier when their Spouse is Teleworker?

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Abstract

This study explores the household production allocation and happiness of women when their spouse is teleworker using data from the British Household Panel Survey (BHPS) over the years 1991-2009. The study aims to answer whether the women spend additional time on housework and are happier when they or their partner is teleworker. Also, we explore whether are happier when they share the household-domestic production with their partners. Fixed effects estimates take place, and we consider a Bayesian Network (BN) framework and a Directed Acyclic Graph (DAG) for causal inference. The results show that women are more likely to state that the household allocation, such as cooking, cleaning, ironing and childcare is shared when their partner teleworks. Shopping is an exception which can be regarded as an outdoor activity while one partner may be mainly responsible for this chore. In addition, women are happier when they or their spouse is teleworker, and they report higher levels of happiness when the household production allocation is a shared process. This may indicate men teleworkers may contribute extra to the household production releasing a burden for the partners and improving their well-being.

Keywords: Bayesian Networks; Directed Acyclic Graphs; Gender Roles; Household Production; Quality-of-life; Teleworking

1. Introduction

Teleworking is a specific flexible employment type which allows people to work from home instead at the employer's premises (Lim, Thompson and Har 1997). It has become a major and common element in the debate of employment policies and the future of the work, especially in the last 20 years. This phenomenon is proposed as a potential solution to various individual, economic and societal challenges. Balance in work-family life, work flexibility, stress reduction related to commuting, reduction of office and other expenditures, traffic congestion reduction, improvement in air quality are some of the possible benefits of teleworking.

This study explores whether the women whose spouse is teleworker are happier due to household production allocation. The roles within a household and family have been tragically changed the last 20 years. Nowadays an increasing number of women and men are involved in work and family arrangements. These arrangements were mostly unknown to the parents' of the last generations (Barnett and Rivers 1996; Hochschild 1997; Sullivan and Lewis 2001). Earlier studies try to explore the work-family balance nexus. Their main interest of analysis is the understanding of policies and practises that may affect the individuals through the new work family arrangements.

Household tasks are identified and characterised by femininity and masculinity (Coltrane 1989; Warde and Hetherington 1993; Ilahi 2000; Sullivan and Lewis 2001; Oláh et al. 2014). However, in the previous studies home-based production and teleworking is discussed as it was solely women's preserve. This fails to recognize that teleworkers can be also men. Nevertheless, little is known how teleworking affects men and women, the ways that they reconcile the demands of work and household and the effects on work-family conflict and people's well-being. Another fundamental point is both gender divisions and the diversity of household types within which gender relationships are embedded are essential. (Anderson et al. 1994, Benjamin and Sullivan 1996).

The purpose of this study is to examine: whether the women who telework spend additional hours in housework; whether their spouse who is teleworker devotes more time in household production-chores; and whether women whose spouse is teleworker are happier as a result of the household production allocation. The paper expands the previous literature by exploring the link between teleworking, household chores and happiness of women in United

Kingdom (UK). We use a comprehensive and detailed dataset the British Household Panel Survey (BHPS) for the period 1991-2009. The empirical analysis relies on panel data and fixed effects regressions allowing to capture the individual effects which include unobserved variables that may influence and have persistent effect on the dependent variables. In addition, we apply a Bayesian Network framework to test the causal assumptions between teleworking, gender roles and happiness.

There has been a debate about whether the growing trend for home-based teleworking affects the gender roles in workplace and in family (Silver, 1993; Bulos and Chaker, 1995; Ilahi 2000; Sullivan and Lewis 2001). Huws et al. (1996) argue that teleworking can be a solution to problems of balancing work and family particularly for women. Increase flexibility will facilitate the management of work and family together. Hence, it is necessary to identify the relationship between teleworking and household production allocation. Two processes are central to the ordering and living experience of household life; the domestic or household division of labour and the management and control of the household's finance (Pahl 1983; Vogler and Pahl 1993, 1994; Warde and Hetherington 1993; Morris 1993; Anderson et al. 1994; Ilahi 2000; Sullivan and Lewis 2001). Members of households may be more or less equal with the household labour distribution. It is well known that women's career path can be influenced in a negative way more than men, in terms of gender-pay gap and job loss during the pregnancy, while women spend more time on household chores (Becker 1981; Hersch and Stratton 1994; Waldfogel 1998; Ilahi 2000; Sullivan and Lewis 2001; Oláh et al. 2014). Therefore, men who telework may contribute more to the household production allocation, while women teleworkers may cope with both work and family obligations. Earlier studies show that parents with young children are more likely to work at home, due to child needs and due to maximization of the time spent with them. (Han 2004; Barnett and Gareis 2007; Wight et al. 2008). So far the work-family nexus understanding remains limited. Thus, the research based on which policies and practises can be developed to help individuals through the new work family arrangements, remains also limited. Furthermore, teleworking can be a strategic response to occupational and family circumstances. However, previous studies explored the relationship between home-based workers, household production and family obligations for women (Sullivan and Lewis 2001; Wiesenfeld et al. 2001; Greenhill and Wilson 2006; Madsen 2006; Golden 2006), while the role of men teleworkers on household production allocation and woman's well-being has been

neglected. Thus, exploring the effects of teleworking on gender roles and well-being, may provide valuable insights for future policy implications related to work-family balance, distribution of household production allocation and well-being.

The structure of the paper is: Section 2 presents a short literature review, in section 3 the methodology followed is discussed, while in section 4 the data sample used in the analysis is presented. In section 5 the empirical results are reported while in the final section the concluding remarks and some possible policy implications are discussed.

2. Literature Review

The last 30 years a significant increase of women's participation in the labour market is observed. However, this increasing participation of women has not been matched with the men's participation in household chores (Hochschild 1989; Presser 1994; Gregson and Lowe 1994; Mansfield and Collard 1988; Baxter 2000; Sullivan and Lewis 2001; Greenhill and Wilson 2006). Several studies show that there is evidence of men's participation rise in domestic household production when their wives are working. But, the additional participation time in household production of husbands is insignificant relative to the extra work taken by women in the labour market (Nichols and Metzen 1982; Sullivan 2000; Greenhill and Wilson 2006).

Previous studies explored the relationship between teleworking and well-being and the association between teleworking and household production. (Golden and Veiga 2005; Golden et al. 2006; Fonner and Roloff 2010). Regarding the former relationship, the most relevant paper in our study, is the paper by Vittersø et al. (2004), who investigated the effects of home-based telework on quality of life (QoL) considering four dimensions; overall satisfaction with life, the sense of belonging, the sense of becoming and the sense of being. The authors used cross-national survey data from Europe including 217 job holders and 112 partners. They applied a structural equation modelling, and they found a positive association between home-based telework and the worker's sense of belonging. On the other hand, they found a negative relationship between the job holder's home-based telework and his or her partner's overall life satisfaction. Bentley et al. (2016), analysing low-intensity and hybrid teleworkers, found

that providing the necessary organisational and support can be important for enhancing the teleworker-environment fit ensuring desirable telework outcomes of well-being. In another study Anderson et al. (2015) used a survey of 102 employees from a large US government agency, to explore the relationship between teleworking and affective well-being. They further used the following measures of well-being: openness to experience, rumination, sensation seeking, and social connectedness outside of work. Their results suggest that the employees experience more job-related positive affective well-being during the teleworking days compared to the days where they were working in the office. In another study, Vega et al. (2015) used a sample of 180 employees (56 males and 106 females) in a large federal government agency. The results of their study show that employees report higher levels of state job satisfaction and self-rated job-performance when they telework. Also, they are more productive in creative problem-solving tasks when they work at home. Nevertheless, the association between teleworking and well-being by gender has not been systemically explored using panel data.

The relationship between gender roles and well-being has been explored in the literature. Brown and Roberts (2014) explored the perception of gender roles within "modern" and "traditional" marriages on well-being in United Kingdom. The authors used the British Household Panel Survey (BHPS) over the period 1996-2008 and the psychological well-being, which is expressed by the General Health Questionnaire (GHQ) (Goldberg and Williams, 1988). Their results show that in couples with "modern" views, women who earn more than their husbands and still manage most of the household production, report lower levels of well-being. On the other hand, women who accept their role as homemakers have improved well-being. Men who hold traditional views report lower well-being levels if their wives work. On the other hand, men who express modern views on gender roles report higher levels of well-being only when their wives are the higher earners and they work part time. Working women also report higher levels of happiness, when they work, because job satisfaction is one of the three most important predictors of overall happiness, while the other two is marriage and family satisfaction (Clark 1997; Argyle 2001; Sironi and Mencarini 2012). Pina and Bengston (1993) used as sample of 287 white middle-class white women who took part in the third wave of the University of Southern California Longitudinal Study of Generations in 1988. They found that a wife's marital quality and psychological well-being are influenced by the way the household labour is divided by her husband. She is more likely

to report higher levels of well-being when she perceives that the household labour division is fair. Sironi and Mencarini (2012) explored the effect of the unequal division of household labour between the partners and women's happiness. They used data from the second round of the European Social Survey (ESS) in 2004 covering 26 countries. The authors found that a large share of housework negatively affects women's happiness, only for those who are employed for more than 30 hours per week, relative to the unemployed women or the housewives.

Another important domain of the theoretical framework is the collective rationality of the household and family decision-making. Within this framework the man considers his own utility function given his partner utility function and vice versa. Household resource allocation and labour supply have been always a subject of economics and have been long studied. Various theories have been developed to identify the patterns where household members participate in the labour market, household production and share the resources maximising their utilities. Theoretical studies, initiated with Chiappori (1992), use the conceptual framework of utility, to analyse the process of choosing the labour supply and domestic production level by the household members. In this context the labour-working hours and the housework hours supplied by each member depend not only on their own age, education, wage and other characteristics, but also on the characteristics of their spouse and their decisions. These models have developed a systemic theoretical framework to explore the decision-making in terms of labour supply, household-domestic production participation and resource allocation within the household, accounting for both spouses' characteristics. However, the effects of teleworking on household-domestic participation and well-being have not yet been explored within this framework.

This study extends the previous literature, by attempting to answer about whether the employed men and women who are teleworkers spend more time on family work and household production than the non-teleworkers. In addition, this study explores whether the women whose spouse is teleworker are more likely to state that the household production is a shared process. The effect of family life on gender roles and well-being, considering additionally teleworking, is an important setting. However, the economists and work organisations have overlooked teleworking and its association with household production allocation and well-being with plausible implications on the productivity of the workers. According to the exchange theory, the empirical applications use beliefs and perception of the

household production allocation, rather than the actual time spent on it. Exchange theory and the economic bargaining models suggest that the resources between the couples should be related to bargains about the labour division in the market and household production, the quality of marriage and the perceptions of whether the bargains are fair (Thompson 1991; Pina and Bengston 1993; Lundberg and Pollak 1996). The actual time spent to household production is not as important as the perception on whether the household production process is shared or fair. This perspective has some empirical support in the literature where in the case the feeling that the labour division is fair, the wives' and husbands' marital satisfaction and thus life satisfaction is increased (Wilkie, Ferree, and Ratcliff 1998; Voydanoff and Donnelly 1999; Frisco and Williams 2003).

Teleworking can be an alternative or a substitution tool to parental leave benefits, or a complementary policy which can allow the parents to divide time on childcare and labour market with flexible working hours or part time allocation provided by this flexible employment type. For instance, a study by Ozdamar (2015a) found a significant relationship between child health and parental leaves suggesting that the traditional social policies might not be efficient. In a similar study the female political participation-representation and the public spending allocation on family allowances differs (Ozdamar, 2015b). Therefore, exploring teleworking as a distributional factor, following the collective approach (Chiappori, 1988, 1992), can allocate the bargaining process between the couples. This will offer the option to the women to work and to spend time on housework and childcare.

In addition, the study relies on panel data instead of cross-sectional data, which follows the respondents across time and it allows the inclusion of individual fixed effects. This setting makes possible to account for the within-person and not between-person analysis. Furthermore, it allows us to control for unobservable characteristics that may affect both teleworking and the outcomes of interest- well-being and household chores- solving in this way the omitted variables bias. The regressions control for unobserved area characteristics, such as the traffic and commuting to work, which can be correlated with teleworking and happiness. Furthermore, the study applies a Bayesian Network framework which is a concrete mathematical tool for causal inference.

Based on the literature we include various demographic and socio-economic characteristics into the analysis. For the regressions of the housework time and household allocation some of the most important variables include the spouses' labour income, age and

education level (Bourguignon et al. 2009; Mazzocco et al. 2013; Browning et al. 2014; Dauphin et al. 2014). The idea is that increases in the wage of the husband can increase his bargaining power, contributing less to the household production and more in the labour market or leisure and vice versa. Similarly, Chiappori (1988, 1992) found the age and education difference between males and females increase the bargaining power in favour of one of the two spouses.

For the happiness regression the common control variables include the age, education, job status, marital status, house tenure, household size and income among others (Pina and Bengston 1993; Clark and Oswald 1996; Levinson 2012; Giovanis 2014; Brown and Roberts 2014). However, since only the employed and the married couples are considered, the marital and the job status are not included. This is because the marital status refers additionally to singles, divorced and widowed people, while job status includes also unemployed, retired, disabled and those who are housekeepers and therefore they fulfil only domestic-household tasks. The literature shows that age usually presents a U-curve shape. This indicates that in the first years, increases in age are associated with lower levels of happiness, while after a turning-minimum point, happiness is increased. Education can have positive effects on happiness, as more educated people are able to have more labour opportunities, resulting to higher income and higher job satisfaction and therefore leading to increases in happiness. A similar interpretation can be given to the other factors.

The methods used in the previous studies are various, including correlation, mean test *t-statistics*, regression analysis and Bayesian Networks. In this study, we prefer the regression analysis with fixed effects for the following reasons: First, fixed effects allow the inclusion of the history since the same individual is followed across time. Second, fixed effects may solve for the endogeneity coming from the omitted variables bias that may affect both teleworking and the outcomes of interest which is the household-domestic production allocation and happiness. Third, regression analysis allows us to include control variables that may affect both teleworking and the outcomes explored in this study which are known as confounders (Pearl 2000; Spirtes et al. 2000). Even though there might be a significant positive relationship between teleworking and housework hours or happiness, as we will show in the table 2 in the data section, this association does not consider for those confounders or control variables. Bayesian Networks is a valuable tool to derive causal relationships among variables.

3. Methodology

3.1 Theoretical Framework

The theoretical framework presented in this section is based on the models proposed by Zuidberg (1981), Goossens and De Vos (1987), Van Soest (1995), Gronau (1997), Van Soest and Stancanelli (2010) and the collective model developed by Chiappori (1988, 1992). These studies are included in the domain of the home or family economics. This field investigates the phenomena of household and family in an integrated approach. The model used is presented in figure 1, proposed by Zuidberg (1981). Nevertheless, advances in family and household economics took place by Gronau (1997) and Chiappori (1988, 1992), who suggest that the spouses' labour income, age, education and other characteristics can affect the household production allocation and the participation in the labour market. This is also related to changes of the overall utility or well-being expressed by happiness in our case.

As we can see in figure 1, the central interests of family economics are the activities and functions of the household. Family economists examine how the daily care and domestic production are organised and which resources are applied to it. In this model activities are defined as the satisfaction of material needs and other non-material needs in the domains of food, clothing, health, care, housing and leisure. These activities require human resources, including skills, knowledge and non-human resources, such as goods, services, time and money. Goossens and De Vos (1987) introduced to Zuidberg's model the effect of external factors, including political, economic and cultural factors and the availability of environmental resources, such as telephone, electricity and others. The application of time, labour and money by the household results in goods and services, either supplied by the market, or produced within the home, as the household chores explored in this study. Changes in the environment of the household are most likely to influence both resources, the standard of care and the overall well-being.

In addition, the model of Goossens and De Vos (1987) is extended by introducing the individual characteristics, as additional controls or distribution factors that may affect the household production allocation (Bourguignon et al. 2009; Mazzocco et al. 2013; Browning et al. 2014; Dauphin et al. 2014). These factors, as we discussed in the literature review,

include the age, education level, the health status of each partner, the house tenure, the household size and area dummies. Nevertheless, the estimates are not presented, as the main point of interest is the teleworking, household production allocation and well-being. Moreover, area fixed effects allow for controlling for unobservables that may affect the household's resources, production allocation and well-being.

The core of the family-home economics is formed by three types of household activities; function, process and category activities. The function activities consist of the acquirement of resources, the domestic production and consumption, in terms of food, housing, and clothing for family members. These functions are subject to the second type of household activities, which is the process, and it refers to activities related to decision-making, planning and organisation and the actual execution and implementation of domestic tasks. Decision-making is a main issue and topic of research within home economics and family studies. Pennartz and Niehof (1999) note that it is considered being a crucial process underlying all functions of family resource management and essential to the quality of human life. The decision-making has been extended into the intra-household resource collective allocation model (Chiappori 1988, 1992; Van Soest 1995; Bourguignon et al. 2009; Van Soest and Stancanelli 2010; Browning et al. 2014). The household production is directed to the third type of activity which is the categories: food, housing, clothing and care for members and others. These are often called the household activities or chores in the narrow sense which comprise the preparation of meals, washing the dishes, making beds, cleaning the house, doing the laundry, ironing, other chores around the house, shopping, and transportation for household activities. Personal care and caring for members of the household consist of sleeping, eating and other personal care, care for children and others. Wheelock (1990) also points at the interrelation between work and non-work, where the long-term well-being of the individual and the household is mainly secured by activities in the work domain. However, this has been originally men's concern, whilst women were more concerned with immediate needs of everyday life, because of their role as housekeepers in the past. Nevertheless, the gender roles have been significantly changed, even though woman has still the main responsibility of household chores, at least in United Kingdom that is explored in this study.

In our case, teleworking is introduced in the model presented in figure 1 as a part of the non-human resources, which is a type of employment scheme. Teleworking is assumed that may affect well-being and happiness either directly or indirectly through household activities.

These household activities then affect the household production allocation through three types of activities; function, decision-making process and category.

(Insert Figure 1)

Overall, the purpose of the study is to explore the following research questions and hypotheses.

Hypothesis 1. Do the women spend more time on housework when they or their spouse is teleworker or works at home?

The hypothesis 1 is based on various assumptions according to theoretical framework. First, the women who telework or work at home are more likely to spend more time on housework especially when their partner is non-teleworker. The same assumption may hold for men since their bargaining power can be lower relative to men who are non-teleworkers and especially for women who are employed and are non-teleworkers.

Hypothesis 2. Are the women happier when the household chores are shared?

The hypothesis relies on the hypothesis that when the household is shared women have more time for other activities, such as leisure increasing their happiness.

Hypothesis 3. Are the women happier when they or their partner is teleworker?

The hypothesis 3 is based on the two previous hypotheses. More specifically, when the men are teleworkers are more likely to spend more time to domestic household labour than the men non-teleworkers. On the contrary, the effect of teleworking on women's happiness can be unambiguous. Women are more likely to spend more time on household production reducing the probability of sharing the household with their partner. On the other hand, teleworking can be an alternative tool for women to cope with family demands and obligation, such as childcare. For instance the time lost to commuting from home to work which can be long in many cases, can be substituted for time allocation to household chores. Thus, teleworking can have a positive effect on happiness.

3.2 Fixed Effects

The model described below explores the impact of teleworking on the hours of housework. In addition, the analysis on whether the respondent or the partner is contributing more, less or equal on specific house chores will take place. Although women continue to be responsible for most part of the housework, few may perceive it as unfair. As we discussed in the previous section, critics of exchange theory argue is more fruitful to explore the perceptions of fairness rather than concentrating only to the relationship between job, marital and life satisfaction and the household production division measured by hours or volume (Thompson 1991; Pina and Bengston 1993). Pina and Bengston (1993) find that the way wives perceive the amount of support and the help they receive from their husband is more important in determining the happiness than the actual division of labour expressed in hours. Regarding the teleworking and gender roles association, the general model used to answer the first hypothesis is:

$$GR_{i,j,t} = a_0 + a_1 tel^{f}_{i,j,t} + a_2 tel^{m}_{i,j,t} + \alpha' \mathrm{Z}_{i,j,t} + \mu_i + \theta_t + l_j + l_j T + \varepsilon_{i,j,t} \quad (1)$$

GR denotes the gender roles and the housework division for individual *i* in area *j* and in time *t*, and the possible answers are: *whether the individual does mainly the housework, whether his/her partner does mainly the housework, both share the housework, somebody else does the housework* and are discussed in more details in the data section for individual *i*, in household *h*, in location *j* and time *t*. The dummy variable *tel* indicates whether the individual *i* is teleworker for *f* and *m,* where *f* denotes females and *m* indicates males. **Z** is a vector of individual and household characteristics, discussed in the data section. Set μ_i denotes the individual-fixed effects, l_j is a location-residence fixed effects based on local authority districts. Set θ_t is a time-specific vector of indicators for the day and month the interview took place and the survey wave, while $l_j T$ is a set of area-specific linear time trend. The last interaction term controls for unobservable, time-varying characteristics in the area which can affect the propensity to telework, such as the transportation infrastructure and services, the distance and the time takes to reach employer's premises.

The dependent variable in equation (1) is nominal, as it answers on who is more responsible for each household chore. So, the multinomial Logistic regression with fixed effects is applied, which is a classification method that generalises logistic regression to multiclass problems with over two possible discrete outcomes. This will allow

us to estimate whether teleworking increases the probability that the couples share the housework. Also, we will examine the hypothesis that spouses who are teleworkers may spend more time in house chores and whether housework is a more or less shared process. Next the dependent variable "hours per work in housework" is used and the model (1) is estimated with Fixed Effects as:

$$HH_{i,j,t} = a_0 + a_1 tel^{f}_{i,j,t} + a_2 tel^{m}_{i,j,t} + \alpha' \mathrm{Z}_{i,j,t} + \mu_i + \theta_t + l_j + l_j T + \varepsilon_{i,j,t} \quad (2)$$

Model (2) is defined as in (1), except for the dependent variable which is the housework hours per week. In addition, model (2) is used to explore again the first hypothesis. The difference is that the dependent variable measures the hours spent in housework, while in model (1) the dependent variable measures the belief on household production allocation. Also, regression (1) is used to answer the hypotheses 2-3 which is estimated using the happiness as dependent variable and it can be written as:

$$HP_{i,j,t} = a_0 + a_1 tel^{f}_{i,j,t} + a_2 tel^{m}_{i,j,t} + a_3 GR_{i,j,t} + a_4 tel^{m}_{i,j,t} * GR_{i,j,t} + \alpha' \mathrm{Z}_{i,j,t} + \mu_i + \theta_t + l_j + l_j T + \varepsilon_{i,j,t} \quad (3)$$

The variables in (3) are defined as in the models (1) and (2), with the difference that the dependent variable *HP* is the happiness. The model (3) using happiness as dependent variable can be estimated by ordered Logit and Probit with random effects. However, a fixed effects framework is not feasible using these approaches into a panel data structure. One option is to use the Probit OLS introduced by van Praag and Ferrer-i-Carbonell (2004) by rescaling the categorical dependent variable and deriving *Z*-values of the standard normal distribution that correspond to cumulative frequencies of the original categories. The main objective of regression (3) is to test the hypotheses 2-3 mentioned above. First, the estimated coefficient of the variable teleworking will show whether women are happier when they or their spouse is teleworker. Second, their perception about the household production allocation and fairness and the association to their happiness will be explored. The last objective is to examine whether the women are happier if their spouse is teleworker and whether he contributes more to the household production, due to teleworking. For this reason we take the interaction terms

between their gender roles and beliefs and whether their spouse is teleworker. This will show us whether women are happier if the household division is main responsibility of their partner or is shared among them because he is teleworker.

3.3 Heckman Selection Model

In this section the Heckman selection model (Heckman, 1979) is described. The main reason of using the Heckman selection model is to test whether there is a selection bias in our sample. The treatment variable is a dummy variable taking value 1 for teleworkers and 0 otherwise. Even if the hypothesis that there is no selection bias is rejected, there is still endogenous selection bias using the Heckman model. This is described in more details in the next section of the methodology part, where the Bayesian Networks framework is presented. Overall, there are two main sources of selection bias. The first comes from the fact that the information on the dependent variable for part of the respondents is missing. One example is the teleworking effect on the household production allocation of women or their happiness. If there are many women that are not engaged in household production allocation or labour market, the effect of teleworking on the dependent variable will be biased. However, this form of selection bias is not the case of our study, because we observe the time spent on household production, whether they are teleworkers and their happiness. The second source of selection bias is coming from the selective way that the distribution of the respondents over the categories of the independent variables takes place. For instance, the effect of a teleworker on the main outcomes of interest in this study might be biased if the distribution of respondents over the categories of teleworkers and non-teleworkers is not random. Thus, if there are characteristics that affect peoples' decision to telework and these are related to the household production allocation then the coefficient of the teleworking dummy may be biased.

Heckman model comprises two processes which can be described by two equations; the "selection" equation and the "observation" equation. The "observation" equation in this case is the household production allocation (1) and (2), while the "selection" equation is the teleworking equation.

3.4 Bayesian Networks

In this section the present the Bayesian Network framework followed for causality. Even if this study is based on panel data and fixed effects are considered, where causality on some degree can be assumed, still an evidence of reverse causality between teleworking and household production or happiness remains. For instance, those who want to contribute more to household production or are less happy with their previous job, they might choose teleworking creating the problem of reverse causality.

A Bayesian Network (BN) is a graphical structural model that encodes probabilistic relationships among the variables of interest (Heckerman, 1996)[1]. A graph $G(V,E)$ can be referred to as a directed acyclic graph (DAG), when the edges E linking node V are directed and acyclic. *Directed* means that E has an asymmetric edge over V variables, while edges E represent direct causal effects (Spirtes et al. 2000; Pearl 2000, 2009). *Acyclic* means that the directed edges do not form circles. Following Heckerman's (1996) notation, a generic graph is presented in Figure 2. Figure 2 represents causal relationships when there is an edge from one node to another. For instance, there is an edge from *A* to *C*, if and only if *A* is a direct cause of *C* in Graph *G* (Spirtes et al. 2002). So an edge $A \rightarrow C$ is interpreted as *A* is directly causing *C* or that *C* is causally dependent on *A*. Similarly, there is a causal relationship between *B* and *C*. In Figure 2, the parents of *C*, are *A and B*, while *C* is defined as the child of *A and B*. Similarly D is the child of C or C is the parent of D. Thus, *child* is defined as the variable which is directly caused by another variable, while *parent* is defined as a variable which directly causes another one. Regarding, A and B are *parents* of C, but also they are *ancestors* of D. while D is defined as the *descendant* of A and B.

(Insert Figure 2)

The DAG defines a factorization of the joint probability distribution of $V = \{X_1, \ldots, X_N\}$, often called the global probability distribution, into a set of local probability distributions, one

[1] Major advances have been made in inferring causal relationships from observational data (Pearl 2000, Spirtes et al. 2000).

for each variable. The form of the factorization is given by the Markov property of Bayesian networks which states that every random variable X_i directly depends only on its parents:

$$p(x) = \prod_{i=1}^{m} p(x_i \mid par_i) \tag{4}$$

Applying the chain rule of probability, we have:

$$p(x) = \prod_{i=1}^{m} p(x_i \mid x_1, ..., x_{i-1}) \tag{5}$$

The causal Markov assumption is that each node is independent of its non-descendants in the graph conditional on its parents in the graph. In Figure 2 the Markov condition (see appendix) entails the following conditional independence relations:

$$A \perp B \tag{6.a}$$

$$D \perp \{A, B\} \mid C \tag{6.b}$$

More specifically, (6.a) implies that nodes *A* and *B* are independent as there is no direct edge connecting them. Relation (6.b) implies that node *D* is independent from *A* and *B* given *C*. The causal Markov assumption reduces the complexity of relation (5) and if a joint distribution over variables satisfies this condition for Figure 2, then it can be factored in the following way:

$$P(A, B, C, D) = P(A)P(B)P(C \mid A, B)P(D \mid C) \tag{7}$$

For all values of *A,B,C,D* such that P(*A,B,C,D*)≠0. In a DAG *G*, vertices of zero indegree are said to be exogenous. If *G* satisfies the Markov condition for a distribution *P*, then for every pair of exogenous variables (nodes) V_1 and V_2 is $V_1 \perp V_2$. Besides the causal Markov assumption a BN is causal under the *d*-separation condition (more details in appendix).

4. Data

The dataset used in this study is the British Household Panel Survey (BHPS) which is a panel survey started since 1991 and completed in 2009 covering 18 waves. The BHPS is implemented in United Kingdom and specifically in England, Scotland, Wales and Northern Ireland. Each survey takes place from the 1st September of one year through the end of April of the following year. The BHPS survey started in England, Scotland and Wales, while a major development at Wave 9 in year 1999, was the recruitment of two additional samples to the BHPS in Scotland and Wales. In addition, 2,000 households from Northern Ireland were included in wave 11 or year 2001. The aim of the sample extension was twofold. First, to increase the relatively small Scottish and Welsh sample sizes which was around 400-500 households in each country in the initial BHPS sample. This extension may allow for independent analysis of the two countries. Second, the aim was to facilitate analysis of the three countries compared to England to evaluate public policy changes (Taylor et al. 2010).

The structure of the BHPS is longitudinal, so the same individual is followed every year. This allow us to estimate fixed effects models, where the history of the individual can be included into the regression analysis. At the first stage of sampling in 1991, 250 postcode sectors were selected as the Primary Sampling Units (PSUs) which on average contain 2,500 addresses. For the selection, the population was implicitly stratified into an ordered listing by region and three socio-demographic variables, the age, gender and professional class which were derived from the 1981 Census. The stratification was implicit through ordering the frame listing, and is preferred to explicit stratification since it allows for the use of systematic selection procedures, the definition of strata and subsequent independent sampling within each strata. Then the PSUs were selected from this list using a systematic procedure with a random integer start and a systematically applied sampling interval. The population of the postcode sectors was ordered into 18 regions, including the inner London, outer London, East midlands, East Anglia and greater Manchester among others. The PSUs were checked for size and they contained at least 500 households. In the case where the PSUs did not meet the size criterion, they were grouped with their nearest adjacent sector. This is defined as the shortest straight line distance from the centre of the undersized sector. Then the PSUs were ranked within each of these implicit regional strata in order by the proportion of heads of households according to the professional position. PSUs were then split within each region, into major strata of approximately equal size. In the next step within the major strata created in the regions, PSUs were then re-ranked by the proportion of the population of pensionable age,

which refers to females older than 60 years and males older than 65. The major strata were then split into two minor strata each of approximately equal size. In the final step within the minor strata the PSUs in non-metropolitan areas were ranked by the proportion of the employed PSU population working in agriculture while in the metropolitan areas the PSUs were ranked by the proportion of the PSU that was under pensionable age. From each of the 250 PSUs selected at stage one, on average thirty three delivery points using a systematic sampling procedure are selected. In the third stage, whether from a delivery point or address up to three households were present, all households were included in the sample. The target size was 5,000 households, with the extension samples in Wales and Scotland in wave 9 or year 1999 and the inclusion of 2,000 households in Northern Ireland in wave 11 (Taylor et al. 2010).

We should notice that the number of participants regarding the number of housework and gender roles differ. The reason is that the first question is available in all waves, except for wave 1, while the gender roles are available in all waves except for waves 2-3. In addition, the gender role for childcare is available in all waves, except the second wave, but the participants with children are less than the total sample. Regarding the housework hours the number of participants is 1,410 while for the gender roles is 1,154. For the couples having children the number of participants is 842. The age of the participants ranges between 18 and 65 and specifically, 18-60 for women and 18-65 for men.

BHPS, as we mentioned in the methodology section, has statements on the housework division, helpful to observe which gender is responsible on different house chores. These include shopping, cooking, cleaning, ironing and childcare and the possible answers are: *whether the individual does mainly the housework; whether his/her partner does mainly the housework; both share the housework; somebody else does the housework.* Also, there is a quantitative variable *hours per work in housework,* which will be an additional dependent variable. The survey includes a question about happiness, which is an ordinal variable measured on a 4-point scale answering to the following question "Have you recently been feeling reasonably happy, all things considered". In addition, the health status is included into the regressions, which is an ordinal variable answering on whether the respondent's health is very poor/poor/fair/good/excellent.

In table 1 the summary statistics for gender roles, housework, personal and household income, teleworking and happiness are reported. The sample of analysis refers only to

married and those who live together as a couple. The percentage of teleworkers is 11.08, while the 3.71 is home-based teleworkers. It should be noticed that for gender roles paid help is applied, with the exception from the question of the childcare responsibility, where the answer is *someone else*, meaning that could be another member of the family, paid help or help from relatives.

In panels B-E the beliefs of the women on household chores-production allocation are presented under four conditions: when they are teleworkers, they are non- teleworkers, their spouse is teleworker and their spouse is non-teleworker. The summary statistics show overall that when the man is teleworker the woman's proportion of being mainly responsible is lower. The proportion of sharing the household chores, and the statement that men are responsible is increased.

First the comparison of gender roles between men teleworkers and non-teleworkers are presented. Women whose spouse teleworks report they are responsible for shopping at 57.82 per cent. The respective percentage for the spouses who are non-teleworkers is 52.37 per cent (t-statistic=5.2160, p-value=<0.001). It should be noticed that the *t-statistic* is positive since teleworking takes value 1 for those who telework and 0 otherwise, and in this case the percentage of women who are mainly responsible is higher when their partner teleworks. The sharing process is reduced from 37.47 per cent for men non-teleworkers to 32.43 per cent for men who telework and the difference is statistically significant (t-statistic=-4.800, p-value=<0.001) indicating that women are more likely to shop when their partner teleworks. On the other hand, women who report that their partner is responsible for shopping or someone else, is not significant between men teleworkers and non-teleworkers (t-statistic= -1.1824, p-value=0.2371 for mostly partner t-statistic= 1.0078, p-value=0.3136 for paid).

About cooking, women state that is their main responsibility at 63.77 per cent when their partner is teleworker versus 66.11 for men non-teleworkers (t-statistic= -3.962, p-value<0.001). They state that cooking is main responsibility of their partner at 11.55 and 9.60 when their spouse is respectively teleworker and non-teleworker (t-statistic= 3.406, p-value<0.001). However, there is no difference on the sharing process and cooking with payment between spouses who are teleworkers and non-teleworkers (t-statistic= 1.0211, p-value=0.3072 for sharing, t-statistic= 1.1007, p-value=0.2710 for paid). A similar situation holds for cleaning, where women whose partner is teleworker report that are responsible for this chore at 65.88 per cent versus 67.30 for men non-teleworkers (t-statistic= -2.0462, p-

value=0.0165). The percentage of the women who state that their partner is responsible is increased from 4.48 per cent (man non-teleworker) to 5.03 (men teleworker) (t-statistic= 1.2179, p-value=0.3265). Similarly to the previous chores, the responsibility by payment is not significantly different between the statement of women whose partner is teleworker or not. On the other hand, the percentage of the sharing process is increased from 21.85 for women whose spouse is non-teleworker to 23.52 per cent for men teleworkers and is significant (t-statistic= 2.947, p-value<0.001).

The next household chore is ironing, where the sample of women whose spouse is non-teleworker, is responsible for this chore at 78.72 and is reduced at 76.29 for the sample of women whose partner is teleworker and is significant (t-statistic= -2.4517, p-value=0.0176). Whether the man is teleworker has no significance on the women's statement if the ironing is mainly responsibility of their partner or someone else. On the other hand, the sharing process presents an increase from 15.55 (men non-teleworkers) to 17.36 (men teleworkers) and is statistically significant (t-statistic= 2.8682, p-value=0.0039). The gender roles of women for childcare present a different situation where all the differences are significant. The percentage of women whose spouse is teleworker is different of the women whose partner does not telework in terms that childcare is main responsibility of women, respectively at 40.26 and 35.25 (t-statistic= -4.006, p-value<0.001). There is also a large increase of women who state that their partner is responsible for childcare when he is non-teleworker at 3.21 per cent to 8.38 when their partner teleworks (t-statistic= 8.0347, p-value<0.001). Similarly, women with non-teleworker partner, state that childcare is a sharing process at 19.45 per cent, while the respective percentage for women with teleworker partner is 24.92 (t-statistic= 8.6939, p-value<0.001). The paid aid is reduced from 37.08 per cent (women with partner non-teleworker) to 31.45 per cent (women with partner teleworker) and is statistically significant (t-statistic= -7.8420, p-value<0.001).

Next, the differences in the household division of labour between women teleworkers and non-teleworkers are presented. Women who telework are more likely to state that are responsible at 56.98 versus 53.99 per cent of women who are non-teleworkers (t-statistic=4.5679, p-value<0.001). On the other hand, women who telework state that their partner is responsible for shopping at 9.54 per cent versus 8.90 per cent of women who do not telework and is insignificant (t-statistic=1.1764, p-value=0.2395). Women who are teleworkers state that shopping is a sharing process at 32.92 per cent and is increased at 36.03

per cent for women who do not telework (t-statistic=-4.9624, p-value<0.001). This shows that women when telework still are more likely to spend more time to this chore.

For the women who telework is more likely that they will manage cooking at 64.84 per cent, than the women who are non-teleworkers at 61.64 per cent (t-statistic= 4.9500, p-value<0.001). Similarly, women who telework are less likely to state that the cooking is main responsibility of their partner (non-significant) or that cooking is a sharing process than women who are non-teleworkers and is significant (t-statistic= -1.5867, p-value=0.1126 for mostly partner, t-statistic= -2.7413, p-value=0.0061 for sharing). A similar situation holds for cleaning, where women who telework are more likely to be responsible, and less likely that the cleaning is a shared process or main responsibility of their partner (t-statistic= 2.8887, p-value=0.0038 mainly myself, t-statistic= -2.4538, p-value=0.0141 for mostly partner, t-statistic= -3.5250, p-value<0.001 for sharing). For the ironing the conclusions are similar, where women who telework are more likely to state that they are responsible (t-statistic= 2.2264, p-value=0.0123), less likely to be a shared process (t-statistic= -3.4421, p-value<0.001), while the other differences are insignificant. On the last gender role, teleworking for women implies additional childcare responsibility. The percentage for teleworking women who are responsible for the child is 34.64, while the respective percentage for women non-teleworkers is 33.33, but is insignificant (t-statistic=1.2032, p-value=0.2230). In addition, the shared housework is reduced from 20.74 for non-teleworking women to 19.06 for women who telework and is significant (t-statistic=-1.8628, p-value=0.0622).

In panel F of table 1 we present the hours devoted in housework. Both men and women who are teleworkers on average spend two more hours for housework than non-teleworking men and women. Overall, the summary statistics show that based on the theoretical model teleworking for both men and women implies additional housework for themselves. On the other hand, shared housework proportion is higher for men teleworkers, while is lower for women teleworkers. Additionally, the average labour market hours of men teleworkers and non-teleworkers are 36.18 and 38.57, while the respective average weekly hours for women are 26 and 29.5. In panel G the *F-statistics* derived from the analysis of variance (ANOVA) presenting the effects of men and women teleworkers, and their interaction term are reported. In the first column the outcome is women's housework hours, while the respective time for men is reported in column (2) of the panel G. According to the *F-statistics* and the associated

p-values, the principal effects of men and women teleworking are significant, while their interaction term becomes insignificant. This is explained by the cross effect which is positive and negative respectively for women and men teleworkers. Women who telework are more likely to spend more hours to household production, while when men telework, women spend fewer hours on household chores, due to the contribution of their teleworking spouses. This negative cross-effect explains the non-significance of the interaction term. The same conclusion holds for the men's time spent on household chores. Men who telework are more likely to spend more hours on the household labour division and is significant at 10 per cent level. On the contrary, when women telework, men spend on average less time on housework. The interaction term is insignificant, due to negative cross effect of men and women teleworkers, related to the working hours of men spent on household production. In panel H the monthly average personal and household income, as well as, the average happiness in a scale 1-4 are reported. The average happiness of both men and women who telework is higher than those who are non-teleworkers. Men who telework have on average a higher wage than non-teleworking men by £110, while women teleworkers have a higher personal income by around £60 per month than non-teleworking women. Similarly, the household income of teleworking members is higher.

In table 2 the correlation matrix of gender roles, weekly housework hours, happiness and income is presented. We should notice that the gender roles shopping, cooking, cleaning, ironing and childcare are binary variables taking value 1 whether the housework is shared and 0 otherwise. This is not the best representation as there is heterogeneity between teleworkers, as well as, between men and women. Nevertheless, the purpose in table 2 is to see the association between the shared housework and the other variables. Moreover, a more detailed analysis takes place separately for men and women. The association between teleworking and housework hours is negative. This may imply either that teleworkers share the housework with their partners or their partners are mainly responsible for the housework. However, we have also seen that teleworkers, especially women, are assigned with extra housework hours. The latter might be offset by the shared housework, especially when the spouse is also teleworker. Teleworking implies that women reduce or even eliminate the commuting time which can be allocated on additional hours spent on housework. In addition, teleworking may increase the happiness of women because they might be able to manage the work and household obligations in a more efficient way. This may include compressing the working

time, e.g. three days the week instead of five days, saving from the time lost in commuting, lunch breaks, meetings and interruptions at work.

The association of teleworking and whether shopping is shared is negative, which can be explained by the fact that shopping is an outdoor activity. This can be seen by the positive association between teleworking and whether cooking, ironing and cleaning are shared or not. The association between teleworking and whether childcare is shared is insignificant while a positive correlation between teleworking and happiness and income is presented. As we mentioned the gender roles in the correlation matrix 2 are converted into a binary variable from a 4-class categorical-nominal variable to allow for correlation analysis. This is not the best treatment, since there is a large heterogeneity not only between teleworkers and non-teleworkers or between men and women, but also there is heterogeneity within those classes. This is confirmed by the *t-statistic* test in table 1. More specifically, we found that the difference between men teleworkers and non-teleworkers concerning whether childcare is shared is significant. The difference between women who telework and those who do not is insignificant. In correlation matrix 2 therefore this association is not clear since it does not consider for the gender. In addition, this will be confirmed by the findings presented in the next section where regression analysis considers also for possible controls or confounders.

Regarding the housework hours, there is a negative association with the probability that the housework is shared, as expected, with higher income resulting to less housework hours. The latter association may be explained by the fact that people with higher income can work more hours and thus may lead to lower contribution in household production. However, this is not entirely clear and true since the correlation of income and the probability that both partners share the housework on ironing, cooking and cleaning is positive. In addition, happiness and shared household production are positively associated. Similarly, additional housework hours are negatively associated with happiness, which can be derived by the fact that sharing the housework implies less housework hours.

(Insert tables 1-2)

5. Empirical Results

In table 3 the Heckman selection model (Heckman, 1979) is presented. This model is used to ensure the two groups, teleworkers and non-teleworkers share similar individual and household characteristics. The dependent variable in the selection equation is a dummy

variable indicating whether the respondent is teleworker. In the observation equation the dependent variable is the number of housework hours. The second column reports the estimated coefficients of the "selection" equation- which is the propensity to telework. The women with young children, 0-11 years old- are more likely to telework while the remained coefficients of the children's age are insignificant. When the labour income of the partner is increased women are less likely to telework while their labour income and the propensity to telework is positive and significant. The spouses' age and the labour market hours of man have no significant effect on the woman's propensity to telework. On the contrary, women who spend more hours in the labour market are more likely to telework. This shows that telework is a useful tool for women who spend many hours in the labour market to adjust their time based on the family needs and labour demands. Teleworking, as we mentioned, saves time, such as the time loss in traffic congestion and commuting to work. Education level is an important factor where when both partners are low educated and have no educational qualification, woman is less likely to telework.

In the first column the "observation" equation is reported, where the dependent variable is the housework hours of women. The inverse Mills ratio (IMR) coefficient is insignificant, accepting the hypothesis that there is no selection bias in the sample. Labour income is significant and negative indicating that those who earn more are less likely to contribute to household chores and production. Women are more likely to spend more hours when their partner's labour income increases, as a result of the bargaining power (Chiappori, 1992). This is also related to the hours spent on market as there is a positive correlation between hours worked and the labour income. Similar, the women with no education qualification, spend more time on household labour than those with university degree. This has two main explanations. First, education is an important distribution factor, which affect the bargaining power of the spouses and household production allocation (Bourguignon et al. 2009; Browning et al. 2014). Second, low educated women may belong to more "traditional" marriages and they may share the "traditional" views about the gender roles (Brown and Roberts 2014). Women whose partner is employee, spend fewer hours on housework chores than when their partner is self-employed. This is because the men who are employees are more likely to choose teleworking, and therefore to contribute more in the household labour. Health status is an important determinant, and specifically women whose spouse reports very bad levels of health status are more likely to contribute to additional housework hours. This is

derived from the fact that women support their spouse when he faces with health problems which is related to the spouse's standard of care.

In table 4 the housework fixed effects estimates of equation (2) are reported. The regressions control for both partners' characteristics. More specifically, partners' working hours per week, age, education level, job status, and health status, commuting time to work are included into the regressions. The personal income may be an important factor as it can capture the bargaining power of partners. For instance, women with higher income may have a higher bargaining power regarding the household allocation (Chiappori 1988, 1992; Bourguignon et al. 2009; Mazzocco et al. 2013; Browning et al. 2014; Dauphin et al. 2014). The number or the age of children could be included too. However, the number of children is highly correlated with the household size. As we mentioned the regressions control for the day of the week, the month of the year and the wave of the survey, and for residence location which is the local authority district. The latter can capture unobserved characteristics associated with the area, such as traffic volume and congestion which affect the time needed to attend at work etc. Moreover, the day of the week is important, for those who telework at both home and employer's premises, which captures the effects of teleworkers who stay at home or commute to work. We present only the coefficients of teleworking as the conclusion remarks remain the same with those found in the second stage of the Heckman selection model. Regarding men who telework are more likely to contribute more to housework relative to men non-teleworkers. Regarding the woman sample, both men and women teleworking coefficients are significant with a negative and positive sign, respectively. This shows that women, whose spouse is teleworker, spend less time on housework hours.

(Insert tables 3-4)

In table 5 the results derived from the multinomial fixed effect Logit model (1) are reported. The base outcome of the multinomial Logit is *mostly partner*. The results confirm the assumptions derived from tables 1-2. Women who telework are less likely to state that cooking is a shared process while women whose spouse is teleworker, has no significant effect on sharing the chore. Similar, women who or their spouse is teleworker has not significant effect on whether women are main responsible for the specific chore. For the ironing, is observed that women who telework are more likely to state that they are main responsible relative to the women non-teleworkers. The belief that ironing is their main

responsibility does not differ between women whose spouse either teleworks or not. On the other hand, when the man is teleworker, women are more likely to state that ironing is a sharing process. When women telework there is no significant effect on whether ironing is a sharing process relative to the base category which is main responsibility of the partner (man). The same concluding remark holds for cleaning. On the other hand, the coefficients of man and woman teleworking are insignificant in the case of the childcare. The exception is the women whose partner is teleworker, who are more likely to state that the process of childcare is shared than the women with non-teleworker partner. Shopping presents different conclusions. When either women or their partner telework, are less likely to report that shopping is shared. On the other hand, women who telework are more likely to state that are mainly responsible for shopping, indicating that women teleworkers contribute more to shopping, ironing and cleaning. On the contrary, men who telework contribute more to the household labour in the cases of ironing, childcare and cleaning.

(Insert table 5)

In table 6 the happiness regression results for women are reported. As we expected the household income is positive and significant. For the gender roles, the base outcome of the multinomial Logit model chosen is whether the respondent replies she is main responsible for the specific household chore examined. At this point we should note that the gender roles may be correlated; however the results remain robust when we examine each gender role separate. Furthermore, we estimated the regressions considering couples with and without children. Based on the Likelihood-Ratio (LR) test we accept the null hypothesis of no difference between these two regressions. Thus, in table 6 only the couples with children are considered, examining also the relationship between teleworking and childcare.

Based on the results women are happier when they and their partner are teleworkers. Regarding the other chores, women are happier when the housework allocation is shared, while regarding cooking and ironing are also happier when their partner is mainly responsible for them. Increases in the housework hours are associated with lower levels of happiness; however, as we discussed before, is not clear whether these increases reflect or capture the fairness beliefs. The question is whether women whose partner is teleworker are more likely to state that household production is a sharing process. Additionally, women teleworkers may contribute more into the household production affecting their utility. Nevertheless, they may

choose to telework because they prefer to spend more time on household chores, activities and leisure activities.

So far the results in table 6 show two main relationships; the relationship between teleworking and happiness, and the relationship between household production allocation and happiness. To explore the effect of household production on well-being of women due to teleworking contribution to household labour, the interaction terms between teleworking and gender roles are taken. The estimated coefficients are presented in the second column of the table 6. It is observed that, while man's housework hours coefficient is insignificant, its interaction term with the men teleworkers is positive and significant. This shows that women whose partner is teleworker are happier because their partners spend more hours in the household labour than their non-teleworkers counterparts. For shopping, cleaning and childcare, women are happier when their partner is teleworker and they state that those chores are shared among them. On the other hand, the coefficient of the other interaction terms of teleworking with those household chores are insignificant. For cooking the situation is the same. The difference lies on women who state that this chore is main responsibility of their partner who is teleworker and are happier than the women whose spouse does not telework. For ironing the interaction terms with teleworking are insignificant, except for those who state that is mainly responsibility of their partner who is teleworker. They also report higher levels of well-being due to this household labour allocation.

(Insert table 6)

The main findings of the analysis, in terms of the association between teleworking and well-being, are consistent with previous studies. A positive and significant effect of teleworking on job satisfaction, life satisfaction and psychological well-being is found (Vittersø et al. 2004; Golden and Veiga 2005; Golden et al. 2006; Anderson et al. 2015). Furthermore, the results so far are consistent with the earlier literature, exploring whether the gender roles and the fair household division of labour improves the well-being of women (Pina and Bengston 1993; Brown and Roberts 2014). However, these studies do not examine the teleworking association to household production allocation and well-being. In addition, the spouses' characteristics, including age, education and labour income on the bargaining power of the household division labour are not considered. Also, these studies explored the

perception of the women on the overall household division and the household production in specific chores has not been explored. For instance, how the perception of women or the perception of their partner belonging to "traditional" or "modern" marriages affect the women's well-being. As this study shows, there is heterogeneity on the household production depending on the chore type. The results show that men are more likely to contribute to childcare and cleaning, and less on shopping.

The results also confirm the findings of other studies that both spouses' characteristics are important for the household production allocation, in terms of bargaining power, and are significant for the well-being. More precisely, education, age, labour income and health status of both spouses are significant determinants; however, their relationship to well-being and household division of labour is not explored in this study. This is because the main aim is to test whether teleworking effects household production and happiness (Bourguignon et al. 2009; Mazzocco et al. 2013; Browning et al. 2014; Dauphin et al. 2014; Pina and Bengston 1993; Clark and Oswald 1996; Brown and Roberts 2014).

The main findings show that telework is positively associated with the probability that the housework is shared and with happiness. In figure 3 the estimated DAG, including the gender roles and teleworking and their relationship to women happiness, is presented. It should be noticed that estimating separate the gender roles with multinomial Logit fixed effects will not change the results. Actually, as we discussed in details in the methodology section, the partial regression based on the PC algorithm, the conditional dependencies and the Fisher test are taking place. The BN framework and DAG allows us to avoid and check for over-control bias. Here a casual path between the factor of interest and the outcome is blocked off by another variable as it has been described also by the back-door criterion

For example man's age (*m_age* in the figure 3) has a direct causal effect on woman's age (*f_age*), in education level (*m_qfachi*), in number of labour market hours (*m_jbhrs*), in marital status (*mastat*), in health status of men (*m_hlstat*) in woman's belief of sharing the childcare role (*f_childcare*) and the shopping role (f_shopping), the household income. The latter is the logarithm of the household income represented as *lnhousehold_income* in the figure 3 and the house tenure (*tenure*). These results can be expected as the health status, the income and the number of hours work depend on age and working experience as well. Tenure is caused by age as older people, with more working experience and time spent on labour, earn higher income which leads to house ownership. Regarding the gender roles, age may just reflect that

older people are more likely to have more children and responsibilities. This can go also through other channels, such as income, health status and hours working on labour market may affect the household production allocation. For the woman's age, the causal direction from man's to woman's age does not imply a causality. This simply reflects that the age of a married woman or a spouse depends on the man's age and it is important to condition on this variable. Here the effect of man's age on happiness is just the regression of age, considering time and area fixed effects on woman's happiness. This is based on the factorization (5), where there is no parent of man's age. Also, according to back-door criterion there is no other confounder of age and the factor of outcome which is the happiness. In that case, since other variables may block off the causal effect, since we should not condition in any descendant of man's age, the front door criterion is applied. The causal effect in that case is -0.0045 (sd. error -0.0012) indicating that women are less happy with increases in their spouses' or husband's age. This can be confirmed also with the fixed effects models; however, we have included a quadratic term in the regressions, resulting to insignificant coefficients of both linear and quadratic terms. Therefore, a linear relationship between man's age and woman's happiness is presented, while a quadratic relationship between her happiness and her age is significant. Nevertheless, the main factors of interest is the gender roles and teleworking and their association to happiness of women.

(Insert figure 3)

In addition, women teleworkers (*f_tel* in figure 3) have a direct causal effect on happiness (*f_happiness*). The causal effect of *m_tel* is not direct, but it mediates through female teleworking and other factors such as gender roles. Thus, in this case the DAG allows us to explore whether there is an over-control bias since *f_tel* may block off all the causal effects from *m_tel* to woman's happiness. Regarding *f_tel* a partial regression from this variable and its parents which are man's age, woman's education level and whether her partner is teleworker or not is taking place. The causal effect to happiness is 0.0149 (sd. error 0.0065) which is higher than the causal effect found in table 6 equal at 0.0097. The DAG allows us to take only the relevant controls. This is because conditioning on gender roles the regressions over-control for gender roles, since are causes of teleworking and not controls or confounders.

Even though in either case, considering or not the gender roles, a causal effect from teleworking to woman's well-being is presented.

Since we estimated the remained regressions for each gender role, DAG confirms that the only direct effect from teleworking to household chores is the one of cooking. Thus, using the back-door criterion and controlling again on woman's teleworking parents, the effects of sharing the cooking on woman's well-being is 0.0117 (sd. error 0.0052), which was found 0.0100 in table 6. The effects of men who are teleworkers on women's belief of sharing the household production are: -0.1506 (sd. error 0.0398) for shopping, 0.0141 (sd. error 0.0180) for ironing, 0.0254 (sd. error 0.0088) for cleaning and 0.1483 (sd. error 0.0576) for childcare. Thus, in all cases there is a significant and positive probability that women will state that the household production allocation is shared when their spouse is teleworker. Shopping is the exception where the probability is negative and ironing which is insignificant. For the housework hours the women and men who are teleworkers are more likely to spend more hours on household production respectively 1.069 (sd. error 0.0264) and 0.5781 (sd. error 0.1936) confirming the assumption that both men and women who telework are more likely to spend more hours in household production than the non-teleworkers. The effect of men being teleworker in woman's well-being is positive and significant, equal at 0.0345 (sd. error 0.0144) which is lower than the adapted Probit fixed effects. Thus, the estimates of the men who telework on woman's well-being are over estimated. In addition, BN allows us to consider more things than the traditional econometric modelling like confounding, selection and over-control bias. Other direct effects on woman's happiness include both man's and woman's health status, her age, marital status, man's working hours on labour market, household income and size.

Nevertheless, BN framework as most of the econometric and quantitative modelling has drawbacks and is based on various assumptions, as every mathematical method does. The most common issue is the unobserved confounders which are not fixed along the time period examined and they are not under the control of the researcher. But this is a common problem in all quantitative techniques, including instrumental variables, natural experiments and randomised experiments which are mainly based on the quality of the experiment.

Various theoretical and empirical applications can be derived from the results. Married women who seek a career path they can telework to cope with both labour market demands and family obligations. Teleworking can be a valuable tool having effects on employees'

well-being, allowing them to use it as a mean of relief from stressful conditions derived by commuting at work. Additionally, teleworking is valuable providing work autonomy, control of the working schedule, including household chores, childcare and leisure. Overall, employers are less likely to hire individuals whom they expect to have shorter or discontinuous working lives. Women face life events, including pregnancy and maternity which are the main factors creating employment spells for women due to their greater responsibilities such as breastfeeding and childbearing. Teleworking is a policy tool that can provide occupational opportunities for women and especially for women with children. Thus, it can be a strategic response to these challenges, allowing women to adjust their needs according to the job and family circumstances. This flexible employment scheme may encourage a higher number of qualified and skilled women interested in splitting time more equitably between work and family. The main two household types that characterise the society is the egalitarian and the hierarchical. Egalitarian households are characterised by group work where all members can point their view and they try to reach into a consensus. In that case, tasks and decisions are shared and made together and domestic life is conducted in collaboration with other members. Therefore, men interested in a greater work-life business will also apply in greater numbers to teleworking, with benefits for both couples, employers and family. Also, the positive effects of teleworking on happiness can have spill-over effects in both family and workplace, producing a more balanced family environment and contributing to the increase of the firm performance.

6. Conclusions

The study examined the relationship between teleworking, household production allocation and happiness of women. The findings confirm the hypothesis that men who telework spend more hours on housework and household chores. Women are more likely to report that the household allocation is shared. Therefore, based on women's belief, when men telework, are likely to state that the household production is shared, except for shopping. However, even though women's belief that the household allocation is shared, they spend more hours on household chores than men, including also the teleworkers. About the hypothesis on whether women teleworkers are happier, the findings show that they report

higher levels of well-being than the non-women teleworkers. According to the results, this is due the fact that teleworking allows women to cope with both market labour and household-family obligations, such as the household production and childcare. Also, the findings of this study support that women whose partner is teleworker, and whether the household production process is shared, are more likely to report higher levels of happiness. This confirm the theoretical framework which implies that men who telework are more likely to contribute more to household production than their non-teleworker counterparts. Therefore, men who telework increase their spouse's happiness either directly by following teleworking or indirectly, by contributing more to the household labour tasks.

But, the results show that the British people are still dominated by strong "traditional" gender roles, where women are more responsible for the household chores and production than men are. However, even though the housework hours are significantly higher for women, this does not imply that the household allocation is unfair, based on their perception. In addition, the findings show that women's well-being is improved when household production allocation is shared. Despite any kind of limitation, such as the self-reported happiness and perception of the gender roles, this study fills an important gap in the household collective theory, by exploring the within person effects of teleworking on household production allocation and happiness, employing panel data.

Future research studies can explore the impact of teleworking on other life domains, including health, job satisfaction, firm performance, air quality. This study showed that teleworking can be a valuable tool for work-family life balance that allocates the domestic labour among couples more fairly and improves their well-being. Nevertheless, future research may study the effects of this flexible employment scheme on work autonomy and control, job satisfaction and productivity. Furthermore, the relationship between firm performance and teleworking is another area of study that may improve both employee's and firm's performance. Another area is the air quality that can be achieved by the teleworking implementation, through the reduction of traffic congestion, greenhouse gas emissions and reduction of air pollutants related with automobiles and traffic. This reduction may have further positive effects on public health, including the reduction of hospitalisation admission owned to asthma, bronchitis and other respiratory diseases. The long-term effects include reduction of cardiovascular and other diseases caused by air pollution, such as heart problems, stroke, and cancer.

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APPENDIX A.

The graphical structure G= (**V, E**) of a BN is a directed acyclic graph *DAG* where $\boldsymbol{V}$ denotes the vertex or node set and **E** represents the edge set as $\boldsymbol{V_i \rightarrow V_j}$ The notation $\mathbf{P_i^G}$ is used to denote the parent set of V_i in G. $\mathbf{p_i^j}$ is used to denote the *j-th* configuration of the parents of $\boldsymbol{V_i}$: $\mathbf{P_i} \in \{\mathbf{p_i^1} \ \ldots, \mathbf{p_i^{qi}}\}$. Based on that the definition of BN is:

Definition 1 (Bayesian network) (Pearl, 2000; Neapolitan, 2003): A Bayesian network model M over a set of variables $\mathbf{V} = \{X_1, \ldots, X_N\}$ is a pair $(\Gamma, \boldsymbol{\theta})$, where $G(\mathbf{V})$ is a *DAG* over **V** and $\boldsymbol{\theta}$ is a set of conditional probabilities: $\theta = \{\theta_{ijk}: \forall\ (ijk)\}$ such that $(\theta_{ijk} = X_i = x_i^k \,|P_i = p_i^j)$.

Definition 2 (One-step ahead conditional independence non-causality). *X* does not strongly cause *Y* one-step ahead given a set of covariates *Z* and *Y* does not cause *X* given a set of covariates *K* if (A.1)-(A.2) hold.

$$Y_{i,t} \perp X_{i,t-1} \mid Z_{i,t} \tag{A.1}$$

$$X_{i,t} \perp Y_{i,t-1} \mid K_{i,t} \tag{A.2}$$

$Y_{i,t} \subseteq Z_{i,t} \subseteq \Omega_{i,t}$ and $X_{i,t} \subseteq K_{i,t} \subseteq \Omega_{i,t.}$ and Ω is the set of all covariates included in sets *K* and *Z*, for individual *i* and time *t*. The symbol $\perp$ is used to express independence.

Definition 3 (Conditional independence non-causality). The conditional independence *X* is conditional independent from *Y* in the edge set *E* iff $Y_{i,t} \perp X_{i,t} \mid \Omega_{i,t}$

The independence assumptions discussed above and are represented by the graph imply that parameters need to be estimated because the probability distribution for each variable depends only on the node's parents as it is shown in relations (4)-(5) in the methodology section. Using the factorisation equation (5) it allows the network factorisation in such a way that it considers each node and its parents in isolation from the rest of the model variables. Otherwise, without employing this factorisation, far more parameters would be required to be estimated and therefore to specify the causal-effect relationships by a fully connected network and "unfactorable" model. Thus, employing factorisation model (5) the very complex models can be estimated avoiding the combinatorial explosion problem.

Definition 4. (d-separation) (Pearl, 1988; Spirtes et al., 2000; Neapolitan, 2003): Let $G=(V,E)$ be a DAG, $A \subseteq V$, *X* and *Y* be distinct nodes in *V—A*, and *h* be a chain between *X* and *Y*. Then *h* is blocked if one of the following cases holds:

There is a node $S \in A$ on the chain *h* and the edges incident to *S* on *h* meet head-to-tail at *S*.

- There is a node $S \in A$ on the chain *h* and the edges incident to *S* on *h* meet tail-to-tail at *S*.
- There is a node *S* such that *S* and all of *S's* descendants are not in *A* on the chain *h* and the edges incident to *A* on *h* met head-to-head at *S*.

The *d*-separation condition is especially important and useful in constructing a BN because it controls possible confounds as in the form of *S* described here. Graphically, *d*-separation

usually exhibits two main cases: firstly $X \rightarrow S \rightarrow Y$ and secondly $X \leftarrow S \rightarrow Y$. The intuition behind this graphical representation is that X and Y are independent from each other conditioned on S. In the first case X causes Y through S, while in the second case X and Y have a common cause S. In addition, given the edge $X \rightarrow S$ it is said that the tail of the edge is at X, while the head of the edge is at S. It is also: So let us consider a general directed graph in which X, Y and S are arbitrary non-intersecting sets of nodes and whose union may be smaller than the complete set nodes in the graph. To ascertain whether a particular conditional independence statement $X \perp Y|S$ is implied the possible paths from any node in X to any node in Y are considered. Any such path is blocked if it includes a node such that either the arrows on the path meet either head-to-tail or tail-to-tail at the node, and the node is in S, such as the relations $X \rightarrow S \rightarrow Y$ and $X \leftarrow S \rightarrow Y$ or the arrows meet head-to-head at the node, and neither the node, nor any of its descendants, is in S. If all paths are blocked, X is d-separated from Y given S, and the joint distribution over all of the variables in the graph will then satisfy $X \perp Y|S$.

Estimating the effect of a factor of interest X on the outcome of interest Y a back-door path is an undirected path between X and Y with an arrow into X and these paths create confounding, by providing an indirect non causal channel along which information can flow. Thus, a set of conditioning variables or controls Z satisfies the backdoor-criterion when Z blocks every back-door between X and Y and also no node in Z is a descendant of X or both descendent of X and ancestor of Y because it will block the causal path between X and Y. Thus, if set Z satisfies the back-door criterion then it will be:

$$\Pr(Y \mid do(X = x)) = \sum_{z} \Pr(Y \mid X = x, Z = z) \Pr(Z = z) \tag{A.3}$$

All the items on the right hand of (A.3) are observational conditional probabilities and not counterfactuals. Based on (5) in the methodology section and the back-door criterion, for example the causal effect of C to D in the figure 2 is a regression of C and its parents (A and B) on D. In this case the back-door criterion is met since A and B block every back-door between C and D and they are not descendant of C. However, figure 2 is a very simple case, where DAG derived in the empirical results section is more complicated. In the case where a variable or set of variables S are descendants of C and block every path from C to D, then the causal effect may be totally blocked off. In this case it is said that there is over-control bias, since the descendants of C are effects and not confounders or causes of C. In that case the front-door criterion (Pearl, 2000; Spirtes et al., 2000; Neapolitan, 2003) is applied.

Definition 5. (Partial Correlation): For $i \neq j \in 1, \ldots, p$, $k \in X_r$, let $\rho_{i,j|k}$ be the partial correlation between X_i and X_j given X_r and X_r denotes the rest of the variables.

Based on this definition we have that $X_i \perp\!\!\!\perp X_j | X_r \Leftrightarrow \rho_{i,j|k}$. A test for conditional independence is therefore a test for partial correlation between the variables and the partial correlations can be estimated, via regression analysis. Next a test for the conditional independence is presented.

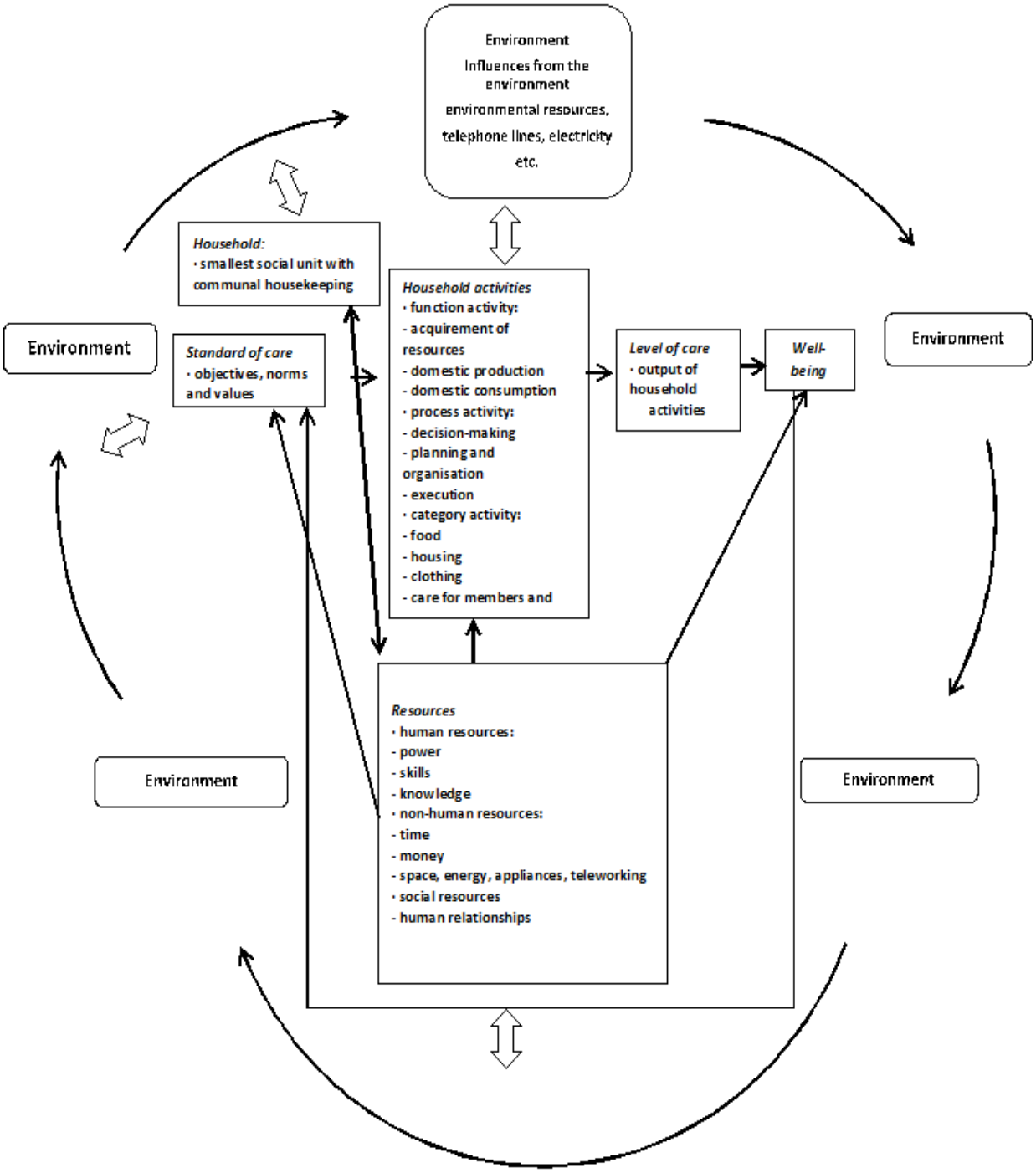
$$Z(i.j \mid k) = \frac{1}{2} \frac{(1+\hat{\rho}_{i,j|k})}{(1-\hat{\rho}_{i,j|k})} \tag{A.4}$$

Then it will be:

$$\sqrt{n-|k|-3}\,|Z(i.j \mid k)| N(0,1) \tag{A.5}$$

The test for independence is based on the PC algorithm (Spirtes et al., 2000) at significance level α. Kalisch and Buhlmann (2007) show that the choice of α is not too important. However, a significance level α=0.05 is used. The pseudo-code of the PC algorithm is presented in box 1.

Figure 1. The Home-Family Economics Model



Source: Zuidberg (1981) and Goossens and de Vos (1987); English descriptions from Hardon-Baars 1994.

Figure 2. A Generic Bayesian Network and Directed Acyclic Graph (DAG) with Four Nodes

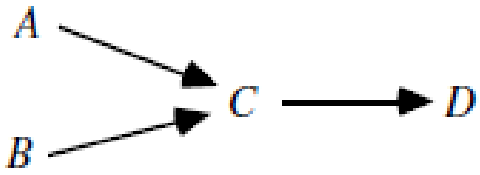
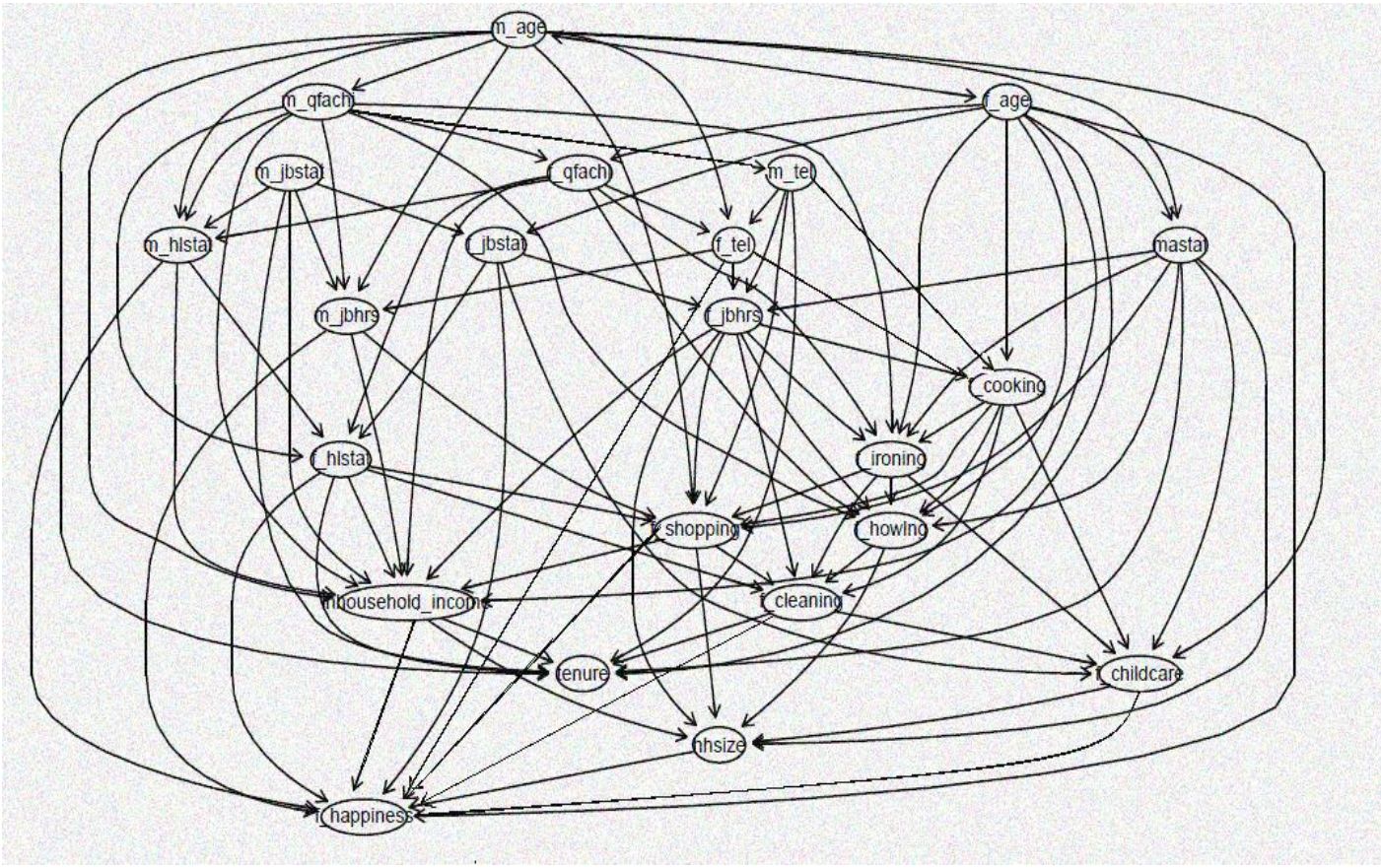


Figure 3. Estimated DAG for Gender Roles and Women Happiness



Box 1. PC algorithm

Step 1. Form the complete undirected graph C on the vertex set V

Step 2. n=0

Repeat

Select an ordered pair of variables X and Y that are adjacent in C such that Adjacencies(C,X)\{Y} has cardinality greater than or equal to n, and a subset S of Adjacencies(C,X)\{Y} of cardinality n, and if X and Y are d-separated given S delete edge X - Y from C and record S in *Sepset*(X,Y) and *Sepset*(Y,X) until all ordered pairs of adjacent variables X and Y such that Adjacencies(C,X)\{Y} has cardinality greater than or equal to n and all subsets S of Adjacencies(C,X)\{Y} of cardinality n have been tested for d-separation.

Loop n=n+1

Until for each ordered pair of adjacent vertices X, Y, Adjacencies(C,X)\{Y} is of cardinality less than n.

Step 3. For each triple of vertices X, Y, Z such that the pair X, Y and the pair Y, Z are each adjacent in C but the pair X, Z are not adjacent in C, orient X - Y - Z as $X \rightarrow Y \leftarrow Z$ if and only if Y is not in *Sepset*(X,Z).

Step 4. Repeat

If $X \rightarrow Y$, Y and Z are adjacent, X and Z are not adjacent, and there is no arrowhead at Y, then orient Y - Z as $Y \rightarrow Z$. If there is a *directed* path from X to Y, and an edge between X and Y, then orient X - Y as $X \rightarrow Y$ until no more edges can be oriented.

. **Table 1.** Summary Statistics

			Panel A: Teleworkers		
	Both teleworkers and non-teleworkers	**Total teleworkers**	**Home-based only teleworkers**	**Teleworkers (more than one place)**	**Non-teleworkers**
Total sample		11.08	3.71	7.37	89.92
Men	48.64	14.77	3.47	10.10	86.31
Women	51.36	8.06	3.94	4.80	92.95
			Panel B: Gender Roles for Men Non-Teleworkers		
	Who does the grocery shopping?	Who does the cooking?	Who does the cleaning?	Who does the ironing?	Who is responsible for childcare?
Mostly self	52.37	66.11	67.30	78.72	40.26
Mostly partner	8.35	9.60	4.48	2.80	3.21
Shared	37.47	22.45	21.85	15.55	19.45
Paid Help Only or someone else	1.81	1.84	6.37	2.93	37.08
			Panel C: Gender Roles for Women Non-Teleworkers		
	Who does the grocery shopping?	Who does the cooking?	Who does the cleaning?	Who does the ironing?	Who is responsible for childcare?
Mostly self	53.99	61.64	64.87	76.96	33.33
Mostly partner	8.90	11.37	6.30	3.52	3.40
Shared	36.03	25.87	23.47	16.88	20.74
Paid Help Only or someone else	1.08	1.12	5.36	2.64	42.53
			Panel D: Gender Roles for Men Teleworkers		
	Who does the grocery shopping?	Who does the cooking?	Who does the cleaning?	Who does the ironing?	Who is responsible for childcare?
Mostly self	57.82	63.77	65.88	76.29	35.25
t-statistic (df=20,256)	5.2160	-3.962	-2.0462	-2.4517	-4.006
p-value	(<0.001)	(<0.001)	(0.0165)	(0.0176)	(<0.001)
Mostly partner	7.84	11.55	5.03	3.14	8.38
t-statistic (df=20,256)	-1.1824	3.406	1.2179	0.4737	8.0347
p-value	(0.2371)	(<0.001)	(0.3265)	(0.5406)	(<0.001)
Shared	32.43	22.73	23.52	17.36	24.92
t-statistic (df=20,256)	-4.800	1.0211	2.947	2.8682	8.6939
p-value	(<0.001)	(0.3072)	(<0.001)	(0.0039)	(<0.001)
Paid Help Only or someone else	1.91	1.95	5.57	3.21	31.45
t-statistic (df=20,256)	1.0078	1.1007	-0.8373	0.2478	-7.8420
p-value	(0.3136)	(0.2710)	(0.5731)	(0.7821)	(<0.001)
			Panel E: Gender Roles for Women Teleworkers		
	Who does the grocery shopping?	Who does the cooking?	Who does the cleaning?	Who does the ironing?	Who is responsible for childcare?
Mostly self	56.98	64.84	68.38	78.04	34.64
t-statistic (df=20,256)	4.5679	4.9500	2.8887	2.2264	1.2032
p-value	(<0.001)	(<0.001)	(0.0038)	(0.0123)	(0.2230)
Mostly partner	9.54	10.41	4.77	3.93	2.86
t-statistic (df=20,256)	1.1764	-1.5867	-2.4538	1.1823	-1.2333
p-value	(0.2395)	(0.1126)	(0.0141)	(0.2406)	(0.2175)
Shared	32.92	23.12	21.00	14.95	19.06
t-statistic (df=20,256)	-4.9624	-2.7413	-3.5250	-3.4421	-1.8628
p-value	(<0.001)	(0.0061)	(<0.001)	(<0.001)	(0.0622)
Paid Help Only or someone else	0.56	1.63	5.85	3.08	43.44
t-statistic (df=20,256)	-1.3685	1.5930	1.1416	1.0325	1.0417
p-value	(0.1502)	(0.1990)	(0.2794)	(0.3022)	(0.2975)

Table 1 (cont.) Summary Statistics

	Panel F: Weekly Housework hours			
	Men Teleworkers	Women Teleworkers	Men Non-Teleworkers	Women Non-Teleworkers
Average Weekly Housework hours	7.070	16.803	5.027	15.262

	Panel G: ANOVA Effects of Teleworking on Weekly Housework hours	
	Outcome: Women housework hours	**Outcome: Men housework hours**
F-statistic for Women Teleworkers (df=1;25,156)	12.63***	1.93
p-value	(<0.001)	(0.0682)*
F-statistic for Men Teleworkers (df=1;25,156)	5.13**	2.33
p-value	(0.0235)	(0.0479)**
F-statistic for interaction of Women and Men Teleworkers (df=1;25,156)	0.27	0.09
p-value	(0.6013)	(0.9183)

	Panel H: Income and Happiness			
	Men Teleworkers	Women Teleworkers	Men Non-Teleworkers	Women Non-Teleworkers
Personal Income	2,137.324	1,225.17	2,027.146	1,168.262
Household Income	3,357.823	3,368.338	3,256.206	3179.008
Happiness	3.060	2.987	3.028	2.979

P-values within brackets, ***, ** and * indicate significance at 1%, 5% and 10% level, df denotes degrees of freedom, the degrees of freedom for t-statistic and for childcare are 15,384

Table 2. Correlation Matrix

	Teleworking	Housework hours	Shopping	Cooking	Cleaning	Ironing	Childcare	Happiness	Personal Income
Housework hours	-0.0409***								
	(<0.001)								
Sample Size n	25,162								
Shopping	-0.0200***	-0.0406***							
	(<0.001)	(<0.001)							
Sample Size n	20,258	20,258							
Cooking	0.0081**	-0.0508***	0.2353***						
	(0.0265)	(<0.001)	(<0.001)						
Sample Size n	20,258	20,258	20,258						
Cleaning	0.0076***	-0.0437***	0.2051***	0.2450***					
	(0.0374)	(<0.001)	(<0.001)	(<0.001)					
Sample Size n	20,2586	20,258	20,258	20,258					
Ironing	0.0022*	-0.0639***	0.1453***	0.2190***	0.3276***				
	(0.0012)	(<0.001)	(<0.001)	(<0.001)	(<0.001)				
Sample Size n	20,258	20,258	20,258	20,258	20,258				
Childcare	-0.0050	-0.0209***	0.0395***	0.1054***	0.0736***	0.0745***			
	(0.1750)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)			
Sample Size n	15,386	15,386	15,386	15,386	15,386	15,386			
Happiness	0.0041**	-0.0413***	0.0270***	0.0111***	0.0188***	0.0198***	0.0139**		
	(0.0019)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.0062)		
Sample Size n	20,258	25,162	20,258	20,258	20,258	20,258	15,386		
Personal Income	0.0614***	-0.3072***	-0.0412***	0.0401***	-0.0062***	0.0629***	0.0706***	0.0351***	
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	
Sample Size n	20,258	25,162	20,258	20,258	20,258	20,258	15,386	25,162	
Household Income	0.0236***	-0.0900***	-0.0792***	0.0324***	-0.0361***	0.0642***	0.0689***	0.0282***	0.6750***
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Sample Size n	20,258	20,162	20,258	20,258	20,258	20,258	15,386	25,162	25,162

P-values within brackets, ***, ** and * indicate significance at 1%, 5% and 10% level.

Table 3. Heckman Selection Model Estimates of Housework Hours for Women

	Observation Equation	**Selection Equation**
	DV: Housework Hours	**DV: Teleworking**
IMR	0.0384	
	(0.1250)	
Children 0-2 years old		0.4283**
		(0.1719)
Children 3-4 years old		0.0599**
		(0.0294)
Children 5-11 years old		0.1756*
		(0.0913)
Children 11-16 years old		0.3929
		(0.1495)
Children +16 years old		0.2521
		(0.2027)
Commuting Time (Man)	0.0043	0.0022
	(0.0050)	(0.0032)
Commuting Time (Woman)	-0.0042	0.0202***
	(0.0045)	(0.0040)
Labour Income (Man)	0.7744***	-0.6007**
	(0.2194)	(0.2377)
Labour Income (Woman)	-1.655***	0.3804*
	(0.1911)	(0.1806)
Number of Market Hours (Man)	0.0189**	0.0122
	(0.0090)	(0.0096)
Number of Market Hours (Woman)	-0.1463***	0.0321***
	(0.0090)	(0.0091)
Age (Man)	-0.0641*	0.1319
	(0.0384	(0.1019)
Age (Woman)	0.1806***	0.0789
	(0.0495)	(0.0714)
Marital Status (Reference=married)		
Marital Status (Living as a couple)	-0.5918**	0.4809
	(0.2381)	(0.3081)
Job Status Man (Reference=Self-Employed)		
Job Status Man (Employee)	-1.5851*	1.2169
	(0.9118)	(1.0158)
Job Status Woman (Reference=Self-Employed)		
Job Status Woman (Employee)	1.9132	1.0955**
	(1.5612)	(0.4711)
Education Level Man (Reference=Higher Degree)		
Education Level Man (1st Degree)	0.6500	0.2265
	(0.9833)	(0.3539)
Education Level Man (None)	1.5115	-0.5279**
	(1.2671)	(0.2511)
Education Level Woman (Reference=Higher Degree)		
Education Level Woman (1st Degree)	-0.6418	0.4634
	(1.1832)	(0.6796)
Education Level Woman (None)	3.3375***	-1.7577*
	(1.2601)	(0.0971)
Happiness (Reference= Much Less Happier)		
Happiness (Happier)	0.4280	
	(0.4549)	
Health Status Man (Reference=Very Good)		
Health Status man (Very Bad)	0.5971***	0.6356
	(0.1962)	(0.9942)
Health Status Woman (Reference=Very Good)		
Health Status Woman (Very Bad)	-0.5722	-0.3494
	(0.6361)	(0.5809)
No. observations	25,162	
Wald chi square (771 df)	1,884.78	
P-value for Wald Chi -square Statistic	[<0.001]	

Standard Errors within brackets, p-values within square brackets, ***, ** and * indicate significance at 1%, 5% and 10% level.

Table 4. Teleworking and Housework Hours Fixed Effects Estimates

	Panel A: Total Sample	
Variables	**Men**	**Women**
Teleworker (Man)	1.1511**	-0.4083*
	(0.5384)	(0.2336)
Teleworker (Woman)	-0.0336	1.8275**
	(0.0596)	(0.8356)
No. observations	25,162	25,162
R Square	0.1606	0.1946
F statistic (771; 20,874 df)	133.06	122.25
P-value for F-statistic	[<0.001]	[<0.001]

Robust standard Errors within brackets, p-values within square brackets, ** and * indicate significance at 5% and 10% level

Table 5. Teleworking and Gender Roles Multinomial Fixed Effects Estimates for Women

	Outcome: Mostly Self	**Outcome: Shared**	**Outcome: Mostly Self**	**Outcome: Shared**
	Shopping		Ironing	
Teleworker (Man)	-0.1350**	-0.1713***	0.0888	0.1749***
	(0.0622)	(0.0528)	(0.1373)	(0.0876)
Teleworker (Woman)	0.1123*	-0.1561**	0.1518*	-0.0890
	(0.0575)	(0.0784)	(0.0838)	(0.0639)
No. Observations	20,242		20,242	
Wald Chi-square Statistic (752 df)	3,740.97		3,844.16	
P-value for Wald Chi -square Statistic	[<0.001]		[<0.001]	
Cooking			Childcare	
Teleworker (Man)	0.0569	0.0801	0.0770	0.1672**
	(0.0816)	(0.0571)	(0.0712)	(0.0770)
Teleworker (Woman)	0.0340	-0.2077***	-0.0701	0.0412
	(0.1232)	(0.0801)	(0.0867)	(0.0928)
No. Observations	20,242		15,342	
Wald Chi-square Statistic (752 df)	3,985.99		7,908.86	
P-value for Wald Chi -square Statistic	[<0.001]		[<0.001]	
	Cleaning			
Teleworker (Man)	-0.0132	0.0299**		
	(0.1165)	(0.0143)		
Teleworker (Woman)	0.4132**	0.0353		
	(0.1926)	(0.0439)		
No. Observations	20,242			
Wald Chi-square Statistic (752 df)	4,459.90			
P-value for Wald Chi -square Statistic	[<0.001]			

Robust standard Errors within brackets, p-values within square brackets, ***, ** and * indicate significance at 1%, 5% and 10% level

Table 6. Probit-OLS Fixed Effects Happiness Function Estimates for women

Variables	Coefficients	Variables	Coefficients
Teleworker (Man)	0.0401**	Men housework hours	0.0047
	(0.0196)		(0.0032)
Teleworker (Woman)	0.0097*	Men housework hours × Men Teleworker	0.0034*
	(0.0049)		(0.0018)
Women Housework Hours	-0.0021*	Shopping Respondent (Base	
	(0.0011)	Outcome=mainly myself)	
Shopping Respondent (Base		Men Teleworker × Shopping Respondent	-0.0248
Outcome=mainly myself)		(My partner)	(0.0595)
Shopping Respondent (My partner)	0.0353	Men Teleworker × Shopping Respondent	0.0759**
	(0.0231)	(Shared)	(0.0345)
Shopping Respondent (Shared)	0.0239*	Men Teleworker × Shopping Respondent	-0.0181
	(0.0125)	(Paid Only)	(0.0336)
Shopping Respondent (Paid Only)	-0.1786**	Cooking Respondent (Base	
	(0.0860)	Outcome=mainly myself)	
Cooking Respondent (Base		Men Teleworker × Cooking Respondent	0.1009*
Outcome=mainly myself)		(My partner)	(0.0556)
Cooking Respondent (My partner)	0.0223*	Men Teleworker × Cooking Respondent	0.0646**
	(0.0115)	(Shared)	(0.0274)
Cooking Respondent (Shared)	0.0103**	Men Teleworker × Cooking Respondent	0.0153
	(0.0046)	(Paid Only)	(0.0260)
Cooking Respondent (Paid Only)	0.0755	Cleaning Respondent (Base	
	(0.1022)	Outcome=mainly myself)	
Cleaning Respondent (Base		Men Teleworker × Cleaning Respondent	0.0131
Outcome=mainly myself)		(My partner)	(0.0260)
Cleaning Respondent (My partner)	-0.0081	Men Teleworker × Cleaning Respondent	0.0228*
	(0.0112)	(Shared)	(0.0122)
Cleaning Respondent (Shared)	0.0087**	Men Teleworker × Cleaning Respondent	-0.0262
	(0.0043)	(Paid Only)	(0.0304)
Cleaning Respondent (Paid Only)	-0.0532	Ironing Respondent (Base Outcome=mainly	
	(0.0454)	myself)	
Ironing Respondent (Base		Men Teleworker × Ironing Respondent (My	0.0812*
Outcome=mainly myself)		partner)	(0.0413)
Ironing Respondent (My partner)	0.0816	Men Teleworker × Ironing Respondent	0.0449
	(0.0458)	(Shared)	(0.0405)
Ironing Respondent (Shared)	0.0189*	Men Teleworker × Ironing Respondent	-0.0751
	(0.0101)	(Paid Only)	(0.1175)
Ironing Respondent (Paid Only)	0.0545	Men Teleworker × Childcare Respondent	
	(0.0591)	(Base Outcome=mainly myself)	
Childcare Respondent (Base			
Outcome=mainly myself)			
Childcare Respondent (My partner)	-0.0576	Men Teleworker × Childcare Respondent	-0.0252
	(0.0535)	(My partner)	(0.0854)
Childcare Respondent (Shared)	0.0204*	Men Teleworker × Childcare Respondent	0.0404**
	(0.0108)	(Shared)	(0.0200)
Childcare Respondent (Someone Else)	0.0927	Men Teleworker × Childcare Respondent	0.0138
	(0.1047)	(Someone Else)	(0.0314)
No. Observations	15,258	F-statistic (758; 13,692 df)	3.28
R Square	0.1193	P-value for F-statistic	[0.3232]
LR test (3 df)	3.28		
P-value for LR test	[0.3232]		

Robust Standard Errors within brackets, p-values within square brackets, ** and * indicate significance at 5% and 10% level