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Retirement and Intra-Household Labour Division of Italian Couples: A New Simultaneous Equation Approach

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Abstract The effect of retirement on couple's labour division has been investigated using cross-sectional and longitudinal data, providing, however, contradictory results. This may be due to the difficulty of specifying the influence of latent factors, such as gender ideology or the bargaining process between partners. The risk of misspecification may be particularly high when referring to Italy, where the life of couples is strongly influenced by familistic norms and gender ideology. We examine the impact of retirement of the man on the market and domestic work of both partners, adopting a Difference-in-Differences estimation procedure and using a correction mechanism to control for misspecifications of latent factors. Our results show that Italian men increase their commitment in domestic activities after retirement. However, the influence of gender ideology and familistic belief significantly hampers this propensity for traditionalist men. Finally, the significativity of estimation results confirms that the correction here introduced leads to robust estimates and allows to use a gender-role score index as a valid predictor.

Keywords Transition to retirement · Difference-in-Differences estimator · Gender-attitude items score · Gender role · Familistic belief

1 Introduction

Does the retirement of one of the partners lead to a more equitable labour division within the couple? The effect of retirement of the partners on labour division has been investigated in developed countries (cf. Gauthier and Smeeding 2003; Hank and Jürges 2007), but

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contradictory results regarding the influence of retirement on the gendered division of labour between partners have been found. Specifically, opposite conclusions have been reached about whether gender role can be considered a valid predictor in determining whether retirement has different consequences on the time balance between partners in couples with contrasting ideologies. In particular, several longitudinal studies regarding the U.S. found that the propensity of a family member to give help in housework increases with his/her retirement (e.g. Kahn et al. 2011, using Wisconsin Longitudinal Survey data (WLS), and Szinovacz 2000, using National Survey of Families and Households data (NSFH)). However, Solomon et al. (2004), also using WLS data, found opposite results, whereby men who agree with traditional gender ideology work less in the house after retirement than men who do not agree. In general, the variety of results across studies regarding the effect of retirement on partners' labour division may depend on the different approach to the specification of the impact of latent factors, given by the influence of gender and familistic attitudes and the bargaining process between partners in the intra-household allocation of working activity (e.g. Baxter et al. 2008; Shelton and John 1996).

We are persuaded that the problem of misspecification of the gender and familistic attitudes effect may be particularly significant if the empirical analysis concerns a socioeconomic context characterized by a strong influence of gender-role social norms such as in Italy (Mills et al. 2008). Italy, as is known, is a country with a familistic welfare regime, according to the classification by Esping-Andersen (1999), where women generally suffer a higher gender gap in intra-household labour division than elsewhere in Europe (Anxo et al. 2011), and more generally where significant double standard norms for men and women still exist (Ferrero-Camoletto 2011). However, even though the Italian case may be of particular interest for an analyst, the influence of bargaining and gender-familistic attitudes on the relationship between retirement and labour division within the couple has not been extensively analysed for this country. Therefore, in this study we intend to close this gap, using data on Italian couples from the Istat Multipurpose Family and Social Subjects survey for the years 2003 and 2007. We estimate the effect of retirement on the change in the working behaviour of both partners, focusing our interest on the effect of the retirement of the male partner to simplify the analysis.

To measure the effect of the man's retirement on the partners' labour allocation, we estimate simultaneously the paid and domestic work supply of both partners, employing paid and unpaid weekly working hours as dependent variables in different simultaneous equations. We adopt a Difference-in-Differences (*DID*) parametric specification of equations to verify the extent to which the effect of the transition to retirement of the man on a couple's paid and unpaid work supply depends on the latent influence of gender and familistic ideology and bargaining. In order to remedy the potential effect of the misspecification of these latent variables we adopt a proper correction strategy.

Another problem in estimating the effect of retirement on labour allocation may occur because the working activity of a subject influences his/her decision to retire (French 2005), as well as the "option value" of continued work (Stock and Wise 1990). In this case, the estimation of the impact of retirement on partners' labour division may be affected by inconsistency due to the endogeneity of the retirement decision. Neglecting this influence may lead to overstating the effect of retirement on the working behaviour of the couple. Thus, we propose a correction strategy both for the misspecification of bargaining and the endogenous influence of working activity on the retirement decision. Our correction consists in adopting a "feasible" Generalized Method of Moments (*GMM*) procedure that allows us to impose specific constraints on the covariances between the error terms. In addition, to control our estimates for the influence of gender and familistic

attitudes, we stratify the sample for different profiles of these attitudes, using a cluster-based classification of couples. In this way, we can compare the effect of retirement on working activity for different types of couples.

Finally, improved methodology is certainly one of the innovations of our study. However, we also present new and substantial results about the consequences of retirement on homework division between partner and, more generally, about family issues and aging, all relevant themes in social research. Moreover, our results are new also for Italy: even if a large body of literature exists about gender and familistic issues in this country, the role of retirement was never analyzed up to now.

The paper is organized as follows: in the next Section we discuss the most relevant misspecification problems in estimating paid and unpaid work allocation within couples, especially considering the effect of retirement of one of the partners on labour division. In Sect. 3, we present our model and explain the rationale of the methodology employed. In Sect. 4, we present the characteristics of the dataset and discuss the results of the empirical analysis. In Sect. 5, we conclude with final observations and remarks. In the "Appendix", we present the stochastic specification of our model.

2 Conceptual Framework

2.1 Retirement and Division of Working Activity Between Partners

Participation in the labour market of older partners (even if they are actively engaged in grandchildren's care) shows dramatic variations across developed countries. Recent studies found that a gender effect influences early retirement in several European countries. In particular, the results of a multilevel event-history analysis reveal that becoming a grandparent speeds up retirement, especially between 55 and 60 years old. However, the effect is statistically significant only for women (cf. Van Bavel and De Winter 2013). This phenomenon may also depend on the influence, different across countries, of cultural and psychological factors on the partners' allocation of paid and unpaid work. This question is also potentially important for public policy, considering, for instance, that reforms in public pension plans should take into account, among many relevant elements, the opportunities for older partners to coordinate their labour force behaviour and retirement decision (e.g. Blau and Riphahn 1999). This is also because recent pensions reforms established the same minimum age at retirement for men and women, while previously this was lower for women in many countries. In this framework, an evaluation of the propensity to the reallocation of domestic work and caregiving among family members, as a result of the retirement of one of the partners, may serve to better manage welfare policies, especially in countries characterized by a gendered division of labour (e.g. Anxo et al. 2011). For this reason, it is relevant to evaluate the extent to which gender role and familistic belief influence labour division between partners.

Generally, studies focusing on age and gender differences in housework have shown that, at least in developed countries (namely, Canada, the United States, Japan, Northern and Southern European countries), a large share of time freed up by the retirement of both partners from the labour market is reallocated to domestic activities (e.g. Gauthier and Smeeding 2003). However, a considerable variation in the overall distribution of housework between partners after retirement has been found between more egalitarian countries

in northern Europe and more traditional countries in southern Europe (Hank and Jürges 2007; Mencarini and Tanturri 2004).

Consequently, a markedly gendered division of working activity between partners is registered as a response to the retirement of the male partner in "more traditional" countries such as Italy. In particular, taking into account the Italian socio-economic context, characterized by a strong influence of gender-role social norms and familistic belief, the behaviour of Italian couples in housework division can differ from what was theorized by analysts in accordance with the "time availability theory" (e.g. Blood and Wolfe 1960).[1] Thus, a reallocation of the domestic work between partners more favourable to the woman may occur in Italy as a consequence of the man's retirement, and this should happen more often for egalitarian couples than for traditional couples, more influenced by traditional gender (and familistic) ideology. In particular, in Italy gender differences in housework division are one of the numerous facets of familistic ideology, still prominent among older cohorts and the less educated, and in southern regions (Micheli 2000, 2004). This familistic model, common to southern European countries, is founded on the principle that the interest of the family prevails over that of the individual components. As a consequence, family members are required to specialize their working tasks according to the traditional gender-role ideology: the "breadwinner" husband works for the market—but never at home—whereas the wife takes care exclusively of housework, children, and eventually of older parents (Dalla Zuanna 2001; Reher 1998). For this reason, in order to perform our empirical analysis on labour division within the couple, we take into account the joint influence of gender ideology and familistic belief.

However, when estimating the effect of retirement on partners' labour division it is very difficult to specify the influence of gender and familistic ideology, as well as the bargaining process between partners. A consequence of this potential misspecification is that it is extremely hard to evaluate the extent to which gender differences in labour division depend on the agreement of the partners with gender ideology and with familistic belief using usual estimation methods.

This problem has been faced by analysts, and several remedies have been suggested in order to control the influence of latent variables on the intra-household labour division. The most common approach is to include in the model as explanatory variables specific proxies of bargaining and gender ideology based on the contribution of each partner to the production of family income and on the agreement of partners with normative statements regarding gender-role. However, this approach leads to a lack of consistency of estimation results across studies in both cross-sectional and longitudinal analysis.

In particular, the use of variables measuring the contribution of each partner to the household labour income as an "inverse" proxy-measure of both "economic dependency" and "relative bargaining power" did not lead to consistent findings across studies (e.g. Brines 1994; Gupta 2007; Gupta and Ash 2008). Similarly, proxy variables explaining gender role attitude, such as the square of the contribution of each partner to household earnings (e.g. Brines 1994) or the attitudes score index based on the degree of agreement of each individual with gender ideology (Baxter et al. 2008), are not fully convincing for the variety of estimation results produced. The problem of the robustness of estimates is

[1] The time availability theory posits that as available time increases (e.g., after retirement), time invested in household chores increases. This implies that, if the man's available time increases as an effect of his retirement, time invested in household chores should increase. As Solomon et al. (2004) observe, "Time pressures may be a factor in determining men's and women's investment in routine tasks. They also may play a role in the relation between gender attitudes and investment in housework" (Solomon et al. 2004, p. 4).

particularly significant if the empirical analysis concerns a socioeconomic context characterized by a strong influence of gender-role social norms and familistic belief such as in Italy. Our point of view on these methodological issues will be presented in more detail in the next Sect. 2.2, while some possible remedies for the problem of misspecification will be suggested in the third Section.

2.2 Specification of Latent-Variables in Estimating the Effect of Retirement

Past and recent studies on the impact of retirement on intra-household labour division generally fail to provide robust estimates because of the difficulty of specifying the influence of latent variables. This is the case, for instance, of the longitudinal studies based on the US National Survey of Families and Households (NFSH) dataset, in which different analyses of the effect of the transition to retirement have given opposite results (cf. Szinovacz 2000; Solomon et al. 2004). Szinovacz (2000), in order to identify the effect of the change over time in housework commitment, adopted as a dependent variable the residuals obtained by regressing the domestic work surveyed in Wave 2 on the domestic work surveyed in Wave 1. In the model specification, dummies or categorical variables measuring gender and family attitudes were included as explanatory variables, as well as dummies signalling the retirement decisions. As a result of this approach, he demonstrated the complementary nature of the partners' division of housework, finding that men did more housework after retiring, and that the wives spend less time in their own domain as their husbands' paid work hours decline.

Opposite results were obtained by Solomon et al. (2004) using a Structural Equation Model (*SEM*) approach. In particular, estimates are controlled for reverse causality effects specifying simultaneously the effect of gender ideology (measured at Wave 1) on commitment in household tasks (measured at Wave 2) and the inverse effect of routine tasks (measured at Wave 1) on gender ideology (measured at Wave 2). Perhaps surprisingly, their findings reveal that women with an egalitarian ideology increased their investment in routine tasks when retired. Egalitarian men, however, did not invest more in routine tasks postretirement. The retirement transition does not appear to be an event of sufficient significance to strengthen the relation between egalitarian gender ideology and the division of household tasks.

Using the Wisconsin Longitudinal Survey (WLS) data, Kahn et al. (2011) showed how the propensity of a family member to help with housework increases with his/her retirement. This result is obtained by performing a logistic regression to examine gender differences over time in the provision of different types of help. In particular, as they retire from the workforce, married men become significantly more involved in the care of their grandchildren.

More generally, the variety of results across studies on the effect of retirement on labour division between partners may depend on the different approach to the specification of the impact of latent factors such as the bargaining process in intra-household allocation and the influence of gender attitudes (e.g. Baxter et al. 2008; Campolo et al. 2012; Shelton and John 1996). We realize how the use of different estimation procedures by the researcher prevalently depends on how the single researcher interprets the mechanism by which latent psychological and cultural factors, such as the bargaining process between partners, influence the relationship between retirement decision and partners' labour division. In particular, the intra-household labour division may be a result of the relative bargaining power of each partner, and the allocation of working time may affect the retirement decisions of both partners, introducing a "reverse-causality" effect in the model. This can

occur, for example, if one of the partners, very busy with housework, is not satisfied with how the housework chores are allocated within the couple. For this reason, the endogenous influence of working activity on the retirement decisions of both partners has to be controlled to avoid inconsistency of the estimation results. However, managing empirically the impact of these latent factors is usually difficult, and it may provide an incomplete or unsatisfactory specification of the cause-effect relationship between labour division and retirement decision. Consequently, estimation results may be affected by endogeneity and may be characterized by a lack of robustness.

Thus, the influence of gender attitudes on labour division and on retirement decisions is difficult to specify in a regression model, and several methodological problems arise, especially in a longitudinal approach. In most of the research on the gendered division of labour in the family, the main problem of an empirical approach is to evaluate the extent to which gender difference can be considered a good predictor of paid and unpaid work supply. In doing this, several authors suggest using a proxy of individual gender attitudes, or a clustering classification criterion for couples, such as the extent to which the subject agrees with specific statements regarding the role of women and men in the family (e.g. Sanchez and Thomson 1997). In general, the normative statements submitted to respondents in order to interpret their gender-role attitudes are aimed at investigating different aspects of this issue, given by: (i) the propensity of the subject to agree with the gender-role ideology, considered, as the set of individual attitudes regarding the appropriate roles, rights, and responsibilities of women and men in society (e.g. Kroska 2007); (ii) the propensity of the subject to conform her/his behaviour with the gender equality rule, implying equal outcomes for men and women in both the private and public sphere (e.g. Aassve et al. 2015; Neyer et al. 2013); (iii) the agreement of the subject with a "gender equity model" of the family, based on equal respect for men and women, equality of resources and capabilities, parity of participation both in familial and socially valued activities, and an end to male-centred measures of social value (Goldscheider et al. 2013; McDonald 2000).

In this analysis, regarding woman's attitudes, we are convinced that not only the degree of agreement with gender and familistic ideology (and/or with gender equality rule), but also the level of the husband's involvement in housework tasks ("mattering") may influence the woman's perceived fairness of the household labour division (perceived "gender equity" in labour division) and, consequently, her propensity to help in housework tasks (e.g. Blair and Johnson 1992; Kawamura and Brown 2010; Wilkie et al. 1998). For this reason, we manage here the latent influence of gender and familistic attitudes by stratifying the analysis for different profiles of couples according to their propensity to agree with gender and familistic ideology and with the perceived equity of the female partner in labour division.

3 Methodology and Model Specification

3.1 Methodology and Model Selection

In order to avoid endogeneity effects and misspecification of the influence of latent variables, we take into account in this work the association between the two partners' domains in the intra-household allocation of working time over the course of life. In doing this, we adopt a simultaneous-equation approach that considers how the bargaining process

influences the effect of retirement on both the market work and domestic work supply of each partner. To this end, we estimate the paid and unpaid work of both partners simultaneously (four simultaneous equations in total) introducing a proper correction strategy for the misspecification of the latent bargaining process. In order to measure the effect of retirement of the man on the woman's labour allocation, we adopt a *DID* parametric specification of each equation (e.g. Angrist and Krueger 1999).

We have to take into account that the *DID* approach to the estimation requires as a prerequisite that the event determining the transition not be affected by endogeneity and measurement errors (Angrist and Krueger 1999; Athey and Imbens 2006; Greene 2012; Wooldridge 2010). However, in our analysis, we consider how endogeneity may affect the transition of retirement mainly as a consequence of the unobserved heterogeneity "between" individuals, given by the latent bargaining process between partners, and of the correlation between the repeated observations over time (due to the reverse causality effect of the working activity on the retirement decision). Moreover, for the process we are focusing on, the effect of latent variables influences simultaneously the paid and unpaid work supply of both partners. Consequently, in order to take into account the influence of latent variables, we also need a method that allows us to estimate the paid and unpaid work equations of both partners simultaneously.

We solve these problems by adopting a Seemingly Unrelated Regression (*SUR*) stochastic specification of the simultaneous equations (cf., among others, Srivastava and Giles 1987). In this way, the misspecification problems given by the bargaining process (determining a latent effect between equations) and the endogeneity in the retirement decision (determining a latent effect on the repeated observations over time) can be managed by imposing specific constraints on the covariance matrix of the error terms.

Another relevant problem in our analysis is represented by the presence of censoring in dependent variables. When modelling paid work equations, we should take into account that women may be indifferently employed, unemployed or retired in both Wave 1 (2003) and Wave 2 (2007). Instead, all male partners were employed at the year 2003, but not all the men active in 2003 who were not working at Wave 2 should be considered retired (some of them, for example, may have lost their jobs between 2003 and 2007). Therefore, in order to account for censoring due to the circumstance that both men and women may have dropped out from the labour force, we modify the *SUR* stochastic specification of the simultaneous equations by introducing censoring. This is possible by adopting a Seemingly Unrelated Tobit Regression (*SUTR*) estimation model that allows us to apply a computationally feasible estimation procedure if one or more dependent variables are censored (Campolo et al. 2012; Jones and Labeaga 2003; Meyerhoefer et al. 2005, among others). This estimation procedure, in particular, allows us to manage a longitudinal-panel specification of the model with repeated observations on the same subject over time. In this way, time-varying effects on both censored and uncensored dependent variables can be introduced into the model.

Following this approach, a two-stage procedure is implemented to estimate our model. At the first stage, both censored and uncensored equations are estimated equation-by-equation in a reduced form. At this stage, we use an Ordinary Least Square (*OLS*) estimator for the non-censored equations and a heteroscedastic *Tobit* for the censored equations. At the second stage, we perform a *GMM* estimator to manage the restrictions on the covariances of the error terms.

Using this estimation procedure, we provide an original application of the *GMM* method. In particular, after the *OLS* and *Tobit* estimation of the first stage, we introduce an intermediate step in order to estimate the covariances of the disturbances using the

residuals obtained by the first-stage regressions. This allows us to incorporate the nonzero constraints on covariances between equations, accounting, in this way, for a relevant component of the cross-sectional dependence given by the latent bargaining process. In particular, the unobserved bargaining process between partners is corrected by imposing specific constraints on the covariances between the error terms of the paid and unpaid work equations of both partners. In addition, we impose restrictions on the covariances of the error terms between repeated observations over time to control our estimates for the endogenous influence of paid and unpaid working activity on the retirement decision.

Another significant problem arises to account for the influence of the activity of grandchildren's care on the retirement decision. The transition to retirement of both men and women may in part depend on the circumstance that they may be engaged in their grandchildren's care. Note that the grandparents' commitment to childcare is particularly frequent in Italian families, given that in Italy the parental ties between descendants and ascendants are generally strong and characterized by a high propensity to provide reciprocal help (Dalla Zuanna 2001). Neglecting this aspect may lead to an incomplete specification of the relationship between the transition to retirement and work. We dealt with this specification problem by disentangling the effect of caring for grandchildren, introducing as a control variable a dummy signalling if the couple is engaged in looking after grandchildren.[2]

In order to assess the influence of gender and familistic attitudes, we hypothesize that *DID* coefficients change according to the gender ideology and familistic belief of the subjects. Therefore, we take into account the moderating effect of attitudes by performing a cluster procedure to classify couples into homogeneous groups, evaluating the adherence of both partners to gender and familistic ideology. In doing this, we consider the agreement of both partners with statements regarding the relevance of gender equality rules in partners behaviour and the importance of the traditional family. In addition, we consider also woman's level of satisfaction (perceived fairness) with the division of household tasks with the male partner. Therefore, proxy variables measuring the gender and familistic ideology of partners and woman's perception of fairness are jointly used to stratify the sample according to different profiles of couples in terms of gender and familistic attitudes.

To this purpose, we compute an item score index obtained taking into account the level of agreement of each subject in 2003 (first wave) with eight statements regarding the importance of marriage (familistic belief) and the role of women in the care of children and elderly relatives (gender equality). The statements are:

1. Marriage is an outdated institution; [familistic belief]
2. A couple can cohabit without planning to marry; [familistic belief]
3. A woman can have a child even if she doesn't have a stable partner; [familistic belief/gender equality]
4. Boys and girls aged 18–20 should leave their parents' home; [familistic belief]
5. It is right that unhappy spouses divorce, even if they have children; [familistic belief]
6. A housewife can be fulfilled as much as a woman who has paid work; [gender equality]
7. If spouses divorce, the custody of children must be entrusted to the mother; [gender equality]

[2] We tried to introduce into the regression set an interaction term for the effect of transition to retirement and the commitment to caring for grandchildren by adopting a Difference-in-Differences-in-Differences (*DDD*) parameterization (e.g. Gruber 1994; Wooldridge 2010). However, significant estimates of the *DDD* coefficient were not obtained.

8. Daughters should take care of aged parents who are in need of assistance, rather than sons. [gender equality]

The degree of agreement is expressed by the interviewee on a five-item scale from (a) strongly disagree to (e) strongly agree. The agreement with the familistic belief is expressed by respondents who disagree with the statements 1–5, while the aversion to gender equality rules is expressed by respondents who agree with statements 6–8 and disagree with statement 3. Consequently, the score of statements 6–8 has been rearranged, in order to allow a consistent computation of the mean of the standardized scores for each subject. Then, after testing the reliability of the item scores (Cronbach's alpha = 0.73), we create a scalar index, where lower scores indicate a couple with more traditional attitudes. This index and a categorical variable measuring women's level of perceived fairness about the division of labour in 2003 are used to perform a cluster procedure applying the Ward algorithm. Hence a Calinski-Harabasz pseudo-F test is applied to choose the optimal number of groups (we obtain two clusters, with $F = 528.88$).

Note that, in order to improve the reliability of the scalar index, several versions of it, built using only some of the previous statements, were tested. In particular, we tested separately statements concerning gender equality and statements related to familistic ideology. As a result, we found that the best score of the reliability test was obtained by employing jointly the statements related to gender-equality and familistic belief.

Therefore, we divide the sample into two groups that we label, respectively, as "traditional" (couples whose partners reported a low level of the gender attitude score-index and where the woman is satisfied with the division of domestic work) and "modern" (couples with a high score-index and where the woman is generally unsatisfied with the division of domestic work). We use this clustering not only to stratify the analysis but also to estimate our model separately for couples belonging to a more traditional or modern group. This cluster-based classification of couples allows us to estimate to what extent the gender gap in partners' labour division depends on gender and familistic ideology.

3.2 Model Specification and Estimation Procedure

In order to manage misspecification and censoring problems, as discussed above, we modelled simultaneously four equations referring to both partners' domestic (D) and paid work (L) hours as in a *SUTR* model:

$$\ln L_{wti} = \alpha_{Lw} r_{mi} + \lambda_{Lw} t + \delta_{Lw} t r_{mi} + \mathbf{x}'_i \boldsymbol{\beta}_{Lw} + \mathbf{z}'_{ti} \boldsymbol{\gamma}_{Lw} + u_{Lwti} \quad (1)$$

$$\ln D_{wti} = \alpha_{Dw} r_{mi} + \lambda_{Dw} t + \delta_{Dw} t r_{mi} + \mathbf{x}'_i \boldsymbol{\beta}_{Dw} + \mathbf{z}'_{ti} \boldsymbol{\gamma}_{Dw} + u_{Dwti} \quad (2)$$

$$\ln L_{mti} = \alpha_{Lm} r_{mi} + \lambda_{Lm} t + \delta_{Lm} t r_{mi} + \mathbf{x}'_i \boldsymbol{\beta}_{Lm} + \mathbf{z}'_{ti} \boldsymbol{\gamma}_{Lm} + u_{Lmti} \quad (3)$$

$$\ln D_{mti} = \alpha_{Dm} r_{mi} + \lambda_{Dm} t + \delta_{Dm} t r_{mi} + \mathbf{x}'_i \boldsymbol{\beta}_{Dm} + \mathbf{z}'_{ti} \boldsymbol{\gamma}_{Dm} + u_{Dmti} \quad (4)$$

The dependent variables of Eqs. (1), (3), given by the logarithm of weekly working hours, are censored,[3] while the dependent variables of Eqs. (2), (4), given by the logarithm of weekly domestic work, are uncensored. The indexes i and t refer respectively to the ith individual and to time t (0, 1). The indexes w and m refer, respectively, to women and men.

[3] In order to better specify the effect of the retirement of the man, we select only couples in which the man is employed at the first wave (year 2003). At the second wave (year 2007), some men decided to retire, while some (very few subjects) became unemployed.

On the right side of each equation, the Greek letters refer to parameters. The parameters α_m and α_w measure the impact of the retirement of men on the market and the domestic work of both partners in each equation. The (time invariant) dummy r_m is equal to one if the subject retired between 2003 and 2007. The product between the dummy $t{\cdot}r_m$ and the coefficient δ, given by $\delta t{\cdot}$r, measures the interaction effect of both status and time. This represents the *DID* specification of the retirement of the man.

The impact of time-invariant and of time-varying vectors of control variables on the dependent variables is measured by the scalar products $\mathbf{x}_i'\boldsymbol{\beta}$ and $\mathbf{z}_i'\boldsymbol{\gamma}$.

Control variables, referring to the subject or the couple, are the following: the Italian macro region of residence (dummy), age and age squared, education, caring of grandchildren when their parents work, offspring living in the house (dummy time varying), the hourly wage, free help and paid help received in housework, marital status (time-varying dummy), attendance at church[4] (1 = at least once a week; 0 = otherwise), the retirement of the woman before the second wave, health and an elderly living in the house. Moreover, when estimating our model on the full sample we also considered as a regressor the gender attitudes score-index.

The impact in percentage terms of a dummy variable, such as the *DID* coefficient (δ), on the logarithm of working time (dependent variable) is the exponential term $100{\cdot}[\exp(\delta) - 1]$. Thus, we can compare those who retired between the two waves and those who did not, obtaining the difference of changes in percentage terms (population average effect). In addition, we evaluate as a percentage the impact of the transition to retirement for those subjects who experienced retirement only (subject-specific effect), computing $100{\cdot}[\exp(\lambda + \delta) - 1]$ (see Greene 2012; Wooldridge 2010).

As discussed above, in order to correct the model for latent variable influence, we assume that the error terms of each equation are correlated with the error terms of all other equations in correspondence with each *i*-th observation. This non-null correlation is a consequence of the common influence of shared latent factors on the paid and unpaid work of the *i*-th subject and on the paid and unpaid work of his/her partner. In addition, we assume that a non-null correlation occurs, in each equation, between the disturbances of the single observation repeated over time. This is a consequence of the assumption that each value of the dependent variable observed on the *i*-th subject at Wave 1 is correlated with the value observed at Wave 2 for the effect of the endogeneity of retirement decision with respect to paid and unpaid work. The stochastic specification of the error terms is shown in the "Appendix" in greater detail.

The adoption of a *SUTR* model (cf., above, Sect. 3.1) allows us to easily provide a stochastic specification of the correlations (or covariances) between equations and between repeated observations over time. Namely, the "nonzero restrictions" on covariances can be incorporated in a *SUTR* procedure using the residuals of the first-stage estimates of both paid and unpaid work equations. This allows us to perform a computationally feasible estimation procedure and to control estimation results for the latent influence of the bargaining process between partners (correlation between equations) and of the endogenous influence of paid and unpaid working activity on the retirement decision (correlation over time).

The residual-based method to correct the *SUTR* estimates by implementing restrictions on covariances is reported in the "Appendix".

[4] Considered as a proxy of adherence to traditional values.

4 Empirical Analysis and Estimation Results

4.1 Data

In this study we use longitudinal data from the first and second wave of the Italian Generations and Gender Survey (GGS). To understand the recent social and demographic changes occurring in European countries, an international project has been developed: the *Generations and Gender Programme* (GGP). The GGP's aim is to provide an international contextual database, obtained by means of a system of national surveys, the Generations and Gender Surveys (GGS), involving the collaboration of a broad range of countries, European and non (United Nations 2000, 2005; Vikat et al. 2007). Through a longitudinal survey of 18–79 year-olds in 19 countries (the data are collected on the same persons at three-year intervals) and applying both a gender and a life course approach, it is possible to

Table 1 Descriptive statistics on the sample of 540 Italian couples (97 transitions to retirement) Means, percentages and Standard Deviations of explanatory variables by time and by man's retirement

Mean and percentage values	Comparison between 2003 and 2007				Man retired between 2003 and 2007			
	2003		2007		No		Yes	
	Means or %	SD	Means or %	SD	Means or %	SD	Means or %	SD
Woman's age	47.66	6.16	50.89	6.14	46.37	5.67	53.53	4.71
Man's age	51.49	5.25	54.74	5.26	50.18	4.53	57.48	3.95
Woman's years of schooling	10.89	4.03	10.92	4.05	11.19	3.95	9.56	4.14
Man's years of schooling	11.19	4.32	11.20	4.32	11.53	4.26	9.64	4.24
Woman's health	2 %		2 %		2 %		4 %	
Man's health	2 %		2 %		1 %		4 %	
Woman's attendance at church	41 %		39 %		41 %		43 %	
Man's attendance at church	26 %		26 %		25 %		29 %	
Women who care grandchildren while parents work	5 %		5 %		3 %		13 %	
Men who care grandchildren while parents work	3 %		3 %		1 %		9 %	
Area (South and Islands = 1; North-Centre = 0)	36 %		36 %		37 %		28 %	
Married (Married = 1, 0 otherwise)	98 %		99 %		98 %		98 %	
Couples with cohabiting offspring	77 %		74 %		82 %		56 %	
Couples with elderly cohabiting	17 %		13 %		18 %		15 %	
Couples who received free help for domestic activities	6 %		5 %		7 %		0 %	
Couples who received paid help for domestic activities	10 %		13 %		11 %		6 %	
Woman retired before 2007	10 %		10 %		7 %		27 %	
Gender attitudes Index-Score	2.26	0.49	2.26	0.49	2.28	0.50	2.19	0.47

Standard deviations are reported only for continuous measures

compare the various factors that affect the relationships between parents and children and between partners (generations and gender). GGP also aims to explain how and why individuals and couples take important life course decisions, and a great relevance is given to retirement, because of its multiple implications for demographic change and family relationships (cf. Vikat et al. 2007, pp. 392, 419).

The Italian longitudinal GGS data were collected in two waves. The first one, "Family and Social Subjects—2003" (in Italian *Famiglia e soggetti sociali*), internationally known as the Italian GGS (or GGS Italy, 1st Wave), was held by the Italian National Institute of Statistics (Istat). This survey included a sample of 19,227 households and 49,541 individuals (the response rate was 82.3 %). The second wave (GGS Italy, 2nd Wave, in Italian *Criticità dei percorsi lavorativi in un'ottica di genere*), was jointly conducted by Istat and the Italian Ministry of Labour and Social Policy in 2007 through CATI (Computer Assisted Telephone Interviewing) method, on a random sub-sample of 9997 subjects aged 18–64 already interviewed in 2003 (response rate was 61 %).

In our study we use longitudinal data from the first and second wave of Italian GGS. We select a sample of 540 couples (1080 individuals married or cohabiting, equally distributed by geographical area), in which the male partner was working in 2003, while women could be employed or unemployed. Men were aged 45–64 in 2003, women 33–63. The number of men who retired between 2003 and 2007 is 97. More details on the sample characteristics are reported in Table 1.

Table 2 reports descriptive statistics that reveal how the time spent on work (paid and unpaid) varies among profiles that differ for gender attitudes. Namely, women classified as "traditional" work more indoors than "modern" women, while the opposite occurs for men. In general, the time devoted to domestic work by men increases, on average, moving from the year 2003 to 2007, while paid work decreases. This result is influenced by the retirement of the men between the two waves. As Table 2 shows, the paid work of traditional women decreases more (−2.16 weekly hours) compared to that of modern ones (−1.06 weekly hours), while the reverse happens for domestic work (−3.35 for traditional women and −4.30 for modern ones).

Given these descriptive results, we would like to evaluate to what extent the retirement of the male partner influences the different performance over time of labour supply (paid and unpaid), respectively, of traditional women and modern women. To this purpose, we discuss in the following section the estimation results of the model introduced in Sect. 3.

Table 2 Weekly hours of market and domestic work for different gender-attitude profiles (traditional or modern couples)

Attitudes	Women		Men	
	Paid	Unpaid	Paid	Unpaid
2003				
Full sample	18.23	35.21	40.39	6.02
Traditional	17.50	36.85	41.20	5.44
Modern	18.69	34.19	39.88	6.38
2007				
Full sample	16.76	31.27	32.99	13.93
Traditional	15.34	33.50	31.42	13.70
Modern	17.63	29.89	33.96	14.06

4.2 Estimation Results

We report in Table 3 the estimates of the most relevant coefficients of our *SUTR-DID* model using the full sample of 1080 subjects. In Tables 6 and 7 we also report the estimates for the subsamples of traditional and modern couples.

Considering the full sample, the *DID* coefficient is significant for both men and women in the paid and unpaid work equation. The coefficient measuring the gender-role impact is highly significant in the women's paid work equation (women living in a traditional family work less in the market than women living in a modern family) and in the men's unpaid work equation (men who agree with the traditional familistic and gender ideology work less indoors).

Among the other covariates, education (less educated women work more indoors), and help (paid) received in domestic activity are also significant, as well as a proxy of religiosity (measuring the adherence to traditional values), denoting a positive influence on a woman's domestic activity and a negative influence on her paid work, as well as caring for

Table 3 *SUTR-DID* model estimation results—effect of a man's retirement on his partners' working activity (full sample: 1080 subjects, 540 couples; 97 transitions to retirement)

Log weekly hours	Women		Men	
	Paid coeff.	Unpaid coeff.	Paid coeff.	Unpaid coeff.
Age in 2003 (TI)	−0.02***	0.00	−0.02***	−0.02**
Education (years of schooling) (TI)	0.20***	−0.05***	0.02***	0.03***
Caring for grandchildren while parents work (TI)	−1.15***	0.26***	−0.12	0.03
Area (1 = South and Islands, 0 = otherwise)	−0.64***	0.16***	−0.21***	0.00
Married (1 = yes, 0 = cohabiting) (TV)	0.17***	0.00	0.25	−0.30
Children cohabiting (1 = yes, 0 = no) (TV)	0.39***	0.16***	0.05	0.21*
Religiosity: attendance at church (1 = at least once a week, 0 = otherwise) (TV)	−0.38***	0.12***	−0.10*	0.19*
Help received in free form (TV)	0.06**	0.02	−0.05	0.52***
Help received in paid form (TV)	0.61***	−0.23***	0.16**	−0.06
Health (TV)	−1.08***	0.12	0.23	−0.09
Wave (1 = 2007, 0 = 2003) (λ)	−0.07***	−0.02	−0.11**	0.70***
Retired (1 = yes, 0 = no) (α)	0.21***	0.08	0.04	0.48***
DID (WAVE*RETIRED) (δ)	−0.25***	−0.19*	−3.45***	0.35*
Log Wage (TV)	0.68***	0.11	−3.88***	−0.46
Elderly in the house (TV)	0.27***	0.05	−0.04	−0.05
Score Z	0.50***	−0.02	−0.04	0.21**
Retirement of woman (TI)	−1.65***	0.20***	−0.12	−0.16
Constant	−1.65***	3.61***	4.01***	1.46**
N	1080	1080	1080	1080
R^2	0.99	0.24	0.78	0.18

TI: time invariant, TV: time varying. *P* value: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

grandchildren while their parents work. Finally, retired women dedicated more time to unpaid work.

As mentioned above, in order to evaluate the mean impact (in percentage terms) of the transition to retirement on the logarithm of working time, we compute the exponential term of the *DID* coefficient (δ) measured as a percentage: $100 \cdot [\exp(\delta) - 1]$ (Table 4). In the same way, computing $100 \cdot [\exp(\delta + \lambda) - 1]$, we evaluate as a percentage the "subject-specific effect" of the man's retirement on the subjects living in families who experienced this transition (Table 5).

In general, man's retirement leads to a "mean" reduction (*DID* effect) of the domestic activity of the woman (−17.3 %). While the reduction of domestic activity calculated as a "subject-specific" effect is more marked (−18.9 %). The reduction of women's unpaid work is the same (−18.9 %) if we compare the two subsamples, respectively, of traditional and modern women.

Using the (estimated) percent variation presented in Table 5 to measure the "subject-specific" effect of retirement in weekly working hours, we obtain the results shown in Fig. 1.

In particular, we found an estimated average reduction of woman's paid work between 2003 and 2007 equal to $18 - 10 = 8$ weekly hours for traditional women, and equal to $19 - 16 = 3$ weekly hours for modern women. This result is due, at least in part, to the retirement of both partners, that occurred 15 times in the subsample of modern couples (out of 57 transitions to retirement of the man), and 9 times in the subsample of traditional couples (out of 40 transitions to retirement of the man).

Considering men's behaviour, males' commitment to domestic work, as a consequence of retirement, increases in both traditional and modern families. More generally, considering the decrease of female unpaid work ($37 - 30 = 7$ weekly hours for traditional women, and $34 - 28 = 6$ weekly hours for modern women), and the contextual increase of a man's commitment to domestic activity ($13 - 5 = 8$ weekly hours for traditional men, and $20 - 6 = 14$ weekly hours for modern men), the retirement of a man seems to contribute to a more equitable labour division between partners.

Nevertheless, these results reveal that the agreement with gender and familistic ideology affects the division of domestic work in the family, and especially the man's commitment to housework. Namely, as a consequence of retirement, the increase in domestic work shown by men living in a traditional family (8 weekly hours) is markedly lower than the

Table 4 *DID* effect (*DID* %) of the transition to retirement ($100 \cdot [\exp(\delta) - 1]$)

	Women		Men	
	Paid	Unpaid	Paid	Unpaid
Transition to retirement (full sample, no.: 540 couples; 1080 subjects; 97 transitions to retirement)				
	22.1	17.3	96.8	41.9
Transition to retirement (traditional, no.: 206 couples; 412 subjects; 40 transitions to retirement)				
	41.1	18.1	97.0	10.5
Transition to retirement (modern, no: 334 couples; 668 subjects; 57 transitions to retirement)				
	6.8	16.5	96.5	64.9

Table 5 Subject-specific effect (*DID* + Wave %) of the transition to retirement (100·[exp ($\delta + \lambda$) − 1])

Women		Men	
Paid	Unpaid	Paid	Unpaid
Transition to retirement (full sample, no.: 540 couples; 1080 subjects; 97 transitions to retirement)			
−27.4	−18.9	−97.2	185.8
Transition to retirement (traditional, no.: 206 couples; 412 subjects; 40 transitions to retirement)			
−44.6	−18.9	−97.6	141.1
Transition to retirement (modern, no: 334 couples; 668 subjects; 57 transitions to retirement)			
−13.9	−18.9	−96.6	215.8

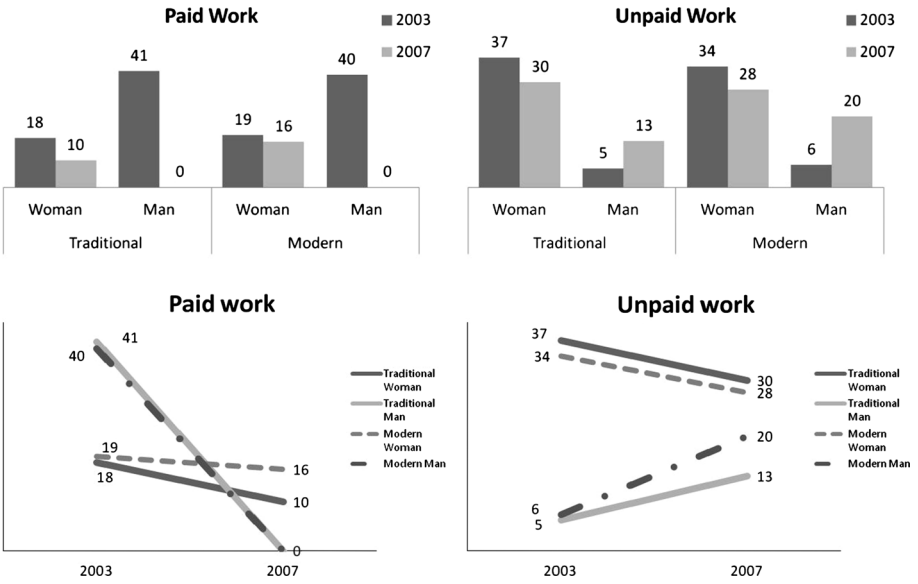

Fig. 1 Estimated weekly working hours for traditional and modern couples who experienced the retirement of the man

increase recorded by men living in a modern family (14 weekly hours). Surprisingly, the difference in the variation of women's housework related to gender and familistic attitudes influence is found to be negligible. In fact, women living in a traditional family report a reduction in weekly domestic work of seven hours, while women living in a modern family report a reduction of six hours per week. Considering the overall time dedicated to unpaid work by the family, we observe that men's proportion of total domestic activity increases between waves in both types of couple, but in the traditional ones this proportion increases from 12 % in 2003 to 30 % in 2007 (respectively 5/42 in 2003 and 13/43 in 2007), while in the modern ones it increases from 15 to 42 % (6/40 in 2003 and 20/48 in 2007).

The propensity of traditional and egalitarian partners to reallocate housework as an effect of the man's retirement can be evaluated using our estimation results to measure the relative contribution of each partner to housework tasks. To this purpose, we adopt the Sørensen and McLanahan (1987) (*SM*) formula,[5] obtained by computing the ratio: (man's hours − woman's hours)/(man's hours + woman's hours). The resulting scores can range from −1 to +1, with a score of zero indicating an equal division of housework. A negative value of this ratio signals that the contribution of the woman to housework is higher than the man's. The opposite occurs if this index shows a positive value.

Using the estimated weekly working hours of the partners in couples who experienced the retirement of the man (see Fig. 1), traditional couples report a *SM* ratio equal to −0.77 in the year 2003 (before retirement of the man), and equal to −0.49 in the year 2007 (after retirement of the man). On the other hand, egalitarian couples report a *SM* ratio equal to −0.70 in the year 2003 (before retirement of the man), and equal to −0.08 in the year 2007 (after retirement of the man).

These results show that a more equitable reallocation of household chores between men and women prevalently occurs in modern Italian couples as a consequence of the retirement of the male partner, while this effect of reallocation appears less marked in traditional Italian couples, where the adhesion to double standard (gender and familistic) norms is more marked.

5 Conclusions

The results of our analysis confirm that in Italy a gender gap in labour division between partners occurs in both paid and unpaid work. However, the retirement of the man seems to contribute to a more equitable division of domestic work between partners, because men's increased commitment to domestic chores after retirement seems to compensate for the reduction in woman's domestic activity.

However, considering the influence of gender and familistic ideology, "more traditional" women work more indoors than "modern" women, while men who agree with the traditional gender ideology after retirement work less in the house than men who do not agree. This result, obtained stratifying the analysis for different gender-role profiles, indicates that the domestic work supply of Italian men is negatively influenced by their agreement with the gender ideology.

These results imply that a more equitable (for the woman) reallocation of housework tasks in the household after the retirement of the male partner is hampered if the couple agree with traditional gender ideology. In particular, men living in "traditional" families work less in the house after retirement than men living in "modern" families. This behaviour may be explained by considering that a man living in a traditional family is more likely to identify himself with the role of masculinised 'breadwinner'. For this reason, a man with a traditional profile, after retirement, proves ill-suited to shifting his commitment from paid work to housework (Barnes and Parry 2004).

Regarding the classification of couples by gender and familistic attitudes, note that the item-scores computed for one of the two partners are generally aligned with the item-scores computed for the other partner.[6] This implies a substantial alignment of both partners in terms of agreement (or disagreement) with traditional social norms. However,

[5] Used also by Szinovacs (2000).

[6] Related statistics are not reported here for the sake of brevity but are available upon request.

in order to improve the consistency in the classification and subsequent stratification of couples, we control the clustering procedure by introducing, as a further classification variable, the woman's degree of satisfaction with housework division. As a result emerging from our stratification, we observe that the contribution provided by men in domestic work is larger if women express more dissatisfaction with the actual division of household chores at Wave 1. Therefore, women's perception of equity in housework division with the male partner may be a further relevant factor in the bargaining process.

A limitation in the classification procedure may be given by the risk that the answers to the statements on the attitudes (especially those relating to gender equality) could be influenced by the changes in labour division.[7] In order to prevent the endogenous effect of work reallocation between partners on the classification of couples in terms of gender attitudes, in our analysis we refer to statements measured at the first wave (year 2003), before the potential change in the division of labour between the partners. Despite the remedy here adopted, the potential endogenous nature of the change over time of gender attitudes in longitudinal analysis deserves to be investigated in future developments of this research.

In general, we found that the gender-attitudes index here adopted can be utilized as a good predictor of working activity when evaluating the modification of the transition-to-retirement effect moving from "traditional" to "modern" couples. In particular, testing the reliability of the mean score of the attitudes index (see Sect. 3.1), we found a strong connection between the answers to the "familistic-belief" statements and the "gender equality" statements. This could be interpreted as a confirmation of the strong connection, for a relevant number of Italian couples, between familistic mentality and gender ideology (e.g. Dalla Zuanna 2001; Reher 1998).

Not only the gender equality perception—or other latent variables included in the error terms of paid and unpaid work equations—may influence the bargaining process between partners. We also have to take into account another relevant factor considered by analysts to explain the bargaining process: the earnings profile of each partner (e.g. Francesconi 2002). Proxy variables generally assumed to measure this factor are education and individual labour income (wage). In our model, education, measured in years of schooling, is found to be significant in both paid and unpaid work estimates, and reveals that more educated women (with a higher earning profile) work less in the house, while the opposite occurs for more educated men, who work more indoor than the less educated (see Tables 3, 6 and 7). In addition, as shown by the estimated coefficients measuring the effect of education on paid work, the effect of education on the paid work of men is less marked than that on the paid work of women. These results seem to contradict the hypothesis that the distribution of work between the partners is determined by the different skills or by the different ability in income production (earnings profile). In Italian couples, a markedly gendered division of labour appears, not dependent on the ability of each partner.

However, in our analysis, the role of wages as a measure of the earnings profile should be evaluated with caution, considering that, it was not directly surveyed in our dataset but assigned to each subject by adopting a matching procedure.

Finally, another question concerns the effect of caring for grandchildren on partners' housework division. Our estimates show that this has a significant impact on Italian women's paid work (negative) and domestic work (positive), while its influence on Italian men's commitment in housework appears to be less marked. This result differs to what

[7] E.g., Carlson and Lynch (2013) have found that not only do gender attitudes affect the housework, but that the reverse is also true.

Table 6 *SUTR-DID* model estimation results. Traditional couples (subsample: 412 subjects, 206 couples; 40 transitions to retirement)

Traditional log weekly hours	Women		Men	
	Paid coeff.	Unpaid coeff.	Paid coeff.	Unpaid coeff.
Age in 2003 (TI)	−0.08***	0.00	−0.02	−0.03*
Education (years of schooling) (TI)	0.33***	−0.07***	0.02*	0.03*
Caring for grandchildren while the parents work (TI)	−1.28***	0.10	0.04	−0.08
Area (1 = South and Islands, 0 = otherwise)	−0.57***	0.07	−0.18**	−0.06
Married (1 = yes, 0 = cohabiting) (TV)	(omitted)			
Children cohabiting (1 = yes, 0 = no) (TV)	0.39***	−0.02	−0.07	0.26
Religiosity: attendance at church (1 = at least once a week, 0 = otherwise) (TV)	−0.59***	0.11*	−0.15*	0.19
Help received in free form (TV)	−0.06	0.04	−0.10	0.78***
Help received in paid form (TV)	0.36***	−0.02	0.35**	−0.19
Health (TV)	−0.26***	0.06	0.29	0.05
Wave (1 = 2007, 0 = 2003) (***l***)	−0.06**	−0.01	−0.22**	0.78***
Retired (1 = yes, 0 = no) (***a***)	1.03***	−0.10	0.12	0.75***
DID (WAVE*RETIRED) (***d***)	−0.53***	−0.20	−3.50***	0.10
Log Wage (TV)	−0.48***	0.11	−4.71***	−1.29
Elderly in the house (TV)	0.44***	−0.07	−0.12	0.11
Retirement of woman (TI)	−0.54***	0.16	−0.05	−0.09
Constant	1.05***	3.95***	3.97***	1.70*
N	412	412	412	412
R^2	0.99	0.22	0.74	0.21

TI: time invariant, TV: time varying. *P* value: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 7 *SUTR-DID* model estimation results. Modern couples (subsample: 668 subjects; 334 couples; 57 transitions to retirement)

Log Weekly hours	Women		Men	
	Paid coeff.	Unpaid coeff.	Paid coeff.	Unpaid coeff.
Age in 2003 (TI)	0.01***	0.00	−0.02***	−0.02
Education (years of schooling) (TI)	0.14***	−0.04***	0.01**	0.04***
Caring for grandchildren while the parents work (TI)	−1.03***	0.33***	−0.29*	0.12
Area (1 = South and Islands, 0 = otherwise)	−0.89***	0.21***	−0.20***	0.03
Married (1 = yes, 0 = cohabiting) (TV)	−0.17***	0.02	0.27*	−0.31
Children cohabiting (1 = yes, 0 = no) (TV)	0.39***	0.22***	0.11*	0.22*
Religiosity: attendance at church (1 = at least once a week, 0 = otherwise) (TV)	−0.49***	0.16***	−0.03	0.11
Help received in free form (TV)	0.10**	0.04	−0.03	0.37
Help received in paid form (TV)	0.72***	−0.28***	0.05	0.00
Health (TV)	−1.74***	0.2	0.21	−0.31

Table 7 continued

Log Weekly hours	Women		Men	
	Paid coeff.	Unpaid coeff.	Paid coeff.	Unpaid coeff.
Wave (1 = 2007, 0 = 2003) (*l*)	−0.08***	−0.03	−0.03	0.65***
Retired (1 = yes, 0 = no) (*a*)	−0.27***	0.18*	−0.07	0.35*
DID (WAVE*RETIRED) (*d*)	−0.07	−0.18	−3.36***	0.50*
Log Wage (TV)	1.33***	0.09	−3.22***	−0.02
Elderly in the house (TV)	0.21***	0.10	0.02	−0.14
Retirement of woman (TI)	−2.31***	0.21**	−0.14	−0.24
Constant	−0.38***	3.34***	4.15***	1.94**
N	668	668	668	668
R^2	0.98	0.23	0.81	0.15

TI: time invariant, TV: time varying, *P* value: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Kahn et al. (2011) found for the US, confirming the peculiarity of the Italian context (Anxo et al. 2011). In particular, Khan and colleagues showed that in the US when retiring from the workforce, married men become significantly more involved in the care of their grandchildren, virtually eliminating any gender difference by the time they are in their 60 s. However, the different level of commitment for Italian men and women in the care of grandchildren found here needs to be confirmed, in future studies, by performing a specific empirical analysis.

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Appendix: Restrictions Imposed on the Covariances of the Error Terms: Specification and Implementation in the Estimation Procedure

The error terms of each equation are specified taking into account the correlation between equations in correspondence to each observation, and the correlation of each repeated observation over time. We report here the specification of the error terms, respectively, of the equations of paid and unpaid work of women, (1) and (2); and the equations of paid and unpaid work of men, (3) and (4). Indexes and suffixes are the same.

$$u_{Lwti} = \varphi_{Lw1}u_{Dwti} + \varphi_{Lw2}u_{Lmti} + \varphi_{Lw3}u_{Dmti} + \rho_{Lw1}u_{Lwt-1i} + \rho_{Lw2}u_{Dwti-1} + \rho_{Lw3}u_{Lmt-1i} + \rho_{Lw4}u_{Dmt-1i} + \varepsilon_{Lwti} \quad (5)$$

$$u_{Dwti} = \varphi_{Dw1}u_{Lwti} + \varphi_{Lw2}u_{Dmti} + \varphi_{Dw3}u_{Dmti} + \rho_{Dw1}u_{Dwt-1i} + \rho_{Dw2}u_{Lwt-1i} + \rho_{Lw3}u_{Lmt-1i} + \rho_{Dw4}u_{Dmt-1i} + \varepsilon_{Dwti} \quad (6)$$

$$u_{Lmti} = \varphi_{Lm1}u_{Dwti} + \varphi_{Lm2}u_{Lwti} + \varphi_{Lm3}u_{Dmti} + \rho_{Lm1}u_{Lwti} + \rho_{Lm2}u_{Dwt-1i} + \rho_{Lm3}u_{Lwt-1i} + \rho_{Lm4}u_{Dmt-1i} + \varepsilon_{Lmti} \quad (7)$$

$$u_{Dmti} = \varphi_{Dm1}u_{Lmti} + \varphi_{Lm2}u_{Lwti} + \varphi_{Dm3}u_{Dwti} + \rho_{Dm1}u_{Dmti} + \rho_{Dm2}u_{Lmt-1i} + \rho_{Lm3}u_{Lwt-1i} + \rho_{Dm4}u_{Dwt-1i} + \varepsilon_{Dmti} \quad (8)$$

The coefficients indicated with the Greek letter φ measure the relationships between the errors of different equations (for instance, between paid work and domestic work of the same subject, or between the domestic work of the subject and that of his/her partner), while coefficients indicated with the Greek letter ρ measure the relationship across time (or across the two Waves) of the errors referred to the same observation (or the same subject). The covariances between the equations and between the repeated observations over time (imposed as non-null) can be easily obtained from the coefficients φ and ρ using the well-known second-order moments relationship.

We assume that the errors u_{Lwti}, u_{Dwti}, u_{Lmti}, u_{Dmti} are omoskedastic and distributed with zero mean, as well as the disturbances ε_{Lwti}, ε_{Dwti}, ε_{Lmti}, ε_{Dmti}. However, the latter, unlike the former are non-correlated with each other. Considering the restrictions imposed on the covariances, the covariance matrix, $\mathbf{\Omega}$, of the error terms is similar to those used in *SUR* models.

To incorporate the constraints on the errors' covariances in the estimation procedure, we use the residuals, $\hat{u}_{\mathrm{i}}$, of the *OLS* (uncensored) regressions of Eqs. (2) and (4) and of the *Tobit* (censored) regressions of Eqs. (1) and (3) that we run separately at the first stage. Then, at the second stage, four *OLS* regressions using the first-stage residuals are estimated as follows (for the sake of brevity, we report the regression referring to the residuals of Eq. 1 only):

$$\tilde{u}_{Lwti} = \tilde{\varphi}_{Lw1}\hat{u}_{Dwti} + \tilde{\varphi}_{Lw2}\hat{u}_{Lmti} + \tilde{\varphi}_{Lw3}\hat{u}_{Dmti} + \tilde{\rho}_{Lw1}\hat{u}_{Lwt-1i} + \tilde{\rho}_{Lw2}\hat{u}_{Dwti-1} + \tilde{\rho}_{Lw3}\hat{u}_{Lmt-1i} + \tilde{\rho}_{Lw4}\hat{u}_{Dmt-1i} \quad (9)$$

The predicted values, $\tilde{u}_{Lwti}$, of Eq. (9) are obtained by the *OLS* regression of the residuals $\hat{u}_{Lwti}$ of Eq. (1) on the residuals of Eqs. (2), (3) and (4) and on the lagged residuals, $\hat{u}_{t-1,i}$, of Eqs. (1), (2), (3) and (4).

In this way, the covariances between equations and over-time are incorporated in the estimated *OLS* coefficients φ and ρ considering the well-known second-order moments properties.

Analogously, we use the second-stage estimated residuals of Eqs. (1), (2), (3) and (4) to compute the following dependent variables, corrected for the common unobserved latent factors such as bargaining and endogeneity of the retirement decision:

$$\ln \tilde{L}_{wti} = \ln L_{wti} - \tilde{u}_{Lwti}; \quad \ln \tilde{D}_{wti} = \ln D_{wti} - \tilde{u}_{Dwti}$$
$$\ln \tilde{L}_{mti} = \ln L_{mti} - \tilde{u}_{Lmti}; \quad \ln \tilde{D}_{mti} = \ln D_{mti} - \tilde{u}_{Dmti} \quad (10)$$

Finally, at the third stage, we substitute the corrected dependent variables (10) into Eqs. (1)–(4), and run *OLS* and *Tobit* regressions. To improve the efficiency of estimates, this procedure can be iterated until the estimated coefficients converge.[8]

The result of this correction is satisfactory, as evidenced by the gain of significance of the estimates derived from the iterative process (further details are not given here for the sake of brevity, but are available upon request).

[8] The estimation procedure used here is implemented by combining different STATA 13 packages.

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