Can you do the dishes?
Intra-household time use and division of labor

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Across the world, women carry out a larger share of housework compared to men, which can negatively affect both fertility and women's career. The time allocated to housework depends on spouses' comparative advantage, on the competing uses of time, and long-term, personal or external factors that have often been unobservable in the data. Using detailed time use data from Italy, I introduce a new dynamic life-cycle model of marriage, employment and fertility, where individuals choose their time allocation to formal work, housework, and leisure. The key contribution of the model is that it can estimate to what extent each of these factors, including gender-specific home productivity, determine differences in housework among spouses. The model estimates that men are about one fourth as home-productive as women. In a counterfactual exercise, a zero gender wage gap paired with free, perfectly available nursery schools, increases fertility to 2.2 (+56.1%) children per woman and married women's employment rate to 0.57 (+15.6%). If men were as home productive as women, the results would be 2.55 (+81%) and 0.98 (+99.8%) respectively. I also simulate the transition after increasing nursery school availability to 33%: 3 and 9 years after the policy, respectively, fertility increases by 1.8% and 6.1%, married women's employment increases by 2.8% and 3.4%, and tax revenues increase by 0.11% and 0.17%.

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1 Introduction

Within the household, cohabiting partners[1] choose the amount of time they devote to housework, like chores and family care,[2] and to a formal job outside the home. All across the world, women carry out a larger share of housework compared to men: in Italy, the focus of this paper, the difference amounts to over 3 hours per day.[3] This can decrease women's labor market participation on both the extensive and intensive margin, access to professions where time flexibility is highly rewarded, and total realized fertility.[4]

The time allocated to housework depends not only on spouses' comparative advantage, but also on the fact that time is limited and it has other competing uses in formal jobs and in leisure. Moreover, the optimal allocation of time to productive activities also responds to external factors like the gender pay gap and the availability of nursery schools for parents, to long-term factors like unilateral divorce, limited commitment among spouses and unemployment and motherhood penalties, and to personal factors like a taste for tidiness and traditional gender norms. Hence, employment and leisure are intertwined with housework time choices. However, despite its importance, there is less quantitative evidence on housework time choice, both because of lack of data and difficulty in disentangling unobservable factors.[5]

In this paper, I propose a dynamic life-cycle model of marriage, employment and fertility, where individuals choose their time allocation among competing uses: housework, formal work and leisure. The key contribution and advantage of the model is that it can estimate to what extent each of those external, long-term and personal factors determine gender differences in housework, and what is instead due to productivity differences. To do this, I use a restricted-access version of the time use survey by ISTAT, the Italian national statistical bureau, which provides a detailed real-time diary of daily activities in 10-minute intervals for a nationally representative sample of households in the years 2002, 2008, and 2013.[6] Importantly, the survey directly asks respondents about their job-search activity and reasons for joblessness, their opinions on gender norms in the household, their beliefs about male housework productivity, and their taste for tidiness.

I start by presenting a number of stylized facts that the model has to reproduce and explain. First, marriage is associated with higher housework specialization for women and the opposite for men, whereas there is little difference in employment between men and women

[1] Since this research focuses on heterosexual couples, in the remainder of the paper I will refer to partners as husband and wife or men and women. I will also equate stable cohabitation to marriage.

[2] Throughout the paper, unless otherwise noted, the term housework includes all forms of unpaid work related to household production.

[3] Source: ISTAT Time Use Survey 2013.

[4] For reviews see, for instance, Goldin (2014), Carta, De Philippis, Rizzica, and Elena (2023) and Doepke, Hannusch, Kindermann, and Tertilt (2023).

[5] A few notable recent exceptions are Goussé, Jacquemet, and Robin (2017), Cubas, Juhn, and Silos (2022), Erosa, Fuster, Kambourov, and Rogerson (2022), and Calvo, Lindenlaub, and Reynoso (2024).

[6] The 2023 survey will be added to the project when it is released.

when they are single or divorced.[7] Second, among cohabiting or married couples, women always do more housework regardless of their employment status[8] and, when they work, they have less leisure time.[9] Third, in the presence of children, the degree of specialization within the household also increases, with women taking up a larger share of housework and men doing more formal work.[10] Fourth, the main factor that correlates with gender difference in housework is the employment status of both spouses, but traditional gender values and taste for tidiness have moderate relevance as well.

Then, I introduce the model, which is based on the principle of household specialization as in Becker (1981). The main intuition is that household members pick their level of specialization depending on their comparative advantage in each sector. Even if husband and wife have the same formal work productivity, since the wife is assumed to be more productive in the household sector, she will specialize relatively more in household production. Individuals receive utility from a consumption good, produced through housework and formal work earnings, and from leisure. The household production function allows flexibility and potentially complementarity between husband and wife's housework time.[11] People who have a taste for tidiness are assumed to be relatively more productive in the household.

The optimal allocation is affected by life-cycle, external and heterogeneity factors. Not working full-time places individuals on a lower life-cycle earnings trajectory, due to human capital depreciation.[12] Limited commitment and unilateral divorce limit the incentive for women to specialize away from the labor market and for men to do too little housework in order to prevent the marriage from breaking. The gender wage gap and the presence of traditional gender values increase women's incentive to specialize in household production, but other than that, women and men have equal labor market productivity. Spouses have to agree on fertility decisions[13], and the availability of nursery schools offers parents of newborns the option to pay for childcare services that they would otherwise have to do at home by subtracting time from utility-producing activities. Connecting all these relevant heterogeneity dimensions, which are often not observed in the data, and placing them into a dynamic life-

[7] In the preferred data sample, about 87% and 79% of single and divorced women, respectively, are employed. The rate falls below 54% for married women. Single men's employment rate, instead, is about 88% and increases to about 93% for both married and divorced.

[8] Wives who work do about 37 housework hours compared to 56 hours when they do not, whereas husbands do about 15 hours in both cases.

[9] About 15 hours per week less than their husbands according to the data.

[10] Women's housework load increases by about 12 hours per week when they have children.

[11] The Italian data shows, on the one hand, limited variation in leisure time across individuals and, on the other hand, very little (around 6% of households in the sample) substitution from spouses' housework time to hired cleaning services or babysitting. Hence, flexibility in unpaid work arrangements between spouses appears to be the main channel of adjustment.

[12] This feature reflects evidence about the scarring effects of unemployment starting with Jacobson, LaLonde, and Sullivan (1993) and, since the employment choice is interlinked with the fertility one, it can reproduce the "child penalty" first found in Kleven, Landais, and Søgaard (2019).

[13] This reflects a point made by Doepke and Kindermann (2019).

cycle framework, is the most important and novel contribution of the model.

The model is estimated using the method of simulated moments, with identification helped by two facts: (i) Italian part-time and full-time work contracts allow little variation in terms of total hours,[14] and (ii) individuals face exogenous nursery school availability since they have to use the local services, if any, provided by their town, and they are price-takers for the tuition fee.[15] The model shows that men are about one quarter as productive in housework as women, and that spouses' home production hours are substitutes.[16] This is by far the most important determinant of gender differences in housework time.

I use the model to predict female employment and fertility in three counterfactual scenarios: (i) zero gender wage gap; (ii) nursery schools are free and perfectly available to all newborns; (iii) nobody holds traditional gender values. In all cases, the effects are strongly amplified if the counterfactual is paired with an increase in the man's housework productivity. For instance, the first two counterfactual policies together increase fertility to 2.2 (+56.1%) children per woman and married women's employment rate to 0.57 (+15.6%). If men were as home productive as women, the results would be 2.55 (+81%) and 0.98 (+99.8%) respectively. I also simulate a realistic policy of the Italian government which increases nursery school availability to 33%: 3 and 9 years after the policy, respectively, fertility increases by 1.8% and 6.1%, married women's employment increases by 2.8% and 3.4%, and tax revenues increase by 0.11% and 0.17%.[17] The counterfactuals show that there is high complementarity between men's home productivity, female labor supply and fertility. The effectiveness of any policy aimed at increasing the latter two will be stifled if the comparative advantage in housework is not rebalanced. The data and the model do not allow disentangling whether the gender difference in housework productivity is due to disparity in skills or effort,[18] but the magnitude of the effects points to a large payoff of understanding the root causes of such difference more in depth.

The paper makes the following contributions to the literature.

First, it adds a quantitatively precise focus on housework time choice to the literature on

[14] Weekly hours are tightly distributed around 24 for part-time contracts and 40 for full-time contracts, regardless of gender.

[15] At the national level, in the period considered, nursery schools have enough spots for about 25% of children aged 0-3, and tuition fees for the average household are about 300 euros per month, or 10% of their net income.

[16] This differs from the complementarity result obtained by Calvo, Lindenlaub, and Reynoso (2024) for 2010-16 in Germany, but it is in line with the paper's historical perspective using data from 1990 and, in general, with the paper's conjecture that part of the gender convergence can be due to the increase in complementarity between men and women's home production time.

[17] The magnitudes differ slightly depending on the assumptions made about the speed of changes to gender values and male home productivity over time in society.

[18] While girls do more chores than boys from a very young age, learning by doing seems to be only part of the explanation. In fact, husband and wife both devote only about one third of their time to tasks with a reasonable scope for learning like cooking, small construction and childcare. On the other hand, a lack of effort by men could be due, for instance, to explicit traditional gender values or to an implicit adherence or interiorization of said values.

collective models of the household and intra-household allocation of resources. Other papers in this strand have looked at other sides of this topic, for instance labor supply specialization (Browning, Bourguignon, Chiappori, and Lechene (1994), Browning and Chiappori (1998), Attanasio, Low, and Sánchez-Marcos (2008)), consumption and expenditure (Lise and Seitz (2011), Dunbar, Lewbel, and Pendakur (2013), Lise and Yamada (2018), Lechene, Pendakur, and Wolf (2022)), asset accumulation and unilateral divorce (Voena (2015), Lafortune and Low (2023)), college choice and family-friendly work arrangements (Bronson (2019)), and home production technology (Calvo, Lindenlaub, and Reynoso (2024)).

Second, it adds the channel of inability to reconcile formal work, housework, leisure and childcare as one of the determinant of long-term fertility. Other structural papers that have looked at fertility individually or from other angles are Ward and Butz (1980), Hotz and Miller (1988), Fernández, Fogli, and Olivetti (2004), Angelov, Johansson, and Lindahl (2016), Adda, Dustmann, and Stevens (2017), Doepke and Kindermann (2019), Zhang (2021), Kozlov (2020), Guner, Kaygusuz, and Ventura (2020), Cumming and Dettling (2023). Moreover, I also include nursery schools and worktime arrangements into a dynamic, life-cycle model while incorporating evidence from reduced-form papers like Baker, Gruber, and Milligan (2008), Havnes and Mogstad (2011), Carta and Rizzica (2018), Ciasullo and Uccioli (2024) and, for reviews, Olivetti and Petrongolo (2017) and Cortés and Pan (2023).

The remainder of the paper is organized as follows. In section 2, I present the data and the stylized facts that the model reproduces and explains. In section 3, I present all the details of the structural model and the estimation results. In section 4, I present the counterfactual results and discuss concluding policy remarks.

2 Data and descriptive analysis

2.1 Dataset and sample restrictions

The key advantage of the dataset I use is that it provides enough information to disentangle the relative importance of individual values, preferences and housework productivity in determining each household's division of labor between partners. I use a restricted-access version of the time use survey carried out in Italy by ISTAT, the National Statistical Agency, as part of the Harmonised European Time Use Survey (HETUS). This dataset is a repeated cross-section of a nationally-representative sample of households[19] for years 2002, 2008 and 2013.[20]

The survey is made up of three main parts.

[19] In particular, the sample is built to be representative of each of the 20 regions of Italy as well.

[20] A new wave of the survey is currently being carried out between December 2023 and December 2024 and will be included in future developments of this research.

First, every individual aged 3 and above fills in a diary of their activities over an entire day in 10-minute intervals.[21] For each interval, people have to write down their main activity, where it takes place, who they are with and how much they are enjoying it from -3 to +3 in discrete integer steps. They can also indicate a secondary activity if any, for instance if they are checking over their kids while focusing most of their attention on a different main activity. The survey reports both main and secondary activities according to standardized codes that broadly fall into the following categories: work, leisure, study, chores, childcare, adult care, personal care, transport. Each category can be further specified depending on the objective of the analysis.

Second, every individual aged 15 and above answers detailed questions about demographics, employment, job search, work time and flexibility arrangements, parents' employment status while growing up, and own life satisfaction and opinions. In particular, respondents are asked whether they are satisfied with the time they devote to a number of activities like career, family, leisure, themselves or friendships, and whether it is easy for them to reconcile their schedule with their partner's, with public offices' opening times and with their kids' school. Moreover, starting from the 2013 wave, respondents also state if they agree with a number of questions which gauge their opinions and preference about gender-specific division of labor within the household. Specifically, traditional social values emerge from the following questions: "Is it better when the man works and the woman takes care of the house?"; "When both partners work full-time, the man needs to do the same amount of housework as the woman" and "Working parents need to take turns caring for their sick child". Beliefs about men's productivity within the household are gauged by the questions: "Men can do housework just as well as women" and "Men can take care of children just as well as women". Finally, preferences about the relative importance of housework emerge when answering to "Is it important that the house always be clean and tidy". People cohabiting with a partner are also asked who does more housework, more childcare, whether they talk about how to organize the within-household division of tasks and whether they are satisfied with it.

Third, the head of each household is required to respond to questions about their family, such as what type of house they live in, whether they own it, what type of technology and appliances they have, whether they pay for housework or babysitting and what the general economic situation of the household is.

I apply the following sample restrictions. First, I focus on nuclear households, i.e. composed by the head, their cohabiting partner if they have one, and their offspring if they have any. This excludes about 6% of observations. I also drop widowed individuals and never-married, single individuals who have kids, since these events, for simplicity, are not allowed in the model. This further excludes about 4.5% of observations. Second, I focus on households

[21] Parents fill in the diary for small children. In flagged cases, an adult can also fill in for their partner in case they are absent at the time of the interview.

where the head is 25-63 years old, able-bodied, not in school, not retired and not on vacation. This allows me to focus on a sample of individuals who are credibly making employment, marriage, housework, fertility (if young enough) and divorce decisions, and who are describing a plausibly normal day in their survey diary.[22] Finally, I exclude men who work part-time, since they are less than 5% of working men and this allows me to further simplify the model in the next section.

The final sample is made up of 42,088 individuals, of which 9.71% are single, 81.32% are cohabiting or married and 8.97% are separated or divorced.[23] Of the people who are not single and are at least 45 years old, 22.22% do not have children, 33.80% have one child, 35.52% have two children and 8.47% have at least 3 children.

2.2 Descriptive analysis

I will now show a number of stylized facts and figures that the structural model will match and explain. For the sake of precision, I use the following definitions. The time use data of employed individuals is considered if they are neither on vacation nor on unpaid leave.[24] The notion of housework that I use includes chores, trips to purchase household supplies, childcare, care for pets, gardening and small construction and reparation works in the family's dwelling.[25] The term 'work' includes time actively spent on the job, physically and remotely, and commuting. Breaks taken on the job, social and religious activities, volunteering are counted as leisure time, as are more typical leisure activities like hobbies and entertainment.

The first stylized fact is that marriage appears to push men and women into opposite direction in terms of employment, and most of this difference again disappears upon divorce. In fact, *Figure 1* shows that there is virtually no difference in employment rate between single men and women, which are, in my sample, about 0.9 and 0.87 respectively. When married, the share of employed men increases slightly whereas the share of employed women drops below 0.55. Divorced men are employed at a similar rate as married men, which is about 0.94. The employment rate of divorced women is, instead, about 0.79, much higher than married women and slightly below single women. It is important to point out that, conditional on being employed, the share of women working part-time is about 17% when single, 27% when married and 20% when divorced. This means that, on the intensive margin, women work less

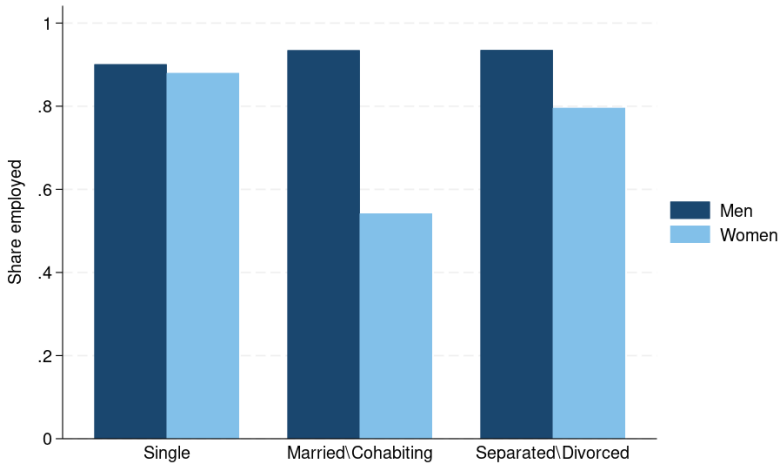
[22] Some never-married individuals are still in school, with the share decreasing from about 30% at age 24 to less than 5% at age 30. For simplicity, school choice is not allowed in the model. However, as will be explained later, the chance of meeting a college-educated partner at younger ages will be lower, to reflect this feature of the data.

[23] In what follows and subsequently in the model, cohabitation is considered to be equivalent to marriage, as is separation to divorce.

[24] This ensures that the diary observations of employed people are indeed accurately describing a typical work day. Women on maternity leave are included as employed because their use of time has crucial importance in describing the balance between career and housework in the presence of newborns.

[25] Incidentally, this broader notion minimizes gender differences because men tend to do a larger share of gardening, construction and reparation.

Figure 1: *Share of employed individuals by marital status. Men are in dark blue and women are in light blue. Data: ISTAT time use survey, 2002-2008-2013.*



than men even when single or divorced, and also that marriage is associated with a further drop in the intensive margin of employment for women.

The second stylized fact is that, among cohabiting or married couples, women always do more housework regardless of the employment status of both partners, and they do so by forgoing their own leisure time.[26] The average difference in housework time between women and men is about 33 hours per week, or 4.7 hours per day. *Figure 2* shows that when the wife is unemployed, she performs 56 weekly hours of housework, as opposed to 37.5 when she works. The husband's contribution, instead, increases only by 3.5 hours when the wife is employed compared to when she is not. In fact, *Figure 3* shows that, for the wife, employment corresponds to a sizable reduction in her own leisure time from 43.2 to 28.2 hours, on average.[27] Conversely, the wife's employment is not significantly correlated to changes in the husband's leisure time.

Explaining what factors, and to what extent, determine such a large gender difference, especially as a result of female employment, will be one of the main contributions of the model. Moreover, considering housework and leisure time together, even if women spend less time on formal work, the sum of paid and unpaid work time is, on average, higher for women by about one hour per day. This is important because it will inform how, in the model, a

[26] In about 7% of households the husband is reportedly unemployed but in all cases he is in search of a job, hence the time use arrangement of these households is not considered representative of a long-term situation and will not shown in what follows. However, even in the households where only the wife works, she still devotes more housework than her husband.

[27] Leisure time does not include sleeping, washing oneself and eating, which are instead categorized as personal care to underline their primary purpose. Personal care time is fairly stable at about 10 hours per day across individuals regardless of gender, employment and parenthood status. For this reason, work, housework and leisure time sum approximately to 98 hours per week.

Figure 2: *Housework time measured in hours per week by gender and occupational status of both partners. Men are in dark blue and women are in light blue. Values above each bar are rounded to the closest first decimal. Data: ISTAT time use survey, 2002-2008-2013.*

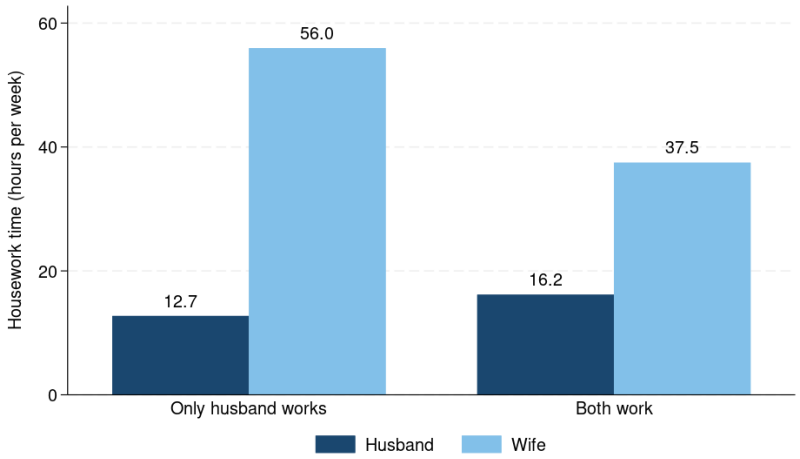


Figure 3: *Leisure time measured in hours per week by gender and occupational status of both partners. Men are in dark blue and women are in light blue. Values above each bar are rounded to the closest first decimal. Data: ISTAT time use survey, 2002-2008-2013.*

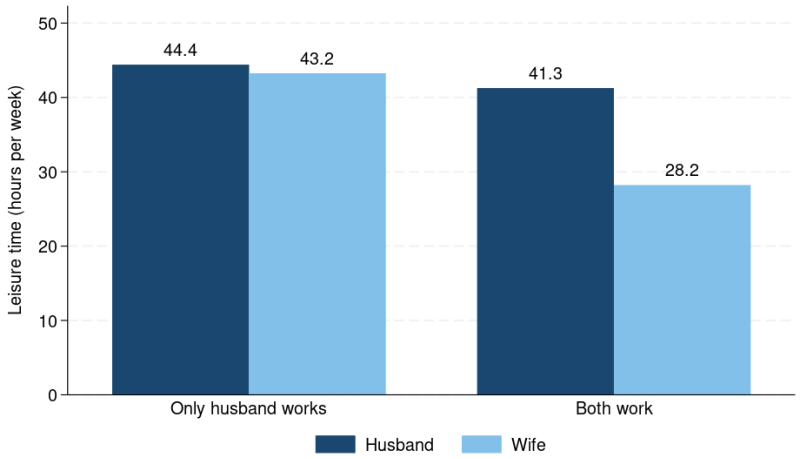
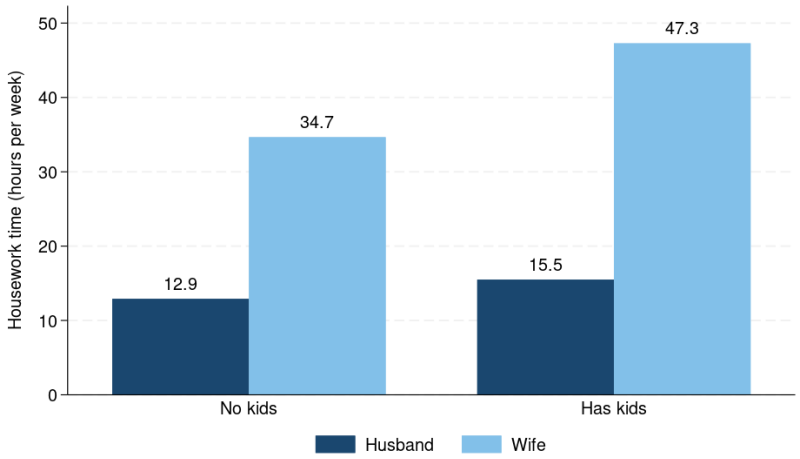


Figure 4: *Housework time among partners measured in hours per week by gender and parenthood status. Men are in dark blue and women are in light blue. Values above each bar are rounded to the closest first decimal. Data: ISTAT time use survey, 2002-2008-2013.*



household efficiently allocates each member's time according to their comparative productive advantages and taking into account the fact that they can share the output of their productive time input.

The third stylized fact is that, when couples have children, the degree of specialization within the household also increases, with men doing more formal work and, especially, women taking up a larger share of housework. In particular, *Figure 4* shows that, after having kids, housework time increases for both spouses, but relatively more for women. The husband's work time increases slightly since his labor force participation goes up from 0.92 to 0.94. However, as *Figure 5* shows, overall having children increases the wife's amount of time devoted to paid and unpaid work significantly more than the husband's. The difference in weekly leisure time enjoyed by the spouses is 4.8 hours in favor of the husband if they do not have children, and it increases to 9.8 hours if they do.[28] The model will be able to disentangle what share of these changes is due to a selection channel of couples endogenously choosing if and how many children they have, and what share is due to the couple's optimal choice of intra-household division of labor.

Finally, the factors that are correlated with the gender difference in housework time and their relative importance are summarized in *Table 1*. The coefficients result from a regression of absolute difference in minutes of housework time between woman and men on a number of relevant covariates, controlling for age of the household head, survey year and geographical location (each of the 20 regions of Italy). The first column shows coefficients using only year

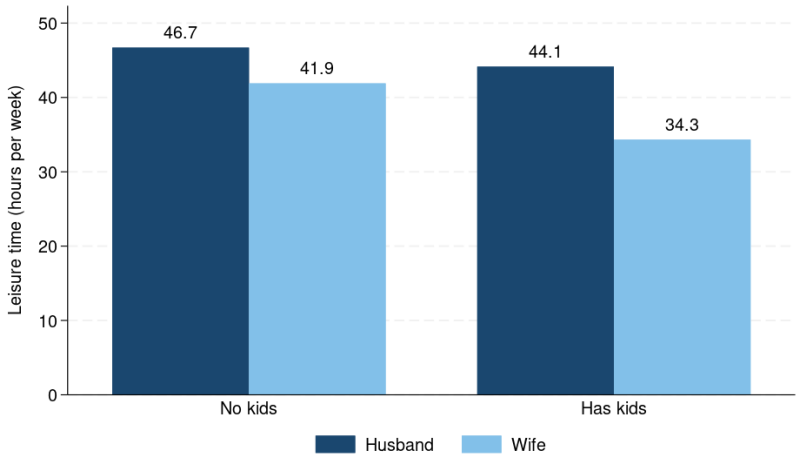
[28]For simplicity, the figures abstract from how many children a couple has, but the gender differences only becomes more marked when the number of children increases.

Table 1: *Relative importance of each factor in determining the absolute difference in housework time, measured in hours per week, between husband and wife. A positive coefficient means that the factor is contributing to increasing the difference. The first specification refers to results using only year 2013 and a set of controls that includes traditional gender values, opinions and taste for tidiness; the second specification uses the full sample (years 2002, 2008 and 2013) but does not include controls that were not available in all years; the third specification uses only year 2013 using the same set of controls as the second specification. Robust standard error are in parentheses. Data: ISTAT time use survey, 2002-2008-2013.*

	Dep: Housework time difference (hours per week)					
	Only 2013		Full sample		2013 (FS spec.)	
	Coeff	Std err	Coeff	Std err	Coeff	Std err
Employment:						
Husband full-time	13.30***	(1.42)	13.41***	(0.84)	15.69***	(1.37)
Wife part-time	-16.81***	(1.30)	-18.31***	(0.73)	-17.84***	(1.29)
Wife full-time	-23.55***	(1.12)	-26.00***	(0.54)	-26.34***	(1.00)
Children:						
1 child	4.61***	(1.20)	6.13***	(0.69)	4.87***	(1.22)
2 children	6.32***	(1.21)	8.46***	(0.69)	6.31***	(1.22)
3 or more children	8.85***	(1.95)	11.02***	(1.03)	9.16***	(1.98)
Any child below age 3	0.49	(1.64)	2.30***	(0.79)	0.44	(1.65)
Husband's education:						
High school	-0.31	(1.31)	-0.47	(0.82)	-0.49	(1.33)
Less than high school	1.76	(1.42)	1.83**	(0.87)	1.86	(1.29)
Wife's education:						
High school	0.68	(1.31)	0.98	(0.82)	1.24	(1.33)
Less than high school	1.36	(1.48)	2.01**	(0.90)	2.62*	(1.50)
Has formal domestic help	-4.97***	(1.90)	-4.66***	(1.09)	-5.59***	(1.93)
Unmarried couple	-0.92	(1.78)	-3.02***	(1.16)	-1.79	(1.80)
Has traditional gender values:						
Husband	4.14***	(1.05)				
Wife	1.73	(1.17)				
Cares about tidy house:						
Husband	-0.87	(1.56)				
Wife	5.66***	(1.84)				
Thinks men home-productive as women:						
Husband	-2.20**	(1.00)				
Wife	-0.79	(0.99)				
Baseline dependent variable:	28.75		32.95		28.75	
Husband + wife housework hours:	59.56		60.66		59.56	
Observations	4,269		14,243		4,269	
Adjusted R^2	0.3746		0.3235		0.3662	
Year FE	No		Yes		No	
Geographical FE	Yes		Yes		Yes	
Household head's age	Yes		Yes		Yes	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 5: *Leisure time among partners measured in hours per week by gender and parenthood status. Men are in dark blue and women are in light blue. Values above each bar are rounded to the closest first decimal. Data: ISTAT time use survey, 2002-2008-2013.*



2013, when it is possible to add covariates about values and attitudes; the second column uses the full sample of years 2002, 2008 and 2013; the third column, as a robustness check, uses the same sample as the first and the same specification as the second. By far, the most relevant determinant of the gender difference is the employment status of both partners, followed by the number of kids. Hiring formal help to assist with housework reduced gender differences by 4.66 weekly hours, but less than 6% of Italian households do so. Finally, unmarried couples seem to have a slightly more gender-balanced allocation of housework time.

When looking at the first column of the table, we notice that values and attitudes factors also contribute a statistically significant, even though smaller, share of the difference. In particular: (i) whether the wife cares about the house being clean and tidy (5.66 more hours per week), (ii) whether the husband has traditional gender role values (4.14 more hours per week), and (iii) whether the husband thinks that men can do housework as well as women (2.2 fewer hours per week).

Other descriptive facts that emerge from the data are useful to inform modeling choices and help check that the model reproduces the data through plausible channels. In particular, there are no significant differences in educational attainment between men and women in the sample: about 17% of individuals are college educated, 42% have a high school diploma and 41% do not have a high school diploma. Less-educated individuals are less likely to be employed, but this is more true for women than for men. Moreover, 30% of wives against 9.4% of husbands are not satisfied with the intra-household division of labor. Conditional on being unemployed, 24.3% of wives (versus 2.6% of husbands) are not looking for a job in order to care for children and 18% of wives (versus 5.3% of husbands) are not looking for a

job for other family reasons. Finally, about 38% of both men and women agree that men are somewhat or completely able to do chores and care for children just as well as women.

Hence, overall, the stylized facts point to stark gender differences in employment and housework time, which tend to appear upon marriage or cohabitation and are exacerbated after the birth of the couple's children. A simple regression analysis highlights correlation patterns that will inform the model. In particular, the model should allow for ample flexibility in housework time choices while at the same time reproducing its strong correlation with discrete employment and fertility choices, followed by a weaker correlation with factors like traditional values and taste for tidiness.

3 The model

3.1 General framework and intuition

The model starts from the principle of Becker (1991) that the household allows spouses to choose an efficient level of specialization in each task and to share the output of their productive work. In particular, I assume that men and women face different productivity levels in the household sector and in the formal work sector. Both sectors contribute to producing units of a consumption good. Spouses receive utility from both consumption and leisure. Hence, they coordinate to pick the optimal amount of time to devote to each sector, under the assumption that their total time available is fixed and limited, and that residual time is leisure. This general framework is inserted into a dynamic life-cycle model, where marriage, employment, fertility and divorce are all endogenous decisions.

The main intuition behind the model is that household members pick their level of specialization depending on their comparative advantage in each sector. Even if husband and wife have the same formal-work productivity, if the wife is more productive in the household sector she will specialize relatively more in household production. The actual level of specialization will depend on a number of complicating factors that derive from the dynamic, life-cycle nature of the model.

First, not working full-time places individual on a lower life earnings trajectory, due to human capital depreciation.[29] Thus, devoting too little time to the formal work sector might cause individuals to permanently lose future earnings potential. Moreover, cohabitation comes with economies of scale and the possibility to specialize in one of the two consumption-producing activities while sharing the output between spouses. For these reasons, single individuals have an incentive to spend less time doing housework compared to married ones, and this is especially true for the spouse who has a comparative advantage in home production

[29] This feature incorporates evidence from the literature that unemployment has long-term earnings consequences. See, for example, Jacobson, LaLonde, and Sullivan (1993), Couch and Placzek (2010), Lachowska, Mas, and Woodbury (2020), Jarosch (2023), and Schmieder, von Wachter, and Heining (2023).

— in this model, the woman. Additionally, women incur an exogenous wage penalty that is supposed to capture a mixture of gender discrimination and other gender-specific dimensions of the labor market which end up penalizing women but which the model needs to represent in a simplified way.[30]

Second, divorce is unilateral and spouses have limited commitment, i.e. they cannot credibly commit to future actions if, when the time to take those actions arrives, they have an alternative that provides more utility.[31] This feature, together with the first one, has the effect of decreasing the level of specialization in home production during marriage. In fact, women have an incentive to retain their earnings potential in case the marriage breaks. Men, conversely, enjoy a higher level of household production during marriage than they would be able to sustain by themselves, so they have an incentive to increase their own home production in order to decrease the burden on their spouse.

Third, each additional kid increases utility but comes at the cost of increased expenditure. The balance between these two forces makes couple endogenously choose whether or not to have a(nother) child depending on their total formal work and home production potential. For some couples in certain periods, it can be optimal to rebalance their time allocation and specialization in order to access the long-term utility reward of having a child.

Fourth, spouses have to agree on fertility decisions[32], and their individual decision can be influenced by external factors. In particular, the availability of nursery schools offers parents of newborns the option to pay for childcare services that they would otherwise have to do at home by subtracting time from utility-producing activities. Depending on which spouse would efficiently carry out the larger share of childcare, men and women can wish to make different optimal fertility choices. In turn, for this and for the previous feature of the model, the spouse who has a comparative advantage in home production can increase housework time and decrease labor market time as the number of children increases.[33]

Finally, individuals are heterogeneous along dimensions that affect the level of intra-household specialization. First, both men and women who hold traditional gender norms prefer the man to work and the woman to care for the house, so couples where at least one spouse is traditional have an increased incentive to specialize in the typical way. Second, men and women can both have different levels of human capital, which corresponds to different earning potential in the formal sector.[34] Third, men can have different housework productiv-

[30] A non-exhaustive list of examples of these other dimensions, found in the literature, includes the fact that women, within profession, tend to be placed in less promotable tasks (Babcock, Recalde, Vesterlund, and Weingart (2017)), or that, for various reasons, they tend to pick majors that are linked to lower-paying jobs (Wiswall and Zafar (2021)), or that they are more risk averse and less confident than men during the job acceptance process (Cortés, Pan, Pilossoph, Reuben, and Zafar (2023)).

[31] See, for instance, Mazzocco (2007).

[32] This incorporates a result highlighted by Doepke and Kindermann (2019).

[33] Bertrand, Goldin, and Katz (2010), for instance, find that motherhood is associated with greater career discontinuity and shorter work hours for women.

[34] A feature to be added in future developments of this work is that highly educated individuals might have

ity levels. Men with lower home productivity will specialize relatively more in formal work but they will also be less attractive on the marriage market to women with high formal work productivity. Fourth and final, individuals who have a preference for a clean and tidy house derive relatively more utility from the household public good and specialize accordingly.

Connecting all these relevant heterogeneity dimensions, which are often not measured or not observed in the data, and placing them into a dynamic life-cycle framework, is the most important and novel contribution of the model. In this way, the model can not only reproduce the observed time allocation of individuals and spouses, but also estimate the relative importance of each factor in determining gender differences in intra-household specialization.

3.2 Model timeline

There are 13 periods in the model and each period corresponds to a time span of 3 years. Individuals start out in the model aged 25, single, childless and with completed education. Starting from the first period, individuals draw potential mates and decide whether to marry.[35] If they marry, they coordinate with their spouse to make an employment, household production and fertility decision.[36] Only married people can have children, up to a maximum of 3 children.[37] Regardless of marital status, all individuals make a time allocation decision between employment and household production.

Starting from the second period, married individuals decide whether to unilaterally divorce or stay in the marriage. Divorced people pay for child expenses equally, cannot have more children and cannot remarry.[38] People can marry and have children up to the 7th period, i.e. up to ages 43-45.[39] Finally, individuals end their career in the 13th period at age 61-63.[40]

3.3 Model equations and value functions

The model has specific period utility and home production functions, which form part of a dynamic problem expressed through value functions. Some of the utility function parameters will be calibrated, hence future robustness checks will make sure that the results are not driven by any particular functional form assumption or calibration choice.

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a comparative advantage or a particular interest in childcaring, in line with the evidence about time use and intensity of parenting in Ramey and Ramey (2010), Doepke, Sorrenti, and Zilibotti (2019), and Kearney, Levine, and Pardue (2022). The model abstracts from status externalities in offspring's education since the Italian data do not seem to support this as a main channel, differently from the South Korean case in Kim, Tertilt, and Yum (2024).

[35] Cohabitation and marriage are equivalent in the model.

[36] Since each period corresponds to 3 years, I assume that all three decisions have space to happen within the same period.

[37] Fewer than 1% of individuals in the data have more than 3 children.

[38] In the data, just above 2% of marriages include divorced people.

[39] There are very few first marriages and virtually no births in the data beyond this age range.

[40] In the period 2013-2018, the average age at retirement in Italy was 63.3 for men and 61.5 for women.

3.3.1 Period utility function

Each individual $j = H, W$, for man and woman respectively, has their own period utility u_j of the following general Cobb-Douglas form:

$$u_j = S_1 \cdot C_j^{\gamma_1} L_j^{1-\gamma_1} \qquad j = H, W$$

where C_j is consumption and L_j is leisure, both measured in utils. Conditional on employment status, γ_1 governs the share of resources (in this case, time) that go to consumption or leisure, and S_1 is a scaling factor.

In a cohabiting/married couple, the household period utility becomes:

$$U = \theta u_H + (1 - \theta) u_W$$

which is a weighted sum of each spouse's utility with husband's weight equal to θ. This means that the household follows a collective model, and that spouses can renegotiate their weight in each period if their outside option of divorcing makes their participation constraint binding.[41]

Household consumption C takes the form:

$$C = S_2 \cdot \Omega^{\gamma_2} Y^{1-\gamma_2}$$
$$C_j = \eta_j \cdot C$$

where Ω is the household's home production, and Y is the household's total earnings from formal work. The exponent γ_2 governs the allocation of resources to each consumption-producing activity, and will be estimated in the model, just like γ_1.[42] When individual j is single or divorced, $\eta_j = 1$ and they consume the entirety of their household-produced consumption. When they are married, the husband receives a share $\eta_j = \eta$ (and the wife a share equal to $1 - \eta$) of the household consumption. The solution for η will depend on the utility function parameters, the husband's Pareto weight, the home production parameters and the total time resources available to each spouse.

The scaling factor S_2, just like S_1 previously, can change depending on employment,

[41] This follows the standard literature on collective household models including, for instance, Chiappori (1992), Browning, Bourguignon, Chiappori, and Lechene (1994), Chiappori (1997) and Browning and Chiappori (1998).

[42] The underlying assumption here is that single-person households and couples have the same consumption production technology. However, they will have different resources Y and a different home production technology, which will be described in detail later.

marital status and fertility. In particular:

$$S_1 = (1 + s_{K_1} \cdot K)(1 + s_L)(1 - s_G \cdot \Phi_W)$$
$$S_2 = (1 + s_M)(1 - s_{K_2} \cdot K)$$

where the parameters, to be estimated in the model, are described as follows. The factor $s_{K_1} > 0$ is a utility premium for each kid K; $s_{K_2} > 0$ is a household consumption increase for each kid K.[43] The balance between s_{K_1} and s_{K_2}, together with concavity of the utility function, determines a different preferred number of children for households with different consumption production potential. For single individuals, $s_{K_1} = s_{K_2} = 0$, since they cannot have children in the model, but the parameters appear in the divorced individuals' utility function if they had children during marriage. The love shock s_L is different from 0 only for married individuals, and it follows a random walk process with $s_L = s_{L,previous} + \varepsilon_L$, which provides a simple way to capture the level of happiness of the couple. The initial shock is drawn at the time of the marriage decision as $s_{L,0} \sim N(0, \sigma_{L,0})$, and more positive shocks make marriage more likely to happen. Conversely, the magnitude of σ_L and the outcome of the random walk process in each period determine both the likelihood of divorce and the expected and effective duration of the marriage. Both σ_L and $\sigma_{L,0}$ will be estimated as model parameters. s_M is different from 0 only for married individuals, and represents a balance between potential economies of scale in consumption during marriage, and potential consumption increases tied to the presence of multiple members in the household.[44] Both these parameters govern how desirable marriage is compared to being single or divorced. The penalty s_G captures traditional gender values about female employment status Φ_W: s_G is larger than 0 for single and divorced women when they work full-time and hold traditional gender values, and for married women and men if the wife works and either the wife or the husband has traditional gender values.

3.3.2 Production functions

Individuals allocate their time to the two competing sectors of formal work and home production, and use the residual time as leisure. The production function of leisure is a one-to-one transformation of time units into leisure units, which then provide decreasing marginal utility. The total time available to people in the model is fixed at 98 hours per week.[45]

[43] Alternatively, s_{K_2} can be interpreted as a decrease in the share of household consumption that produces utility for the parents, under the assumption that the parents receive somewhat less utility from their children's consumption than from their own consumption.

[44] For instance, a two-person household might need a larger house, which likely requires larger expenditure; on the other hand, bigger households likely enjoy economies of scale. For this reason, the model estimation will not restrict s_M to be necessarily positive.

[45] A week has 168 hours, but in the data it appears that people spend about 70 hours per week, with little dispersion, in necessary activities like sleeping and basic personal care.

With time devoted to formal work, each individual earns Y_j units that contribute to producing the consumption good,[46] according to the function:

$$Y_j = f(h_j^{\mathcal{W}}) = w_j(e_j, a_j, \mu_j, N, j) \cdot h_j^{\mathcal{W}}$$

where $h_j^{\mathcal{W}}$ is the amount of weekly hours devoted to formal work $\mathcal{W}$, which is 0 for the unemployed, 24 for part-time contracts and 40 for full-time contracts. To reflect the data, the part-time option will only be available to women. The linear functional form reflects the fact that individuals are usually paid by the hour.[47] The weekly wage rate is w_j and it is a function of education level e_j, age a_j, dummy state variable μ_j for ever having been unemployed, the choice of using a nursery school N, and gender j. In particular:

$$w_j = (1 + \pi^e e_j)(1 + \pi^a a_j)(1 - \pi^\mu \mu_j)(1 + \pi^N N)(1 - \pi^G \mathbb{1}[j = W]) \cdot w_{base}, \quad j = H, W$$

where π^e is the premium for each education level e_j; π^a is the premium for each age level a_j; π^μ is the permanent penalty if the individual was ever unemployed ($\mu_j = 1$); π^N is the wage cut necessary to pay for fees if the couple decides to send their child to a nursery school ($N = 1$);[48] π^g is the gender pay gap if and only if the individual is a woman ($j = W$); w_{base} normalized to 1 without loss of generality.[49]

The wage process thus has a simple structure, linear in education and age with premiums π^e and π^a, which reflects the structure of salaries in the Italian economy, where there is limited flexibility in pay schedules.[50] Importantly, e_j is a state variable whose initial level corresponds to the individual's education level. In each subsequent period, it is subject to a shock with standard deviation σ_e to be estimated, which captures changes in an individual's permanent income potential. There are 3 education levels (college, high school, less than high school) that are drawn in the first period to match the education levels in the data sample.[51]

[46] These earnings have to be intended as a mixture of actual consumption and savings potential, so they represent the entire utility-generating potential of money, i.e. the result of formal work production. In this sense, the interpretation of this money is in terms of net take-home salary.

[47] For simplicity, the model abstracts from the fact that jobs which entail longer work hours might inherently yield a higher hourly pay. This point is especially relevant in Goldin (2014), and it will be added in future iterations of this model, together with the possibility to work extra hours beyond 40 per week, which has been shown to come with a significant pay premium and yet it is relatively more inaccessible for women.

[48] This parameter, even if not completely, captures the fact that nursery school fees increase with income, and in the model will be calibrated to the national average.

[49] In principle, there could be an added layer of preference complication if individuals were allowed to value hours devoted to formal work, home production and leisure differently solely on the grounds of the type of use of time. Since this aspect is not inquired in the data and would be difficult to capture because it amounts to pure preference, the model captures this aspect more simply through the utility parameters γ_1 and γ_2.

[50] The wage equation can easily be made more complex to reflect features of the labor market of other countries, or of smaller, more specific geographic areas of Italy. Similarly, the wage equation can incorporate more complex forms of taxation and incentives, even gender-specific as well.

[51] To be precise, the education level is drawn together with the likelihood of being traditional, taking into account that less educated individuals in the data are more likely to self-identify as holding traditional gender

For single and divorced people, their household total earnings correspond to Y_j, depending on their gender. For a couple, total earnings are equal to $Y = Y_H + Y_W$. This means that there is perfect substitutability between the money earned (i.e. the utility-generating units produced) by each spouse, although the share appropriated by each of them could differ depending on their Pareto weight.

Finally, unemployed individuals receive an amount of income equal to $I_{base} \cdot w_{base}$ regardless of their education and age, where I_{base} is calibrated to match the Italian level of government subsidies to the unemployed.[52]

The other input to the consumption production technology is home production.[53] For a single or divorced person, the home production input Ω_j that is plugged into consumption production $C_j = S_2 \cdot \Omega_j^{\gamma_2} Y_j^{1-\gamma_2}$ is simply:

$$\Omega_j = \pi_j^{\mathcal{H}} \cdot h_j^{\mathcal{H}}$$

where $h_j^{\mathcal{H}}$ is the amount of weekly hours devoted to the home sector $\mathcal{H}$, and the coefficient $\pi_j^{\mathcal{H}}$, also estimated in the model, captures gender-specific home sector productivity. In particular, without loss of generality, women's home productivity is fixed at 1. Men can have two different productivity levels: a high one $\pi_{H,high}^{\mathcal{H}} \leq \pi_W^{\mathcal{H}}$ which could be as high as the woman's, and a low one $\pi_{H,high}^{\mathcal{H}} < \pi_{H,low}^{\mathcal{H}}$. The concept of productivity has to be taken literally as a rate of output (home-produced consumption) per unit of input (time devoted to household production). The model abstracts away from why it may be that different genders might have different productivity levels.[54]

In a couple, to allow for more flexibility, the household home production input Ω to consumption follows the CES function:

$$\Omega = \left[\frac{\pi_H^{\mathcal{H}}}{\pi_H^{\mathcal{H}} + \pi_W^{\mathcal{H}}} (h_H^{\mathcal{H}})^{1-\gamma_3} + \frac{\pi_W^{\mathcal{H}}}{\pi_H^{\mathcal{H}} + \pi_W^{\mathcal{H}}} (h_W^{\mathcal{H}})^{1-\gamma_3} \right]^{\frac{1}{1-\gamma_3}}$$

where spouses' hours contribution are weighted by their relative home productivity and the parameter γ_3, to be estimated in the model, governs the substitution or complementarity pattern.[55]

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norms, which in the model is associated to the utility penalty s_G discussed above.

[52] Similarly to the case of the wage schedule, the subsidy level can easily be made more complex to match other countries' economic environment or to resemble the actual Italian subsidy system more closely.

[53] This type of production incorporates any non-marketable utility-generating unit shared by spouses, including tidiness, cleanliness, home-made meals, home self-made renovations, and childcare.

[54] In other words, the model (and the data) could not possibly find whether any difference in productivity is due to a difference in ability or to a lack of effort or both, although it might be very valuable in the future to be able to do so. The paper will go back to this discussion more in depth in the section about counterfactuals.

[55] In particular, $0 < \gamma_3 < 1$ indicates substitutability, $\gamma_3 = 1$ makes the function collapse to a standard Cobb-Douglas, and $\gamma_3 > 1$ indicates complementarity. The combination of Cobb-Douglas and CES forms can provide a good approximation of the data. *Figure* in the Appendix shows the kernel density distributions of

The home productivity level of potential husbands on the marriage market is drawn according to women's beliefs about male productivity in the data.[56] All else equal, marriage is more likely to happen with more productive men, since they have a higher consumption-producing potential.

It is worth noting at this point that the use of a nursery school can only be paid with formal work and it does not affect home productivity. When a nursery school is not available, parents have to allocate a total of H^N hours[57] of their time, divided among them in the way that is optimal to them, to childcare activity that generates no utility to the parents, thus potentially subtracting time from other utility-generating activities.[58] Hence, if there were no fees, using a nursery school would be a dominating choice for everyone. In the presence of fees, nursery schools are relatively more valuable for couples who are more productive in the formal sector or where neither spouse is already specializing in home production. In particular, nursery school fees decrease utility in the period of birth relatively more for poorer couples, who have higher marginal utility of consumption.

Finally, conditional on the employment choice, the time each individual devotes to leisure, which is directly plugged into the utility function, is equal to:

$$L_j = H^{max} - h_j^{\mathcal{W}} - h_j^{\mathcal{H}} - h_j^N$$

where H^{max} is the total available amount of hours in the week, excluding personal care time such as sleeping, and h_j^N is the number of hours that individual j, if married and with a newborn that does not go to nursery school, has to devote to additional childcare.

3.3.3 Closed-form solutions conditional on employment

Given the particular functional forms chosen, we can solve the individual and the couple's utility maximization period problem conditional on the employment choices and subject to the budget constraint determined by the consumption production technology.

For a single or divorced person, the closed-form solution for their home production hours

the wife's housework and leisure times depending on her employment status. Each status has a very different distribution of housework time, whereas leisure times tend to be more similar across statuses.

[56] In the data, women's and men's beliefs about this actually coincide. Since the data value is taken as the average belief among all women, it is assumed to be accurate given that all married women have had the chance to observe their husband's productivity.

[57] This amount is calibrated from the data at 33 weekly hours, to match the average childcare time offered by nursery schools and also realistically in between the average duration of a full-time job contract and a part-time one.

[58] Around this parameter there is room for allowing some parents to have a preference or a better ability to care for the child themselves instead of outsourcing care to a nursery school or to an informal arrangement. Indeed, Baker, Gruber, and Milligan (2008) show that nursery schools do partly crown out such informal arrangements.

is:

$$h_j^{\mathcal{H}*} = \frac{\gamma_1\gamma_2}{1-\gamma_1(1-\gamma_2)} \cdot H_j$$

which only depends on the utility and consumption production parameters, and on the available amount of hours $H_j = H^{max} - h_j^{\mathcal{W}}$. In particular, the individual optimally chooses how many hours to work in the formal sector according to the dynamic problem, knowing that the choice will, in turn, determine the optimal amount of home production time $h_j^{\mathcal{H}*}$ and, residually, leisure L_j^*. This solution has the advantage of being simple yet at the same time leaving enough flexibility to provide a good representation of the data when plugged into the dynamic problem.

For a couple, using the fact that the Pareto weights do not change within the same period, the closed-form solutions for each spouse's housework hours and the husband's share of consumption are:

$$h_W^{\mathcal{H}*} = \frac{\frac{\gamma_1\gamma_2}{1-\gamma_1(1-\gamma_2)}\left[\left(\frac{\theta}{1-\theta}\right)^{\frac{1}{1-\gamma_1}} H_H + H_W\right]}{1+\left(\frac{\pi_H}{\pi_W}\right)^{\frac{1}{\gamma_3}}\left(\frac{1-\theta}{\theta}\right)^{\frac{1-\gamma_3}{\gamma_3(1-\gamma_1)}}}$$

$$h_H^{\mathcal{H}*} = \frac{\frac{\gamma_1\gamma_2}{1-\gamma_1(1-\gamma_2)}\left(\frac{1-\theta}{\theta}\right)^{\frac{1}{\gamma_3(1-\gamma_1)}}\left(\frac{\pi_H}{\pi_W}\right)^{\frac{1}{\gamma_3}}\left[\left(\frac{\theta}{1-\theta}\right)^{\frac{1}{1-\gamma_1}} H_H + H_W\right]}{1+\left(\frac{\pi_H}{\pi_W}\right)^{\frac{1}{\gamma_3}}\left(\frac{1-\theta}{\theta}\right)^{\frac{1-\gamma_3}{\gamma_3(1-\gamma_1)}}}$$

$$\eta^* = \frac{\left[1+\frac{1-\gamma_1}{1-\gamma_1(1-\gamma_2)}\left(\frac{\pi_H}{\pi_W}\right)^{\frac{1}{\gamma_3}}\left(\frac{1-\theta}{\theta}\right)^{\frac{1-\gamma_3}{\gamma_3(1-\gamma_1)}}\right] H_H - \frac{\gamma_1\gamma_2}{1-\gamma_1(1-\gamma_2)}\left(\frac{\pi_H}{\pi_W}\right)^{\frac{1}{\gamma_3}}\left(\frac{1-\theta}{\theta}\right)^{\frac{1}{\gamma_3(1-\gamma_1)}} H_W}{\frac{1-\gamma_1}{1-\gamma_1(1-\gamma_2)}\left(1+\left(\frac{\pi_H}{\pi_W}\right)^{\frac{1}{\gamma_3}}\left(\frac{1-\theta}{\theta}\right)^{\frac{1-\gamma_3}{\gamma_3(1-\gamma_1)}}\right)\left[H_H + \left(\frac{1-\theta}{\theta}\right)^{\frac{1}{1-\gamma_1}} H_W\right]}$$

which, similarly to the single-person household problem, depend on the utility parameter and on both spouses' available hours, with the additional complication that the optimal solution depends on their Pareto weights and on their relative home productivity as well, and on their joint dynamic labor supply made cooperatively within the collective household framework.[59] It is fundamental for the dynamic solution, however, that each dynamic choice is tied to an optimal period-by-period arrangement of home production, which individuals take into account in their optimization process.

To better understand what this means and the interchangeability between husbands' and

[59] Since in the computer coding of the problem some sets of parameters could give rise to unfeasible solutions, $h_W^{\mathcal{H}*}$ and $h_H^{\mathcal{H}*}$ are bounded between 0 and H_W and H_H respectively, and η^* is bounded between 0 and 1, and any solution outside these intervals is forced to be equal to the corresponding bound.

wives' housework time, the first-order conditions impose the following result that connects the optimal solutions:

$$h_H^{\mathcal{H}*} = \left(\frac{1-\theta}{\theta}\right)^{\frac{1}{\gamma_3(1-\gamma_1)}} \left(\frac{\pi_H}{\pi_W}\right)^{\frac{1}{\gamma_3}} \cdot h_W^{\mathcal{H}*}$$

This equivalence shows that, intuitively, when the husband's Pareto weight θ increases or when his home productivity π_H is lower, *ceteris paribus* he performs fewer hours of housework compared to the wife. A higher γ_3, denoting more complementarity between spouses, pushes the spouses' home contributions closer together. When the husband's Pareto weight is exactly equal to 0.5, the ratio between the two spouses' housework hours is only determined by their relative productivity and the degree of complementarity. In the other cases, the presence of the Pareto weight in the expression serves the purpose of pushing down the home production contribution by the spouse who has the highest weight and, in doing so, would gain relatively more from an increase in own leisure.

In general, given that this period solution is intrinsically linked to the dynamic problem, and in fact it is conditional on the employment choice, home production hours depend on comparative advantage in both sectors. In particular, even if there were no gender gap in the labor market, women would still devote more time to home production if they had a higher home productivity than their husband. This key prediction and feature of the model would be further amplified by the exponent γ_3 if it were estimated smaller than 1, which implies that even small comparative advantages result in large time allocation differences. In practice, in the model this key prediction is made more complicated by the dynamic problem, so that sacrificing work time can result in a permanent earnings penalty, and by labor market contracts' rigidity, since the only two contracts available require working part-time or full-time for fixed weekly hours.

3.3.4 Value functions and endogenous choices

For simplicity, I follow the backward recursive solution of the model, so I start the description of the value functions from the problem of divorced people. In what follows, for ease of notation, I do not indicate that the utility (and thus the whole value) is a function of C_j, L_j, of the number of kids K, and of individual heterogeneity in terms of traditional values G_j, home productivity π_j and taste for tidiness O_j.

Divorced individuals cannot remarry and cannot have more children, so they are only making an employment choice every period. Their value function if they have never been unemployed is:

$$V_j^{div}(e_j, \mu_j = 0) = \Big(max\{u_j(e_j, 0) + \beta \mathbb{E} V_j^{div'}(e'_j, 0), \quad u_j(e_j, 1) + \beta \mathbb{E} V_j^{div'}(e'_j, 1)\}\Big)$$

where the prime subscript indicates the following period value function and the result of the max operator determines the employment choice. The expectation is taken with respect to the permanent income shock which affects e'_j given e_j. For a divorced person who has been previously unemployed, instead, the value is:

$$V_j^{div}(e_j, \mu_j = 1) = (max\{u_j(e_j, 0), \quad u_j(e_j, 1)\}) + \beta \mathbb{E} V_j^{div'}(e'_j, 1)$$

The difference between the two value functions highlights the fact that choosing unemployment in any period, without ever having been previously unemployed, has long-term consequences by changing the continuation value. This feature will appear in the other marital status problems as well with the same intuition.

Married people can choose, in each period, whether to stay married or unilaterally divorce. Denoting the other spouse by j', the married person's problem is:

$$V_j^{marr}(e_j, e_{j'}, \mu_j, \mu_{j'}) = \Big(max\{\tilde{V}_j^{marr}(e_j, e_{j'}, \mu_j, \mu_{j'}), \quad V_j^{div}(e_j, \mu_j)\}\Big)$$

where the result of the max operator determines the divorce choice. This problem nests the value of staying married $\tilde{V}_j^{marr}(e_j, e_{j'}, \mu_j, \mu_{j'})$, which has the form:

$$\tilde{V}_j^{marr}(e_j, e_{j'}, \mu_j, \mu_{j'}) = \Big(max\{\tilde{V}_j^{marr,NF}(e_j, e_{j'}, K_j, \mu_j, \mu_{j'}), \quad \tilde{V}_j^{marr,F}(e_j, e_{j'}, K_j + 1\mu_j, \mu_{j'})\}\Big)$$

where NF and F stand for no fertility and fertility respectively, so that this second max operator determines the decision of having a child, and couples can have up to 3 children. The F problem exists only when fertility is possible, which is up to the 7th period in the model. In sebsequent periods this step of the problem collapses trivially to the NF problem.

Let us examine these two nested value functions. The NF problem takes the following form when the spouse has never been unemployed:

$$\begin{aligned}\tilde{V}_j^{marr,NF}(e_j, e_{j'}, K_j, \mu_j = 0, \mu_{j'}) = max\{&u_j(e_j, e_{j'}, K_j, N_j, 0, \mu_{j'}) + \beta \mathbb{E} \tilde{V}_j^{marr,NF'}(e'_j, e'_{j'}, K_j, 0, \mu'_{j'}), \\ &u_j(e_j, e_{j'}, K_j, N_j, 1, \mu_{j'}) + \beta \mathbb{E} \tilde{V}_j^{marr,NF'}(e'_j, e'_{j'}, K_j, 1, \mu'_{j'})\}\end{aligned}$$

Here it is important to notice that each u_j period utility level results from the share of total production output efficiently assigned to each spouse, and that the expectation operator is now taken with respect to own- and cross- permanent income shock and to the spouse's future unemployment status.

The same problem when the spouse was previously unemployed is, instead:

$$\begin{aligned}\tilde{V}_j^{marr,NF}(e_j, e_{j'}, K_j, \mu_j = 1, \mu_{j'}) = max\{&u_j(e_j, e_{j'}, K_j, N_j, 0, \mu_{j'}), u_j(e_j, e_{j'}, K_j, N_j, 1, \mu_{j'})\} + \\ &+ \beta \mathbb{E} \tilde{V}_j^{marr,NF'}(e'_j, e'_{j'}, K_j, 1, \mu'_{j'})\end{aligned}$$

where, again, previous unemployment affects the continuation value.

The F problem mirrors this one in both cases. For a spouse that was never unemployed:

$$\tilde{V}_j^{marr,F}(e_j, e_{j'}, K_j, \mu_j = 0, \mu_{j'}) = max\{u_j(e_j, e_{j'}, K_j + 1, N_j, 0, \mu_{j'}) + \beta \mathbb{E}\tilde{V}_j^{marr,F'}(e'_j, e'_{j'}, K_j + 1, 0, \mu'_{j'}),$$
$$u_j(e_j, e_{j'}, K_j + 1, N_j, 1, \mu_{j'}) + \beta \mathbb{E}\tilde{V}_j^{marr,F'}(e'_j, e'_{j'}, K_j + 1, 1, \mu'_{j'})\}$$

Instead, when they were previously unemployed:

$$\tilde{V}_j^{marr,F}(e_j, e_{j'}, K_j, \mu_j = 1, \mu_{j'}) = max\{u_j(e_j, e_{j'}, K_j + 1, N_j, 0, \mu_{j'}), u_j(e_j, e_{j'}, K_j + 1, N_j, 1, \mu_{j'})\} +$$
$$+ \beta \mathbb{E}\tilde{V}_j^{marr,F'}(e'_j, e'_{j'}, K_j + 1, 1, \mu'_{j'})$$

From these value functions it is clear that the fertility and employment decisions are intertwined. Depending on the level of the state variables, fertility can be delayed or can become optimal immediately, and it takes into account that each fertility decision affects the optimality of employment for both spouses.

It is important to underline the role of nursery schools at this point. When couples are already married, it is assumed that nursery schools are either available to them or not. This reflects the limited geographical mobility of Italian couples and the fact that, in light of the possibility to have kids, they would have previously tried to settle in a place where nursery schools are available. The availability of nursery schools affect the employment decision through the period utility first, and depending on that, it affects the continuation value as well. For this reason, having more children can progressively push the spouse who specializes relatively more in home production, typically women, out of the labor force if the limited availability of nursery schools lowers their future labor market earnings potential.

Finally, the problem of a single person in periods where they can marry (up to the 7th period in the model timeline) is:

$$V_j^{sing}(e_j, \mu_j) = \Big(max\{\tilde{V}_j^{sing}(e_j, \mu_j), \quad \mathbb{E}\tilde{V}_j^{marr}(e_j, e_{j'}, K_j = 0, \mu_j, \mu_{j'}), \}\Big)$$

where the expectation is taken with respect to all the heterogeneity dimensions of the potential spouse and the availability of nursery schools. The result of the max operator determines the marriage choice. Single people, by model assumption, enter the marriage problem with 0 kids since they cannot have children before marrying. After the 7th period, this part of the singles' problem trivially collapses to just $\tilde{V}_j^{sing}(e_j, \mu_j)$. The marriage surplus Σ is equal to:

$$\Sigma = (\tilde{V}_H^{marr} - \tilde{V}_H^{sing})^{\lambda} \cdot (\tilde{V}_W^{marr} - \tilde{V}_W^{sing})^{1-\lambda}$$

where the husband's Nash bargaining weight is given by λ. Marriage happens if and only if, given the characteristics of spouses, there exists an endogenous value of the initial Pareto

weight such that both spouses receive a positive surplus from the marriage.

Now, similarly to the divorced people problem, a single person who stays single and has never been unemployed has the following value function:

$$\tilde{V}_j^{sing}(e_j, \mu_j = 0) = \Big(max\{u_j(e_j, 0) + \beta \mathbb{E}\tilde{V}_j^{sing'}(e'_j, 0), \quad u_j(e_j, 1) + \beta \mathbb{E}\tilde{V}_j^{sing'}(e'_j, 1)\} \Big)$$

Conversely, when they have previously been unemployed:

$$\tilde{V}_j^{sing}(e_j, \mu_j = 1) = (max\{u_j(e_j, 0), \quad u_j(e_j, 1)\}) + \beta \mathbb{E}\tilde{V}_j^{sing'}(e'_j, 1)$$

This further shows that being unemployed while single has the double negative effect of lowering both the continuation value and one's own attractiveness on the marriage market.

3.4 Identification of the model

First, a number of parameters are calibrated to match the environment of the Italian economic system, in particular, the cost and availability of nursery schools and the full-time and part-time contract hours. Moreover, other parameters are calibrated from the data, to match the initial unobserved heterogeneity among individuals in terms of perceived home productivity, traditional gender values, taste for tidiness and education level. Finally, the time discount rate was fixed in accordance with the standard in the literature. The full list is in *Table 2*.

Identification is helped by a number of features of the economic environment that are exogenous to individuals and plausibly taken as given by them when making decisions. The fixed amount of hours in each work contract exogenously changes the time budget constraint that individuals face when making the time allocation choice. The cost of nursery school fees exogenously shifts the cost of having a child, which has to be traded off against the parents' cost of providing childcare themselves. Finally, the characteristics of potential mates are taken as given by singles on the marriage market, since no individual can alone modify the market conditions.

Then, the model is estimated using the method of simulated moments. There are 18 remaining parameters to be estimated by matching 30 moments in the data. I explicitly target mostly moments that involve women and leave the moments that involve men free to be used for validation, together with other general moments that are left out of the list of 30. Even if, in theory, all parameters are identified by all moments, I now explain which moments are intuitively more tightly linked to which parameters, with the full list of moments in Appendix A.

First, I match the number of children women have by age 45. This is the result of the balance between scaling factors s_K and s_C.

Table 2: *List of calibrated parameters, with description in the left column, source in the center one and value in the right one.*

Description	**Source**	**Value**
Average cost of nursery schools (π^N)	National average	0.1
Nursery school availability chance	National average	0.25
Full-time contract hours	National average	40
Part-time contract hours	National average	24
Total available weekly hours (H^{max})	Time use data	98
Childcare hours covered by nursery school (H^N)	Time use data	33
% men with high home productivity	Time use data	0.38
% men with traditional gender values	Time use data	0.27
% men with taste for tidiness	Time use data	0.91
% men with college education	Time use data	0.16
% men with less than high school education	Time use data	0.41
% women with traditional gender values	Time use data	0.21
% women with taste for tidiness	Time use data	0.93
% women with college education	Time use data	0.18
% women with less than high school education	Time use data	0.36
Time discount rate (β)	Standard literature	0.98

Second, The shares of divorced and married women help identify the economies of scale of marriage s_M and the standard deviation of the love shock σ_L.

Third, a number of employment-related moments help identify the wage process parameters and the penalty for ever being unemployed. In particular, the share of women who are employed when single, married or divorced (similarly to *Figure 1*), the share of women working part-time with or without kids. The education and age wage premiums are identified by the share of employed women for each education level. Finally, the penalty for women working against their own traditional gender values is linked to the ratio of employed women when they have traditional values versus not, and to the ratio of employed married women when their husband has traditional values versus not.

Fourth, the utility and home production parameters are identified by a group of moments about the number of weekly hours devoted to housework. I consider this quantity when women are single, married with or without kids, or divorced, and then for women and men when only the husband works or when both work. Then, men's home productivity level is tied to the ratio of women's home production hours when their husband's productivity is high or not, and to the husband's home production hours when their own productivity is high or not. Finally, the taste for tidiness θ_O is identified by the ratio of the woman's home production hours when married and likes tidiness versus not, and by the ratio of the man's home production hours

Table 3: *List of estimated parameters, with description in the left column and estimated value in the right one.*

Description	**Value**
Gender wage gap (π^g)	0.1115
Unemployment wage penalty (π^μ)	0.2398
Education wage premium (π^e)	0.3104
Age wage premium (π^a)	0.0475
Standard deviation of permanent wage shocks (σ_e)	0.1079
Economies of scale of marriage (s_M)	0.3876
Utility factor increase for each child (s_{K_1})	0.0686
Household budget expansion for each child (s_{K_2})	0.0043
Standard deviation of initial love shock ($\sigma_{L,0}$)	0.3357
Standard deviation of permanent love shocks (σ_L)	0.0405
Man's Nash bargaining power in splitting marriage surplus (λ)	0.5119
Traditional gender values penalty (s_G)	0.0606
Utility exponent of consumption (γ_1)	0.7527
Exponent of home production (γ_2)	0.2778
Substitutability between spouses' housework time (γ_3)	0.6936
Men high home productivity (π_{H_1})	0.4106
Men low home productivity (π_{H_2})	0.1490
Home productivity bonus for tidiness (π_O)	0.1288

when married and likes tidiness versus not.

In terms of identification, it is helpful that the data ask questions that allow separating between relevant but otherwise unobservable factors like taste for tidiness, traditional values and home productivity. Even if these values are self-reported, they are informative about people's own perceptions and stated preferences, which is what likely guides their choices. Moreover, knowing individuals' actual use of time allows linking stated to revealed preferences. This is an important advantage of this model also compared to previous literature.

3.5 Estimation results

The full list of estimated parameters is in *Table 3*.

The main result to be highlighted is that men are, on average, a quarter as home-productive as women, with the low level of productivity estimated to be about 0.15 and the high one well below 0.5. As mentioned earlier, the data (and consequently the model) are unable to explain whether such a difference is due to ability or to lack of effort. For example, men could be less productive because they do not have the same skills as women. Since it does not seem plausible that this set of skills is biological, there might be a role of learning by doing,

especially if one gender devotes more time to home production starting from a young age. To an extent, teenage girls do spend about 3-5 hours more than boys doing chores[60]. However, husband and wife both spend only about one third of their housework time performing tasks that could reasonably have a relevant learning-by-doing component, such as cooking, small constructions and reparations, and childcare. In fact, the majority of housework time is spent performing tasks that are likely repetitive and with limited scope for learning (or where the learning curve is very steep only in the very first tries, and then flattens out), such as cleaning, washing the dishes, doing laundry, and buying groceries.[61] Hence, learning by doing is unlikely to be the main explanation. Another speculative explanation could be that, for instance, men do not put effort into housework because they do not think it is their social or gender role. However, only 27% of men explicitly hold a conservative view of gender roles. Such views might be underestimated in the data, or they could produce effects even when held unconsciously or when internalized, or they could also be only part of the full explanation. In any case, given the magnitude of the gender difference in housework productivity and, as will become clear in the counterfactual exercises, its complementarity with both fertility and female employment, there would be a large payoff to understanding its root causes more in depth.

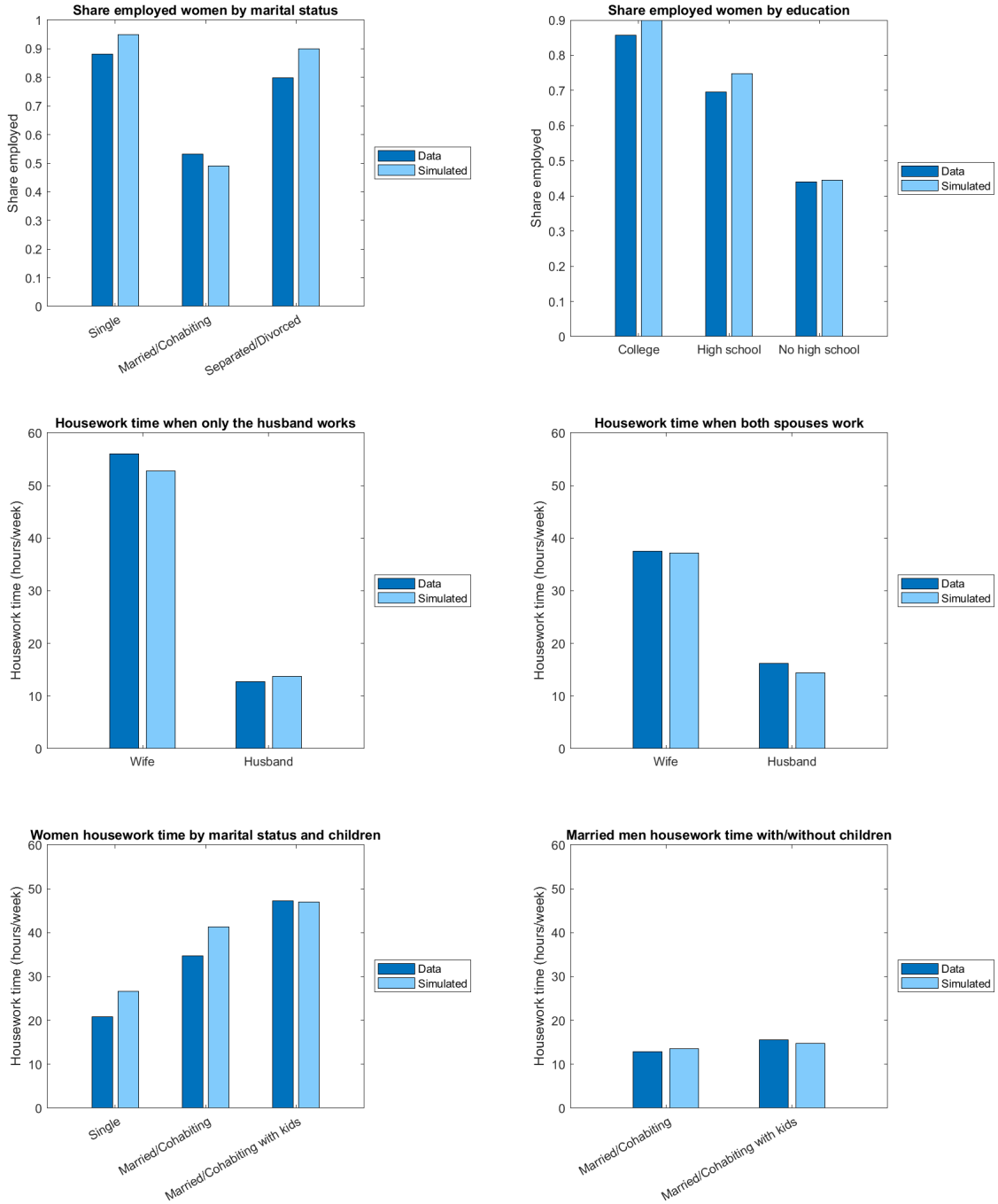
Among the other results, the wage increases by 0.31 with each education level and by 0.05 with each age level, and it decreases by 0.11 because of the unconditional gender wage gap and by a permanent 0.24 for ever being unemployed. Marriage provides economies of scale in consumption in the measure of 0.39, and children require a very small expansion of the entire household budget while raising utility by a factor of 0.07. The utility from marriage decreases by 0.06 when the wife works full time and either she or her husband hold traditional gender values. Of the time resources remaining after sleeping and personal care, the share devoted to consumption-generating activities is about three quarters. About one quarter of that share is invested in the housework side of consumption production, whereas the remaining goes to the formal labor market. The taste for tidiness is associated to a home productivity bonus of about 0.13. Finally, the housework time input is slightly substitutable among spouses, with the relevant parameter estimated at 0.69.

The simulated moments resulting from the estimated parameters fit the data very well, and they fall, on average, within only 10% of the data moments. While the full list of simulated moments compared to their data counterparts is in Appendix A, the plots below in *Figure 6* illustrate the main moments, which directly refer to the stylized facts that the model was supposed to reproduce.

[60] The time difference in chores between girls and boys starts being statistically significant around age 8 and grows over time up to age 18, when girls perform about 1 hour more chores than boys per day.

[61] Moreover, when children are born, the wife starts performing relatively more chores but husband and wife spend similar amounts of time doing childcare (with the husband devoting relatively more time to leisure activities with the child), so this might not produce stark differences in learning.

Figure 6: *Summary of fit of moments that show the stylized facts in the data that the model needed to reproduce. The class of moments represented in each plot is described in the header. The full list of moments is in Appendix A.*



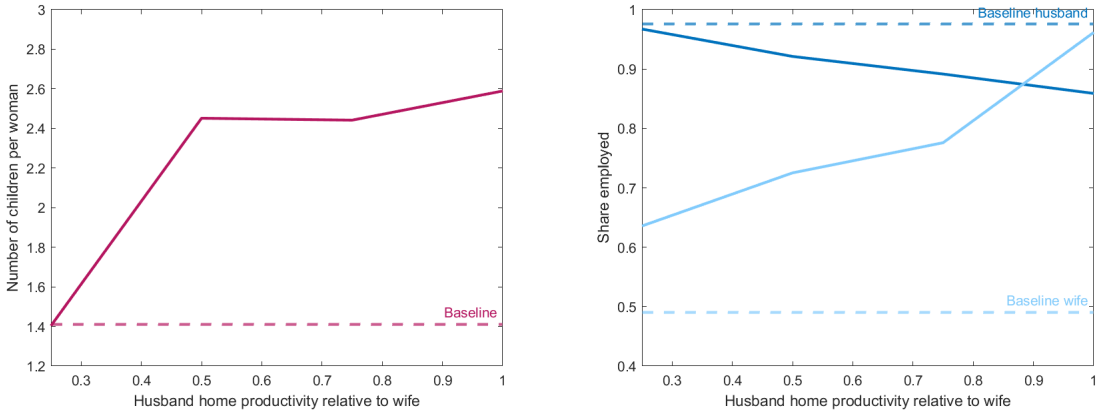
Starting from the top left graph, the model correctly predicts the large drop in female labor force participation associated with marriage, as well as the rebound upon divorce. The simulated employment rate for single and divorced women is slightly higher than the corresponding rate in the data, which might be due to the model not having enough flexibility to rationalize not working for these categories of people. In the top right plot, the simulated moments accurately portray the negative employment gradient linked to decreasing education levels. In terms of housework hours, the two center plots show that the model correctly predicts the amount of housework hours for both spouses regardless of their employment status. As the stylized fact showed, the husband contribution remains fairly constant whether the wife works as well or not, whereas the wife's contribution drop significantly when she works. Finally, the bottom two graphs capture the fact that marrying and having children corresponds to an increase in the wife's housework hours contribution, whereas the husband's increases only very modestly. Hence, overall, the model appears to be reproducing the desired stylized facts very well.

4 Counterfactuals and policy discussion

I use the model to predict employment for married men and women and fertility in three counterfactual scenarios: (i) a zero gender wage gap, which could be thought of, for instance, as a gender-specific taxation that erases the gap; (ii) perfectly available and completely free nursery schools; (iii) the absence of traditional gender values. In all cases, I also show how the counterfactual result would be amplified if, at the same time, men's home productivity were to increase until it matches the woman's. Finally, I test three scenarios that mix the previous policies: (i) zero gender wage gap together with free and perfectly available nursery schools; (ii) the gender wage gap, nursery school fees and traditional gender values are reduced by half, the availability of nursery schools and men's home productivity are doubled; (iii) the gender wage gap, nursery school fees and traditional gender values are reduced to zero, the availability of nursery schools and men's home productivity relative to the woman's are increased to 1.

In all the counterfactual figures that follow, I will show effects for fertility and husband's and wife's employment rates. In both graphs representing these effects, the x-axis represents the husband's home productivity level relative to the woman's, and the plotted lines show the estimated counterfactual magnitudes as the husband's home productivity changes. The leftmost value on the x-axis corresponds to the average husband's home productivity estimated in the model, which is about a quarter of the wife's. Thus, the plots highlight the degree of complementarity between the man's home productivity and fertility and employment. The counterfactual results have to be interpreted as the new equilibrium values that are reached in response to each policy. Regarding the employment results, in particular, I do not consider any general equilibrium effects that might arise in the labor market as a response to large

Figure 7: *Fertility and wife's and husband's employment rate if the gender wage gap were completely erased. In both graphs, the x-axis represents the level of male home productivity relative to the woman's, and the plotted lines show the estimated counterfactual magnitudes as the man's home productivity changes. In the right side plot, the husband is in dark blue and the wife in light blue. The two baseline levels estimated by the model before the counterfactual are dashed.*



(a) Fertility

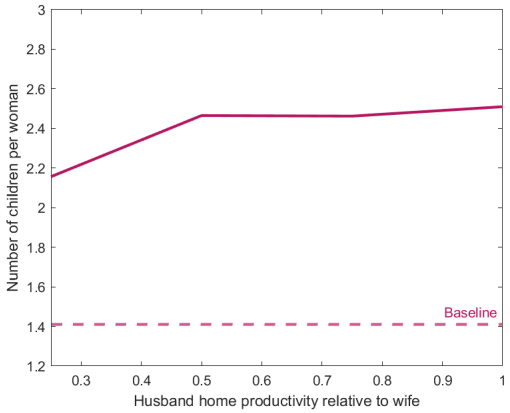
(b) Husband's and wife's employment

employment shifts.

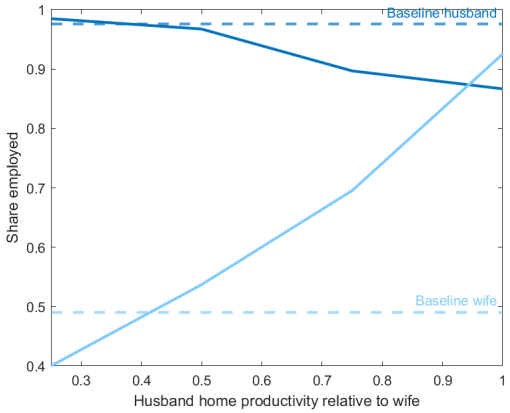
Figure 7 shows the results for the first counterfactual, where the gender wage gap has been completely erased, which increases women's take-home earnings. Without any changes to the husband's home productivity, erasing the gender gap does not have any significant effect on fertility, but it raises the wife's employment rate to 0.64 (a 29.6% increase). However, if the man's productivity doubles to half that of the woman, fertility jumps up to 2.45 (+73.8%) children per woman, and increases to 2.59 (+83.5%) if men are as home productive as women. Married women's employment would keep increasing up to 0.92 (+87.9%) and, if there was no comparative advantage in home production, would actually surpass the men's, because women are more educated than men and the model gives the same premium to both genders for each education level.

Figure 8 shows the results for the second counterfactual, which makes nursery schools perfectly available for all newborns and completely free of charge. Even absent any improvements to the husband's home productivity, this policy would increase fertility to 2.16 (+52.8%) children per woman, and it would then continue increasing up to 2.51 (+77.9%). Instead, the wife's employment rate would, at first, decrease to 0.4 (a 18.4% decrease). This is because, when there are positive nursery school fees, it is optimal for some couples to have children anyway but have the wife enter employment to increase the family's earnings resources. As the man's home productivity grows, like in the previous counterfactual, married women's

Figure 8: *Fertility and wife's and husband's employment rate if nursery schools were completely free and perfectly available. In both graphs, the x-axis represents the level of male home productivity relative to the woman's, and the plotted lines show the estimated counterfactual magnitudes as the man's home productivity changes. In the right side plot, the husband is in dark blue and the wife in light blue. The two baseline levels estimated by the model before the counterfactual are dashed.*



(a) Fertility



(b) Husband's and wife's employment

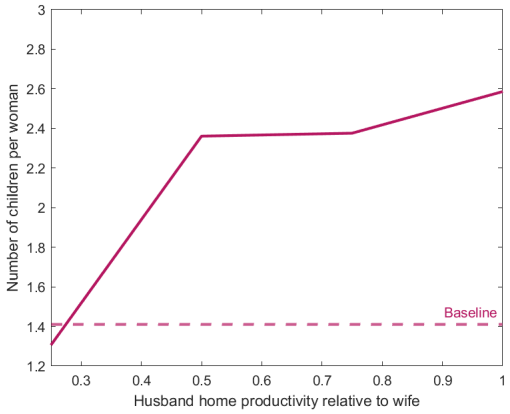
employment increases up to 0.93 (+88.6%).

Figure 9 shows the results for the third counterfactual, where nobody holds traditional gender values, so that there is never a penalty for any woman for ever working full time. In this case, without any rebalancing of comparative advantage in home production, fertility would initially decrease to 1.31 (-7.4%) children per woman. When the man's home productivity increases, fertility also increases quickly up to 2.59 (+83.3%). Female employment follows a very similar path as in the counterfactual with zero gender wage gap, but on a slightly lower level, because the gender values penalty is less pervasive (it can be avoided by marrying a non-traditional husband) and it is smaller in magnitude compared to the gender wage gap.

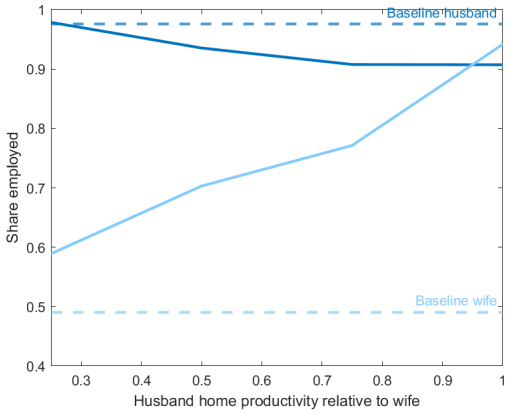
Taken together, the three counterfactuals highlight a strong degree of complementarity between male housework productivity and fertility and female employment. Moreover, the counterfactuals show that the household rebalancement of spouses' time use does not imply a major exit from the labor force by the husband, hence also achieving an output increase in absolute terms.

To further corroborate the complementarity point, *Figure 10* shows how fertility and married women's employment respond to changes in male home productivity only, without any other policy changes. The shape of the two plots remains largely the same, underlining that rebalancing the difference in home productivity and, consequently, the housework load, is estimated by the model to be the main factor that could raise both fertility and female em-

Figure 9: *Fertility and wife's and husband's employment rate if nobody held traditional gender values. In both graphs, the x-axis represents the level of male home productivity relative to the woman's, and the plotted lines show the estimated counterfactual magnitudes as the man's home productivity changes. In the right side plot, the husband is in dark blue and the wife in light blue. The two baseline levels estimated by the model before the counterfactual are dashed.*

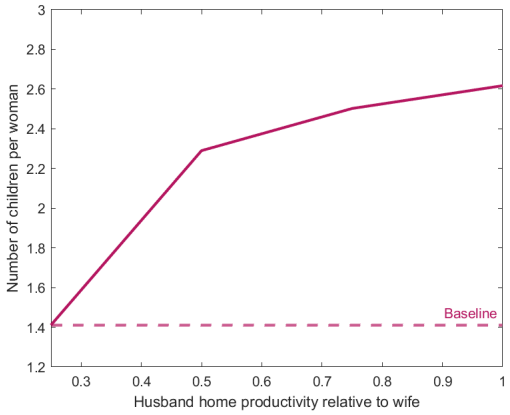


(a) Fertility

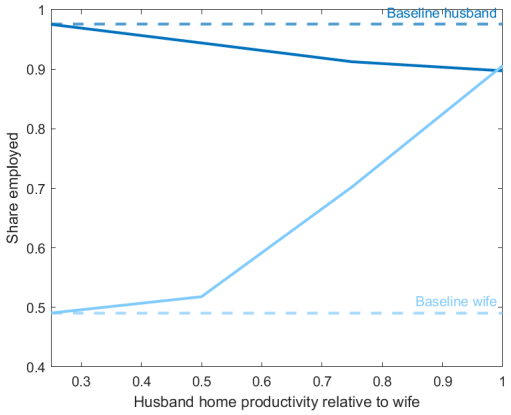


(b) Husband's and wife's employment

Figure 10: *Fertility and wife's and husband's employment rate as the man's home productivity grows from a quarter to the same level as the woman's. In both graphs, the x-axis represents the level of male home productivity relative to the woman's, and the plotted lines show the estimated counterfactual magnitudes as the man's home productivity changes. In the right side plot, the husband is in dark blue and the wife in light blue. The two baseline levels estimated by the model before the counterfactual are dashed.*

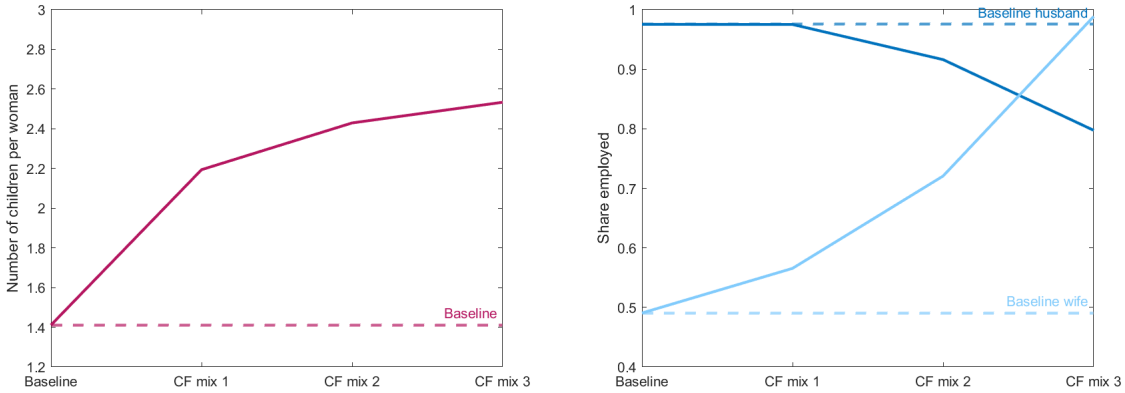


(a) Fertility



(b) Husband's and wife's employment

Figure 11: *Fertility and wife's and husband's employment rate in 3 counterfactual policy mix scenarios: (i) zero gender wage gap together with free and perfectly available nursery schools; (ii) the gender wage gap, nursery school fees and traditional gender values are reduced by half, the availability of nursery schools and men's home productivity are doubled; (iii) the gender wage gap, nursery school fees and traditional gender values are reduced to zero, the availability of nursery schools and men's home productivity relative to the woman's are increased to 1. In both graphs, the x-axis shows first the model baseline level without any policy change, and then the 3 scenarios. In the right side plot, the husband is in dark blue and the wife in light blue. The two baseline levels estimated by the model before the counterfactual are dashed.*



(a) Fertility

(b) Husband's and wife's employment

ployment. It is worth noting that the strongest effects seem to emerge after male productivity hits at least half of the woman's. This means that, in the time that is required to reach that threshold, there might be room to implement policies that increase nursery school supply and decrease the gender wage gap.

Finally, *Figure 11* shows the fertility and employment results in the case of 3 counterfactual policy mix scenarios: (i) zero gender wage gap together with free and perfectly available nursery schools; (ii) the gender wage gap, nursery school fees and traditional gender values are reduced by half, the availability of nursery schools and men's home productivity are doubled; (iii) the gender wage gap, nursery school fees and traditional gender values are reduced to zero, the availability of nursery schools and men's home productivity relative to the woman's are increased to 1. In the first counterfactual mix, fertility jumps to 2.2 (+56.1%) children per woman and married women's employment rate grows to 0.57 (+15.6%). These are sizable effects, but they would be magnified, especially the employment one, when paired with an increase in male home productivity. The second and third counterfactual yield, respectively, fertility of 2.42 and 2.55, and wife's employment of 0.73 and 0.98.

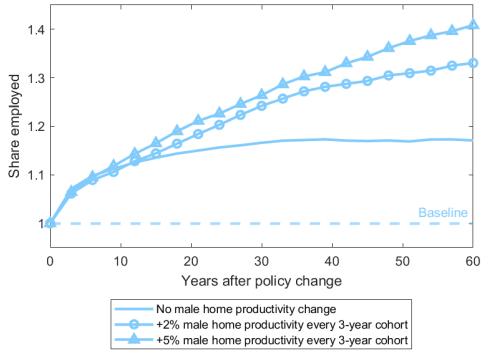
The model, with some additional assumptions, sheds light on two fundamental aspects of the counterfactual policies: their impact on the government budget and the speed of the

transition to the new equilibrium. In particular, in this exercise I assume the government levies a 27% income tax, and that 0.25% of tax income covers existing nursery school costs, with both numbers calibrated to the national averages in Italy. In terms of transition after the policy, in every iteration of the model, which corresponds to 3 years, I draw a new generation with potentially new gender values and male home productivity. In this respect, I consider 3 scenarios: (i) no changes in values or male productivity ever; (ii) at every new generation, 2% reduction in penalties linked to traditional gender values and 2% increase in male housework productivity relative to the female one; (iii) same as (ii) but with 5% shifts at every new generation.[62] I assume that, after being drawn, existing generations do not change their values and productivity anymore over the course of their life. I simulate the transition for 20 periods, equivalent to 60 years after the policy. In each period, tax revenues could change due to changes in the employed population, and expenditures could change due to changes in the newborn population, in order to keep the availability of nursery schools constant at the fixed policy level. I simulate two counterfactual policies. In the first, the gender wage gap is erased through a gender-specific taxation that increases women's take-home earnings. In the second, which mimics a realistic policy by the Italian government, the availability of nursery schools is increased to 33% of the newborn population through government spending. The results of this simulation are in *Figure 12*.

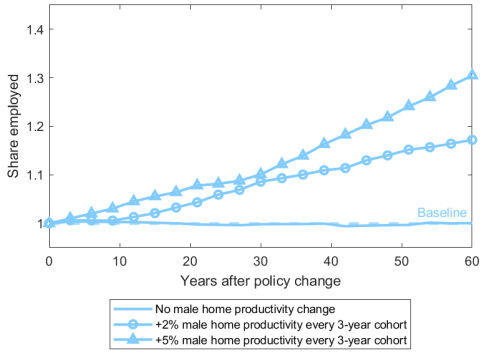
The first counterfactual would raise female employment steadily over the course of 60 years, up to a 32% increase in the central scenario with 2% shifts in values and productivity. Fertility would decrease on impact to 1.1, recover only after 20 years and increase to 2.2 children per woman after 60 years. Notably, in the lower bound scenario with no changes, long-term fertility would not be significantly different from the baseline. The feasibility of this policy for the public budget, however, is extremely unlikely, since it would entail an increase of over 10% in tax revenues on impact, which are not recovered even after 60 years in any of the scenarios. The second counterfactual has more modest consequences. On impact, fertility increases by 1.8% and female employment increases by 2.8%. At the end of the 60 years period, fertility increases by 55% and female employment by 17%. In this case, there is a positive impact on the government budget as well: tax revenues increase by 0.11% on impact and to 7% after 60 years. It is worth noting that, under the lower bound scenario, the employment and tax results do not carry over, and the only long-term effect that remains is a 4% increase in fertility. In general, the transition exercise again shows the relevance and complementarity of male housework productivity on the fertility and employment outcomes, with stark differences depending on the scenario considered. Moreover, it shows that, intuitively, while employment can change quickly on impact, fertility results tend to appear after about one generation.

[62] The 2% shifts are a realistic depiction of the data, where it appears that such values change by 2% with every 3-year cohort. Hence, the no change and the 5% change scenarios are meant to be, respectively, a lower bound and an upper bound to the central scenario.

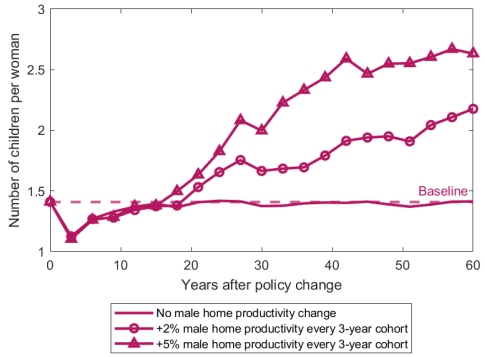
Figure 12: *Transition to new equilibrium for 2 counterfactual policies: (i) zero gender gap financed through gender-specific taxation (left column); (ii) availability of nursery schools increases to 33% (right column). The top graphs represent the female employment rate relative to the baseline; the center graphs represent fertility per woman; the bottom graphs represent the government budget (tax revenues net of expenditure) relative to the baseline.*



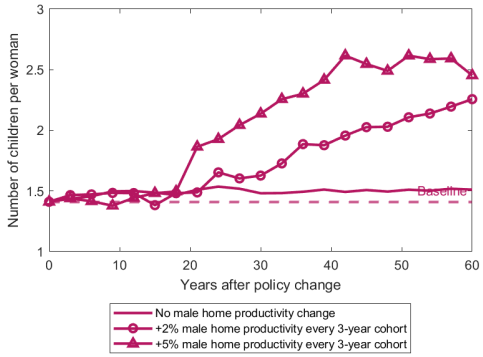
(a) Female employment



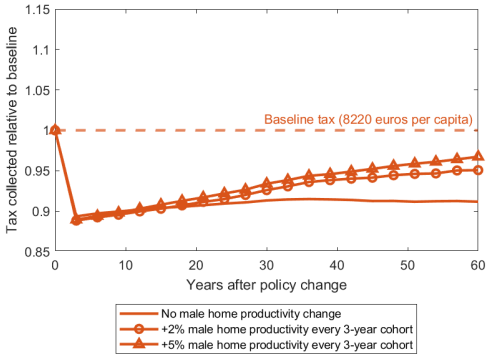
(b) Female employment



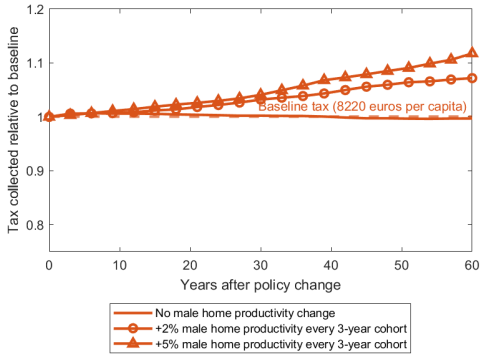
(c) Fertility



(d) Fertility



(e) Government budget



(f) Government budget

5 Concluding remarks

This paper proposes a novel structural, life-cycle model of employment, fertility, marriage and divorce where individuals and couples choose to devote their time to competing uses between formal work, housework and leisure. Men and women have different comparative advantages in each sector. The model is estimated using a restricted-access version of the Italian time use data for years 2002-2008-2013, which importantly allows for disentangling the effect of traditional values about gender roles and attitudes about male housework productivity.

The model is estimated with the simulated method of moments and predicts that men are about one fourth as home-productive as women, and that husbands' and wives' home production hours are weakly substitutes. This gender difference has a strong degree of complementarity with fertility and female labor supply. In fact, it causes female employment to drop upon marriage and, even further, upon the birth of children. It also explains why the husband's amount of hours devoted to home production remains low regardless of his wife's employment status and of the presence of children; at the same time, it explains why wives who work take a sizable portion of their leisure time out in order to free up time to join the labor force.

I simulate a number of counterfactual scenarios. Among these, a zero gender wage gap paired with free, perfectly available nursery schools, increases fertility to 2.2 (+56.1%) children per woman and married women's employment rate to 0.57 (+15.6%). If men were as home productive as women, the results would be 2.55 (+81%) and 0.98 (+99.8%) respectively. I also simulate the transition after increasing nursery school availability to 33%: 3 and 9 years after the policy, respectively, fertility increases by 1.8% and 6.1%, married women's employment increases by 2.8% and 3.4%, and tax revenues increase by 0.11% and 0.17%. The counterfactual exercises show that any policy aiming at increasing fertility and labor supply would be stifled if it did not also take into account the gender difference in housework productivity.

The data and the model cannot ascertain whether such difference is due to a disparity in skills or effort. It can be speculated that learning by doing is part of the full explanation, especially regarding skills. On the other hand, the lack of effort might be due to adherence or internalization of gendered norms and household roles. In general, the model and the policy simulations point to a prominent and sizable role of the gender difference in housework productivity in determining fertility and female employment outcomes. Hence, there is a large payoff for future work to understand the root causes of this phenomenon more deeply.

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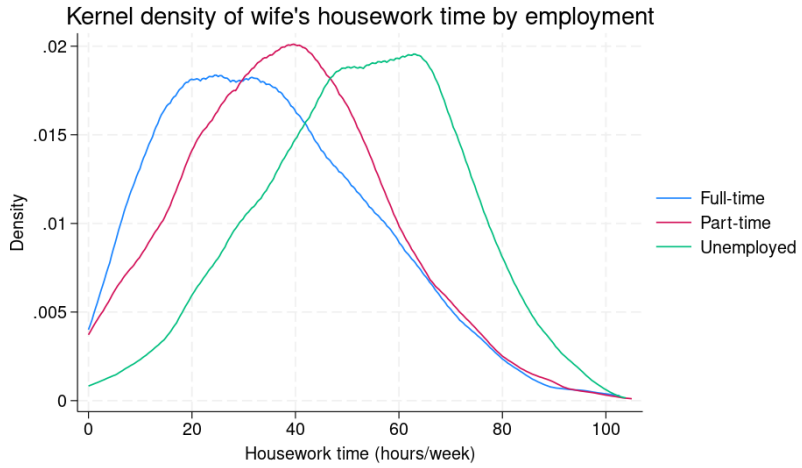
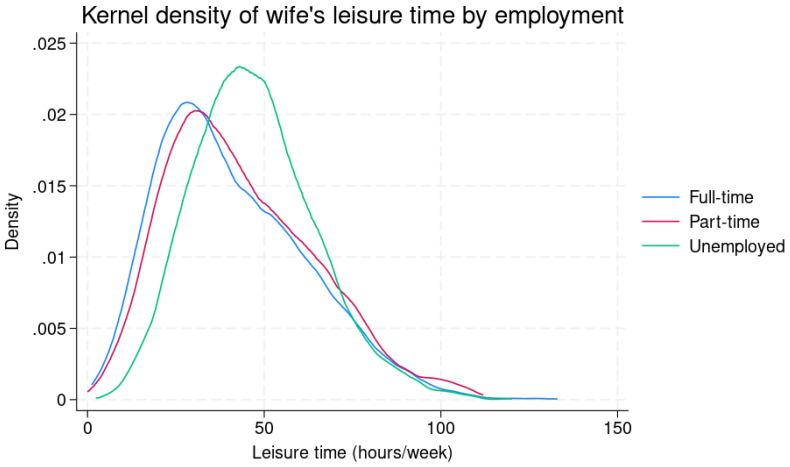
Appendix A. Additional figures and tables

Figure A.1: *Kernel density distributions of wife's housework time (a) and leisure time (b) in weekly hours depending on wife's employment status as a full-time worker, part-time worker, or unemployed.*



(a) Housework time



(b) Leisure time

Table A.1: *List of moments, with description in the left column, data value in the center one and simulated value in the right one.*

Moment description	**Data**	**Simulated**
Average number of kids (after age 45)	1.3023	1.4109
Share divorced women	0.1011	0.1003
Share never married women (after age 45)	0.0564	0.0123
Share employed women when single	0.8739	0.9504
Share employed women when married without kids	0.5825	0.5768
Share employed women when married with kids	0.5266	0.4567
Share employed women when divorced	0.7892	0.8995
Share employed men when married without kids	0.9204	0.9841
Share employed men when married with kids	0.9408	0.9681
Share married women working part-time, no kids (unconditional)	0.1140	0.1139
Share married women working part-time, with kids (unconditional)	0.1524	0.1536
Share employed women with college education	0.8578	0.8992
Share employed women with high school education	0.6952	0.7484
Share employed women with no high school education	0.4400	0.4449
Ratio employed women when conservative vs not	0.7591	0.7484
Ratio employed wife when conservative husband vs not	0.7232	0.7189
Woman housework hours when single	20.8698	26.5738
Woman housework hours when married without kids	34.7406	41.2886
Woman housework hours when married with kids	47.2961	47.0142
Woman housework hours when divorced	32.4076	26.5837
Man housework hours when married without kids	12.8966	13.5283
Man housework hours when married with kids	15.5404	14.8012
Ratio wife housework hours when home-productive husband vs not	0.8894	0.9684
Ratio husband housework hours when home-productive vs not	1.1748	1.7233
Ratio wife housework hours when likes tidiness vs not	1.1950	1.0178
Ratio husband housework hours when likes tidiness vs not	1.0203	1.0212
Husband housework hours when only husband works	12.7008	13.7185
Wife housework hours when only husband works	56.0284	52.7653
Husband housework hours when both work	16.1881	14.4137
Wife housework hours when both work	37.5326	37.1507