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The wage gap and the leisure gap for double-earner couples

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Abstract Empirical research has consistently shown that, on average, men are paid higher wages than women. Moreover, men enjoy more leisure time than women. We develop a noncooperative model of the private provision of family public goods to analyze whether the wage gap and the leisure gap are related. Simultaneous and sequential decision-making structures within a couple lead to different empirical hypotheses. Our estimates based on the German Socio-Economic Panel data show that husbands enjoy, other things equal, more leisure time than their wives. This advantage can be explained if the husband is the Stackelberg leader in a sequential private provision game.

Keywords Gender wage gap · Leisure · Private provision of public goods

JEL J22 · J16 · H41

1 Introduction

In most industrial countries, employed women work longer hours (paid and unpaid) than employed men, i.e., there is a "leisure gap" between men and women, favoring men.[1] Another established fact is the analogous "wage

[1] See the European Time Use Survey in Eurostat (2004).

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gap" between men and women: Even after controlling for individual and job characteristics, working men are paid significantly more than working women.[2]

If men earn higher wages, one might argue that it may be efficient for men to specialize in market work and women in household work, leading to the traditional intrafamily time allocation. But this distribution of working hours between market and household work according to comparative productivity advantages does not necessarily imply that employed men work in sum shorter hours than their working wives, i.e., that men enjoy more leisure time than women.

Most empirical studies on the wage gap or the leisure gap concentrate on the gaps between men and women after controlling for individual and job characteristics like education, work experience, having children, etc. The central focus of our paper is to analyze, theoretically and empirically, the relationship between the wage gap and the leisure gap by modeling the decision-making *within* couples.

An obvious link between spouses' wages and time use might be that the lower her relative wage income, the more time a woman devotes to household work. However, sociologists have found that wives who earn more than their husbands do not delegate more household chores but compensate them for their "loss of face" by instead doing a "second shift" in the household (Hochschild 1989). Brines (1994) and Greenstein (2000) find that an economically dependent husband does less household work the more he depends on his wife for income. Once a man's financial identity as the breadwinner has been undermined, he cannot afford to further weaken his position by doing household work.[3]

The economic theory of time allocation within the family was initiated by Becker (1965, 1976, 1985). In Becker's seminal theory, a couple maximizes (joint) utility when both partners allocate their time according to their comparative productivity advantages. That is, if the husband has a higher wage than his wife, he will specialize in paid employment and she will specialize in household production, while possibly holding a part-time job. Because Becker did not make a distinction between household work and leisure, no direct link between wages and the leisure gap can be drawn in this setting.

More sophisticated game-theoretic models have been developed where husband and wife interact as individual family members. Manser and Brown (1980), McElroy and Horney (1981), and Ott (1992) propose Nash bargaining models remaining single or becoming divorced are possible threat points. Lundberg and Pollak (1993) and Chen and Woolley (2001) consider the case where the threat point is not divorce but a noncooperative outcome within marriage. Konrad and Lommerud (1995) model a noncooperative game of the private provision of a public good, whereas Konrad and Lommerud (2000) mix

[2]This wage gap has been extensively documented. For recent sources, see, e.g., O'Neill (2003) for US data, the report of the European Commission (2003) for EU data, and the survey by Weichselbaumer and Winter-Ebmer (2005).

[3]See also Huber and Spitze (1983) and Daly (1996).

cooperation and noncooperation at different decision stages in the couple's lifetime. In the emerging Nash equilibria, there is, in general, underprovision of the family public good. Vagstad (2001) presents a similar model where the spouses have different comparative advantages in the production of family public goods.[4]

In most of these models, husband and wife maximize the consumption of two goods: a private good that is paid for by individual labor income and a public family good that is generated by household production. This does not allow for analysis of the residual leisure time. We extend this approach by *explicitly* including leisure in a model with three distinct time uses: market work (paid), household work (unpaid), and private leisure time.[5] Leisure is defined as time spent on self-determined activities. Because these are activities that are pursued for their own sake, they must be exclusively performed by the same person and cannot be delegated to anyone else and then be transferred (third-person criterion[6]). Sports activities, watching TV, eating, and sleeping, for instance, are leisure activities because they must be performed by oneself.[7]

We further assume that time spent both in market work and household work generates family public goods. The latter assumption is widely used in the literature: The household production of child care, a clean house, and a neat garden are public goods provided privately by each partner. The former assumption, on the contrary, goes against the usual assumption in the literature that one's income is a private good. However, in our setting, it is justified to regard income as a family public good because housing, transportation, the family car, the TV set, and, in general, the family's expenses are paid for with that income. Most importantly, income can be transferred to a joint bank account in a way that private leisure time cannot.[8]

For the sake of simplicity, the private provision model involves no private utility of one's contribution as introduced by Cornes and Sandler (1984) and Bergstrom et al. (1986). The model is also related to Buchholz et al. (1997), who analyze a game of private provision of public goods when two individuals contribute to a public good sequentially. In contrast to their model, where income is transferable, in our setting, time cannot be transferred between the partners.[9]

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[4]For a survey of noncooperative family models, see Lommerud (1997).

[5]The distinction between household production and leisure has been particularly stressed by Apps (see, e.g., Apps 2003). However, it is sometimes difficult to determine the category to which a certain time use belongs. Juster and Stafford (1991) survey the problems of measurement that arise when dealing with time allocation and summarize the empirical evidence.

[6]See Ott (1998).

[7]We do not distinguish joint leisure of spouses and leisure coordination as studied, e.g., by Hallberg (2003) and Jenkins and Osberg (2003).

[8]Leuthold (1968) and Kooreman and Kapteyn (1990) also treat household income and household consumption, respectively, as a public good.

[9]See also Bolin (1996), who considers a similar Stackelberg model in a noncooperative setting with two goods, and Apps and Rees (1996), who also distinguish among market work, household production, and leisure in their exchange model of the household, without, however, explicitly modeling the decision process.

We model the noncooperative game with two possible time-decision structures. First, we assume that both spouses choose their time allocation simultaneously. Second, we present an alternative model where one spouse chooses first. Thus, the spouses play a noncooperative Stackelberg game where the "leader" decides on his contributions to the public goods first and thereby sets the restrictions for the "follower". Why should one partner have a first-mover advantage and greater commitment effect than the other one? As Frank (1978) argues, the spouse who works longer hours and has accumulated more human capital (on average, this is the husband) is the spouse who will be willing to make fewer compromises and whose decisions thus may have a higher commitment effect. Another argument has been put forward by Elul et al. (2002). They analyze the gender wage gap as a consequence of demographics: Men tend to marry younger women. This age difference gives the husband a time advantage in the sequential decision game about time allocation. Neither paper considers the gender leisure gap, so our paper extends the wage gap analysis in this respect.

The simultaneous and the sequential contributions games lead to different, testable empirical hypotheses that allow one to discriminate between the models. The latter model leads to an asymmetric outcome. Moreover, if the hypothesis of a Stackelberg spouse is supported by the data, the empirical analysis can establish which spouse is the Stackelberg partner.

The empirical hypotheses are tested using the German Socio-Economic Panel (GSOEP). Within our structural model with symmetric household productivity, the hypothesis of partners making simultaneous choices is rejected by the data. The husband enjoys, other things equal, more leisure time than the wife, that is, he has a first-mover Stackelberg advantage. In particular, women who outearn their husbands bear a double time burden of market work plus household work. Given our assumptions, the empirical results are consistent with the sociological hypothesis that there is more to a gender-specific leisure gap than the wage differential between women and men.

To summarize the novel points in our approach that distinguish our model from that found in the standard literature, our first departure consists of modeling the asymmetry as a sequential time advantage in the private provision game. It is also feasible (even within Becker's unitary framework) to achieve an asymmetric outcome by assuming different preferences and/or household productivities. But to concentrate on the effect of the sequential decision structure, we choose to assume identical preferences and productivities because these latter effects have been extensively analyzed in the literature. Our second novelty is the consideration of leisure as a third good and, crucially, as the only private good because it cannot be transferred between household members.

The paper proceeds as follows: In Section 2, we outline the basic model. Sections 3 and 4 analyze the simultaneous and the sequential Stackelberg games. An empirical analysis of the relationship between the wage and the leisure gap, based on the GSOEP data, is given in Section 5. Alternative theoretical models potentially leading to a similar empirical hypothesis, and

the empirical robustness of the results, are discussed in Section 6. The last section summarizes the main results.

2 The model

We consider a model of intrafamily time allocation in which each spouse has an exogenously given time endowment T. This "time budget" T is allocated among three time uses: paid market work g, unpaid household work h, and leisure l:

$$T = g_i + h_i + l_i, \quad \text{with} \quad i = \text{f(emale), m(ale).} \tag{1}$$

The utility functions are given by

$$U^{\text{m}}(g_{\text{m}}, g_{\text{f}}, h_{\text{m}}, h_{\text{f}}, l_{\text{m}}) = G(w_{\text{m}}g_{\text{m}} + w_{\text{f}}g_{\text{f}}) + H(h_{\text{m}}, h_{\text{f}}) + V(l_{\text{m}}) \quad \text{and} \tag{2}$$

$$U^{\text{f}}(g_{\text{m}}, g_{\text{f}}, h_{\text{m}}, h_{\text{f}}, l_{\text{f}}) = G(w_{\text{m}}g_{\text{m}} + w_{\text{f}}g_{\text{f}}) + H(h_{\text{m}}, h_{\text{f}}) + V(l_{\text{f}}), \tag{3}$$

where $U^{\text{m}}(\cdot)$ and $U^{\text{f}}(\cdot)$ denote the utility of the husband and the wife, respectively. We use capital letters G, H, and V to denote the additive contribution to utility from market income, household production, and leisure, resulting from the spouses' allocation of those time uses: market work g_{m} and g_{f}, household work h_{m} and h_{f}, and leisure l_{m} and l_{f}, which are denoted with lowercase letters. As usual in the literature, a capital letter with a subscript will denote the first (partial) derivative, whereas a lowercase letter with a subscript denotes the origin of the contribution, *m*ale or *f*emale.

The assumption that the utility associated with each of the three time uses enters total utility in an additive way is certainly restrictive, but it is made for the sake of tractability of the model. It also ensures that all three time uses (leisure, market work, and household work) are "normal" in the sense that for an increase in the time endowment T, the spouses increase their time commitment to all three activities.[10] In the following, we state our assumptions about each utility component.

Market work G. The household receives a joint income $w_{\text{m}}g_{\text{m}} + w_{\text{f}}g_{\text{f}}$, where g_{m} and g_{f} denote his and her contributions to household income and w_{m} and w_{f} denote his and her exogenous and observable wages. Both spouses derive the same utility from market income given by $G = G(w_{\text{m}}g_{\text{m}} + w_{\text{f}}g_{\text{f}})$. One can think of household income as a joint bank account into which both spouses' income is transferred and from which the cost of rent, food, furniture, etc.

[10] This normality result guarantees the uniqueness of the equilibrium in the private provision game, see Bergstrom et al. (1986), and is usual in the literature.

is paid. It is irrelevant where the household's money income comes from: A dollar from *his* income is as valuable as a dollar earned by *her*. Although this linearity in the contributions allows in principle for situations where one partner is the only money earner, we will exclude such corner solutions (see below). G has a positive and decreasing first derivative.

Household work H. The husband and the wife also contribute to the household good production h_m and h_f (male and female, respectively). Again, both spouses also derive the same utility from household production, which we denote with $H = H(h_m, h_f)$. The household production technology is more general, allowing for cross effects between his and her contribution. This is the case for the production of goods and services like bringing up children, cooking, tidying up, etc. The household production function H has marginal productivities $H_{h_m} > 0$ and $H_{h_f} > 0$, with $H_{h_m h_m} < 0$ and $H_{h_f h_f} < 0$ and $H_{h_m h_f} < 0$ for the second derivatives. This last assumption means that the contributions h_m and h_f to household work H are substitutes.

Leisure time V. The residual time $l_i = T - g_i - h_i$, $i = m, f$ is the individual leisure time of the spouses. This is the time they spend reading a book, watching TV, surfing the Net, etc. In this paper, we also assume that the husband and wife have the same leisure utility, given by $V(l_i)$, $i = m, f$. V has a positive and decreasing first derivative.

Because we want to concentrate on the empirically relevant case of double-earner couples and avoid corner solutions, let us assume that $V'(0) = G'(0) = \infty$, $V'(t) = G'(w_m t) = G'(w_f t) = 0$, $\lim_{h_m \to 0} \frac{H_{h_m}}{H_{h_f}} = \lim_{h_f \to 0} \frac{H_{h_f}}{H_{h_m}} = \infty$. Throughout the following, we will assume interior equilibria where both spouses contribute to market work and household work and enjoy at least some private leisure.

Notice that both spouses derive the same utility from market income G, household production H, and leisure V. Besides, market income and household production are family public goods to which both partners contribute. The decision problems of the two partners are interrelated because the family public goods are provided privately. The only private good reflecting the spouses' relative position is personal leisure time l_i, $i = m, f$.[11]

3 The simultaneous game

Each spouse maximizes utility (2) or (3) subject to the time budget constraint (1) for a given contribution by the other spouse (Nash behavior). We

[11] From a theoretical point of view, we could subsume all household production into one single public good, "household output". Although this way of modeling would be simpler, it would not be clear whether new results were caused by having leisure as a good or by subsuming household output in one good. Therefore, we prefer to maintain the two familiar arguments as separate items (market and nonmarket work) and to include leisure as a third good.

obtain the following result when both spouses choose their time allocation simultaneously:

Proposition 1 *If both spouses make their decisions simultaneously, the interior Nash equilibrium is defined by*

$$\frac{V'(l_m)}{V'(l_f)} = \frac{w_m G'}{w_f G'} = \frac{w_m}{w_f} = \frac{H_{h_m}}{H_{h_f}}. \tag{4}$$

Proof Calculating the first-order conditions for an interior solution and rearranging leads to condition (4). □

Proposition 1 implies that, for husbands and wives with equal wage rates, the same amounts of leisure time result. This allows us to derive a testable hypothesis:

Hypothesis 1 *Suppose both spouses choose their contributions simultaneously. Then the better-paid spouse should have less leisure time, and we should observe similar amounts of leisure time in couples where the spouses have similar wage rates.*

4 The sequential Stackelberg game

What happens if one spouse is able to make the first decision or his decision carries more commitment? Without loss of generality, let us call this Stackelberg leader "husband". The time structure of the game is as follows:

1. The husband makes his choice about outside (money-earning) work and household work.
2. The husband's choice is observed by his wife.
3. The wife chooses her optimal amount of work.

Because there is no uncertainty and the wife takes the decision of her spouse as given, we solve the Nash equilibrium of this Stackelberg game through backward induction, calculating first the wife's optimal behavior as the Stackelberg follower. Her first-order conditions are given by

$$\frac{\partial U^f(h_m, h_f, g_m, g_f)}{\partial g_f} = -V'(l_f) + w_f G' = 0 \tag{5}$$

$$\frac{\partial U^f(h_m, h_f, g_m, g_f)}{\partial h_f} = -V'(l_f) + H_{h_f} = 0, \tag{6}$$

where the indices denote the partial derivative with respect to the variables and the arguments are omitted for the sake of clarity. The budget constraint

has been eliminated by setting $l_i = T_i - g_i - h_i, i = g, h$. These first-order conditions implicitly define the wife's best response functions $g_f(g_m, h_m)$ and $h_f(g_m, h_m)$ for a given choice by the husband. By the implicit function theorem, it can be shown:

$$\frac{\partial g_f(g_m, h_m)}{\partial g_m} = \frac{-w_f w_m G''(V_f'' + H_{h_f h_f})}{D} < 0 \tag{7}$$

$$\frac{\partial g_f(g_m, h_m)}{\partial h_m} = \frac{V_f'' H_{h_m h_f}}{D} > 0 \tag{8}$$

$$\frac{\partial h_f(g_m, h_m)}{\partial g_m} = \frac{w_f w_m G'' V_f''}{D} > 0 \tag{9}$$

$$\frac{\partial h_f(g_m, h_m)}{\partial h_m} = \frac{-(w_f{}^2 G'' + V_f'') H_{h_m h_f}}{D} < 0, \tag{10}$$

where the denominator is $D = (w_f{}^2 G'' + V_f'')(V_f'' + H_{h_f h_f}) - (V_f'')^2$. D is the determinant of the 2x2 unbordered Hessian corresponding to the wife's optimization problem. Our assumptions about V, G, and H guarantee that the second-order conditions for the wife's optimization problem are fulfilled. D is therefore positive.

That the reaction functions (7) and (10) are downward sloping is well established in the literature on the private provision of public goods.[12] If the husband contributes more to one public good, the wife has an incentive to reduce her contribution to this public good, e.g., to do less out-of-home or household work, respectively. The reaction functions (8) and (9) are different. Consider Eq. (8): If the husband contributes more to household work $dh_m > 0$, this reduces the wife's marginal utility of household work because we have assumed h_f and h_m to be substitutes. Therefore, the wife shifts time from household work into gainful employment and leisure. Equation (9) shows that the wife reacts with an increased contribution to household production if the husband makes a larger contribution to the common income $dg_m > 0$.

We can formulate the maximization problem of the Stackelberg leader as

$$\max U^m(h_m, g_m) = V(l_m) + G(w_m g_m + w_f g_f(g_m, h_m)) + H(h_m, h_f(g_m, h_m)),$$

which leads to the following first-order conditions:

$$\frac{\partial U^m(h_m, h_f, g_m, g_f)}{\partial g_m} = -V'(l_m) + w_m G' + w_f G' \frac{\partial g_f}{\partial g_m} + H_{h_f} \frac{\partial h_f}{\partial g_m} = 0, \tag{11}$$

[12] See for instance Bergstrom et al. (1986).

$$\frac{\partial U^{\mathrm{m}}(h_{\mathrm{m}}, h_{\mathrm{f}}, g_{\mathrm{m}}, g_{\mathrm{f}})}{\partial h_{\mathrm{m}}} = -V'(l_{\mathrm{m}}) + w_{\mathrm{f}} G' \frac{\partial g_{\mathrm{f}}}{\partial h_{\mathrm{m}}} + H_{h_{\mathrm{m}}} + H_{h_{\mathrm{f}}} \frac{\partial h_{\mathrm{f}}}{\partial h_{\mathrm{m}}} = 0. \quad (12)$$

Combining the four first-order conditions (5), (6), (11), and (12), we obtain the following optimality conditions for the time allocation of the couple:

$$\frac{V'(l_{\mathrm{m}})}{V'(l_{\mathrm{f}})} = \frac{w_{\mathrm{m}} G' + w_{\mathrm{f}} G' \frac{\partial g_{\mathrm{f}}}{\partial g_{\mathrm{m}}} + H_{h_{\mathrm{f}}} \frac{\partial h_{\mathrm{f}}}{\partial g_{\mathrm{m}}}}{w_{\mathrm{f}} G'} \quad (13)$$

$$= \frac{H_{h_{\mathrm{m}}} + w_{\mathrm{f}} G' \frac{\partial g_{\mathrm{f}}}{\partial h_{\mathrm{m}}} + H_{h_{\mathrm{f}}} \frac{\partial h_{\mathrm{f}}}{\partial h_{\mathrm{m}}}}{H_{h_{\mathrm{f}}}}. \quad (14)$$

The four reaction functions $\frac{\partial g_{\mathrm{f}}}{\partial g_{\mathrm{m}}}$, $\frac{\partial h_{\mathrm{f}}}{\partial g_{\mathrm{m}}}$, $\frac{\partial g_{\mathrm{f}}}{\partial h_{\mathrm{m}}}$, and $\frac{\partial h_{\mathrm{f}}}{\partial h_{\mathrm{m}}}$ reflect the sequential nature of the game structure. If we eliminate those reaction functions by setting them to zero, we arrive at solution (4) of the simultaneous game.

From the wife's first-order conditions (5) and (6), we obtain $H_{h_{\mathrm{f}}} = wG'$. The right-hand side (RHS) of Eq. (13) simplifies to:

$$w_{\mathrm{m}} G' + w_{\mathrm{f}} G' \frac{\partial g_{\mathrm{f}}}{\partial g_{\mathrm{m}}} + H_{h_{\mathrm{f}}} \frac{\partial h_{\mathrm{f}}}{\partial g_{\mathrm{m}}} = w_{\mathrm{m}} G' + w_{\mathrm{f}} G' \left(\frac{\partial g_{\mathrm{f}}}{\partial g_{\mathrm{m}}} + \frac{\partial h_{\mathrm{f}}}{\partial g_{\mathrm{m}}} \right)$$

$$= \frac{w_{\mathrm{m}}}{w_{\mathrm{f}}} + \left(\frac{\partial g_{\mathrm{f}}}{\partial g_{\mathrm{m}}} + \frac{\partial h_{\mathrm{f}}}{\partial g_{\mathrm{m}}} \right).$$

In an analogous way, we transform the RHS of condition (14) and arrive at the following proposition:

Proposition 2 *Assume that (without loss of generality) the husband m is the Stackelberg leader and can make his decisions first. The interior Nash equilibrium of this sequential game is defined by the following conditions:*

$$\frac{V'(l_{\mathrm{m}})}{V'(l_{\mathrm{f}})} = \frac{w_{\mathrm{m}}}{w_{\mathrm{f}}} + \frac{\partial g_{\mathrm{f}}}{\partial g_{\mathrm{m}}} + \frac{\partial h_{\mathrm{f}}}{\partial g_{\mathrm{m}}} = \frac{H_{h_{\mathrm{m}}}}{H_{h_{\mathrm{f}}}} + \frac{\partial g_{\mathrm{f}}}{\partial h_{\mathrm{m}}} + \frac{\partial h_{\mathrm{f}}}{\partial h_{\mathrm{m}}}. \quad (15)$$

In the following, we will analyze several subcases of the sequential model. For this purpose, let us define the husband's wage and leisure time as functions of the wife's corresponding variables: The husband's wage is $w_{\mathrm{m}} = w_{\mathrm{f}} + \Delta w$, and the husband's leisure time is $l_{\mathrm{m}} = l_{\mathrm{f}} + \Delta l$. The variables Δw and Δl denote the wage gap and the leisure gap, respectively.

4.1 A negative wage gap

Consider first the situation where the wife earns a higher wage than her partner: The wage gap is negative. The husband earns less than his wife, and he enjoys more leisure. Because the first term in condition (15) (the wage "ratio")

is smaller than 1 and the sum of the reaction functions is always negative, the expression in Eq. (15) is smaller than 1. The condition will always be fulfilled as long as the husband earns a lower wage than his wife. Given our structural assumptions regarding symmetric household productivity and additive separable utility, the interior equilibrium of the sequential Stackelberg model in this situation is characterized by a negative wage gap and a positive leisure gap: Husbands who are outearned by their wives enjoy more leisure time than their partners.

This sequential model is consistent with the findings of Brines (1994), Daly (1996), and Greenstein (2000) concerning couples where the female earns a higher wage or is less economically dependent and still enjoys less leisure time than her partner. Intuitively, this is the case because the husband benefits both from his Stackelberg leadership and from his wife's higher wage productivity in the marketplace.

4.2 Equal wages

Assume next that the female wage remains fixed but the male wage increases and thus the wage gap diminishes. The husband's increased market productivity makes him shift some time to market work. His wife reacts by reducing her commitment to market work and increasing both household work and leisure time.

Consider now the special case where the market wages of both partners are equal, $w_m = w_f$. Even when both partners have the same contribution costs to the public goods, we would expect the husband to benefit from his Stackelberg advantage. This amounts to a reduction in his contributions to the public goods and to enjoying more leisure compared to the Nash equilibrium when both spouses make simultaneous decisions.

$$\frac{V'(l_m)}{V'(l_f)} = \frac{w_m}{w_f} + \frac{\partial g_f}{\partial g_m} + \frac{\partial h_f}{\partial g_m} \tag{16}$$

$$= 1 + \left(\frac{\partial g_f}{\partial g_m} + \frac{\partial h_f}{\partial g_m}\right) \tag{17}$$

$$= 1 + \underbrace{\left(\frac{-w_f w_m G'' H_{h_f h_f}}{D}\right)}_{<0} < 1 \tag{18}$$

Because "his" marginal utility of leisure is smaller than "her" marginal utility of leisure, the husband as Stackelberg leader enjoys more leisure time than his wife, $l_m > l_f$. Intuitively, this is the case because, if the husband contributes more to the public good market work, $dg_m > 0$, this always leads to a greater (absolute) change of his wife's commitment to G than of her commitment to H.

In other words, the "direct" effect (in absolute terms) exceeds the "indirect" effect:

$$0 < \frac{\partial h_f}{\partial g_m} < \left| \frac{\partial g_f}{\partial g_m} \right| < 1. \tag{19}$$

Proposition 2 implies that, for husbands and wives with equal wage rates, the husband uses his Stackelberg advantage and reduces his contributions to the public goods, thereby enjoying more leisure. This leads to the next testable hypothesis:

Hypothesis 2 *Consider couples where the spouses have similar wage rates and assume that spouses choose their contributions sequentially. We expect that the spouse being the Stackelberg leader, and thereby choosing first, enjoys more leisure time than his partner.*

4.3 A large, positive wage gap

For a very large wage differential, it can be shown that the direct effect of the wage gap is larger than the reaction effect; that is, the RHS of Eq. (16) is greater than 1. In this situation, the husband enjoys less leisure than his spouse *despite* being the Stackelberg leader. Intuitively, this happens because his market productivity is so much higher than his wife's that it dilutes his Stackelberg advantage.

We know from inequality (19) that, in absolute terms, the direct effect on g_f of a change of g_m exceeds the indirect effect on h_f. Because even the direct effect $\frac{\partial g_f}{\partial g_m}$ can never be greater than 1, the bracketed term in inequality (17) is always negative, but never smaller than -1. For a wage ratio greater than 2, the RHS of Eq. (17) will always be greater than 1:

$$\frac{w_m}{w_f} + \left(\frac{\partial g_f}{\partial g_m} + \frac{\partial h_f}{\partial g_m} \right) > 2 + \underbrace{\left(\frac{\partial g_f}{\partial g_m} + \frac{\partial h_f}{\partial g_m} \right)}_{-1<(\cdot)<0} > 1 \tag{20}$$

$$\Longrightarrow \qquad V'(l_m) > V'(l_f) \tag{21}$$

$$l_m < l_f. \tag{22}$$

When the wage gap is "large enough," the leisure gap is negative, and the husband takes less free time than his wife.

4.4 Comparative statics

How does the (leisure) time allocation change in reaction to an exogenous change of the relative wages? Suppose that the male wage increases, $dg_m > 0$. The term with the wage ratio on the RHS of Eq. (16) also adjusts to a wage change. If there were no further reactions, the left-hand side (LHS) would have to increase, i.e., the husband would shift time away from leisure. But the reaction functions on the RHS of Eq. (16) also change with a wage change. In

the following, we turn to this more general case and analyze the effect of the wage gap on the leisure gap. We can re-state the first equilibrium condition of expression (15) corresponding to the sequential Stackelberg game in terms of the leisure gap:

$$F(\Delta l, w_{\mathrm{m}}, w_{\mathrm{f}}) := -\frac{V'(l_{\mathrm{f}} + \Delta l)}{V'(l_{\mathrm{f}})} + \frac{w_{\mathrm{m}}}{w_{\mathrm{f}}} + \frac{\partial g_{\mathrm{f}}}{\partial g_{\mathrm{m}}} + \frac{\partial h_{\mathrm{f}}}{\partial g_{\mathrm{m}}} \equiv 0, \tag{23}$$

We obtain the following negative relationship between the wage gap and the leisure gap:

Proposition 3 *Assume the following properties of the function* $G(w_{\mathrm{m}}g_{\mathrm{m}} + w_{\mathrm{f}}g_{\mathrm{f}})$*, which describes the contribution of market income to utility:* $G''' > 0$ *and* $-w_{\mathrm{f}}g_{\mathrm{f}}\frac{G'''}{G''} < 2$*. Then the leisure gap* Δl *decreases if the male (female) wage increases (decreases) for all* $dw_{\mathrm{m}} > dw_{\mathrm{f}}$*:*

$$\frac{d(\Delta l)}{dw_{\mathrm{m}}} dw_{\mathrm{m}} + \frac{d(\Delta l)}{dw_{\mathrm{f}}} dw_{\mathrm{f}} < 0. \tag{24}$$

Proof See Appendix. □

Basically, what Proposition 3 states is that, the larger the wage gap, the lower the leisure gap. As the male relative wage increases, the husband's leisure time decreases and the wife's leisure disadvantage diminishes. To obtain a monotonic result with respect to the wage gap, additional assumptions are needed. For equal wages $w_{\mathrm{m}} = w_{\mathrm{f}}$, the husband still has more leisure because he is able to extract a leisure rent from his Stackelberg leadership, although both spouses have the same market productivity. If the male wage increases further, there will be a critical, "large enough" wage differential where the leisure gap Δl turns negative, e.g., the husband enjoys less leisure than his spouse *despite* being the Stackelberg leader.

What is the intuitive explanation behind the additional requirements of Proposition 3? Suppose the male wage rises and the husband increases his commitment g_{m} to the joint household income. The wife is better off, and the effect amounts to a time budget increase for the wife in units of household income. Let us call this effect the "endowment effect" (in analogy to the usual income effect, where, in our setting, income is time). Because all goods are normal, the wife increases her commitments to H (household work) and V (leisure), therefore, increasing her leisure time. But this adjustment also makes the husband better off. If the additional conditions apply, the endowment effect decreases in the male wage, and this ensures that the indirect reaction of the wife to the male wage increase is small enough, leading to a smaller leisure gap. The opposite effect works in a similar way: A female wage increase leads to a smaller leisure gap if the endowment effect increases in the female wage.

The requirement of $G''' > 0$ resembles the coefficient of relative prudence as defined by Kimball (1990). In the theory of precautionary saving under uncertainty, the relative prudence influences the optimal variable choice under risk. In analogy to a "prudent" individual who reacts to increased income

uncertainty by increasing her precautionary saving to avoid very low levels of income in the future, a "prudent" wife reacts to a wage increase by increasing her leisure time to avoid a high market work output and a low leisure level. Of course, the analogy is not perfect because, in the original prudence setting, we have real uncertainty. But in our model, the comparative statics result of the wife's optimal choice is also determined by the third derivative.

We summarize our results in the following conjecture:

Hypothesis 3 *If both spouses choose their contributions sequentially and under the additional assumptions of Proposition 3, we expect a negative, monotonic relationship between the wage gap and the leisure gap.*

5 Empirical analysis

Theoretically, we have developed three testable hypotheses that allow us to discriminate between the model where both spouses choose simultaneously and the Stackelberg sequential model. For spouses earning a similar wage (i.e., for a zero wage gap), the distribution of leisure may provide information about the timing of decisions within the couple (Hypothesis 1 vs Hypothesis 2).

If Hypothesis 1 is rejected empirically and the data are consistent with Hypothesis 2 (i.e., one spouse has a time-decision advantage), we can further check whether the data are consistent with Hypothesis 3: If the husband earns less than his wife, he will enjoy more leisure than his wife.[13] The husband gains both from his Stackelberg leadership and from his wife's higher productivity in the marketplace. As the wage gap diminishes and turns positive, the husband's increased market productivity makes him shift some time from leisure to market work. His wife reacts by reducing her commitment to market work and increasing both household work and leisure time. For a large enough wage gap, the leisure gap turns negative, and the husband enjoys less free time than his wife.

We now investigate the empirical relationship between the wage gap and the leisure gap with data from the GSOEP. The GSOEP is a set of representative micro data of the German population, gathered since 1984 for West Germany and since 1990 for East Germany. Although far from being as informative as a time-use survey as regards the individual use of (leisure) time, the GSOEP has the advantage of containing many additional socioeconomic variables, e.g., the reported time spent on different activities as well as data on various sources of income, particularly earned income, and working hours.[14] This information is necessary to compute the hourly wage rate and, hence, the difference in wages

[13] See Section 6 for alternative theoretical models that may be compatible with our empirical results.

[14] Individual wage income, in particular, cannot be taken for granted in time-use surveys. The German time budget surveys from 1991/1992 and 2001/2002 do not include individual gross labor income.

Table 1 Sample characteristics

Variables	Mean	Standard Deviation	Minimum	Maximum
Age, wife	39.00	8.94	20.00	60.00
Age, husband	41.53	9.23	20.00	60.00
Age difference	2.53	3.87	−14.00	26.00
Gross hourly wage, wife	21.54	9.92	2.03	118.70
Gross hourly wage, husband	27.77	12.82	2.11	154.07
Wage difference (h–w)	6.22	12.63	−102.71	134.30
Part-time wife	0.41	0.49	0.00	1.00
East Germany	0.37	0.48	0.00	1.00
Married	0.83	0.38	0.00	1.00
Number of children	0.70	0.87	0.00	5.00
Child <3	0.05	0.22	0.00	1.00
Child 4–6	0.10	0.30	0.00	1.00
Child 7–12	0.24	0.43	0.00	1.00
Child <3*No care	0.03	0.18	0.00	1.00
Leisure per day (hours), wife	1.81	1.41	0.00	12.29
Leisure per day (hours), husband	1.90	1.45	0.00	10.00
Leisure gap (h–w)	0.10	1.35	−9.00	7.14
Disposable time (hours), wife	12.46	2.73	8.00	21.86
Disposable time (hours), husband	13.23	2.34	8.00	24.00
Disposable time gap (h–w)	0.77	2.53	−13.29	10.86

Notes: Based on a sample of 5,240 observations from 2,810 dual-earner couples, age 20–60, in GSOEP waves 1993, 1995, 1997, 1999, and 2001. Wages in German marks.

between spouses. Due to changes in the questionnaire over time, only the uneven years 1993, 1995, 1997, 1999, and 2001 yield comparable information on time use.[15] Hence, these five waves constitute our unbalanced panel. We restrict the sample to couples (married or cohabiting) where both spouses are gainfully employed and report a positive hourly wage rate. It is further limited to adults between the ages of 20 and 60 to prevent the results from being excessively affected by education decisions and early retirement behavior, possibly accompanied by special part-time work arrangements.

Table 1 summarizes the characteristics of the pooled sample, with 5,240 unweighted observations from 2,810 couples. Wives are 39 years old on average, husbands almost 42. Men outearn women by 6.22 German marks

[15] The time-use data in the GSOEP are based on the following questions: "What does your typical (work)day look like? How many hours do you spend on the following activities?

- occupation (including multiple jobs and commuting time),
- housework and shopping,
- child care,
- repairs to the house or the car and garden work,
- education, training,
- hobbies, and other leisure activities."

Hours are to be given for weekdays, Saturdays, and Sundays separately by both the husband and the wife. The 2001 wave additionally contains time spent with those in need of care, which we consider household production time.

(approx. 3.19 euros) in terms of hourly gross earnings. Forty-one percent of the wives in the sample work part time. Thirty-seven percent of the couples live in East Germany, which means that East Germans are overrepresented both due to oversampling and to the larger percentage of dual-earner couples in the eastern part of Germany. A majority of 83% is married. Five percent have at least one child under 3 years of age, three fifths of which have no institutional care to rely on. Ten percent of couples live with a child age 4 to 6 and 24% with a child 7 to 12. As regards leisure time, we have different variables to choose from.

Respondents are asked to report the average amount of time per day spent on hobbies and other leisure activities. In Table 1, "leisure" denotes the amount of time explicitly reported as leisure. However, this measure does not accurately reflect the residual private (leisure) time enjoyed by each individual as modeled in our theoretical analysis. Therefore, we have constructed a variable, denoted by "disposable time" in Table 1, measuring the individual's disposable time as the residual of total daily time minus all work activities (see note (16) for the detailed activities). This variable includes both genuine leisure and regeneration time (sleeping, eating, etc.). To cope with a few respondents who reported simultaneous activities cumulating to more than 24 h per day, "disposable time" needs to be censored (we assume a minimum of 8 h per day, i.e., we limit the sum of all work activities to 16 h per day). Both leisure variables reveal a positive gap for the husband. The difference in "disposable time" amounts to 0.77 hours (46 min) between the spouses.[16]

Table 2 reports the findings on the relationship between the leisure gap and the wage gap between spouses in a panel regression while taking into account individual heterogeneity. Individual effects are assumed exogenous in a random effects specification (see Section 6 for details on an alternative fixed effects specification).

The first model in Table 2 is our basic regression of the absolute difference between husbands' and wives' disposable time on the absolute difference between gross hourly wages as the only explanatory variable. Notice that the intercept is positive: For a zero wage gap (equal wages), we obtain a positive leisure gap. This result rejects Hypothesis 1 (which predicts also a zero leisure gap) and is compatible with Hypothesis 2. Because, on average, for equal wages, the husband enjoys more leisure time than his wife, this supports the hypothesis that it is the male spouse who chooses first within the couple, which confirms the observations in the sociological literature cited above. The coefficient of the wage gap is negative and statistically significant at the 1% level, i.e., the larger the husband's wage rate compared to his wife's, the less leisure time he enjoys. Both the positive intercept and the negative relationship between the wage gap and the leisure gap are confirmed in the

[16]Notice that the wage and leisure gaps, on their own, are not statistically significantly different from zero. This is due to the high variation in our data and is not the focus of our analysis. Our hypothesis does not consider the wage and the leisure gaps on their own, but the (negative) relationship between them, which may indeed be both statistically and economically significant.

Table 2 Estimation of the intrafamily difference in disposable time with random effects

Explanatory variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coefficient	*t* val.	Coefficient	*t* val.	Coefficient	*t* val.	Coefficient	*t* val.	Coefficient	*t* val.
Constant	0.840**	18.00	1.042**	9.56	0.517**	4.62	0.531**	4.74	−0.074	−0.35
Wage difference (h–w)	−0.013**	−4.22	−0.015**	−4.69	−0.015**	−4.79	−0.016**	−4.93	−0.020**	−5.77
Wage level (wife)			−0.009**	−2.05	−0.003	−0.77	−0.003	−0.85	−0.008*	−1.93
No. of children					0.160**	2.46	0.155**	2.39	0.145**	2.22
Child <3					1.058**	6.74	0.432*	1.74	0.545**	2.18
Child 4–6					0.868**	6.86	0.870**	6.89	0.934**	7.28
Child 7–12					0.601**	5.38	0.603**	5.41	0.638**	5.69
Child <3*No care							0.973**	3.26	0.907**	3.02
Married									0.146	1.32
Age, wife									0.015**	2.90
Age difference (h–w)									0.029**	2.78
East Germany									−0.144	−1.55
R^2 within	0.0008		00.0012		0.0211		0.0222		0.0221	
R^2 between	0.0047		00.0058		0.0772		0.0803		0.0880	
R^2 overall	0.0060		00.0068		0.0542		0.0564		0.0626	

Notes: Based on a sample of 5,240 observations from 2,810 dual-earner couples, age 20–60, in GSOEP waves 1993, 1995, 1997, 1999, and 2001.

*At the 10% significance level.

**Indicates statistical significance at the 5%.

following steps when supplementary variables are included in more refined model specifications.

In addition to the wage difference, we first control for the wage level (Model 2). The negative coefficient estimate of the wage gap remains, whereas the wage level is also negatively related to the difference in disposable time. High-earning women face a smaller intrahousehold inequality in leisure time, suggesting that women (and men) in high-income households have more leisure than those in poorer households.

In Model 3, information on children in the household is added. The more children under 16 present, the larger the leisure gap between mother and father. The presence of small children up to 3 years old adds further to this difference in a significant magnitude. The presence of older offspring has positive, although smaller, effects on the leisure gap: The older the age category, the smaller the estimated coefficient. When including an interaction term for children for whom no institutional care is available (Model 4), the coefficient of the children dummy is much smaller and statistically significant at the 10% level only, implying that mothers' leisure is not only affected by the fact of having small children but mainly by not having them looked after. Considering the significant effect of having children, it may be argued that the existence of children alone leads to the leisure gap. This hypothesis is rejected by a regression of a sample of childless couples (see Section 6 on sample definition).

Model 5, finally, brings in several variables that are possibly correlated with the family model pursued by the couple. Marriage, for instance, may be more likely among those couples pursuing a more traditional role model where the husband is the main earner and the wife carries responsibility for housework and child care. If the wife decides to take on gainful employment in this setting, she has to deal with a double shift. The traditional role model may also be more likely for older couples as reflected by the wife's age in the regression equation (cohort effect).

The age difference between husband and wife is also possibly related to the extent to which human capital and job decisions have been made sequentially. Men may "dominate" the family decision-making process on time allocation by deciding first, as in the job-matching model by Frank (1978), where the husband optimizes his individual job search in the first place and the wife optimizes her job search for a given choice by her husband. In our analysis, the wife's age and the spouses' age difference are positively related to the leisure gap. In accordance with our expectations, this may indicate that women of older cohorts and those who are much younger than their husbands have relatively less time at their disposal. Note that the age difference and the cohort effect take up the positive constant of the previous models, indicating that the male Stackelberg advantage is, in fact, mostly prevalent in the time-use decisions of older couples.

The variables "being married" and "living in East Germany" yield no significant coefficient estimates. Further regressions show that education is not significantly related to the leisure gap, neither the wife's years in schooling nor

the difference in schooling years between the husband and the wife. Finally, we also tested for a nonlinear relationship by including higher-order polynomials of the wage gap. These did not yield statistically significant results.

6 Discussion

Our theoretical model makes several assumptions, some of them not standard in the literature. The utility of both husband and wife is additively separable in the three time uses market income, household production, and private leisure. Crucially, we assume that the husband and wife have equal preferences and equal household productivity. Within this setting, we analyze simultaneous and sequential decision making and find that our data reject the hypothesis that working men and working women choose their time allocation simultaneously. Besides, the wage gap is found to have an additional effect on the leisure gap within couples. However, we would like to discuss a few possible theoretical complications and additional empirical robustness tests we used to back up our results.[17]

Alternative models. Our empirical results are consistent with sequential decision making given our specific assumptions, but they may also be consistent with other hypotheses that cannot be discriminated against with our data. In particular, we assume that men and women have equal preferences and equal productivities. In alternative models used in the literature, one spouse is assumed to have specific preferences or a productivity advantage, which also results in an asymmetric outcome. It is precisely our aim to show that an asymmetric distribution can also be the result of the decision-making process within the couple, other things equal. Using suitable assumptions regarding the threat points, for instance, Nash bargaining models could be set up such that family members' behavior leads to an asymmetric outcome.[18] However, an asymmetric Nash bargaining model where the wife earns a higher wage and thus has a better outside option would never lead to the wife having a worse position than her husband. Moreover, a symmetric Nash bargaining model with symmetric threat points would not lead to an asymmetric outcome.

Determinants of Stackelberg advantage. In our setting, the driving force behind our results is the Stackelberg position. One may argue that this position is endogenously determined within the couple and that the high-income spouse becomes the Stackelberg leader in the household's time allocation decision game. To check this possibility, we split our sample in three subsamples corresponding to a positive, a zero, and a negative wage gap and estimate

[17] All additional estimation results are available from the authors on request.

[18] We are grateful to an anonymous referee for pointing this out.

our model for the subsamples. If the wage gap was the variable determining the time-decision structure, we should observe no effect on the leisure gap for a zero wage gap. But in the zero-wage-gap sample, the husband still has a Stackelberg advantage, thus rejecting the hypothesis that the wage gap is the determining variable. In line with the sequential job-search argument, it may also be argued that the Stackelberg leader does not necessarily have to be the husband but simply the older of the two spouses. Thus, we investigated whether the results are the same for couples where the wife is older than the husband. Even in this case, the hypothesis of the Stackelberg advantage of the husband is supported.

Fixed effects model. It may be argued that, in an analysis of the determinants of the intrafamily leisure gap, the individual-specific, or couple-specific, effects shall be treated as fixed effects because couples' preferences toward time allocation may differ systematically rather than randomly. When applying fixed instead of random effects, however, time-constant variables cannot be analyzed as explanatory variables. Because a couple's age difference hardly changes from year to year, and neither does being married or living in East Germany, these variables cannot be included in a fixed effects specification. In any case, a Hausman test on the hypothesis of the appropriateness of a random effects specification cannot be rejected (test statistic $= 15.79$).

Sample definition: presence of children and full-time employment. To check whether the result applies to all subsamples, we ran additional robustness regressions on two subsamples: childless couples and couples where both spouses are employed full time. Regarding the effect of children (see Section 5), it may be argued that the presence of children is a major contributor to the wage gap between parents. Furthermore, child care may be seen as encompassing both work and leisure activities, thus imposing a definition problem in the distinction between work and leisure. However, the results of the control regression on a sample of childless couples are basically similar, in particular with respect to the statistically significant negative relationship between the wage gap and the leisure gap and the Stackelberg hypothesis. Thus, our results do not depend on the presence of children.

Second, we ran a control regression considering only couples with both spouses employed full time. Again, our main results are confirmed. The only difference is the fact that the variable "living in East Germany" is also statistically significantly related to the leisure gap. This variable is meant to take up the cultural aspect of family time-use arrangements as well as the greater availability of institutional child care in East Germany.[19] On average, East German working couples experience a more equal distribution of leisure time between spouses. In an alternative specification, we modified the regional indicator, but the inclusion of a variable indicating whether the

[19]The provision of all-day child care is much more extensive in East Germany than in West Germany; see Spieß et al. (2002).

woman originates from East Germany did not reveal any correlation with the leisure gap. Thus, the negative coefficient of living in East Germany seems to capture the provision of public child care rather than cultural differences between the two regions.

Assortative matching. A further matter of concern may be a possible "matching bias" in the data, i.e., that, if people do not match by chance, but instead choose partners with a common social, cultural, or economic background. This self-selection effect would tend to equalize all wage gaps and work against our findings. Thus, our results may underestimate the true link between the wage gap and the leisure gap.

Summing up, all empirical estimations and robustness checks lead us to reject the hypothesis that spouses choose simultaneously. Instead, the husband is the Stackelberg leader and enjoys more leisure time. Only when there is a large enough wage gap between husband and wife does the husband's higher productivity in the market place lead to more leisure time for his wife.

7 Conclusions

In this paper we explicitly model leisure time decisions within a couple. This allows us to establish a direct link connecting the leisure gap and the wage gap between spouses. We depart from the assumption widely used in the literature that men and women differ in their preferences and household productivities and show that asymmetric results may be caused by sequential decision making within the family. Even with equal wage rates, men enjoy more leisure than their wives, but with larger wage differentials, this leisure gap diminishes. Our empirical results are consistent with this Stackelberg behavior. Social structures in which the male makes the first move lead to an intrafamily time allocation that keeps women out of full-time employment because doing so maximizes their disposable free time or minimizes their leisure reduction, respectively.

In our setting, the gender-specific leisure gap results not only from the pay differential between men and women but also from socially based gender inequality. Hence, if the policy goal is to abolish this gender inequality, social structures that define gender roles decisive for asymmetries in family decision making will have to change. The asymmetric decision process, in which women usually adapt to the career needs of their husbands, and the structural discrimination against women in the labor market (e.g., through lower wages) may foster a vicious circle of a self-enhancing wage–leisure gap phenomenon. Or, as Daly (1996, 153) puts it: "In as much as women's work is consistently linked with lower power, prestige, and material rewards than men's work..., men continue to enjoy advantages in the control of their time by virtue of their status advantages."

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Appendix

Proof of Proposition 3 First, let us derive the effect of a change in the time endowment T on the optimal choice of the wife with the help of the first-order conditions (5) and (6). We will call this reaction "endowment effect" in analogy to the usual income effect:

$$\frac{dl_f}{dT} = \frac{w_f^2 G'' H_{h_f h_f}}{D}$$

$$= \frac{w_f^2 G''(w_m g_m + w_f g_f) H_{h_f h_f}}{w_f{}^2 G''(w_m g_m + w_f g_f) V_f''(l_f) + w_f{}^2 G''(w_m g_m + w_f g_f) H_{h_f h_f} + V_f''(l_f) H_{h_f h_f}} > 0, \tag{25}$$

where $D > 0$ is the determinant from above corresponding to the wife's optimization problem.

We can then calculate the reaction of this endowment effect to a wage change:

$$\frac{d(\frac{dl_f}{dT})}{dw_f} = \frac{D H_{h_f h_f} N_f - w_f^2 G'' H_{h_f h_f} N_f (V_f'' + H_{h_f h_f})}{D^2} \tag{26}$$

$$= \frac{(N_f H_{h_f h_f})\left(D - w_f^2 G''(V_f'' + H_{h_f h_f})\right)}{D^2} \tag{27}$$

$$= \frac{(N_f H_{h_f h_f})\left(w_f^2 G'' V_f'' + w_f^2 G'' H_{h_f h_f} + V_f'' H_{h_f h_f} - w_f^2 G''(V_f'' + H_{h_f h_f})\right)}{D^2} \tag{28}$$

$$= \frac{(N_f H_{h_f h_f}) V_f'' H_{h_f h_f}}{D^2} = \frac{N_f V_f'' H_{h_f h_f}^2}{D^2} > 0 \quad \text{if} \quad N_f < 0, \tag{29}$$

$$\frac{d(\frac{dl_f}{dT})}{dw_m} = \frac{D H_{h_f h_f} N_m - w_f^2 G'' H_{h_f h_f} N_m (V_f'' + H_{h_f h_f})}{D^2} \tag{30}$$

$$= \frac{(N_m H_{h_f h_f})\left(D - w_f^2 G''(V_f'' + H_{h_f h_f})\right)}{D^2} \tag{31}$$

$$= \frac{(N_m H_{h_f h_f})(V_f'' H_{h_f h_f})}{D^2} = \frac{N_m V_f'' H_{h_f h_f}^2}{D^2} < 0 \quad \text{if} \quad N_m > 0, \tag{32}$$

where $N_f = (2w_f G'' + w_f^2 G''' g_f)$ and $N_m = (w_f^2 G''' g_m)$. The expressions N_f and N_m are the derivatives (with respect to w_f and w_m, respectively) of the numerator of the endowment effect $\frac{dl_f}{dT}$ corrected for the term $H_{h_f h_f}$. N_f and N_m both determine the direction of the endowment effect.

Consider now the first-order condition given by expression 23:

$$F(l_f, \Delta l, w_m, w_f) = -\frac{V'(l_f + \Delta l)}{V'(l_f)} + \frac{w_m}{w_f} + \frac{\partial g_f}{\partial g_m} + \frac{\partial h_f}{\partial g_m} \tag{33}$$

$$= -\frac{V'(l_f + \Delta l)}{V'(l_f)} + \frac{w_m}{w_f} + \frac{-w_f w_m G''(w_m g_m + w_f g_f)(V_f''(l_f) + H_{h_f h_f}(h_m, h_f))}{D} + \frac{w_f w_m G''(w_m g_m + w_f g_f) V_f''(l_f)}{D} \tag{34}$$

$$= -\frac{V'(l_f + \Delta l)}{V'(l_f)} + \frac{w_m}{w_f} - \frac{w_f w_m G''(w_m g_m + w_f g_f) H_{h_f h_f}(h_m, h_f)}{D} \equiv 0. \tag{35}$$

Substituting the endowment effect into the last term of expression 35 gives:

$$F(l_f, \Delta l, w_m, w_f) = -\frac{V'(l_f + \Delta l)}{V'(l_f)} + \frac{w_m}{w_f} - \frac{w_m}{w_f}\frac{dl_f}{dT} \tag{36}$$

$$= -\frac{V'(l_f + \Delta l)}{V'(l_f)} + \frac{w_m}{w_f}\left(1 - \frac{dl_f}{dT}\right) \equiv 0. \tag{37}$$

We are interested in the change of Δl when the male wage w_m increases and/or the female wage w_f decreases, leading to an increased wage gap, i.e., when $dw_m > dw_f$. By the implicit function theorem, we obtain for the expressions $\frac{d\Delta l}{dw_f}$ and $\frac{d\Delta l}{dw_m}$:

$$\frac{d\Delta l}{dw_f} = \frac{\frac{\partial F(\Delta l, w_f, w_m)}{\partial w_f}}{\frac{\partial F(\Delta l, w_f, w_m)}{\partial(\Delta l)}} = -\frac{\overbrace{-\frac{w_m}{w_f^2}}^{(-)} \overbrace{\left(1 - \frac{dl_f}{dT}\right)}^{(+),\text{by normality}} - \overbrace{\frac{w_m}{w_f}}^{(+)} \overbrace{\left(\frac{d(\frac{dl_f}{dT})}{dw_f}\right)}^{(+),\text{by assumption, see Eq. 29}}}{\underbrace{-\frac{V''(l_f + \Delta l)}{V'(l_f)}}_{(+)}} > 0 \tag{38}$$

$$\frac{d\Delta l}{dw_m} = \frac{\frac{\partial F(\Delta l, w_f, w_m)}{\partial w_m}}{\frac{\partial F(\Delta l, w_f, w_m)}{\partial(\Delta l)}} = -\frac{\overbrace{\frac{1}{w_f}}^{(+)} \overbrace{\left(1 - \frac{dl_f}{dT}\right)}^{(+),\text{by normality}} - \overbrace{\frac{w_m}{w_f}}^{(+)} \overbrace{\left(\frac{d(\frac{dl_f}{dT})}{dw_m}\right)}^{(-),\text{by assumption, see Eq. 30}}}{\underbrace{-\frac{V''(l_f + \Delta l)}{V'(l_f)}}_{(+)}} < 0. \tag{39}$$

Thus, an increasing wage gap leads to an increasing leisure gap if the endowment effect as given by Eq. 29 is positive with respect to w_f and Eq. 30 is analogously negative with respect to w_m. That is, a higher female wage leads to a greater endowment effect, and a higher male wage leads to smaller

endowment effects. The sign of the change of the endowment effects depends on the signs of $N_f = (2w_f G'' + w_f^2 G''' g_f)$ and $N_m = (w_f^2 G''' g_m)$.

For N_m to be positive, we assume a positive third derivative of G: $G''' > 0$. Then, a condition for N_f to be negative is given by

$$2w_f G'' + w_f^2 G''' g_f < 0$$

$$\iff \quad -w_f g_f \frac{G'''}{G''} < 2, \tag{40}$$

□

The expression on the LHS of Eq. 40 resembles the coefficient of relative prudence as defined by Kimball (1990). If condition 40 holds and her coefficient of "relative prudence" is sufficiently small, then her endowment effect increases in her wage, and a higher female wage leads to the wife having less leisure. This cardinalization of utility allows us to establish the monotonicity result given in Proposition 3.

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