The Labour Division of Italian Couples after a Birth: Assessing the Effect of Unobserved Heterogeneity ~~due to Gender Attitudes and Endogenous Fertility~~

Abstract

The results of previous studies on the effect of childbearing on both parents' paid and unpaid work suffer from the difficulty related to the specification of latent variables that influence the relationship between reproductive behaviour of the couple and working activity. The aim of this study is to estimate the effect of transition to parenthood on the partners' division of labour by accounting for latent variables, such as the bargaining process between partners and endogenous fertility decisions. In particular, this is the first time that our specific estimation strategy has been applied to determine the impact of childbearing on the division of household labour between partners taking into account the reverse causality effect between labour and fertility decisions. We use longitudinal data on married or cohabiting Italian couples provided by the Italian panel survey of the Generation and Gender Program. Our results are consistent with previous studies, and show that the birth of a child affects a woman's unpaid labour strongly and positively and her paid labour negatively, while men's work is mostly unaffected. Moreover, when partners hold traditional attitudes regarding gender roles and the family, the female partner is even more strongly affected by childbearing in terms of total amount of labour (paid plus unpaid). However, our sensitivity analysis shows that these results appear only when our correction strategy for the misspecification of latent variables is applied.

Keywords Parenthood Transition - Intra-Household Labour Division - Difference-in-Differences estimator - Gender Attitudes – Traditional Family

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1 Introduction

According to the welfare state classifications proposed ~~by Esping-Andersen (1999),~~ in the literature, Italy is characterized by a welfare system where the family has the main responsibility for its vulnerable members (Orloff 1993 and 1996; Saraceno 1994; Esping-Andersen 1999). Italy is also characterized by double standard norms, giving women the main responsibility for the family (Ferrero-Camoletto 2011). The consequence is that the total amount of women's work related to the home and childbearing and the related gender gap are higher than elsewhere in Europe (Craig and Mullan 2010; Anxo et al. 2011). In particular, the relationship between women's participation to the labour market and fertility in Italy reflects the peculiarity of the 'economics of the family' in Mediterranean countries, where the combination of low fertility and low participation is favoured by a family-centered welfare system, a family-biased production system, and a family-oriented value system (cf. Bettio and Villa 1998; Bettio and Plantenga, 2004).

This study gauges the effect of childbearing on both parents' paid and unpaid labour, allowing us to detect the gender gap in Italian society and the strength of gender and family norms related to parenthood.

Few studies have focused on partners' paid and unpaid work after the birth of a child. Their findings show that women's time is especially affected (Sanchez and Thomson 1997; Kluwer et al. 2002; Gjerdingen and Center 2005; Baxter et al. 2008; Grunow et al. 2012; Campolo et al. 2016a, 2016b). However, when considering the intra-household allocation of time, some methodological issues arise. Researchers have to deal with some problems deriving from the fact that the bargaining process between partners is unobserved and can endogenously affect the allocation of time in the family. The specification of the influence of bargaining is

very difficult because of the dependence of bargaining process on latent factors given by the gender attitudes and patriarchal or "familistic" mentality of the partners[1]. The use of proxy variables to identify these factors and specify the effect of unobserved bargaining leads to a lack of robustness of findings (Brines 1994; Gupta 2007; Gupta and Ash 2008; Garcia-Mainar et al. 2011). Another source of endogeneity is given by the reverse causality relationship existing between labour and the reproductive decisions of partners. In this case, as we will discuss below, the traditional remedy for endogeneity, given by the use of "instruments" of observed fertility behaviour (cf. Browning 1992; Nakamura and Nakamura 1992; Carrasco, 2001), may not always lead to satisfactory results.

In this study, we look at the consequences of the transition to parenthood on the division of the paid and unpaid work of Italians. To this end, we use longitudinal data from the Italian National Statistical Institute (ISTAT) Multipurpose Panel Survey for the years 2003 and 2007, the Italian version of the Generations and Gender Survey, and we select a sample of married and cohabiting couples.

Compared to previous studies focusing on partners' paid and unpaid work after the birth of a child, we account for endogeneity caused by latent factors such as bargaining process and fertility behaviour. The paid and unpaid work of both partners is estimated jointly by adopting a Simultaneous Equation approach. In each simultaneous equation, the effect of the transition to parenthood on the dependent variable (paid and unpaid work) is specified by adopting a Difference-in-Differences (*DID*) parameterization (Ashenfelter and Card 1985;

[1] The patriarchal family model, based on the gendered separation of roles in the household, takes the form of a familistic model in the Italian context, where the family, and especially women, care for their vulnerable members. More specifically, familism is based on a gendered and intergenerational solidarity extended also to close kin (Naldini 2003; Saraceno 2016). In the rest of the article, when using the term "familistic", we will implicitly refer to the patriarchal model.

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Angrist and Krueger 1999; Athey and Imbens 2006). We will account for the endogeneity of bargaining by imposing specific constraints on the covariances of the error terms between the simultaneous equations of each partner, as in a Seemingly Unrelated Regression (*SUR*) model (e.g. Srivastava and Giles 1987). A similar approach has been adopted by Campolo et al. (2016a, 2016b) to analyse the effect of parenthood on two-earner couples. Unlike these two previous studies, this analysis also includes couples in which at least one of the partners is unemployed. As a consequence, we should take into account censoring in the dependent variable of the paid-work equations of both partners. In addition, several innovations are introduced in the present analysis, such as how to model the influence of the latent bargaining process in terms of agreement with gender attitudes, and how to correct the endogenous effect of fertility on the estimation of paid and unpaid work equations.

Regarding, in particular, the influence of gender attitudes on bargaining, some studies stress the influence of individual attitudes regarding gender roles and the family on both the division of labour and fertility (McDonald 2000; Aassve et al. 2014). In particular, Balbo and Arpino (2016) found that, after the transition to parenthood, the attitudes of partners towards gender roles may lead to changes in their respective subjective wellbeing, especially if the birth of a child conditions partners' occupational and career prospects.

In this analysis, in order to account for the influence of gender attitudes and ~~male-dominant~~familistic mentality on the division of labour within the couple, we use a cluster procedure to classify couples in homogeneous groups accounting for each partner's gender and ~~patriarchy~~ familistic attitudes and women's dissatisfaction with the housework division in the family. We identify two groups of couples labelled, respectively, as "traditional" couples, if the partners agree with gender norms and a ~~patriarchal~~ male-dominant mindset, and "modern" couples, if they do not agree. We then stratify the analysis according to these two groups.

Our results are consistent with previous studies, and show that the birth of a child affects a woman's unpaid labour strongly and positively and her paid labour negatively, while almost no effect is observed for men. The new result of our study is that the change in a woman's total workload, paid plus unpaid labour, is greater when she belongs to a traditional couple than when she is in a modern couple. However, this result appears only when our correction strategy for the misspecification of latent variables is applied.

The paper is organized as follows: in the next section (Section 2), we discuss some relevant theoretical issues of the relation between parenthood and the division of labour. We also discuss problems arising from the misspecification of latent factors and present our hypotheses. In Section 3, we explain the characteristics of the dataset and the rationale of our estimation methodology. In Section 4, we discuss our results. We conclude with final observations and remarks. In Appendix 1, we report the methodological aspects related to the correction of estimates for endogeneity of fertility behaviour; in Appendix 2 we present a comparison, in terms of estimate robustness, of our SUR method with the traditional IV approach used to correct for endogeneity of fertility.

2 Conceptual and methodological background

2.1 The division of labour after a birth

A limited number of studies have focused on how the distribution of paid and unpaid work between partners changes after the birth of a child. Most of these studies show an increase in housework for women after childbearing, while men's housework time remains unchanged, and in some cases diminishes (Sanchez and Thomson 1997; Kluwer et al. 2002; Gjerdingen and Center 2005; Baxter et al. 2008; Grunow et al. 2012; Campolo et al. 2016a, 2016b). Sanchez and Thomson (1997) find that women's housework increases by 14.5 hours per week

with the first child. Baxter et al. (2008) find 6 additional hours of housework per week for the first child. For fathers, no effects on housework are observed with the first child (Sanchez and Thomson 1997; Baxter et al. 2008). However, with a second child, Baxter et al. (2008) observe an 8-hour decrease in men's weekly housework hours

As for employment hours, Gjerdingen and Center (2005) show a significant reduction of 10.5 hours per week for women with the birth of the first child. According to Sanchez and Thomson 1997, women's employment decreases by about 8 hours per week. For fathers, no effects are observed with the first child, while an effect on employment is observed with the second child (about 3 hours more per week). Moreover, in Sanchez and Thomson's study gender attitudes do not affect results for mothers and fathers.

In these studies considering labour change after childbearing, researchers have to deal with some relevant problems deriving from the misspecification of latent factors, such as the bargaining process between partners and the endogeneity of fertility behaviour that influence both the intra-household allocation of working time and the transition to parenthood. In the following Sections, we discuss these problems and suggest a strategy for the correction of misspecification.

2.2 Reverse causality

Not only the birth of a child may affect partners work hours, since fertility decisions may also be influenced by a woman's past and current working status and by the partners' division of household labour (Hotz and Miller 1988; Browning 1992; Cooke 2006; Olah 2003; Torr and Short 2004; Mills et al. 2008; Pinnelli and Fiori 2008).

In order to account for the effect of fertility on both paid and unpaid work estimates, an instrumental variable (*IV*) approach can be adopted by researchers. The instruments, used

to estimate in a reduced form the total number of children born in the family, are variables correlated with fertility but not with labour supply (cf. Browning 1992; Nakamura and Nakamura 1992). To this end, different instruments are used in literature to identify fertility behaviour. Dummy variables indicating the sex of previous children are among the most usual instruments (see Carrasco 2001). This choice is based on the evidence that parents prefer "balanced" families in terms of the gender composition of their set of children, and are more likely to have an additional child if the previous ones are of the same sex. This is an appropriate instrument since the sex of the previous child is a good predictor of fertility, but not of participation in the labour market. One inconvenience, however, is that the traditional *IV* approach is restricted to predicting the fertility behaviour of couples with at least one child (e.g. Carrasco 2001), thus excluding couples without children.

Another method to control for the endogeneity of fertility is suggested by Sanchez and Thomson (1997). They adopt a lagged endogenous variable model to simultaneously estimate both partners' paid and unpaid labour (Y). In their model, the value at time t_2 (second wave) of the dependent variables is considered in both regressions of paid and unpaid work. The lagged version of each dependent variable surveyed at the first wave (t_1) is included as a regressor. As for explanatory variables, their value at t_1 determines the dependent variable at t_1. In other words, they affect Y at t_2 through Y at t_1. In this way reverse causation is avoided, but we lose information on the independent variables at t_1.

In paragraph 2.5, we propose our innovative strategy to account for endogeneity of fertility behaviour, avoiding some of the shortcomings of the previous literature presented above.

2.3 Bargaining process in intra-household allocation

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Several socioeconomic analyses have investigated how social norms affect the division of labour between partners. Especially in southern European countries, gendered social norms influence the structure of the welfare state by leading to a division of labour between state, market and family in which family and "serving work" are carried out prevalently by women (Saraceno 1994; Jurado Guerrero and Naldini, 1996). As a consequence, this condition penalizes women within the family in terms of physical and psychological well-being. In particular, Chiappero-Martinetti (2005), analysing Italian microdata on the use of time and on individual well-being, observed a stronger relationship between gendered division of labour and several specific indicators of well-being, mainly relating to health, education and knowledge, and psychological state.

In addition, gender role considerations also affect the woman's position in the labour market and her earning profile. In fact, women may select occupations that require a limited investment in human capital, is mainly due to existing or planned family commitments. As a consequence, employers may take advantage of women's needs and preferences for family commitments and penalize them in terms of wages when recruiting (e.g. Cutillo and Centra, 2017; Azmat and Petrongolo, 2014). Taking into account these aspects, it emerges that, in the relationship between the division of labour and fertility, work income can be considered as both an exogenous and, in some ways, endogenous component. Endogeneity, in particular, implies a substantial modification in the specification of our model, which needs to be explored in a separate study. In a previous analysis limited to Two-Earner couples, Campolo et al. (2016a), assuming wages as exogenous, found that the wage-elasticity of the time dedicated by the woman to both paid work and domestic work is generally lower than the elasticity calculated with respect to the birth of a child. This result supports, in part, the belief that the well-being of the family occupies a primary place in women's priorities.

In this context, several empirical studies have investigated the dependency of the bargaining process on norms and negotiating power (Brines 1994; Gupta 2007; Gupta and Ash 2008; García-Mainar et al. 2011).

In general, we observe important differences in findings across studies. These could depend on different specifications of models. Specification problems may occur because the common estimation procedures often do not take into account aspects such as the simultaneity of the relationship between paid and domestic work. For example, a woman's paid and unpaid labour decisions are correlated. Similarly, a woman's unpaid labour decision is related to a man's unpaid labour decision.

In this study, similarly to Sanchez and Thomson, we adopt a simultaneous equation approach "to exclude from estimates of parenthood effect any sources of correlation among partners' employment hours and household work hours." (Sanchez and Thomson 1997:755). This approach has been also adopted by Campolo et al. (2016b) and will be summarized in section 2.5.

2.4 The influence of attitudes on the couples' division of labour

Among latent factors, gender and family attitudes play an important role. Gender and family attitudes may affect both partners' hours of paid and unpaid labour (Brines 1994; Coltrane 2000; Greenstein 2000; McDonald 2000; Lachance-Grzela and Bouchard 2010; Carlson and Lynch 2013; Aassve et al. 2014). Partners with traditional attitudes believe that women should have the main responsibility for housework, while men should limit their involvement in these tasks, particularly those that are considered as typically "women's work". The division of labour could also have an impact on individual gender attitudes. At the empirical level, Carlson and Lynch (2013), using the simultaneous equations model, show the

reciprocal influence of gender attitudes and housework. Moreover, gender and family attitudes may affect fertility (Kaufman 2000; Puur et al. 2008; Westoff and Higgins 2009; Miettinen et al. 2011; Bernardi et al. 2013; Goldscheider et al. 2013). Our strategy to account for gender and family attitudes is presented in the next section.

2.5 Our approach to the misspecification of latent variables

In order to account for latent variables affecting the bargaining process, we consider the association between the two partners' paid and unpaid labour during the course of their life by adopting a simultaneous-equation approach (Sanchez and Thomson 1997; Caltabiano et al. 2016; Campolo et al. 2016a, 2016b). Assuming that the latent bargaining process affects simultaneously the error terms of paid and unpaid labour equations of men and women, we impose restrictions on the covariances between the error terms of paid and unpaid labour equations for both partners.

To take into account the endogeneity of fertility behaviour, we adopt an estimation strategy that allows us check for endogeneity without losing information for couples without children, contrary to the *IV* strategy, and without losing information on explanatory variables at t_1, contrary to Sanchez and Thomson. To do this, in estimating simultaneously, by *SUR* estimator, the paid and unpaid work equations of both partners, we impose non-null covariances between repeated observations over time for couples who, given the sex of their previous children as a predictor, show a high propensity to have a child (see Appendix 1 for further details). To our knowledge, this is the first time that this approach has been applied to the estimation of the intra-household allocation of time after childbearing.

We provide below in Appendix 2 a comparison of the results obtained performing both *IV* and *SUR* procedures in estimating the effect of the birth of the second child on partners'

time devoted to work. Adopting the *IV* approach, the endogeneity of partners' fertility behaviour is corrected by instrumenting the dummy signalling the transition to the second-order birth with an indicator-variable of the sex of the first child. Adopting the *SUR* procedure, the information about the sex of the first child is incorporated in the stochastic specification of the errors (see Appendix 1 for details).

The results of the comparison between *IV* and *SUR* procedures show that the coefficients measuring the effect of the transition (the *DID* coefficient, in particular) are substantially consistent for both estimation procedures, while the coefficient estimated by SUR appears more significant.

Regarding the latent influence of gender attitudes and ~~patriarchal~~ familistic mentality, we stratify couples using a proper clustering method, taking into account as a classification variable the degree of agreement of each subject with several statements regarding gender roles and the family: attitudes toward marriage, single motherhood, divorce, custody of children, and age of transition to adulthood[2]. We take into account the potential endogeneity of gender attitudes with respect to the division of household labour by referring to statements measured at the first wave (year 2003), before the potential change in the division of labour between the partners.

By performing a sensitivity analysis, we will show that results are markedly different (and less significant) when our strategy to control for latent variables is not applied[3].

[2] In the rest of the paper we will speak about a family and gender attitudes score index. See below for presentation of statements.

[3] In this work we check for the bargaining between partners also by referring to the woman's and man's income. The information on income is not available in our data-set, but is imported through a matching procedure by the Bank of Italy Survey on Households Income and Wealth. More details are presented below.

In this study, we use the expressions "traditional couples" and "modern couples". Some other categories could be proposed, referring alternatively to patriarchal culture or familism. These alternative expressions has the advantage to clearly point to patriarchal culture as the main cause of the gendered division of labour, or to familism as a key dimension of Italian culture (Banfield 19675~~8~~; Ginsborg 1994; Dalla Zuanna 2001). However, for any of these expression, we cannot solve an inner ambiguity related to the fact these concepts take different forms with different societies (Saraceno 2016) and may change with time (Cotter et al. 2011). In this study, for sake of simplicity, we will keep the traditional/modern dichotomy for clusters denomination, while referring to the patriarchal and familistic culture as theoretical background.

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2.6 Aims and hypotheses

In this study, our aim is to estimate the effect of the transition to parenthood on the paid and unpaid work of both partners by using a method that ensures robust estimates. In our *first hypothesis*, in accordance with the previous literature, we expect to observe an effect of the transition to the first child on mothers' paid and unpaid labour, but no effect for fathers. In line with previous literature, we also expect to observe a greater effect on woman's hours with the first child compared to the second child, while we assume that fathers' paid labour is positively affected by the second child, but not the first. In our *second hypothesis*, we assume that hours of paid and unpaid labour of women in traditional couples are more affected by the birth of a child than for women in modern couples. In particular, we expect a greater increase of unpaid hours and a greater decrease of paid hours.

3 Data and methods

3.1 Data

In this analysis, we use data from the Multipurpose Panel Survey "Family and Social Subjects" (FSS), carried out by the Italian Statistical Office (ISTAT). This is the Italian version of the Generations and Gender Survey (GGS), a longitudinal survey on 18-79 year-olds coordinated by the United Nations and concerning 19 developed countries (United Nations 2005). The Italian survey provides a two-wave balanced panel sample, as all individuals are surveyed at time $t = 0$ (year 2003) and at time $t = 1$ (year 2007). Information on both paid and domestic work (childcare is included in the declared hours), life-course events, and fertility is collected.

A specificity of the Italian GGS is that both partners are interviewed. For the present study, we selected a sub-sample of 956 Italian couples for a total of 1,912 individuals. Partners were married or cohabiting and living together in the years 2003 and 2007. Women were aged 18-45 and their partners aged 18-60 in 2003. Partners of the selected couples were both active (employed or unemployed) at the first wave. The survey did not collect information on income. Thus, we apply a matching procedure using the conditional propensity score method in order to import information on hourly labour income (in euros). To this end, we use the Bank of Italy Survey of Household Income and Wealth (*SHIW*) conducted in the years 2002 and 2006. For both years of the survey, the income is converted according to the 2007 price-index. In order to avoid the risk of importing data characterized by self-selection, we adopt sensitivity tests to verify if latent factors affect matching results. Results of the propensity score estimation and sensitivity tests are not reported here for the sake of brevity, but are available on request.

3.2 Measures

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In Table 1, at each wave we compute mean values (or percentages for categorical or dummy variables) and standard deviations of the variables used in the analysis. The dependent variables are the logarithms of the weekly hours spent in paid and unpaid work by men and women at both waves. The main independent variable is the dummy (*Birth*) for transition to parenthood (equal to 1, if the subject experiences the transition to parenthood between the two waves; otherwise equal to 0). Control variables include demographic and socio-economic characteristics of the subject (see Table 1). We also include a dummy variable for the two waves (*t*: 0=2003; 1=2007).

Table 1 Means, percentages and Standard Deviations[a] of paid and unpaid labour and explanatory variables by gender

	Women		*Men*		
	Means or %	Std. Dev.	Means or %	Std. Dev.	t-*Student* on the difference between means
Dependent variables:					
Unpaid work (weekly working hours): 2003	35.80	21.12	7.43	9.44	37.92
Unpaid work (weekly working hours): 2007	31.68	17.06	13.44	20.48	21.16
Paid work (weekly working hours): 2003	19.94	17.52	42.09	12.29	-32.00
Paid work (weekly working hours): 2007	19.62	17.2	41.9	13.36	-31.63
Independent variables					
Age: 2003	37	5	40.29	5.89	-13.17
Age: 2007	40.24	5	43.53	5.91	-13.14
Education (years of schooling): 2003	11.63	3.31	11.35	3.58	1.78
Table 1 - continued					
Urban: 2003 (1=yes; 0=other)	0.60		0.60		
Help received for domestic and caring activity: 2003 (1=yes; 0=other)	0.22		0.22		
Help received for domestic and caring activity: 2007 (1=yes; 0=other)	0.23		0.23		
Marital status: 2003 (1=married; 0=cohabiting)	0.96		0.96		
Marital status: 2007 (1=married; 0=cohabiting)	0.97		0.97		
Area: 2007 (0=Centre-North; 1=South and Islands)	0.34		0.34		
Number of children: 2003	1.55	0.84	1.55	0.84	
Hourly wage: 2003	9.14	1.52	9.54	1.16	-6.47
Hourly wage: 2007	9.66	0.70	9.70	0.77	-1.19
Birth (parenthood transition between waves)	0.17		0.17		
Table 1 – continued					
Attitudes score index: 2003	2.91	0.54	2.91	0.54	
• marriage is an outdated institution[b]	2.28	0.91	2.32	0.93	-0.95
• a couple can live together without planning to marry[b]	3.34	1.02	3.39	0.98	-1.09

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• a woman can have a child alone even if she doesn't want a relationship[b]	2.73	1.09	2.65	1.06	1.63
• children aged 18-20 years old should leave the parents' home[b]	2.51	0.90	2.62	0.92	-2.64
• it is right that unhappy spouses divorce, even if they have had children[b]	3.71	0.85	3.60	0.85	2.83

Note: [a] Standard Deviations are reported only for continuous measures. [b] The degree of agreement has been expressed as a mean of a 5-points scale (1=strongly disagree, 5=strongly agree)

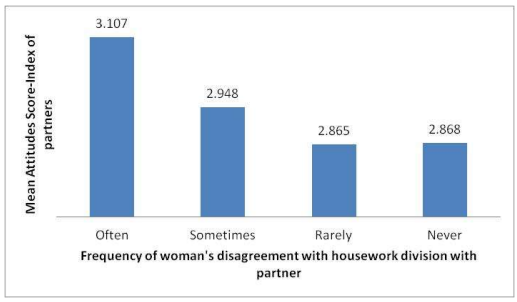
3.3 Clustering on gender attitudes and traditional ~~patriarchal~~ familistic beliefs

We take into account the moderating effect of attitudes in the relation between childbearing and division of labour by performing a cluster procedure to classify couples into homogeneous groups according to their attitudes. For each couple, we obtain an attitudes score index as a proxy of both partners' attitudes (e.g. Sanchez and Thomson 1997). This index is obtained by considering the agreement of each partner with the following five statements: 1) marriage is an outdated institution; 2) a couple can live together without planning to marry; 3) a woman can have a child alone even if she doesn't want a relationship; 4) children aged 18-20 years old should leave the parents' home; 5) it is right for unhappy spouses to divorce, even if they have had children.

The degree of agreement is expressed by the interviewees on a five-item scale, from (a) strongly disagree to (e) strongly agree. We standardize the scores by assigning values 1, 2, 3, 4 and 5, respectively, to the responses a), b), c), d) and e). Then, by computing the mean of the scores of both partners, we create a scalar index measuring the agreement of each partner with these statements. The higher the agreement with each statement, the higher the index, and the more modern the partner. We test the reliability of the item scores with a specific alpha test (Cronbach and Shavelson 2004). In particular, we obtain a high value (0.76) for alpha statistics

(the range of the alpha statistics is restricted from 0 to 1). *t*-Student tests on the mean-score differences reported in Table 1 indicate that both partners are generally aligned in agreeing with at least three statements. We found that women who agree with the above statements (from 1 to 5) are generally dissatisfied with the division of housework tasks with their partner, while the opposite occurs for women who disagree with these statements (see Fig. 1). For this reason, for a better classification, we consider a further categorical variable signalling how frequently women disagree with their partners about the division of domestic labour (this variable ranges from 1 (often disagree) to 4 (never disagree)).

Fig. 1 – Couple's Attitudes Score-Index for different levels of a woman's agreement with her partner about housework division.



Three variables are used to perform a clustering procedure on couples: the attitudes score index of both women and men, and the measure of the frequency of the women's disagreement with partners about the division of domestic labour. A Ward's algorithm is applied. The Calinski–Harabasz pseudo-*F* test is applied to determine the optimal number of clusters. By comparing the pseudo-F statistics corresponding to different partitions (two, three, or more clusters), the highest value of the pseudo-*F* test statistics (1371.98) is obtained by the partition in two groups.

In this way, we obtain two groups. In the first group of couples, labelled as "traditional", both partners disagree with the five statements (showing a traditional attitude) and women generally rarely or never disagree with partners about the division of domestic labour. In the second group of couples, labelled as "modern", partners generally agree with the five statements, and women more often disagree with partners about the division of domestic labour. We use the results of the clustering procedure to obtain a dummy variable, signalling if a couple belongs to a more traditional or modern group. We then we use the results of this classification to stratify the sample into "traditional" and "modern" couples, and we estimate the effect of transition to parenthood on the division of labour for the two groups.

Table 2 shows further details of the sample by comparing the employment rate of women and men in 2003 and 2007. Women in modern couples are more likely to be employed. However, to our surprise, the percentage of women in traditional couples who leave the labour market after the transition to motherhood is lower (16.21%) than the percentage of women in modern couples (22.22%, Table 2). These results can be partly explained by the fact that women in modern couples work more hours in the labour market than women in traditional couples (Table 3), thus making it more difficult to reconcile family and work. In addition, further elaborations reveal that, among women who experience transition to motherhood in the period 2003-3007, those who are in a modern couple are more likely to work in the private sector (38%, in 2003) than women who are in a traditional couple (33%). At the same time, the share of modern women employed in the public sector (56%) is lower than the share of traditional women (63%). Since the balance between work and the family can be more difficult in the private sector than in the public sector, this could explain why modern women are also more likely to leave the labour market after the arrival of a child (Table 2).

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Table 2 Classification of women by working status and gender attitudes in 2003(percentages)

	Women's working status		
Attitudes:	*% Unemployed*	*% Employed*	*% Total*
Traditional couples	42.61%	57.39%	100.00%
Modern couples	30.28%	69.72%	100.00%
Total	38.39%	61.61%	100.00%

Women who have left the work after transition to motherhood in the period 2003-2007

Attitudes:	*%*
Traditional	16.21%
Modern	22.22%
Total	18.18%

Table 3 Weekly hours in paid and unpaid work by attitudes

		Women's hours		*Men's hours*	
	Attitudes:	*Paid labour*	*Domestic labour*	*Paid labour*	*Domestic labour*
2003	*All couples*	19.9	35.8	42.1	7.4
	Traditional	18.6	36.6	42.3	7.1
	Modern	22.5	34.3	41.7	8.1
2007	*All couples*	19.6	31.7	41.9	13.4
	Traditional	18.3	32.0	42.1	12.9
	Modern	22.2	31.1	41.5	14.5

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3.4 The model specification

To estimate the effect of the arrival of a baby on the division of labour, a longitudinal model using a Difference-in-Difference (*DID)* specification is adopted. Moreover, to account for the unobserved bargaining process and for endogenous fertility, the *DID* specification of simultaneous equations model of paid and unpaid labour is applied and the error terms are specified as in a *SUR* model (cf. Caltabiano et al. 2016; Campolo et al. 2016a, 2016b). The stochastic specification of the error terms is shown in the Appendix in detail.

In order to account for censoring in dependent variables (paid work is observed on employed subjects only), a more advanced version of the *SUR* model, known as the Seemingly Unrelated Tobit Regression (*SUTR*) model, is here applied. Using the *SUTR* estimation procedure, one or more equations can be censored in terms of their dependent variable. This procedure is used, among others, by Perali and Chavas (2000) for cross-sectional data, while it

is applied by Meyerhoefer et al. (2005) to a longitudinal panel dataset with repeated observations on the same subject over time.

A three-stage procedure is implemented. At a first stage, both censored and uncensored equations are estimated in a reduced form. At this stage, an *OLS* estimator is used for the non-censored equations and a heteroscedastic Tobit estimator is used for the censored equations. At the second stage, to account for restrictions imposed on the error terms, the covariances of the disturbances are estimated using the residuals obtained from the first-stage regressions. This allows us to incorporate the non-zero constraints on the covariance matrix of the error terms using the first-stage residuals. In this way, restrictions on the covariances between the equations and on the covariances between repeated observations over time can easily be incorporated in the estimator at the second stage of the estimation procedure[4]. In particular, the incorporation of restrictions on covariances between repeated observations over time leads us to assume that changes in paid and unpaid labour depend on reproductive behaviour. In other terms, in our model we control for endogeneity of fertility.

A further significant advantage of using *SUTR* is that this procedure is computationally feasible. In addition, the efficiency of estimates can be improved by implementing an iterative procedure for the second and third stage.

We model simultaneously four equations referring to both partners' domestic and work hours in a *SUTR* model, such as the following:

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

[4] The use of a residuals-based estimation of covariances is also suggested by Wooldridge (2010) in order to obtain the weighting-matrix generally used in the *GMM* estimator.

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

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

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

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The dependent variables, given by the paid work and domestic work of women (Eqs. 1-2) and by the paid work and domestic work of men (Eqs. 3-4), are measured as a logarithm of weekly working hours. Paid work hours are indicated by L (labour) and unpaid domestic hours are indicated by D (domestic). The indexes i and t refer respectively to the i-th individual and to time t (0, 1). The indexes w and m refer to women and men. The dependent variables are surveyed on the same subject at the first time period, $t = 0$, and at the second time period, $t = 1$. Note that the dependent variables of Eqs. (1) and (3) are observed only for subjects who are employed, while the dependent variables of Eqs. (2) and (4) are uncensored.

On the right side of each equation, Greek letters refer to parameters. Namely, α is a coefficient measuring the impact of "being a parent", the latter variable represented by the time invariant dummy *birth* equal to one if the subject becomes a parent between 2003 and 2007. The variable $t \cdot birth$ is a (time varying) dummy that signals if status has changed in year 2007 compared to 2003. δ represents the *DID* coefficient and the product $\delta \cdot t \cdot birth$ represents the *DID* effect, measuring the difference between parents and non-parents in the effect of time on the labour supply. For example, the *DID* effect represents the difference in the change over time of work hours for the subjects who experienced the transition to parenthood and for those who did not experience parenthood (population-average coefficients). λ is the coefficient of time. The sum of δ and λ (the *DID* coefficient and the time coefficient) measures the impact of

the transition to parenthood on the parents' paid and unpaid labour (subject-specific coefficients).

If we consider the dummy variable $t \cdot birth$ whose coefficient is δ, the percentage impact of this variable on the logarithm of working time is the exponential term $[\exp(\delta)-1]$. This term measures the population average effect in percentage terms. In addition, we can evaluate, only for those who become parents during the period of observation, the impact of this transition in percentage terms (subject-specific effect in percentage) as $[\exp(\lambda+\delta)-1]$ (see Greene 2012; Wooldridge 2010).

We estimate the effects of the transition to parenthood by using three samples. First, taking into consideration couples with or without children in 2003 (791 couples), we focus on the transition to parenthood, whatever the parity, and its effects on the partners' labour supply. This sample concerns 165 couples in total, including 35 couples that had two or more children between 2003 and 2007. Second, by considering couples without children in 2003 (112 couples), we focus on the transition to the first birth (53 couples). Third, considering couples with one child in 2003 (302 couples), we estimate the effect of transition to a second-order birth (77 couples).

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4 Results

Table 4 presents the results of our model by measuring the effect of transition to parenthood on partners' paid and unpaid work, accounting for endogenous fertility and the misspecification of latent variables. We firstly estimate the effect of the transition to parenthood for all the couples, whatever their attitudes (Table 4). Second, we stratify the analysis for traditional and modern couples, and report the estimates of the *DID* coefficient in Table 5. Third, considering couples without children and couples with one child in 2003, we

focus, respectively, on the transition to the first child and to the second child to look at the effect on partners' paid and unpaid work (Table 6).

As for the sample size, the results reported in table 5 were obtained using a subsample of 1,258 individuals for traditional couples, and a subsample of 654 individuals for modern couples. Moreover, we have two observations for each subject, in 2003 and in 2007. The subsamples' size is in our opinion sufficient to analyse the modification effect of attitudes on the relationship between parenthood and the allocation of work between partners.

With regards to the results of estimates reported on the table 6, the subsample that refers to the transition to the first birth is small. However, this is a common shortcoming of most panel data on family dynamics. Moreover, despite the sample size, the significance of results for the transition parameters (most often $p<0.001$) make us confident of the robustness of our conclusions.

Table 4 Effect of the birth of the child on couples' division of paid and unpaid labour - Estimates of the *SUTR-DID* model

Dependent variable (log):	*Women*				*Men*			
Weekly working hours	*Paid*		*Unpaid*		*Paid*		*Unpaid*	
Sample size: No 1912	*coeff.*	*p*	*coeff.*	*p*	*coeff.*	*p*	*coeff.*	*p*
constant	-2.16	***	4.77	***	-1.1	*	3.57	***
CONTROLS								
Age[a]	0.07	*	-0.07	*	0.21	***	-0.12	**
Age^2 [a]	0.001		0.001		-0.001	***	0.001	***
Education - years of schooling at 2003 [b]	0.08	***	-0.04	***	0.02	***	0.02	**
Urban at 2003 (1=yes) [b]	-0.06	*	-0.05		-0.03		0.04	
Help received for domestic and caring activity (1=yes) [a]	0.19	***	0.001		0.01		0.28	***
Marital status (1=Married) [a]	-0.16	*	0.22	**	-0.02		-0.28	*
Area (1=South and Islands) [b]	-0.22	***	0.16	***	-0.17	***	-0.15	***
Number of children at 2003 [b]	-0.20	***	0.19	***	0.001		0.07	*
log (real) hourly wage[a]	0.04	**	-0.02		0.07	***	0.04	
t (time: 0=2003;1=2007)	-0.04		-0.09	**	0.06	*	0.52	***
Transition to parenthood (no. 956 couples; no. 1912 subjects; no. 165 transitions)								
Birth (transition to parenthood between waves)[b]	0.04		-0.09		0.07		0.24	**
t · Birth (DID coefficient)	-0.16	*	0.38	***	-0.12	*	-0.08	
D_cluster traditional	-0.23	***	0.08	**	0.05		-0.06	

R^2 (only for *OLS* estimated equations)	0.17	0.11

Note:[a] Time Varying; [b] Time Invariant; p-value = * p<0.05; ** p<0.01; *** p<0.001

Table 5 Effect of the birth of the child on couples' division of paid and unpaid labour - Estimates of the *SUTR-DID* for TRADITIONAL and MODERN couples

	Traditional Couple[a]				*Modern Couple*[b]			
Dependent variable (log):	*Women*		*Men*		*Women*		*Men*	
Weekly working hours	*Paid coeff.*	*p*	*Unpaid coeff.*	*p*	*Paid coeff.*	*p*	*Unpaid coeff.*	*p*	*Paid coeff.*	*p*	*Unpaid coeff.*	*P*
t (time: 0=2003; 1=2007)	0.60***		0.31***		0.08**		0.52***		0.33***		0.28***		-0.04		0.49***	
Birth (transition to parenthood between waves)	0.30***		0.12***		0.06		0.18*		0.12		0.11***		0.10		0.22	
t · Birth (DID coefficient)	-0.40***		0.09***		-0.13*		0.00		-0.59***		0.07*		-0.07		-0.19	
R^2 (only for *OLS* estimated equations)			0.74				0.17				0.66				0.19	

Note: [a] Subsample: no. 629 couples; 1,258 subjects; 111 transitions); [b] Subsample: no. 327 couples; 654 subjects; 54 transitions; p-value = * p<0.05; ** p<0.01; *** p<0.001

Table 6 Effect of the birth of the child on couples' division of paid and unpaid labour - Estimates of the *SUTR-DID* model considering transitions to a first or second order birth

	Transition to first birth[a]				*Transition to second birth*[b]			
Dependent variable (log):	*Women*		*Men*		*Women*		*Men*	
Weekly working hours	*Paid coeff.*	*p*	*Unpaid coeff.*	*p*	*Paid coeff.*	*p*	*Unpaid coeff.*	*p*	*Paid coeff.*	*p*	*Unpaid coeff.*	*p*
T (time: 0=2003; 1=2007)	0.36***		0.26***		0.10		0.26*		0.22***		0.30***		0.09*		0.52***	
Birth (transition to parenthood between waves)	0.46***		-0.03		0.04		0.01		0.07		0.16***		-0.05		0.21	
t· Birth (DID coefficient)	-0.71***		0.27***		-0.24*		0.16		-0.22**		0.12***		-0.22**		0.08	
Score Gender attitudes at 2003	0.13*		-0.17***		-0.09		-0.13		0.06		-0.04***		0.14***		-0.07	
R^2 (only for *OLS* estimated equations)			0.88				0.20				0.62				0.18	

Note: [a] Subsample: no.112 couples; no. 224 subjects; no. 53 transitions; [b] Subsample: no.302 couples; no. 604 subjects; no. 77 transitions; p-value = * p<0.05; ** p<0.01; *** p<0.001

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4.1 Comparing those who had a child to those who did not

In order to interpret the results of the transition to parenthood, we consider the coefficient δ of the variable *Birth·t* in the woman's paid work equation (all orders of birth). This is the *DID* coefficient and is equal to -0.16 (Table 4). The effect of the birth of a child on the woman's paid work is significant and equal in percentage terms to -14.8% (equal to 100·[exp(-0.16)-1], see Table 7). This means that, on average, women who have a child between the two waves see a decrease in hours of paid work of 14.8% compared to women who have no child. When we consider the woman's unpaid work equation, the effect of a birth is statistically significant and equal to 46% (100·[exp(0.38)-1], see Table 7). This means that women who have a child between the two waves increase their domestic work by 46% compared to women who do not have a child.

We then consider the effect of transition to parenthood on a woman's paid work by attitudes and by birth order. In Table 7, the negative effect of having a child on a woman's paid work is confirmed when considering a specific order of birth, and it is especially strong for the transition to the first child. When stratifying the analysis by attitudes, the reduction of a woman's paid labour appears to be greater in modern than in traditional couples (Table 7). Figure 2a shows that, in modern couples, a woman reduces her paid labour by 11 hours a week after the birth of a child, while in traditional couples the reduction is 7 weekly hours. These are unexpected results. One explanation may be related to the fact that traditional women are more likely to work in the public sector (see, above, Sect. 3.2). In Italy, women employed in the public sector who become mothers enjoy greater protection and have more flexible conditions than in the private sector. In line with this, we see in Table 2 that the risk of leaving the labour market after the birth of a child is higher for women who work in the private sector (Table 2).

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When comparing men who have a child to men who do not have a child in Table 7, results are more ambiguous and are rarely statistically significant (for significance, see Tables 4-6). Interestingly, fathers having their first child decrease their labour time compared to childless men in the survey period (on average -21%, $p<0.05$). Conversely, those who are parents for the second time in the survey period increase their paid labour compared to fathers remaining with one child (+9%, $p<0.001$).

In order to verify the effect of endogeneity, we compare estimations obtained with the correction strategy and estimations obtained without the correction. First, significant results are observed only after correction for endogeneity (Table 7). Second, the difference in the magnitude of the two estimations is notable (Table 7 and Figure 2a and 2b). In particular, we observe that with the correction, the increase in women's domestic hours after the birth of a child is less accentuated. With the correction strategy, traditional women show an increase of 3 hours per week instead of 14 hours without the correction (Figure 2a and 2b). Modern women exhibit an increase of 3 hours instead of 16 hours (Figure 2a and 2b). As for men, the correction for endogeneity allows us to identify a higher decrease in paid labour after the birth of the first child. With the correction, their paid labour weekly hours decrease by 21.3 percent (-8.8 weekly hours) instead of -8.6 percent (-3.6 weekly hours) without correction (Table 7). At the birth of the second men's paid labour increases once we account for endogeneity: +9.4 percent of weekly hours (+ 4 hours) instead of -11.3 percent (-4.8 hours weekly hours) without the correction (Table 7).

Table 7 – Change in percentage of paid and unpaid labour. ***DID* effect** [exp(δ)-1]:

a) Applying correction for bargaining and endogenous fertility:

	Women		*Men*	
	Paid labour	*Unpaid labour*	*Paid labour*	*Unpaid labour*
All couples	-14.8 *	46.2 ***	-11.3 *	-7.7
Traditional	-33.0 ***	9.4 ***	-12.2	0.0 *

Table 7 – continued

Modern	-44.6	***	7.3	*	-6.8		-17.3	
First birth	-50.8	***	31.0	***	-21.3	*	17.4	
Second birth	-19.7	***	11.6	***	9.4	***	6.2	

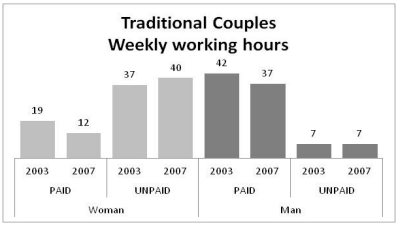
b) Without correction:

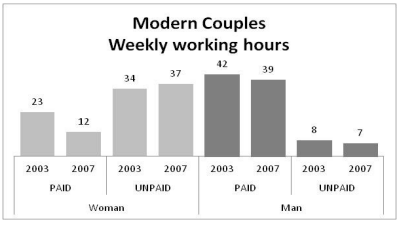
	Women		*Men*	
	Paid labour	*Unpaid labour*	*Paid labour*	*Unpaid labour*
All couples	-42.3	43.3	-7.7	-6.8
Traditional	-38.1	40.5	-9.5	-4.9
Modern	-49.3	44.8	-3.0	-11.3
First birth	-63.2	76.8	-8.6	13.9
Second birth	-39.3	36.3	-11.3	0.0

Note: p-value = * p<0.05; ** p<0.01; *** p<0.001

Fig. 2 Weekly working hours (paid and unpaid) for traditional and modern couples who experienced parenthood transition

a) Applying correction for bargaining and endogenous fertility:





b) Without correction :

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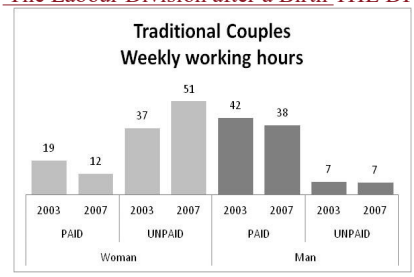

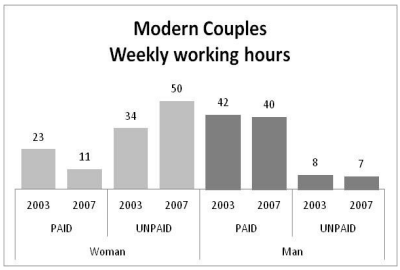

5 Conclusions

In this study, we aimed to provide a method that ensures robust estimates of the effect of transition to parenthood on partners' division of labour. Our starting point is that the effect of latent factors, such as endogenous fertility and bargaining, on the relationship of interest is not completely specified in previous studies. The residual-based correction of the *SUTR* method allows us to account for the misspecification caused by latent variables. In particular, contrary to an approach using the sex of a previous child as an instrument (Carrasco 2001), we can correct for endogeneity of fertility already for the transition to the first child. We showed that our results are consistent with those that would be achieved using the IV approach. In addition, estimates obtained by our SUR method appear more significant and generally less sensitive to change in the specification of the regressors set.

As for the influence of latent bargaining process between partners, a cluster-based classification of couples was provided to identify the influence of gender and family beliefs on the partners' division of labour. Our couples were classified as traditional or modern on the base of an attitudes score index, referring to gender and family attitudes and the frequency of disagreement with partners about the division of household labour. Our stratification strategy based on the attitudes score index allowed us to evaluate the effect of transition to parenthood for traditional and modern couples.

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Our approach to the correction for latent factor influence allows us to obtain interesting innovations compared to the findings of previous studies on the effect of fertility on labour division. In particular, our *first hypothesis* was partially supported by our results. The transition to the first child produces for women a decrease in paid labour and an increase in domestic labour. No significant results were observed for men. This result is in line with Sanchez and Thomson's (1997) findings for U.S. and Baxter et al. (2008) for Australia. According to doing gender theory, the birth of a child could increase the saliency of gender stereotypes and affect the division of labour, which becomes more traditional (Baxter et al. 2008). Our results show that the birth of the first child has a stronger effect on woman's paid and unpaid labour than the birth of the second child, also supporting our first hypothesis. This result is also consistent with the doing gender theory, as norms about being a good mother/father should produce their effects on the division of labour especially when becoming a parent for the first time. However, in opposition to our first hypothesis, the arrival of the first child does affect man's paid labour: on average, Italian men decrease their paid labour time by 21%. Men working many hours may decide to reduce their labour time with the arrival of the first child and be more present (but without affecting the amount of unpaid family labour). This result was accentuated when we applied our correction strategy for endogeneity. Note that compared to Sanchez and Thomson's study, obtaining no results for men, we are referring here to cohorts of the youngest men, which could explain our results.

Also, in line with our first hypothesis, the arrival of the second child increases men's labour time. This result appears when our correction strategy is applied. Sanchez and Thomson (1997) found a 3 hours per week increase in men's paid labour. We also found a 9 percent increase, corresponding to about 3 hours for a man working 40 hours per week. Our DID effects

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shows that fathers of two children work more than other men. Thus, the second child increases an already high amount of hours.

In our *second hypothesis*, we stated that women in traditional couples are more affected by the birth of the child than women in modern couples, and we assume a larger decrease in their labour time and a larger increase in their domestic time. This hypothesis was only partially supported. As expected, after the birth of a child, women belonging to traditional couples increase their unpaid labour more than women in modern couples. However, we obtained unexpected results as ~~to~~ paid labour of women in modern couples was more negatively affected than~~: the~~ paid labour of women in traditional couples ~~is more affected than the paid labour of women in modern couples~~. These results can be partly explained by the fact that women in modern couples work more hours in the labour market than women in traditional couples (Table 3), thus making it more difficult to reconcile family and work. Moreover, a higher proportion of women in traditional couples are employed in the public sector (Table 2). As they work in a less competitive and more flexible environment, they can more easily reconcile work and family. This assumption is ~~confirmed~~ supported by our descriptive results showing that women who left employment after the birth of a child are mostly in modern couples (Table 2).

One can wonder how it happens that more traditional women are more often employed in public sector. The explanation can be twofold. Firstly, i~~I~~n the Italian context, characterised by a limited state support for families, women with traditional attitudes might intentionally choose the public sector in order to have a better balance between the family and the professional life. ~~But why should these traditional women increase their working time? Our positive effect can detect an increase of working time hours during the period of observation accompanied by the birth of a child. Women who benefit from a promotion or improvement~~

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~~from temporary to permanent job may decide to have a child.~~ This choice may occur even before forming a family. In other terms, family and traditional roles are perceived as a "likely destiny" (Froidevaux-Metterie 2015). Secondly, in Southern regions of Italy, in 2017, 40 percent of the employed are in the public sector, compared to 24 percent in Northern regions (Frattola 2018). At the same time, Southern regions are also characterized by more traditional gender attitudes, as shown by Bozzano (2017). Thus, our result may be determined by traditional women residing in Southern countries and employed in public sector. Our findings appear consistent with previous studies on the Italian regional differences in the welfare system. Saraceno (1994) observed that in Center-North regions, where women's movement in the seventies and eighties succeeded in promoting women's interests at the local government level, the social services provision for children are more developed. This explains why, for women who want to enter the labour market, public employment may be more strategic in Southern than in Northern regions.

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To conclude, what can we say about the gender gap in Italy? Women do more than men in the household, while men do more in the labour market; nevertheless, the total workload is higher for women than for men.

Our analysis confirms that the gender gap in unpaid work weekly hours increases after the birth of the child. With our estimation strategy correcting for endogeneity of fertility, the gender gap in unpaid work is 3 hours per week for modern couples and 8 hours for traditional couples. Interestingly, our correction strategy seems to show that the gender gap is less important in Italy than previously shown (Craig and Mullan 2010). Indeed, our estimation strategy corrects for reverse causation, i.e. the effect of paid and unpaid work hours on childbearing, avoiding a potential overestimation of the transition-to-parenthood effect on work.

Our results refer to years 2003 and 2007 and should probably apply with caution to Italian society of more recent years, which might have progressed towards a greater gender equity. However, this hypothetical scenario seems not confirmed by data. OECD statistics show that, in 2014, Italian female labour participation and maternal labour force participation are still among the lowest in Europe. Moreover, if OECD data show an important increase in the 0-2 years old childcare enrolment rates between 2012 and 2016, until 2015 this positive trend was recovering the level preceding the 2008 economic crisis. Following this evidence, the gendered Italian familism appears still alive and kicking.

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Appendix 1

Correction of estimates for the influence of latent bargaining process and endogenous fertility: specification and implementation in the estimation procedure

In order to incorporate specific constraints on the covariances "between individuals" and "across time" in the estimation procedure, we use the residuals, $\hat{u}_i$, of the *OLS* (uncensored) regressions of Eqs. (2) and (4) and of the *Tobit* (censored) regressions of Eqs. (1) and (3), which we run separately at the first stage. Then, the second stage residuals, $\tilde{u}_i$, are estimated by *OLS* and using the first-stage residuals. In particular, four regressions are estimated for men and women and for paid and unpaid labour. To better clarify the second step of our estimation procedure, let's consider, as an example, the following Eq. (5), in which the dependent variable is given by the residuals of the equation (1):

$$\tilde{u}_{Lwti} = \tilde{\phi}_{Lw1}\hat{u}_{Dwti} + \tilde{\phi}_{Lw2}\hat{u}_{Lmti} + \tilde{\phi}_{Lw3}\hat{u}_{Dmti} + \sum_{j=1}^{5} \tilde{\rho}_{Lwj}\hat{u}_{jti} \qquad (5)$$

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 referring to the same observation (or the same subject). The suffix j corresponds to five groups of couples identified according to the number of children and the gender composition of the groups of children (see below).

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The predicted values $\hat{u}_{Lwti}$ of Eq. (5) are obtained from the *OLS* regression of the residuals $\hat{u}_{Lwti}$ of Eq. (1) on the residuals of Eqs. (2), (3) and (4) and on the "restriction-effects", $\hat{u}_{jti}$, specified as follows:

$$\hat{u}_{jti} = \underset{n\times 1}{\begin{bmatrix} \hat{u}_{1ti} \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}} ; \underset{n\times 1}{\begin{bmatrix} 0 \\ \hat{u}_{2ti} \\ 0 \\ 0 \\ 0 \end{bmatrix}} ; \underset{n\times 1}{\begin{bmatrix} 0 \\ 0 \\ \hat{u}_{3ti} \\ 0 \\ 0 \end{bmatrix}} ; \underset{n\times 1}{\begin{bmatrix} 0 \\ 0 \\ 0 \\ \hat{u}_{4ti} \\ 0 \end{bmatrix}} ; \underset{n\times 1}{\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \hat{u}_{5ti} \end{bmatrix}} \qquad (6)$$

where $\hat{u}_{jti} = \hat{u}_{1ti}, \ldots, \hat{u}_{5ti}$, are the residuals obtained by the first-stage regressions of the corresponding repeated observations over time. In Eq. (6) the first column corresponds to the first restriction-effect, and includes residuals only in correspondence of the subjects who had one child (male or female) before the year 2003, while zero is included elsewhere. The second column corresponds to the second restriction-effect, and has over-time residuals for subjects who had two sons before the year 2003. The third column reports over-time residuals only in relation to the subjects who had two daughters before the year 2003. The fourth column reports over-time residuals only in relation to subjects who had no child before the year 2003. In the fifth column, over-time residuals in relation to the remaining subjects are included. The estimated covariances between equations and over-time are incorporated in the estimated *OLS* coefficients $\tilde{\phi}$ and $\tilde{\rho}$ as in the well-known second-order moments relationships.

Then we use these second-stage estimated residuals - explained by the residuals of other equations and by the fixed effects over time - to compute the following dependent variables corrected for the unobservable latent variables that are assumed to be common to the four paid and unpaid work equations:

$$\ln\tilde{L}_{wti} = \ln L_{wti} - \tilde{u}_{Lwti}; \qquad \ln\tilde{D}_{wti} = \ln D_{wti} - \tilde{u}_{Dwti};$$

$$\ln \widetilde{L}_{mti} = \ln L_{mti} - \widetilde{u}_{Lmti}; \quad \ln \widetilde{D}_{mti} = \ln D_{mti} - \widetilde{u}_{Dmti} \qquad (7)$$

At a third stage, we substitute the corrected dependent variables (7) into Eqs. 1-4, and run *OLS* and *Tobit* regressions. To improve the efficiency of estimates, the residuals obtained at the third stage are used to iterate the procedure until the estimated coefficients converge.

Note that, using our correction method by imposing constraints on the covariances, the effect of the correction is extended to all groups of women, unlike the *IV* approach where the effect of fertility, "instrumented" by the information on the sex of previous children, is estimated only for women with at least one or two children (see the discussion reported, above, in Sect. 2.2 and in Appendix 2).

Appendix 2 - Some Methodological Aspects of the SUR Approach

The *SUR* estimator, as that adopted in this study performing a *FGLS* (Feasible Generalized Least Square) procedure, is generally considered more efficient than the corresponding *OLS* estimator applied to each equation separately, if the correlation between the disturbances across the equations is high or, at least, moderate (see, among others, Srivastava and Giles, 1987, pp.70-71). The gain in efficiency using *SUR*, however, could be nullified if conditions for inconsistent estimates occur. One thing to remember, to this regard, is that the *FGLS–SUR* estimator is consistent only if the explanatory variables in each equation are not correlated with the errors in each equation. This means that if the specification of, say, the first equation suffers for omitted explanatory variables or for measurement errors, this affects also for inconsistency the estimates of the other equations. This implies that the problems due to misspecification may be amplified performing *FGLS-SUR*. In the case of our model, for example, if only one among the explanatory variables (self-reported measures, in particular) is observed with bias, or if a relevant variable is omitted in only one among the equations, the *SUR* estimates of all the equations may be affected by inconsistency.

In practice, the SUR approach may perform better than other estimators only if the surveyed data used for the analysis allow a correct specification of the model.

An important aim of this study is the correction of the endogenous effect of fertility on the estimation of the time devoted to work. In particular, in order to prevent the reverse causality effect of the time devoted to work on fertility, we suggest to impose, performing a *SUR* estimation, specific constraints on the covariances of the error terms between the two

periods of survey. This method to correct the endogeneity effects of fertility is an alternative to the instrumental variables approach, in which the variable measuring the effect of the transition to parenthood is instrumented using, in a Two-Stage *IV* procedure, exogenous instruments such as dummy variables signalling the sex of previous children (Carrasco 2001).

We showed above in Sections 2.2. and 2.5 and in Appendix 1 that the preference, of a couple, for a balanced set of sons and daughters can be implemented both as an exogenous instrument in the *IV* approach and as an appropriate constraint on the covariances in a *SUR* model. In addition, we explained that a limitation of the *IV* method lies in the impossibility of deriving instruments given by the "sex of the previous children" if not excluding the couples without children from the sample. Conversely, the *SUR* method can be applied without limitation to the sample composition. This aspect, by itself, should make the *SUR* approach preferable because it can be applied with generality and without any loss of information.

However, in order to compare the robustness of both methods, it is convenient to check the extent to which the coefficients measuring the impact of the transition to parenthood change if a correction for endogeneity is introduced, respectively, using *IV* or a constrained *SUR* approach. In this regard, we hypothesize that the estimates of the coefficients of the dummies *t*, *birth* and *t*birth* (*DID* coefficients) should not vary greatly by applying the two methods to the estimation of the effect of the birth of a second child on both paid work and domestic work. Considering the specific transition to a second-order birth, a better specification of both models is obtained by introducing the age of the first child as an instrument in the IV model, and as a further covariate in the *SUR* model.

In order to estimate the transition to a second-order birth using the *IV* approach, a Two-Stage Least Squares (*TSLS*) estimator is adopted if the dependent variable is not censored, such as in the case of the unpaid work equations of both partners. If the dependent variable is

censored, such as in the woman and man's paid work equations, a Two-Stage *IV*-Tobit is performed. In both cases, the variable measuring the fertility behaviour of the couple is given by the dummy "birth", equal to one if the couple (with one child) experienced the birth of a second child during the period of survey

Note that, despite the circumstance that the endogenous variable, *birth*, is a dummy, we use a standard least squares estimator at a first stage. This choice is justified by the fact that the interpretation of results is more straightforward (Hellevik 2009; Arpino et al. 2014), and tests on the *IV* estimates can be easily implemented.

We instrumented the variable birth by adopting, as instruments, alternatively, the sex and age of the first child, by estimating two distinct models (indicated as *IV*1 and *IV*2, respectively). A third model (*IV*3) is also estimated using both instruments and supported by specific tests for overidentification and validity of instruments. The *SUR* model indicated as *SUR*1 does not incorporate correction for the sex of the first child, the model *SUR*2 incorporates the correction for the sex of the first child and the age of the first child as a covariate, while the model *SUR* 3 incorporates only the correction for the sex of the first child.

Tables 8 and 9 report the estimated *DID* coefficients of the transition to the second birth and the coefficient measuring the impact of gender attitudes, obtained adopting both *IV* and *SUR* estimators. In general, the estimated coefficients of the dummy *t*birth* denote a modest variation moving from the *IV* estimator to the *SUR* estimator, without reporting +/- inversions. More marked differences are reported by the coefficients of the other variables. Note that the coefficients estimated by *SUR* are generally more significant than *IV*'s.

The results of the *IV* estimation and test statistics show that the contribution of the sex of first child as an instrument is not particularly significant. Conversely, significant differences

in the paid work of both partners are obtained by performing the *SUR* method with correction for the sex of the first child.

Table 8. Effect of the birth of the child on unpaid labour of women and men – Comparison between *SUTR-DID* and *IV* approach considering transitions to a second order birth

Dependent variable (log):	*Domestic work of women*						*Domestic work of men*					
Weekly working hours	*SUR-DID* 1	*SUR-DID* 2	*SUR-DID 3*	*IV*1	*IV*2	*IV*3	*SUR-DID* 1	*SUR-DID* 2	*SUR-DID 3*	*IV*1	*IV*2	*IV*3
	coeff. p	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*	*coeff. p*
t (time: 0=2003;1=2007)	0.30***	0.27***	0.30***	-0.14*	-0.16*	-0.16*	0.59***	0.47***	0.52***	0.58***	0.53***	0.53***
Birth (transition to parenthood between waves	0.16***	0.11***	0.16***	3.42	0.24	0.26	0.23	0.16	0.21	5.22	1.18**	1.18**
t · Birth (DID coefficient)	0.11***	0.12***	0.12***	0.31*	0.31**	0.31**	0.06**	0.07	0.08	0.002	0.01	0.01
Score Gender attitudes	-0.04**	-0.05***	-0.04***	-0.06	-0.07	-0.07	-0.07***	-0.07	-0.07	-0.03	-0.04	-0.04
Age of the first child		-0.02***						-0.05***				
Instrumental variable:												
Birth *Instruments:*												
Sex of the first child (Dummy: male=1)				-0.02		-0.03					-0.02	-0.03
Age of the first child					-0.04***	-0.04***					-0.04***	-0.04***
const				0.28***	0.44***	0.49***				0.28***	0.44***	0.49***
Overidentification Chi^2 test (dof=1) (*)					71.03***						64.75***	
Weak instruments *F*-test (dof= 2) (**)					4.01**						4.86**	

Note: Subsample: no.302 couples; no. 604 subjects; no. 77 transitions; p-value = * p<0.05; ** p<0.01; *** p<0.001. (*) H_0: No overidentification. (**) H_0: Instruments are weak

Table 9. Effect of the birth of the child on paid labour of women and men – Comparison between *SUTR-DID* and *IV* approach considering transitions to a second order birth

Dependent variable (log):	*Paid work of women*						*Paid work of men*					
Weekly working hours	*SUR-DID* 1	*SUR-DID* 2	*SUR-DID* 3	*IV*1	*IV*2	*IV*3	*SUR-DID* 1	*SUR-DID* 2	*SUR-DID* 3	*IV*1	*IV*2	*IV*3
	coeff. *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*	*coeff.* *p*
t (time: 0=2003;1=2007)	0.22 ***	0.58 ***	0.56 ***	-0.12	-0.11	-0.12	0.09 ***	0.08 **	0.07	7.02	0.06	0.06
Birth (transition to parenthood between waves	0.07	0.35 ***	0.41 ***	-12.18	-0.10	-0.08	0.05	0.01	0.02	0.07	0.25	0.22
t · Birth (DID coefficient)	-0.22 **	-0.48 ***	-0.47 ***	-0.59	-0.60	-0.59	-0.22 **	-0.12 **	-0.12	-0.11	-0.11	-0.11
Score Gender attitudes	0.06	0.07	0.06	-0.17	-0.17	-0.17	0.14 ***	0.04 ***	0.04	0.06	0.06	0.07
Age of the first child		-0.01						-0.01				
Instrumental variable:												
Birth *Instruments:*												
Sex of the first child (Dummy: male=1)				-0.02		-0.03				-0.02		-0.01
Age of the first child					-0.04 ***	-0.04 ***					-0.04 ***	-0.02 ***
const				0.28 ***	0.44 ***	0.48 ***				0.28 ***	0.44 ***	0.47 ***
Overidentification Chi^2 test (dof=1) (*)					3.81						9.60 *	
Weak instruments *F*-test (dof= 2) (**)					4.01 *						4.86 **	

Note: Subsample: no.302 couples; no. 604 subjects; no. 77 transitions; p-value = * p<0.05; ** p<0.01; *** p<0.001. (*) H_0: No overidentification. (**) H_0: Instruments are weak

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