Right Place, Right Time: Parents' Employment Schedules and the Allocation of Time to Children

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Abstract

Contrary to the predictions of standard household theories, husbands' childcare time does not increase with the wages of their wives even when husbands do participate in childcare. In order to better understand why this might be, I develop a timing-sensitive model that accounts not only for the individual's tradeoff between market labor and alternative time uses, but also the scheduling of these activities. The changes in parents' childcare time in response to increases in each other's market work are shown to depend on the extent of overlap in parents' schedules and their order of arrival home from work. In particular, I show that under the timing-sensitive model, a ceteris paribus increase in the time that the first arriver is home alone results in an increase in the second arriver's childcare time. Under the standard timing-insensitive model, the general result is the opposite: a parent's childcare time should decrease with an increase in the spouse's amount of time at home. The zero correlation of husbands' childcare time with wives' wages may thus result from mixing together families with different schedule configurations. My empirical analysis uses the 1997 PSID-CDS combined with the May 1997 CPS. Identification of conditional demands relating parents' childcare time to their time spent at home comes from commuting times and work schedule rigidities. Analysis using a specification that nests both models favors the timing-sensitive model over the standard model when the second arriver is female. When the second arriver is male, the results are consistent with a corner solution for either model type. Contrary to previous results, husbands do substitute for wives in childcare, but only when wives' longer work hours result in husbands spending more time home alone while wives work.

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1. Introduction and Motivation

Prompted by the tremendous increase in female labor force participation over the past decades[1], academics and policy makers alike have turned their attention to the causes and effects of parental allocation of time to children. At the heart of the issue is the substitutability between childcare provided by parents vs. other caretakers and parents' substitutability for each other. Assuming substitutability between parental and market childcare, comparative advantage and bargaining theories of the household (Becker (1965), McElroy and Horney (1981)) predict that the observed increase in wives' labor force participation should generally be accompanied by an increase in household involvement by the husbands[2]. The data, however, contradict this prediction. For husbands at the interior optimum, i.e. those who contribute time to childcare and whose input is negatively correlated with own wages, the correlation between husbands' childcare time and wives' wages is zero. In households where both parents work full time, wives' average childcare time is almost double that of husbands[3]. This lack of empirical support for parents' substitutability for each other puts into question our understanding of household behavior with respect to parental allocation of time to children.

In this paper, I develop a theory of allocation of time to market labor, leisure and childcare that reconciles the zero correlation between husbands' childcare and wives' wages with parents' substitutability for each other in childcare. This is accomplished by accounting for the importance of timing of these activities. The model shows how schedules directly affect, as well as interact with, other household behaviors. The timing of meals, for example, matters net of total food consumed—an illustration of how inputs at different moments in time substitute for each other imperfectly or not at all. Taking into account the imperfect substitutability of a parent's inputs across different moments in a day changes the testable implications of parents' substitutability for each other.

Few economists have incorporated timing or the configuration of spouses' schedules into the theory of household production. Hamermesh (2002) models joint leisure choice for dual earner couples. Jenkins and Osberg (2003) develop a model where individuals' time use choices are contingent upon those of others. In an empirical study, Presser (1994) finds an association between husbands' share of housework and the extent of overlap in spouses' work schedules net

[1] The United States labor force participation of married women has more than doubled since the 1960s, reaching 64 percent or almost 35 million by 1990 (U.S. Census, 1999)

[2] According to comparative advantage, increases in women's wages cause higher labor force participation, decrease women's comparative advantage in household production. According to the bargaining theory, higher wages and labor market participation increase women's options outside the marriage, thus increasing their bargaining power inside the marriage. Women can then induce greater family involvement by men, either because they dislike certain household duties, or because they consider father involvement advantageous to the family.

[3] Source: 1997 PSID-CDS

of hours of employment: husbands do more the more they are at home when their wives are not. Brayfield (1995) shows a positive association between father's participation in childcare and the extent of overlap in spouses' work schedules. Contrary to the zero correlation of husbands' childcare with wives' wages, these findings suggest that substitutability for each other does operate in spouses' family involvement and that its extent depends on the temporal aspects of both the labor market and the family.

In the theory developed in this paper, childcare has both a timing-insensitive enjoyment component and a timing-sensitive maintenance component. Maintenance is timing-specific and parents are potential substitutes in its production. Examples of maintenance are feeding, changing diapers or checking homework—needs which arrive at regular intervals and do not decrease in the future with greater involvement in the past. Enjoyment is not timing-specific. It can be accomplished whenever most convenient for a given parent. My timing-sensitive theory incorporates both of these components, a combination that results in the importance of both the total time inputs and their timing.

In addition to reconciling parents' substitutability for each other with the observed zero correlation of husbands' childcare time with wives' wages, the timing-sensitive model provides a testable implication that distinguishes it from the standard unitary model. The timing-sensitive model describes parents' schedule configuration in terms of their order of arrival home from work and yields a prediction regarding childcare behavior of the second arriver that is opposite of that of the standard model. In the standard model, there are diminishing returns to total childcare in a given day and parents are substitutes in its provision. Greater time at home by one spouse increases his or her childcare input and decreases not only his or her marginal productivity but also that of the other spouse. Thus the longer one spouse is at home, the less childcare should the other spouse do. By contrast, in the timing-sensitive model longer time home alone by the first arriver increases his or her childcare input and lowers his or her productivity relative to the second arriver. It does not, however, diminish the quantity of maintenance childcare that remains to be provided upon the arrival of the second arriver. Thus the longer the time alone by the first arriver, the higher the second arriver's relative productivity and childcare input. This prediction provides a test for timing-sensitive model against the standard model.

I also show that the timing-sensitive model enables a new assessment of parents' substitutability for each other in childcare by focusing not on total childcare during the day, but specifically on the childcare inputs during the time parents are both available. Finally, I show how the timing-sensitive model enables analysis of effects of schedule changes independently of the effect of hours worked—a question that has grown in importance due to high and growing schedule heterogeneity and flexibility. In the U.S., 17% of workers work a non-day shift such as

evening, night, or rotating schedule[4]. The percent of workers with flexible schedules has more than doubled since the 1980s, to almost 30 % in 1997[5]. Whereas changes in schedules or schedule flexibility are irrelevant in the context of the standard model, my timing-sensitive model conceptualizes schedules and provides a basis for inference of their effects on household time allocation. I show that the effect of arriving home an hour later depends on order of arrival and the resulting change in the length of time each parent spends home alone vs. together with their partner. This implies that controlling for each of these quantities is necessary for proper analysis of effects of labor force participation changes or schedule changes.

Empirical analysis involves demand equations for each parent's childcare time conditional on the parents' work schedule configuration. It is based on the data from 1997 PSID-CDS. Identification relies on acknowledging the rigidities in the number and timing of labor market hours documented by Lundberg & Dickens (1993) and Altonji & Paxson (1987)[6]. These rigidities result in a divergence between spouses' true opportunity costs of time and their observed wages, thus biasing the unconditional demand estimates. However, due to these rigidities wages can be used as instruments, since no substitution effects occur between work and other time uses. Additional instruments include husbands' industry-occupation schedule characteristics and parents' commuting times. Analysis using a specification that nests both types of models favors the timing-sensitive model over the standard model when the second arriver is female. When the second arriver is male, the data is consistent with a corner solution in either model. Contrary to previous results, husbands do substitute for wives in childcare, but only when wives' longer work hours result in the husbands spending more time at home while the wives are at work.

The rest of this paper is organized as follows. In Section 2, I review the standard timing-insensitive model and develop a timing-sensitive model of allocation of time to work, leisure and childcare. I show how the timing-sensitive model is consistent with the data, and provide a testable implication that distinguishes the two models. I also develop a new test for substitutability of parents for each other in childcare provision. Section 3 discusses the instruments used in identification. Section 4 describes the data. In Section 5, I outline the empirical specification motivated by the new theoretic structure. I interpret the results in Section 6. Section 7 concludes.

[4] Current Population Survey, Report on the American Workforce 1999, Chapter 3.
[5] Current Population Survey, Report on the American Workforce 1999, Chapter 3.
[6] An example is the disproportional occurrence 40 hr per week jobs. If timing matters for childcare production, then aggregation into daily totals generally results in biased estimates of unconditional demand estimates. The presence of temporal constraints on household behavior provides an additional reason.

2. The standard and the timing-sensitive models of allocation of time to work, leisure and childcare

This section has three goals. First, I review the standard unitary (timing-insensitive) model of household production and its implications. Second, I propose a new timing-sensitive model. Third, I derive a testable implication that distinguishes the two models in the data. I also develop a new test of parents' substitutability for each other in childcare production. I take a gender-neutral view on time allocation. In line with empirical evidence (Lundberg & Dickens (1993), Altonji & Paxson (1987)), I acknowledge the discrete choice in the number and timing of work hours by each spouse. The resulting discontinuity in labor demand motivates the view of labor supply as a rationed good, and the subsequent treatment of demands for childcare by each parent as conditional on schedules and total non-work time. The theoretic and empirical treatment of conditional demands follows Pollak (1969).

2.1 Standard Model with Timing-Insensitive Childcare Production

In the traditional unitary model of the household, what matters for production of child quality is total childcare inputs by each parent, and not their timing. The household has utility over consumption *u(C),* child quality *Q(.)* and husband's and wife's leisure $F(l_h)$ and $F(l_w)$. There are diminishing returns to consumption: $u_C' \geq 0,\ u_C'' \leq 0$, as well as leisure of each spouse: $F'_{l_i} \geq 0,\ F''_{l_i} \leq 0,\ i = h, w$. Child quality is produced using production function $Q(t_h, t_w, t_{mkt})$ where the inputs are husband's time with children t_h, wife's time with children t_w and market childcare time t_{mkt}. It exhibits diminishing returns: $Q'_{t_i} \geq 0;\quad Q_{t_i}'' \leq 0,\ i = h, w, mkt$. Also, $Q''_{t_h t_w} \leq 0,\ Q''_{t_h t_{mkt}} \leq 0,\ Q''_{t_w t_{mkt}} \leq 0$. h_h and h_w stand for the number of work hours by each spouse, and p_{mkt} denotes the price of market childcare. Price of consumption is normalized to 1. The household's unearned income in Y. The household's problem is:

$$Max_{C, t_h, t_w, t_{mkt}, h_h, h_w, l_h, l_w}$$

$$U = u(C) + Q(t_h, t_w, t_{mkt}) + f_h(l_h) + f_w(l_w) \text{ s.t.}$$

$$C \leq Y + w_w h_w + w_h h_h - p_{mkt} t_{mkt};\ h_w + t_w + l_w = h_h + t_h + l_h = 24$$

The desired labor market hours unconstrained by the discrete nature of labor demand are h_h^* and h_w^* for husband and wife, respectively. With rationing on labor supply, however, h_h^* and

h_w^* are not necessarily the hours observed at equilibrium. Rather, the hours observed at equilibrium are $\bar{h}_h$ and $\bar{h}_w$, the result of each spouse picking the offer that yields the utility closest to that from the unconstrained optimum. The non-work time is $24 - \bar{h}_w = T_w$ for the wife and $24 - \bar{h}_h = T_h$ for the husband. The problem can now be simplified as husband and wife finding optimal allocation of their non-work time towards leisure and childcare:

$$Max_{C,t_h,t_w,t_{mkt},l_h,l_w} \; U = u(C) + Q(t_h, t_w, t_{mkt}) + f_h(l_h) + f_w(l_w)$$

s.t. $C \le Y + \bar{h}_h w_h + \bar{h}_w w_w - p_{mkt} t_{mkt}$; $t_w + l_w = T_w$, $t_h + l_h = T_h$

Comparative statics provided in the Appendix show the expected result: increased availability of one parent increases his or her childcare input and decreases the input of the spouse. Specifically, for the husband $\frac{\partial t_h}{\partial T_h} \ge 0$ and $\frac{\partial t_h}{\partial T_w} \le 0$, while for the wife $\frac{\partial t_w}{\partial T_w} \ge 0$ $\frac{\partial t_w}{\partial T_h} \le 0$, with strict inequalities at interior optima. The intuition behind this result is that at the interior optimum, if the mother, for example, works more and has less non-work time, then her childcare input decreases. This decreases the total amount of parental childcare accomplished, and increases the marginal product of childcare for the father. The father thus does more childcare the more the mother works. As will be confirmed in the Data section, this result is not born out in the data in families where fathers are at interior solutions, i.e. provide some childcare. Additional evidence against fathers being at a corner solution is that even though the correlation of their childcare time with wives' wages is not significant, the correlation of their childcare time with their own wages is negative and significant.

2.2 The Model with Timing-Sensitive Childcare Production

Sensitivity to timing is implemented by taking into account the maintenance aspect of childcare, i.e. that childcare inputs from different parts of the day cannot freely substitute for each other. An example used earlier is that a toddler needs to be supervised throughout the day; double supervision for only half a day is not acceptable. Let *j*=1…24 denote each hour in a day so that $Q_1(.) \ldots Q_{24}(.)$ stand for hour-specific production of maintenance childcare. Parental and market inputs into maintenance childcare in a given moment are substitutes for each other. For each hour *j*, husband's time, wife's time, and market childcare time are labeled t_{w_j}, t_{h_j} and t_{mkt_j} respectively. Maintenance childcare exhibits diminishing returns in each input in each period: $Q'_{i_j} \ge 0, \; Q''_{i_j} \le 0, \; i = h, w, mkt; \; j = 1..24$. Also, $Q''_{h_j w_j} \le 0, \; Q''_{h_j mkt_j} \le 0, \; Q''_{w_j mkt_j} \le 0$.

The household also derives utility from each parent's total childcare time over the course of the day (the enjoyment aspect of childcare), leisure and consumption. Contribution of total childcare by each parent to household utility is captured by function $U(.)$, that of leisure by each parent by function *F(.)* and that of consumption by function *u(.)*. As in the standard timing-insensitive model, diminishing returns are present in each of these components of household utility: $u'_C \geq 0,\ u''_C \geq 0,\ U'_i \geq 0, U''_i \leq 0,\ F'_i \geq 0, F'_i \leq 0,\ i = h, w$.

The household's decision is:

Maintenance childcare | Husband's total childcare | Wife's total childcare | Husband's leisure | Wife's leisure

$$U = u(C) + (\sum_{j=1}^{24} Q_j(t_{hj} + t_{wj} + t_{mkt,j})) + U_h(\sum_{j=1}^{24} t_{hj}) + U_w(\sum_{j=1}^{24} t_{wj}) + (\sum_{j=1}^{24} F(l_{hj})) + (\sum_{j=1}^{24} F(l_{wj}))$$

s.t. $C \leq Y + w_w \sum_{j=1}^{24} h_w + w_h \sum_{j=1}^{24} h_h - p_{mkt} \sum_{j=1}^{24} t_{mkt}$, $h_j \in \{0,1\}$, $t_j \in [0,1], l_j \in [0,1]$ for both the husband and wife, $h_{wj} + t_{wj} + l_{wj} = 1, \forall j$ and $h_{ij} + t_{ij} + l_{ij} = 1,\ i = h, w;\ \forall j$.

Note that while childcare and leisure in each hour *j* can take any value between zero and one, a work hour is indivisible. This assumption simplifies further analysis without significantly affecting the results, and is motivated by high costs of setup and transportation to work.

Given rationing on amount and timing of work and childcare, fix $\sum_{j:h_w=1} h_w = \bar{h}_w$ as the wife's work hours and $\sum_{j:h_h=1} h_h = \bar{h}_h$ as husband's work hours. The problem becomes:

$$Max_{C,t_{h_j},t_{w_j},t_{mkt_j},l_{h_j},l_{w_j}}$$

Childcare vs. leisure when wife is home alone

Childcare vs. leisure when husband is home alone

$$U = \sum_{j:h_w=0,h_1=1} \overbrace{Q(t_{w_j} + t_{mkt_j}) + F_w(l_{w_j})} + \sum_{j:h_w=1,h_h=0} \overbrace{Q(t_{h_j} + t_{mkt_j}) + F_h(l_{h_j})} +$$

$$+ \sum_{j:h_w=0,h_h=0} \underbrace{Q(t_{h_j} + t_{w_j}) + F_h(l_{h_j}) + F_w(l_{w_j})} + U_h(\sum_{j=1}^{24} t_h) + U_w(\sum_{j=1}^{24} t_w)$$

Childcare vs. leisure when both are home

$$\text{s.t. } C \le Y + w_w\bar{h}_w + w_h\bar{h}_h - p_{mkt}\sum_{j=1}^{24} t_{mkt} \; ; \; t_{i_j} \in [0,1], l_{i_j} \in [0,1],$$

$$t_{i_j} + l_{i_j} = 1, \; i = h,w; \; \forall j$$

Any schedule configuration can now be characterized by the lengths of the two non-overlap segments (the time each parent spends home alone) and the overlap segment (when both parents are at home). An overwhelming majority of families in the sample have only one non-overlap period—the time that the parent who finishes work first spends home alone until the second spouse finishes work. The second potential period of non-overlap is the time that parents are available to children before going to work or before children go to school, and is minimal. Taking advantage of the empirical regularity that only one partner spends any time home alone in a given day, estimation will consider only the after-work time, rather than all non-work time. This simplification is made for tractability. Assuming that childcare time before work does not affect childcare time after work (i.e. they are separable in the household utility function), the analysis remains valid. It should be noted, however, that the model explains this regularity by taking into account the physical or psychic disutility of working at night. Also note that while empirically time together usually occurs after time alone, implications of the model rely neither on the sequence nor the number of alone and together periods, but only on their lengths.

The model enables a convenient mapping of a schedule configuration into parents' order of arrival and the lengths of time alone and time together. With *f* denoting the first arriver and *s* the second arriver, without loss of generality group all periods into two: time alone, $T_1 = \sum_{j:h_{f_j}=0,h_{s_j}=1} j$ and time together, $T_2 = \sum_{j:h_{f_j}=0,h_{s_j}=0} j$. Interest lies in the allocation of T_1

by the first arriver towards leisure and childcare, and the allocation of T_2 by each arriver towards leisure and childcare.

When both parents are employed, the child is in non-parental (often market) childcare, with school included in that category. In addition to the first subscript denoting order of arrival (*f* for first and *s* for second), let the second subscript denote the period (1 for T_1, or the time alone and 2 for T_2, or the time together). Using this notation t_{f1} denotes childcare time of the first arriver during his or her time alone T_1. As derived in Appendix 2, the household's problem can be simplified by solving for each period's optimal allocation of time and aggregating all after-work periods in a day into two: the time that the first arriver is home alone, and the time that both parents are home together. The new utility function, which is the derived from the original utility function by aggregating all non-work time into time together and time alone, is defined over proportion of first arriver's time home alone spent in childcare and leisure, respectively, and the proportion of time together that each parent spends in childcare and leisure, respectively, as well as the total childcare time of each parent. The household's task is to determine the optimal leisure and childcare in each of these two aggregated periods.

Let *Q(.)* stand for production of maintenance component of childcare in the time together and time alone, separately; $F_f(.)$ stand for utility of leisure for the first arriver, $F_s(.)$ stand for utility of leisure of the second arriver, $U_f(.)$ stand for the utility of total childcare for the first arriver and $U_s(.)$ stand for the utility of total childcare for the second arriver. The aggregated problem reads:

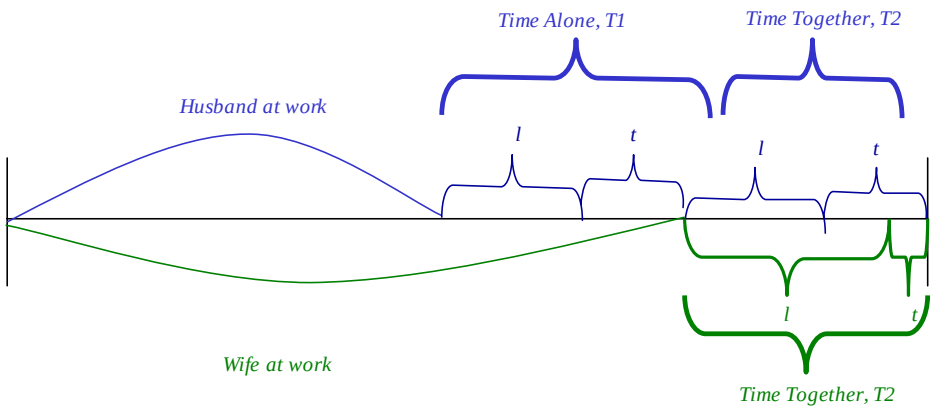
$$Max_{t_{f1},t_{f2},t_{s2},l_{f1},l_{f2},l_{s2}}$$

$$U = T_1 Q(\frac{t_{f1}}{T_1}) + T_1 F_f(\frac{l_{f1}}{T_1}) + T_2 Q(\frac{t_{f2}}{T_2} + \frac{t_{s2}}{T_2}) + T_2 F_f(\frac{l_{f2}}{T_2}) + T_2 F_s(\frac{l_{s2}}{T_2}) + U_f(t_{f1} + t_{f2}) + U_s(t_{s2})$$

$$\text{s.t.} \quad \begin{aligned} t_{f1} + l_{f1} &\le T_1 \\ t_{f2} + l_{f2} &\le T_2 \\ t_{s2} + l_{s2} &\le T_2 \end{aligned}$$

T_1 is the time alone by the first arriver and T_2 is the time parents are home together. $\frac{t_{f1}}{T_1}$ stands for the proportion of home alone time that the first arriver spends in childcare. The rest of the fraction terms can be interpreted similarly.

Genders of the first and second arrivers vary by household. If the husband is the first arriver, for example, the problem can be depicted as follows:



If both spouses finish work at the same time, time alone is zero (T_1=0) and all of their after-work time overlaps. Second arrivers have no after-work time home alone: since they finish work later than their partners, all of their after-work time overlaps with that of the spouse. If a parent finishes work after the child goes to sleep, no after-work time is spent available for childcare: both the time alone and the time together are zero, and all of the after-work time of his or her spouse is the time alone.[7]

The focus is on the distribution of time towards childcare and leisure in one's after-work time, depending on the length of time alone and time together. In empirical analysis I account for the fact that the time alone and the time together are endogenous to childcare time allocations.

2.3 Implications of the Timing-Sensitive Model

The solution consists of the childcare vs. leisure decisions during the time alone and the time together by each spouse, as a function of the lengths of time alone and time together. The first arriver's optimal childcare and leisure during his or her time alone are $t^*_{f1}(T_1,T_2)$, $l^*_{f1}(T_1,T_2)$. The first arriver's optimal childcare and leisure time during the time together are $t^*_{f2}(T_1,T_2)$, $l^*_{f2}(T_1,T_2)$. Finally, the second arriver's optimal childcare and leisure time during the time together are $t^*_{s2}(T_1,T_2)$, $l^*_{s2}(T_1,T_2)$. Diminishing returns over the course of the day introduce interdependence between one's childcare inputs across time. Substitutability in maintenance childcare between parents during their time home together introduces interdependence between parents' time inputs. Together, these produce cross-

[7] Note that conceptually, changes in hours worked do not necessarily imply changes in timing configurations, and timing configurations may vary given the same number of hours worked. I test for the importance of total labor supply effort by each spouse, using IV to account for its endogeneity with respect to childcare allocations.

dependences across parents' behavior in each of the segments. Key comparative statics are provided in the Appendix[8]. Below is a summary comparison of predictions of the timing-insensitive and the timing-sensitive model.

Change in own childcare time	*Timing-insensitive model*	*Timing-sensitive model (By order of arrival)*	
When own non-work time increases	+	*1st*	*?*
		2nd	+
When partner's non-work time increases	-	*1st*	*?*
		2nd	+

In what follows, Propositions 1 and 2 provide the timing-sensitive model's basic implications. Propositions 3 and 4 address the three questions of crucial interest—the testable implication that distinguishes the two models, the alternative test for parents' substitutability for each other, and the timing-sensitive model's explanation for the zero correlation of husbands' childcare with wives' wages observed empirically.

Proposition 1: *The longer a given period of time alone or time together, the greater the childcare time input during that period at the interior optimum*:

$\frac{\partial t_{f1}}{\partial T_1} \geq 0, \frac{\partial t_{f2}}{\partial T_2} \geq 0, \frac{\partial t_{s2}}{\partial T_2} \geq 0$. This is a trivial result due to the assumption of childcare time being a normal good with respect to the time budget constraint.

Proposition 2: *Changes in childcare time caused by changes in lengths of time alone and time together depend on the presence of diminishing returns and substitutability of parental childcare inputs for each other.*

For the first arriver, the presence of diminishing returns over total daily childcare implies that the longer his or her period of time alone, the lower the childcare input during time together, $\frac{\partial t_{f2}}{\partial T_1} \leq 0$. There is no clear prediction on how childcare during the time alone responds to greater length of time together: the sign of $\frac{\partial t_{f1}}{\partial T_2}$ is uncertain. With no diminishing returns or no

[8] The complete set of comparative statics is available on the author's web page.

substitutability (independent marginal products), $\frac{\partial t_{f2}}{\partial T_1} = 0$ and $\frac{\partial t_{f1}}{\partial T_2} = 0$. For the second arriver, the presence of diminishing returns and substitutability imply that the longer the first arriver is home alone, the greater the second arriver's childcare input upon getting home, $\frac{\partial t_{s2}}{\partial T_1} \geq 0$. The intuition for this result is as follows. Keeping constant the length of time that spouses are home together, a longer period of being home alone by the first arriver increases his or her childcare time and lowers his or her marginal product by the time the second arriver gets home. The second arriver becomes relatively more productive in the ensuing maintenance-type childcare, and thus his or her childcare input increases. Absent either diminishing returns or substitutability, $\frac{\partial t_{s2}}{\partial T_1} = 0$.

Proposition 3: *Observed change in the total childcare time of the second arriver caused by an increase in the spouse's non-work time can be used to empirically to distinguish the timing-sensitive model from the timing-insensitive model. The predicted change is negative according to the timing-insensitive model, and positive according to the timing-sensitive model.*

In the standard timing-insensitive model, order of arrival bears no relevance. The only result is that a longer non-work time by one spouse decreases childcare input by the other spouse. Intuitively, longer non-work time by one spouse results in greater childcare input by that spouse, which decreases the marginal productivity of the other spouse if, as is the case in the timing-insensitive model, output depends on total rather than timing-specific childcare inputs. This result holds regardless of the order of arrival, and therefore holds when longer non-work time accrues to the first arriver. Thus $\frac{\partial t_{s2}}{\partial T_1} \leq 0$.

By contrast, in the timing-sensitive model the output of the maintenance component of childcare depends on the timing-specific inputs, and these cannot easily substitute for each other across time. The need to feed, change diapers, or check homework comes in regular intervals and does not decrease in upcoming periods with greater involvement in the previous periods. While greater preceding childcare inputs decrease one's productivity in subsequent periods via diminishing returns, they cannot substitute one-to-one for subsequent childcare inputs. Longer time available for childcare during the time alone increases first arriver's childcare input and lowers his or her productivity relative to the second arriver. However, it does not diminish the quantity of maintenance childcare that remains to be provided upon the arrival of the second arriver. Thus the longer the time home alone by the first arriver, the higher the second arriver's

relative productivity and childcare input: $\frac{\partial t_{s2}}{\partial T_1} \geq 0$. This prediction provides a test for timing-sensitive model against the timing-insensitive model. It also tests the combination of diminishing returns to childcare and parents' substitutability for each other.

Proposition 4: *By accounting for schedules, the timing-sensitive model is able to reconcile the zero conditional correlation of husbands' childcare time inputs and wives' wages with spouses' substitutability for each other in childcare.*

The zero conditional correlation of husbands' childcare time inputs and wives' wages can arise in the data even though parents do substitute for each other in childcare provision. In the timing-sensitive model, the effect of wife's higher wage if there is no labor market hours rationing, or of wife's greater labor market input if there is rationing, depends on who arrives home first. If the wife of the first arriver husband finishes work an hour later, then the husband's time home alone ($T_{1\ husband}$) increases, and his predicted response is to increase childcare time: $\frac{\partial t_{f_1}}{\partial T_1} \geq 0$. However, if the husband is the second arriver and his wife finishes work an hour later, then her time home alone ($T_{1\ wife}$) decreases, and since $\frac{\partial t_{s2}}{\partial T_1} \geq 0$, the husband's predicted response is to decrease his childcare time. The zero conditional correlation between husbands' childcare and wives' wages may thus be due to mixing together the first and second arrivers of the same gender in the same estimating sample.

3. Identification

Interest lies in identifying the effect of changes in the time alone (T_1) and the time together (T_2) on each parent's childcare time input during each of these periods. OLS estimates are likely to be biased since the family and individual level unobservables affect both schedules and childcare time. The exclusion restrictions are that instruments must be correlated with parents' childcare time only through schedules or the number of hours worked, both of which affect the configuration and amounts of parents' after-work time.

I propose the following set of instruments: the spouses' commuting times, wages and the husbands' industry-occupation mean time of ending work and mean occurrence of flexible schedules[9]. Husbands' wages, commuting times and schedules are likely to be minimally affected by selection on childcare behavior, at least as a first-order effect. For wives this assertion

[9] Note that one parent's industry-occupation characteristics are sufficient to shift parents' schedule configuration captured by T_1 and T_2.

is more arguable: role compatibility as a mother and an employee likely has dimensions other than the timing of work. Identification requires that these dimensions are not a first order effect: the caring quality of a worker's chosen job, may affect the type or quality of his or her child interaction, but cannot affect its quantity net of its effect through available after-work time. Similarly, identification relies on the assumption that job location is a secondary determinant of job choice, so that variation in commuting times has a considerable random component.

Industries and occupations vary in the set and variability of available options for work schedules, and specifically in prevalence of flexible schedules and diversity of work shifts[10]. For example, manufacturing is a 24-7 operation while schoolteachers work predominantly during the day. Any sorting into industry-occupation groups and commute arrangements based on desired amount of time with children has to operate entirely through the desired amount of after-work time, rather than the unobservables in the residuals. In line with other studies, I assume that holding constant the number of hours worked, wives' schedules are likely determined jointly with childcare arrangements while husbands' work timing is largely exogenous with respect to childcare choices. Therefore I use the industry-occupation schedule variables for the husband and not the wife. The distribution of workers in the sample across different industry-occupation groups is presented in the Appendix. Variation in availability of flexible schedules and regular daytime schedules among husbands in the sample is addressed in the Data section. Note that identification relies on variation across industry-occupation groups, rather than individuals[11].

Using wages as instruments for the length of after-work time is justified by the empirically documented presence of rigidity in labor market hours. Evidence of discrete choice of labor market hours is presented in the data section. If work hours are rationed, as found in Lundberg and Dickens (1993), wage changes induce no substitution effects in the labor supply vs. childcare and leisure decision, and affect childcare and leisure demands only through money and time budget constraints.

Differences in signs between the OLS and IV estimates, and their consistence with the expected direction of bias of OLS estimates are considered in the Empirical Analysis section.

4. Description of the Data

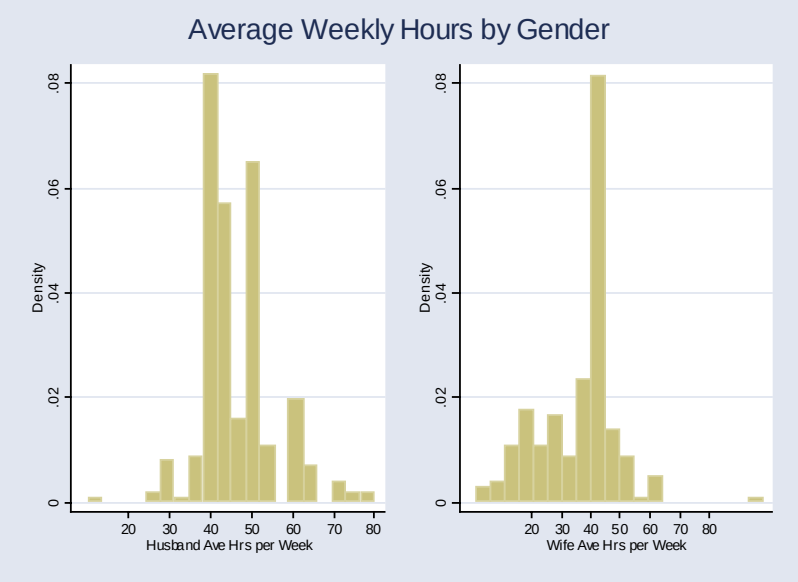
A test of the key implications of the model requires data on timing of work and all childcare activities for each parent over the course of the day. In addition, industry-occupation schedule characteristics are required for identification. I use the 1997 PSID-CDS time use module for information on family time use, and May 1997 CPS schedule supplement for schedule-related industry-occupation variables.

[10] BLS, Current Population Survey, Report on the American Workforce 1999, Chapter 3.
[11] The timing-sensitive model implies that increased flexibility affects not only schedules but also childcare time itself.

4.1 1997 PSID-CDS

The Panel Study of Income Dynamics (PSID) is a nationally representative survey. In 1997, the PSID Child Development Supplement (CDS) completed interviews with 2,380 households and about 3,563 0-12 year old children randomly selected from these households. The overall response rate was 88%. Time diaries for one weekend day and one weekday were collected from about 2,900 children. These time diaries asked about the child's flow of activities over a 24-hour period beginning at midnight of the designated day. Respondents were asked to report when each activity began and ended and who else was present or actively involved.

Each parent also completed a detailed work schedule description as well as labor market information on wages, work hours and industry-occupation groups. Average work hours for the husbands and wives included in the final estimating table are described below. The figure demonstrates the consistence of the data with the premise of the identification strategy: the distribution of work hours appears discrete and dominated by 40 and 50 hr per week jobs.



PSID provides all information needed to create T_1 and T_2, and to aggregate all of child's activities with each parent during T_1 and T_2. I use only families for which data provides the child's weekday time diary and both primary and secondary respondents' work schedules and commuting times for the time diary day if they are employed. Only weekday schedules and diaries are used, since weekend behavior may be qualitatively different[12]. Only principal jobs are considered, since only 6 families that met all other criteria had a parent working two jobs. The

[12] In an overwhelming proportion of families neither parent works on a surveyed weekend day.

final sample consists of 266 families. In 62 of these the husband finishes work first, in 109 the wife works and finishes work first, and in 95 the wife is non-employed.

Note that T_1 and T_2 can be defined even for couples where wife is not employed, since in those cases the time alone is defined as starting from the time the child wakes up and until the husband finishes work. I take advantage of this opportunity in order to increase the already limited sample size. While non-employed wives spend considerably more time in childcare, their ratios of childcare to total non-work time are similar to those of working wives. Men's childcare inputs are almost identical to those in families where women work and arrive home first. To see whether stay-at-home moms are different, an indicator was included in the regressions[13].

The after-work available time is defined as the time between a parent's work end time plus commuting time, and the time the child goes to sleep. The start of T_1 is defined in three ways, depending on the work status of the first arriver and the age of the focus child, since children over 5 years old effectively have mandatory outside childcare until on average 2pm in the form of mandatory school attendance. For the focus child aged less than 5 years old, the start of T_1 was defined as the maximum of 7 am (for non-working mothers) and the time that the earlier arriver becomes available (end of workday plus commuting time for working first arrivers). In the case of the focus child 5 years old or older, the start of T_1 was defined as the maximum of 14pm for non-working mothers and the time that the earlier arriver becomes available. The end of T_2 was defined as the time the child goes to sleep.

Detailed sample statistics and a graph of spouses' starting and ending work times are reported in the Appendix. Below is a graph of the time home alone T_1 and the time together T_2. In only 19 of the 266 families does one partner arrive within 15 minutes of the other (T_1 less than 15 minutes), and only in 6 families is the time together after work (T_2) less than 15 minutes.

[13] Since wages are used as instruments for after-work time (or labor force participation), their wages were imputed using age, education, marital status, number of children and age of youngest child in the selection equation.

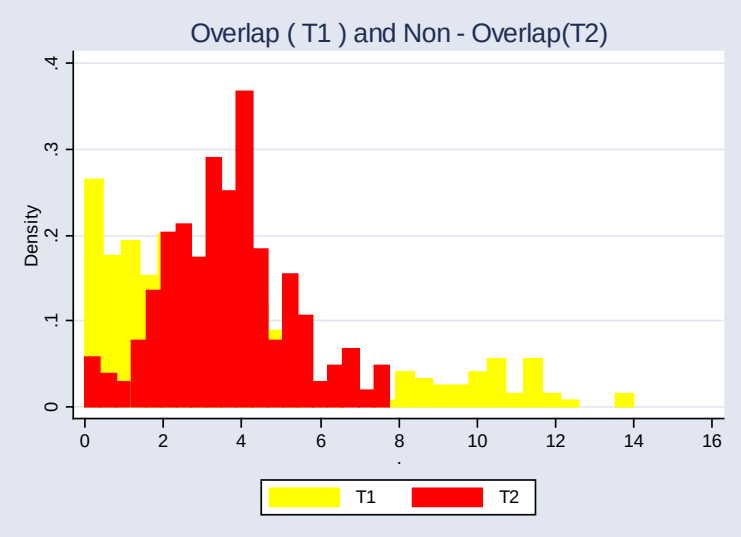
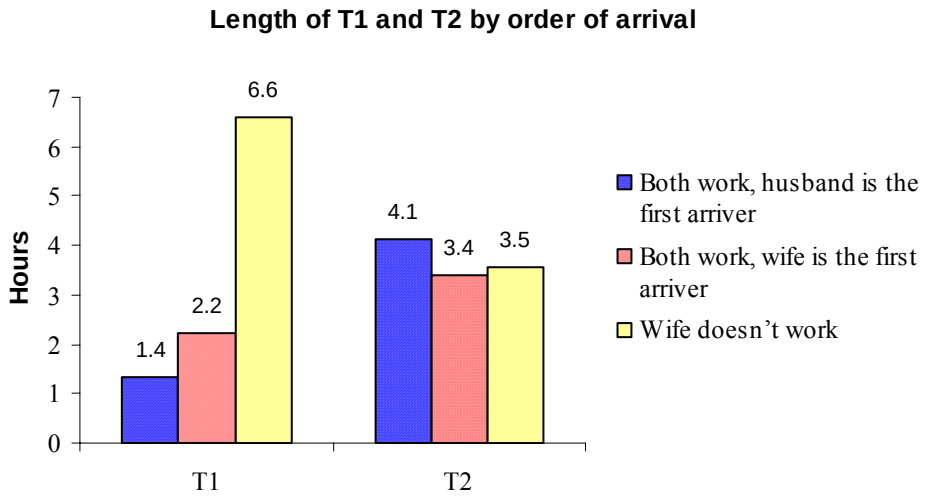


Figure below reports the lengths of time alone T_1 and time together T_2 by order of arrival. The time alone is shortest when the first arriver is the husband, in line with the fact that men on average finish work later than women (distribution of work end times for both spouses is provided in the Appendix). Among dual earner couples the time together is longer for those where the wife finishes work second, in line with the fact that women in the sample on average finish work earlier than men. The length of time together is virtually the same in families where the husband finishes work later than the wife and those families where the wife is non-employed.



In line with other studies I use a broader definition of childcare that includes both active involvement and mere presence. This is done for two reasons. First, the mere presence of a parent may be beneficial for the child. While it is inferior to active involvement, it is may be preferred to the child being unsupervised or in a low quality market care. Second, recent literature has highlighted the importance of secondary activities in parental time use: cumulatively these add up

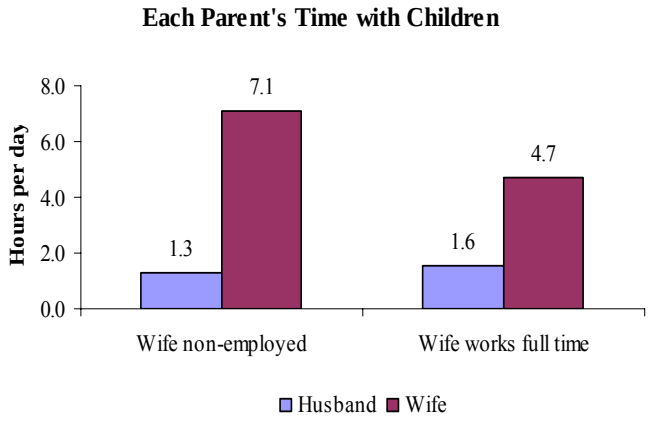
to a considerable productive effort (Folbre & Bittman (2004)). Therefore, analyses in this paper define a parent's childcare time as the time that the parent is either actively involved or present, and when the spouse is not actively involved. This enables a sharper focus on substitutability[14].

Patterns in the sample reflect the general picture presented in the introduction. Men's conditional correlation of supply of childcare with women's wages is indeed statistically insignificant from zero, as the regression below shows.

	Daily Childcare, Husband	Daily Childcare, Wife
ln husband wage	-0.287	0.094
	[2.09]*	[0.56]
ln wife wage	0.004	-0.253
	[0.02]	[1.35]

Controls: child age, husband's education, unearned wealth

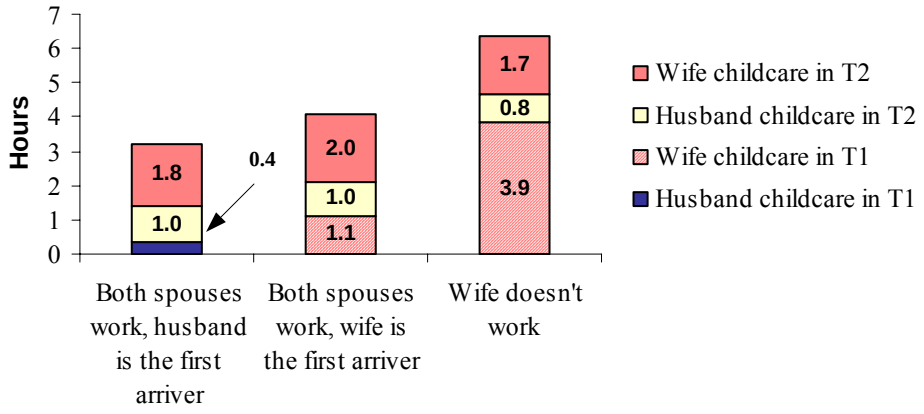
Importantly, even among dual full-time couples, the average husband does less than half as much childcare as the v



The following graph accounts not only for genders and the wife's labor force status, but also the amount of time together and time alone in each household. Recall that the parent who potentially spends childcare time both while alone and while together with the spouse is the first arriver, and the parent who spends childcare time only while home together with the spouse is the second arriver.

[14] Alternative definitions of a parent's childcare time were also tried: only active participation regardless of spouse presence or involvement, and active and passive participation regardless of spouse. These variations did not produce substantive differences in estimated coefficients, although, as expected, "active only" childcare time is significantly less for both mothers and fathers, while childcare time regardless of spouse is greater than childcare time with spouse not actively involved.

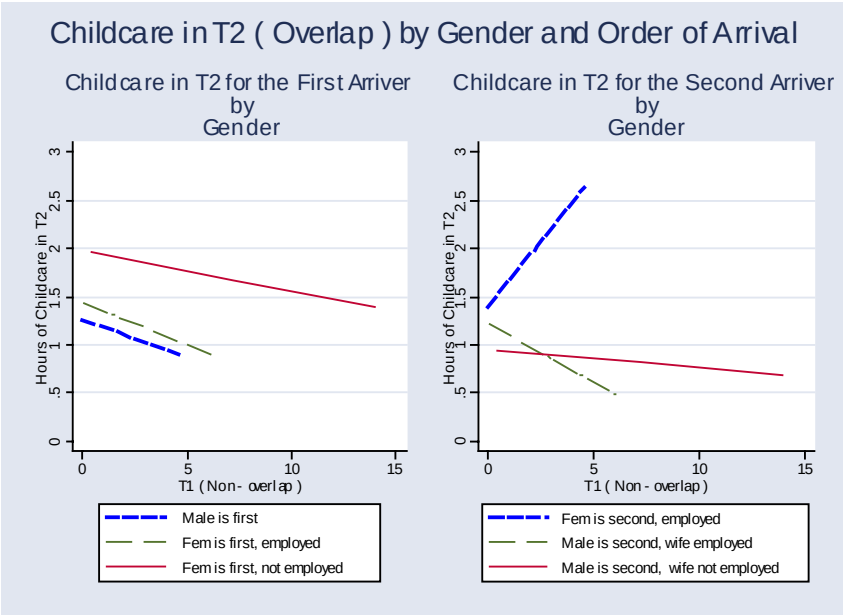
Childcare amount by gender and order of arrival



It appears that without controlling for the lengths of the time together and time alone, the gender and work status dimensions dominate any schedule effects. Across all three arrangements, husbands childcare' time during the time together is stable at about 1 hr, while wives' childcare time during the time together is stable at about 2 hrs. As expected, wives who work but finish work before their husbands spend considerably less time during their time alone than those wives who don't work: 1.1 hr vs. 3.9 hr. Fathers who arrive first spend considerably less time than mothers during their time alone: 0.4 hr vs. 1.1 hr. The difference stays high when childcare inputs during the time alone are divided by the length of time alone: it is 0.41 for first arriver wives vs. 0.14 for first arriver husbands (graph not shown).

Figure below illustrates the relationship between parents' childcare time investments and lengths of time alone and time together. It focuses on the behavior during the time together by order of arrival. The left panel shows that for the first arriver, the longer the time alone, the smaller his or her childcare input during the time together. The rates of decline appear similar by gender, and for the wives, by their work status. This graph appears consistent with diminishing returns to childcare: assuming that time home alone is allocated in part to childcare, as it lengthens, productivity in childcare during time together decreases and childcare time decreases[15].

[15] Graph showing a positive relationship between the length of the overlap and the childcare time during the overlap for both genders (not shown) confirms that for parents of both genders, the more time they have available, the more childcare they do. This suggests that childcare time is a normal good with respect to the time budget constraint.



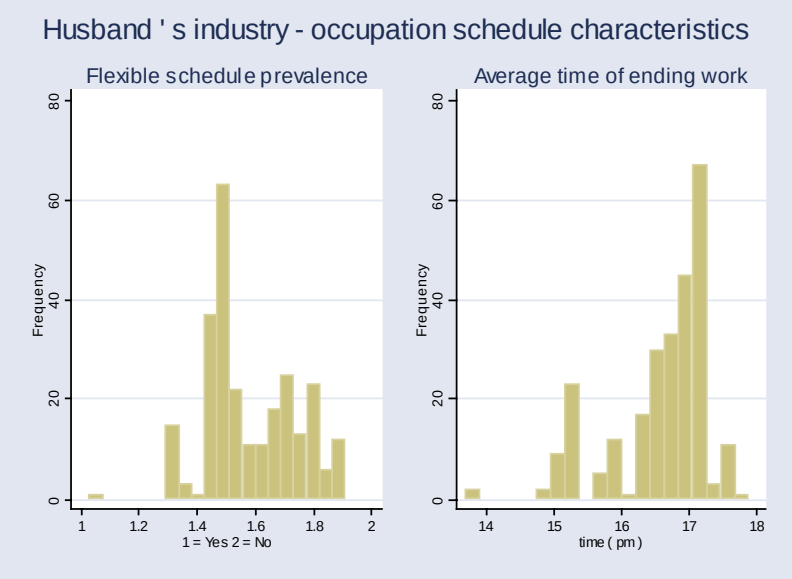
The right side panel presents a case for looking at the time alone and time together separately. It reveals a pattern that would have been obscured when looking at total daily parental childcare. It shows the time the second arriver spends in childcare after work as a function of spouse's home alone time. It appears that if the second arriver is female, her childcare time increases with the length of preceding time alone by her husband. By contrast, if the second arriver is male, his childcare time decreases with the length of time his wife has spent alone and potentially available for childcare. Notably, a husband whose wife works decreases his input at a higher rate than a husband whose wife does not work.

4.2 May 1997 CPS

Variables used as instruments were created using the May 1997 issue of the CPS, which in addition to standard worker characteristics such as education, wages, income, industry and occupation extensively surveyed workers' schedules. The May supplement consists of a total of 122,188 observations, of which 60,393 individuals are involved in the labor market. For these workers, industries are grouped into 12 groups, and occupations are grouped into 11 groups (see Appendix for group definitions). This yields 132 industry-occupation cells. Each worker was assigned into an industry-occupation cell, and within each cell the mean for presence of flexible schedules and mean time of finishing work were calculated. Cell sizes vary from 1 to 5,993. Of the 132 industry-occupation cells, 7 have five or fewer observations [16], 74 cells have over 50

[16] These are, by (industry, occupation): (entertainment and recreation; operatives except transport), (agriculture, forestry and fisheries; operatives except transport), (agriculture, forestry and fisheries; sales workers), (agriculture, forestry and fisheries; service workers other than household), (mining; service workers other than household), (construction, 7).

observations, and 90 cells have over 30 observations. The top 5 largest cells range in size from 1000 to over 5000 observations, depending on the variable. [17] It should be noted that even though cell size is large for most of the industry-occupation cells, cell size does not undermine the validity of the instruments. It translates into higher measurement error for the less populated cells, but since it is reasonable to assume that this measurement error is uncorrelated with the residual in the second stage (and the instruments come from a separate dataset), estimation remains valid in this regard. Figure below presents the variation of availability of flexible schedules and work end time among husbands in the sample.



5. Empirical Specification

The unconditional demand equations motivated by the timing-insensitive household model read:

$$t_{\substack{childcare \\ husband}} = \beta_1 X + \beta_2 w_{husband} + \beta_3 w_{wife} + \varepsilon_h$$
$$t_{\substack{childcare \\ wife}} = \beta_1 X + \beta_2 w_{husband} + \beta_3 w_{wife} + \varepsilon_w \qquad (1)$$

Instead, the comparative statics for the timing-sensitive model proposed in this paper have implications for changes in childcare while alone t_1 and while together t_2 with respect to lengths of time the first arriver spends alone T_1 and time together with his or her spouse T_2. Spouses are distinguished not only by gender but also by their order of arrival. *F* denotes the first arriver and *s* denotes the second arriver. The estimating equation reads:

[17] The five most populated cells are, starting from most populated: (professional and related services; professional, technical and kindred workers), (wholesale and retail trade, sales workers), (manufacturing, operatives except transport), (professional and related services, clerical and kindred workers) (professional and related services, service workers except household).

$$t_{First,T_1} \equiv t_{f,1} = \beta_0 + \beta_1 T_1 + \beta_2 T_2 + \varepsilon_1$$

$$t_{First,T_2} \equiv t_{f,2} = \gamma_0 + \gamma_1 T_1 + \gamma_2 T_2 + \varepsilon_2 \qquad \begin{aligned} T_1 &= a_1 X + a_2 Z + e_1 \\ T_2 &= a_3 X + a_4 Z + e_2 \end{aligned} \qquad (2)$$

$$t_{Second,T_2} \equiv t_{s,2} = \delta_0 + \delta_1 T_1 + \delta_2 T_2 + \varepsilon$$

where T_1 and T_2 are after-work time alone and together with the spouse, respectively.[18]

As mentioned in the Data section, the estimating sample is very limited in size. I pool husbands and wives who arrive first, and those who arrive second. In order to allow the effects of T_1 and T_2 to vary by gender, I include a dummy for parent's gender and its interactions with T_1 and T_2. This allows to maximize the degrees of freedom as well as allows for differences in responses to schedule configurations by gender. The resulting specification is:

$$t_i = \beta_0 + \beta_1 X + \beta_2 T_1 + \beta_3 T_2 + \beta_4 Malefirst + \beta_5 MaleFirst * T_1 + \beta_6 Malefirst * T_2 + \varepsilon \quad (4)$$

where t_i stands for one of the following three behaviors. First is the time with children for the first arriver during the time the first arriver is home alone, t_{f1}. Second is the time with children for the first arriver during the time parents are home together, t_{f2}. Third is the time with children for the second arriver during the time parents are home together, t_{s2}. Controls X include child's age, husband's age and unearned wealth. The latter variable is the value of the household's unearned assets including the value of the house, if owned. *Malefirst* is the dummy for the first arriver being male, and $Malefirst * T_1$ and $Malefirst * T_2$ are its interactions with T_1 and T_2.

6. Results and Discussion

6.1 First stages

OLS regressions are likely to be biased since schedules and childcare allocations are likely to be affected by the same household-level unobservables. Therefore IV regressions were

[18] As mentioned previously, estimation does not account for the possibility of more than one overlap. This is done for tractability but is in line with the overwhelming proportion of the estimating sample. As a specification check, hours per week worked by the first and second arriver respectively were added (both as is and instrumented) to the OLS and IV specifications. This serves to capture any effect hours worked may have that is not captured by the after-work time or any differential effect labor market work may have on one's childcare productivity vs. other time uses. This increased collinearity, but left the key results essentially unchanged. The data does not reject the null hypothesis that the amount of market work does not affect childcare productivity conditional on total after-work time. This may be due to the fact that tasks involved in childcare and outside work are different enough: what matters for the amount of childcare one does may simply be the time available. Thus the number of work hours is omitted from results below.

run, and a comparison with OLS results made apparent the presence of selection. Table below shows the five first-stage equations that correspond to the five endogenous variables: T_1 T_2, dummy for "First arriver is male" and the interactions of this dummy with T_1 and T_2. The instruments are the first and second arrivers' commuting times, log wages of the first and second arriver and the two husband's industry-occupation schedule measures: the prevalence of flexible schedules and the average time that workday ends.

	(1)	(2)	(3)	(4)	(5)
			First arriver		
	T1	**T2**	**is male**	**T1xmalefirst**	**T2xmalefirst**
First arriver commute	-6.533	-0.31	0.681	0.482	2.514
	(8.79)**	-0.75	(6.50)**	(2.18)*	(5.34)**
Second arriver commute	1.456	-1.547	-0.08	-0.205	-0.541
	(2.41)*	(4.58)**	-0.95	-1.14	-1.41
Husband flexible schedules	0.887	1.678	-0.154	-0.663	-0.411
	-0.61	(2.05)*	-0.74	-1.52	-0.44
Husband ave time of ending work	0.204	-0.152	-0.157	-0.379	-0.699
	-0.65	-0.87	(3.56)**	(4.08)**	(3.53)**
ln wage first arriver	-0.007	-0.093	0.093	0.109	0.278
	-0.03	-0.6	(2.36)*	-1.32	-1.57
ln wage second arriver	0.462	-0.222	-0.072	-0.024	-0.136
	(2.16)*	-1.85	(2.38)*	-0.38	-1
Constant	0.22	3.838	2.922	7.308	12.573
	-0.03	-0.99	(3.00)**	(3.55)**	(2.87)**
Observations	253	253	253	253	253
R-squared	0.41	0.2	0.3	0.13	0.24
F-test for joint significance of instruments	17.63	9.19	17.3	5.75	12.21

Controls: child's age, husband's age, unearned wealth ($000)

Column 1 presents the first stage regression for T_1, the length of first arriver's home alone time. The significant instruments for T_1 are both parents' commuting time and the second arriver's wage. These relationships have expected signs. The commuting time of the earlier arriver decreases the length of his or her time home alone, the commuting time of the second

arriver increases it, and the wage of the second arriver increases it, presumably by increasing the second arriver's hours worked.[19] The instruments are strongly jointly significant (F=17.63).

Column 2 presents the first stage for T_2, the spouses' available time together after work. As expected, the first arriver's commuting time has no statistically significant association with the length of the spouses' time together, while the effect of the second arriver's commuting time is negative and strongly significant. Husband's industry-occupation average prevalence of flexible schedules is a significant predictor: in families where husbands are in less flexible jobs, parents overlap more at home. Again, instruments provide substantial explanatory power (F=9.19).

Column 3 presents the regression of the dummy that takes a value of one when the husband finishes work earlier than the wife. As expected, the increase in the average work end time in the husband's industry-occupation group has a negative effect. If we interpret equation 3 as a linear probability model, average work end time decreases the likelihood that he arrives home before the wife. The coefficients on the first arriver's commuting time and both arrivers' wages are also strongly significant. However, these effects are not easily interpretable. Since, unlike the other endogenous variables, *Malefirst* is based on gender rather than order of arrival, it would be more natural to recast wages and commuting times as those of the husband and wife rather than first and second arriver's. They are presented as they are because the other endogenous variables are based on order of arrival. There is a positive association between the commuting time of the first arriver and the first arriver being male. First arriver's wage increases make it more probable that the first arriver is male, and the second arriver's wage increases make it less likely that the first arriver is male. These results are due to the fact that in the sample males tend to have higher wages than females, and are more likely to be second arrivers. F=17.3.

T_1 * *Malefirst* (column 4) is positively and significantly associated with the first arriver's commuting time. This suggests that men who arrive home before their wives tend to have longer commuting time than men who arrive later than their wives. T_1 * *Malefirst* decreases with the average time of ending work in the husband's industry-occupation group. The later the typical ending time, the less time the first arriver husband spends home alone. The instruments are jointly significant at an acceptable level with F=5.75 (Stock (2003)).

Finally, T_2 * *Malefirst* is significantly predicted by the first arriver's commuting time, although there is no obvious reason to expect a particular sign for this relationship. Also, the later the typical work-end time in husband's industry-occupation group, the shorter the spouses' time together. This effect possibly operates through matching of parents' arrival times: the later the

[19] In column 1, the significant coefficient on the first arriver's commute is unexpectedly large: -6.53 means that an hour increase in commute time by the first arriver decreases the time alone by the first arriver by 6.53 hours. The expected magnitude should be close to 1. This unexpectedly high coefficient is due to the inclusion of non-working wives and their zero commute times among the first arrivers.

arrival of the first arriver (in this case the husband), the later the arrival of the second arriver (in this case the wife). The instruments are strongly jointly significant (F=12.21). The over-id tests reported in Main results strongly reject endogeneity of all instruments.

6.2 Main results

	(1) **OLS first** arriver, total	(2) **IV first** arriver, total	(3) **OLS first arriver** in T1	(4) **IV first arriver** in T1	(5) **OLS first arriver** in T2	(6) **IV first arriver** in T2	(7) **OLS second arriver** in T2	(8) **IV second arriver** in T2
Child age	-0.106	-0.089	-0.072	-0.087	-0.074	-0.008	-0.066	-0.099
	[3.65]**	[1.07]	[3.98]**	[1.83]	[3.47]**	[0.12]	[2.55]*	[1.47]
Husband age	0.036	0.042	0.031	0.029	0.002	0.003	-0.009	-0.015
	[2.42]*	[1.98]*	[3.34]**	[2.41]*	[0.17]	[0.16]	[0.69]	[0.86]
Unearned wealth ($000)	0	0	0	0	0	0	0	0
	[1.35]	[0.81]	[0.92]	[1.16]	[0.31]	[0.23]	[1.32]	[0.44]
T1	0.687	0.781	0.638	0.61	0.019	0.205	-0.053	-0.159
	[23.01]**	[3.89]**	[34.44]**	[5.35]**	[0.84]	[1.32]	[2.01]*	[0.98]
T2	0.573	0.606	-0.026	0.065	0.764	0.908	0.395	0.612
	[10.15]**	[3.00]**	[0.74]	[0.57]	[18.34]**	[5.79]**	[7.84]**	[3.76]**
First arriver is male	0.465	-1.555	0.211	-1.446	0.439	2.684	-0.247	0.231
	[0.93]	[0.47]	[0.68]	[0.77]	[1.19]	[1.04]	[0.55]	[0.09]
T1xmalefirst	-0.151	-0.802	-0.229	-0.204	0.064	-1.12	0.4	0.928
	[1.06]	[1.12]	[2.57]*	[0.50]	[0.61]	[2.02]*	[3.13]**	[1.61]
T2xmalefirst	-0.259	0.711	-0.023	0.458	-0.243	-0.156	0.102	-0.377
	[2.52]*	[1.00]	[0.36]	[1.13]	[3.21]**	[0.28]	[1.12]	[0.66]
Constant	-1.794	-2.75	-0.968	-1.094	-0.148	-2.001	1.311	1.417
	[3.22]**	[1.57]	[2.80]**	[1.10]	[0.36]	[1.47]	[2.63]**	[1.00]
Observations	266	253	266	253	266	253	266	253
R-squared	0.78	0.65	0.88	0.83	0.59	0.27	0.36	0.15
F-test for over-id		0.54		0.19		0.5		0.43

F-test for joint significance of instruments: 17.63 , 9.19, 17.3, 5.75, 12.21

Empirical analysis below aims to answer two principal questions. First is whether the data supports the timing –sensitive or the standard model. Second is whether there is evidence for parents' substitutability for each other. Recall that the zero correlation of husbands' childcare and wives' wages points against substitutability when interpreted in light of the standard model. Recall also that what determines whether the timing-sensitive or the timing-insensitive model is valid is parents' behavior during their time home together in response to changes in the first arriver's home alone time. The key estimates are whether an increase in T_1, i.e. the length of time alone by the first arriver, causes a decrease in the first arriver's childcare during T_2, the time parents spend home together, and an increase in the second arriver's childcare during T_2. Thus the test is of whether $\frac{\partial t_{f,2}}{\partial T_1} < 0$ and $\frac{\partial t_{s,2}}{\partial T_1} > 0$. This would lend support to the importance of timing in production of childcare and refute the timing-insensitive model. It would also support substitutability of parents for each other in conjunction with diminishing returns to childcare. The effects of an increase in home alone time are considered for each gender in turn.

6.2.1 The effect of an increase in T_1 on each parent's behavior during T_1 and T_2 when the first arriver is the husband

Effect of increase in T_1 by time segment and order of arrival	*Timing-insensitive model*	*Timing-sensitive model*	*IV Point Estimate (column locations in superscripts)*
1st arriver's (husband's) time in T_1	*N/a*	$\frac{\partial t_{f,1}}{\partial T_1} \geq 0$	$\beta_{T_1}^{col4} + \beta_{T_1 x malefirst}^{col4} =$ *=0.61*[SE=0.48]*
1st arriver's (husband's) time in T_2	*N/a*	$\frac{\partial t_{f,2}}{\partial T_1} \leq 0$	$\beta_{T_1}^{col6} + \beta_{T_1 x malefirst}^{col6} =$ *=-1.12*[SE=0.67]*
2nd arriver's (wife's) time in T_2. Also her total time	≤ 0	$\frac{\partial t_{s,2}}{\partial T_1} = \frac{\partial t_{s,tot}}{\partial T_1} \geq 0$	$\beta_{T_1}^{col8} + \beta_{T_1 x malefirst}^{col8} =$ ***=0.93*[SE=0.70]***
1st arriver's (husband's) total time ($T_1 + T_2$)	≥ 0	$\frac{\partial t_{f,tot}}{\partial T_1} = \frac{\partial t_{f,1}}{\partial T_1} + \frac{\partial t_{f,2}}{\partial T_1} \geq 0$	$\beta_{T_1}^{col2} + \beta^{col2}{}_{T_1 x malefirst} = 0.78*$

For the case when the husband is the first arriver, the IV results are fully consistent with the predictions of my timing-sensitive model, and reject the timing-insensitive model. Keeping

the length of time together constant, longer home alone time by the husband increases the wife' childcare input upon her arrival home. An hour increase in her husband's preceding time home alone causes the wife to increase her childcare by $\beta_{T_1}^{col8} + \beta_{T_1 xmalefirst}^{col8} = 0+0.93=0.93$ hr, with $\beta_{T_1 xmalefirst}$ marginally statistically significant[20]. Her total childcare input thus increases.

Data also lends support to both the diminishing returns in childcare and parents' substitutability for each other, in contrast to conclusions from the conditional correlations based on the timing-insensitive model. Consistent with childcare being a normal good, the first arriver husband increases his childcare as his home alone period lengthens: $\beta_{T_1} + \beta_{T_1 xmalefirst} = 0.61$. The effect is statistically significant. He also decreases his childcare during the time together, consistent with diminishing returns: $\beta_{T_1} + \beta_{T_1 xmalefirst} = 0-1.12=-1.12$, where each coefficient as well as their sum are negative and statistically significant. For the first arriver husband, an hour increase in time home alone leads to $\beta^{col2}{}_{T_1} + \beta^{col2}{}_{T_1 malefirst} = 0.78+0=0.78$ hr increase in total childcare time[21]. For the wife (of the husband who is the first arriver) results are also consistent with diminishing returns and substitutability: for every hour of husband's time home alone potentially available for childcare she increases her involvement upon arrival home, by 0.93 hr.

When the husband is the first arriver, the data is thus fully consistent with the timing-sensitive model and the presence of diminishing returns and substitutability: an increase in time alone increases the first arriver's input during the time alone and decreases his input during the time together, when he is substituted for by the second arriver.

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[20] It is likely that the first arriver has higher unobserved taste or ability for childcare and is the designated childcare provider. Thus the coefficient on T_1 is likely biased upward. Consistent with this hypothesis, $\hat{\beta}^{IV}{}_{T_1}$ is slightly lower than $\hat{\beta}^{OLS}{}_{T_1}$, while $\hat{\beta}^{OLS}{}_{T_1 xMalefirst}$ and $\hat{\beta}^{IV}{}_{T_1 xMalefirst}$ are both insignificant. For the same reason, $\hat{\beta}^{OLS}{}_{T_1}$ and $\hat{\beta}^{OLS}{}_{T_1 xMalefirst}$ in column 5 are also likely to be biased upward. Consistent with this hypothesis, while $\hat{\beta}^{OLS}{}_{T_1}$ and $\hat{\beta}^{IV}{}_{T_1}$ are both insignificant, $\hat{\beta}^{IV}{}_{T_1 xMalefirst}$ in column 6 decreases compared to $\hat{\beta}^{OLS}{}_{T_1 xMalefirst}$ in column 5. While $\hat{\beta}^{OLS}{}_{T_1 xMalefirst}$ is insignificant, $\hat{\beta}^{IV}{}_{T_1 xMalefirst}$ is negative and significant. Finally, the second arriver may have a relatively lower taste or skill in childcare, and thus $\hat{\beta}^{OLS}{}_{T_1}$ and $\hat{\beta}^{OLS}{}_{T_1 xMalefirst}$ in column 7 are likely to be biased negatively. Consistent with this hypothesis, $\hat{\beta}^{IV}{}_{T_1}$ in column 8 is insignificant, compared with negative and significant $\hat{\beta}^{OLS}{}_{T_1}$ in column 7. Also consistently, $\hat{\beta}^{IV}{}_{T_1 xMalefirst}$ in column 8 is positive and significant, compared with insignificant $\hat{\beta}^{OLS}{}_{T_1 xMalefirst}$ in column 7.

[21] Note that this result agrees with that reported by Presser (1989), who finds that the longer the non-overlap, the greater men's housework input.

6.2.2 The effect of an increase in T_1 on each parent's behavior during T_1 and T_2 when the second arriver is the husband

Effect of increase in T_1 by time segment and order of arrival	*Timing-sensitive model*	*Timing-sensitive model*	*IV Point Estimate (column locations in superscripts)*
First arriver's (wife's) time in T_1	*N/a*	$\frac{\partial t_{f,1}}{\partial T_1} \geq 0$	$\beta_{T_1}^{col4} = 0.61^*$
First arriver's (wife's) time in T_2	*N/a*	$\frac{\partial t_{f,2}}{\partial T_1} \leq 0$	$\beta_{T_1}^{col6} = 0$
Second arriver's (husband's) time in T_2. Also his total time	≤ 0	$\frac{\partial t_{s,2}}{\partial T_1} = \frac{\partial t_{s,tot}}{\partial T_1} \geq 0$	$\beta_{T_1}^{col8} = 0$
First arriver's (wife's) total time ($T_1 + T_2$)	≥ 0	$\frac{\partial t_{f,tot}}{\partial T_1} = \frac{\partial t_{f,1}}{\partial T_1} + \frac{\partial t_{f,2}}{\partial T_1} \geq 0$	$\beta_{T_1}^{col2} = 0.78^*$

The implied effect of an increase in T_1 for the total childcare time of each parent when the husband finishes work second is considerably different from the case when the wife finishes work second (and the husband arrives home first). Recall that when the husband arrives home first and has to spend an extra hour alone in T_1, his total childcare increases by 0.78 hr and his wife's total childcare increases by 0.93 hr.[22] If results were in accordance with the gender-neutral model, they would be symmetric. However, keeping parents' time home together constant, when the first arriver wife's time home alone increases, her second arriver husband's total childcare time stays constant. This result is consistent with a corner solution outcome in the context of either the timing-sensitive or the timing insensitive model. It is in line with previous literature consistently reporting resistance of mothers to decreasing childcare time even as they increase their labor force participation[23].

As in the case when the first arriver is the husband, the effect of an hour increase in home alone time (T_1) for the first arriver wife is $\beta_{T_1}^{col4} = 0.61^*$. The crucial difference is that unlike the childcare time of the first arriver husband, her time does not correspondingly decrease during the time together, T_2 : $\beta_{T_1}^{col4}$ is not significantly different from zero. Consistent with this result, the second arriver husband differs from the wife in the same situation because he does not

[22] Note that this result agrees with that reported by Presser (1989), who finds that a longer the time alone is associated with greater men's housework share.
[23] E.g. Bianchi (2000), Sandberg & Hofferth (2001)

substitute for his spouse during the time together T_2 as her time alone (T_1) increases: $\beta_{T_1}^{col6}$ is highly insignificant. It is notable that these two estimated effects are consistent with each other.

Thus in contrast to the case when the second arriver is the wife, when the second arriver is the husband, neither diminishing returns for the first arriver nor substitution by the second arriver during time together are apparent. It is not possible, in the context of the model, to empirically detangle the first arriver's diminishing returns from his or her substitutability with the second arriver. Results suggest that the lack of overall increase in men's childcare in response to women's wage increases may be due to both husbands' greater diminishing returns and to wives' greater readiness to provide childcare in after-work time.

To summarize, keeping parents' time together constant, if it is the wife who is spends any time home alone then as her time home alone increases, her total childcare time increases while husband's childcare time remains constant. On the other hand, if it is the husband who is home alone for longer, both his and his wife's total daily childcare times increase. The crucial point is that an increase in one spouse's time alone affects the second spouse's childcare time differently depending on his or her gender. If the second arriver is the husband, then his total childcare time stays constant. If the second arriver is the wife, then her childcare time increases. The difference is due, again, to the finding that men but not women exhibit diminishing returns to childcare, and also that women respond to the length of preceding time home alone for the husband, but husbands not respond to the preceding home alone time of their wives.

7. Conclusion

This paper is motivated by the apparent unresponsiveness of husbands' childcare time to increases in wives' wages—an empirical finding that runs counter to the predictions of the standard comparative advantage and bargaining theories of the household (Becker (1965), McElroy and Horney (1981)). I address this issue by acknowledging the timing-sensitive nature of childcare—the fact that time inputs at different moments in a day may not easily substitute for each other. Feeding, changing diapers and checking homework are all needs that arise at regular intervals so that greater past involvement does not diminish the need for future involvement. I incorporate this maintenance aspect of childcare and show that the timing-sensitive model can reconcile parents' substitutability for each other with the zero conditional correlation between husbands' childcare time and wives' wages observed empirically. I test the timing-sensitive model against the standard unitary model, and provide an alternative test of parents' substitutability for each other in childcare provision.

The timing-sensitive model describes schedules using parents' order of arrival home from work and the resulting length of each parent's time home alone and home together with the

spouse. The testable implication distinguishing it from the standard model concerns the childcare behavior of the second arriver. Longer time at home by the first arriver increases his or her childcare input and lowers his or her productivity relative to the second arriver. It does not, however, diminish the quantity of maintenance childcare that remains to be provided upon arrival of the second arriver. Thus the longer the preceding time alone by the first arriver, the higher the second arriver's relative productivity and childcare input. This prediction is opposite of that of the standard model, where the general result is that the more time one parent spends at home, the less childcare should the other parent do.

I test the two models against each other using an empirical specification that nests both models. It involves demand equations of parents' childcare time as a function of the lengths of their time home alone and home together. A conditional, rather than an unconditional demand approach is necessary due to the presence of considerable labor market rigidities in hours worked (Dickens and Lundberg (1993)). These rigidities result in a divergence between the true opportunity costs of spouses' time and their observed wages, biasing the unconditional demand estimates. Identification takes advantage of this rigidity in work hours and timing, as well as the data on parents' commuting times. The data favors the timing-sensitive model in the case when the second arriver is female. If the second arriver is male, the results are consistent with a corner solution for either of the two model types.

The timing-sensitive model yields an insight not obtainable from timing-insensitive models. It demonstrates that parents' childcare behavior depends not only on wages but also on the extent of overlap in parents' schedules. It enables a new assessment of parents' substitutability for each other by focusing explicitly on the time they are both at home. This time-specific substitutability may not be detected by traditional conditional correlations of childcare time with parents' wages. Contrary to previous results, I find that husbands do substitute for wives in childcare, but only when wives' longer work hours result in the husbands spending more time at home while their wives are at work. There is evidence of diminishing returns to childcare for men, as well as of women's substitution for men: the longer the husband's time home alone potentially available for childcare, the greater the amount of childcare done by the wife once she becomes available. However, the result is not symmetric: wives do not appear to exhibit diminishing returns, and husbands do not substitute for the wives available to kids for longer.

The timing-sensitive model developed in this paper can be useful for further studies of effects of schedule changes and schedule flexibility on household behavior, and of the determinants of schedule choice. The high and increasing schedule heterogeneity and flexibility in American families makes schedules important in their own right. Also, even if one were

interested solely in the effects of labor market participation, omitting schedules would result in the omitted variable bias, since schedules are correlated with the number of work hours.

The new insight provided by the timing-sensitive model extends to analyses of the effects of policies and social trends on the usage of market childcare, parental childcare and gender equality. For example, the timing sensitive model sheds light on why husbands' housework is positively associated with the occurrence of staggered schedules (Presser (1994)) but not of flexible schedules. Holding individual preferences constant, shift work imposes constraints that counteract traditional gender norms by increasing husbands' exposure to household responsibilities in the absence of their wives. By contrast, flexible schedules remove timing constraints and allow the outcome to come closer to its unconstrained optimum. To the extent that current gender inequality is due to individual preferences rather than labor market rigidities, flexibility will reinforce rather than uproot it.

Preliminary analyses suggest that by showing how work schedules interact with other household behaviors, the timing-sensitive model can be gainfully employed in several other areas of policy relevance. These include the effect of extended daycare on women's labor force participation, which may be especially relevant for low-income single mothers. Finally, the model is applicable to the analysis of effect of shift work on household outcomes and the tradeoff between flexibility and the quantity of labor supplied to the market, which is relevant for the analysis of the proposed changes to the Fair Labor Standards Act governing overtime laws.

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Appendix 1: The Comparative Statics for the Standard Timing-Insensitive Model

The change in husband's childcare time t_h in response to wife's higher non-work time T_w:

$$\frac{\partial t_h}{\partial T_w} = \frac{p^2 F''_h \overbrace{(Q''U''+F''_w Q''+p^2 F''_w U'')}^{G}}{G} \geq 0 \text{, where}$$

$$G = p^2 Q'' F''_h U''+p^2 Q'' F''_w U''+F''_w F_h'' Q''+p^2 F''_w F''_h U'' \leq 0$$

Appendix 2: The Timing-Sensitive Model

$$Max_{C,t_{h_j},t_{w_j},t_{mkt_j},l_{h_j},l_{w_j},h_{h_j},h_{w_j}}$$

$$U = u(C) + (\sum_{j=1}^{24} Q(t_{h_j} + t_{w_j} + t_{mkt_j})) + U_h(\sum_{j=1}^{24} t_{h_j}) + U_w(\sum_{j=1}^{24} t_{wj}) + (\sum_{j=1}^{24} F(l_{h_j})) + (\sum_{j=1}^{24} F(l_{w_j}))$$

$$\text{s.t.} \quad C \leq w_w \sum_{j=1}^{24} h_{w_j} + w_h \sum_{j=1}^{24} h_{h_j} - p_{mkt} \sum_{j=1}^{24} t_{mkt_j},$$

$$h_{i_j} \in \{0,1\},\ t_{i_j} \in [0,1], l_{i_j} \in [0,1],\ h_{i_j} + t_{i_j} + l_{i_j} = 1,\ i = h,w,\ \forall j$$

Note that labor market hours are indivisible, i.e. $h_j \in \{0,1\}$. Given rationing on the amount and timing of work and childcare, fix $\sum_{j:h_w=1} h_w = \bar{h}_w$, $\sum_{j:h_h=1} h_h = \bar{h}_h$. The problem becomes:

$$Max_{C,t_{h_j},t_{w_j},t_{mkt_j},l_{h_j},l_{w_j}}$$

$$U = \sum_{j:h_w=0,h_1=1} Q(t_{w_j} + t_{mkt_j}) + F(l_{w_j}) +$$

$$+ \sum_{j:h_w=1,h_h=0} Q\ (t_{h_j} + t_{mkt_j}) + F(l_{h_j}) + \sum_{j:h_w=0,h_h=0} Q(t_{h_j} + t_{w_j} + t_{mkt_j}) + F(l_{h_j}) + F(l_{w_j}) + U_h(\sum_{j=1}^{24} t_{h_j}) + U_w(\sum_{j=1}^{24} t_{w_j})$$

$$\text{s.t. } C \leq Y + \bar{h}_h w_h + \bar{h}_w w_w - p_{mkt} \sum_{j=1}^{24} t_{mkt_j}\ ;\ t \in [0,1], l \in [0,1] \text{ and } t_{i_j} + l_{i_j} = 1,\ i = h,w;\ \forall j$$

Assume there is only one non-overlap (time alone) in a family: this is born out in the data, and is explained by the model. Group all time alone periods and call the total time alone by a given spouse T_1. Group all the time together periods and call the total time together time T_2.

Call the first arriver's childcare and leisure behaviors t_{f_j} and l_{f_j} where the subscript *f* indexes the first arriver. Call second arriver's childcare and leisure behaviors t_{s_j} and l_{s_j} where *s* indexes the second arriver. Rewrite:

$$Max_{C,t_{fj},t_{sj},t_{mktj},l_{fj},l_{sj}}$$

$$U = \sum_{j\in T_1} Q_j(t_{f_j} + t_{mkt_j}) + F_f(l_{f_j}) + \sum_{j\in T_2} Q_j(t_{f_j} + t_{s_j} + t_{mkt_j}) + F(l_{f_j}) + f(l_{s_j}) + U_h(\sum_{j=1}^{24} t_{f_j}) + U_w(\sum_{j=1}^{24} t_{s_j})$$

$$\text{s.t. } C \le Y + \bar{h}_h w_h + \bar{h}_w w_w - p_{mkt}\sum_{j=1}^{24} t_{mkt_j} \;;\; t \in [0,1], l \in [0,1] \text{ and } t_{i_j} + l_{i_j} = 1, \;\; i = h, w; \;\; \forall j$$

Ruling out the use of market childcare during after-work time allows significant simplification of the problem. Implications remain unaffected when the price of market childcare is higher than the marginal utility of childcare time for parents in equilibrium. This condition is reasonable, given that empirically, the price of market childcare is increasing in the number of hours bought and for periods that occur later in the day. Rewrite:

$$Max_{t_{fj},t_{sj},t_{mktj},l_{fj},l_{sj}}$$

$$U = \sum_{j\in T_1} Q_j(t_{f_j}) + F_f(l_{f_j}) + \sum_{j\in T_2} Q_j(t_{f_j} + t_{s_j}) + F(l_{f_j}) + f(l_{s_j}) + U_h(\sum_{j=1}^{24} t_{f_j}) + U_w(\sum_{j=1}^{24} t_{s_j})$$

$$\text{s.t. } t_{i_j} \in [0,1], l_{i_j} \in [0,1] \text{ and } t_{i_j} + l_{i_j} = 1, \;\; i = f, s; \;\; \forall j$$

FOCs:

1) Intensity of childcare is the same across all non-overlap periods. Specifically, a parent devotes to childcare exactly the same amount of time in each of the time alone periods: $Q'_{t_{fi}}(t_{f_i}) + U'_{t_{fi}}(\sum_{i=1}^{24} t_{f_i}) = Q'_{t_{fj}}(t_{f_j}) + U'_{t_{fj}}(\sum_{j=1}^{24} t_{f_j}) \;\forall i,j \in T_1$, so that

$$t_{f_i} = t_{f_j} \;\forall i,j \in T_1$$

2) Intensity of a parent's childcare is the same across all periods spent together with the spouse:

$$Q'_{t_{fi}}(t_{f_i} + t_{s_i}) + U'_{t_{fi}}(\sum_{i=1}^{24} t_{f_i}) = Q'_{t_{fj}}(t_{f_j} + t_{s_j}) + U'_{t_{fj}}(\sum_{j=1}^{24} t_{f_j}) \;\forall i,j \in T_2,$$ so that

$$t_{f_i} = t_{f_j} \;\forall i,j \in T_2$$

3) At the interior optimum, keeping the length of time together constant, the later the second arriver gets home, the more childcare he or she does.

$$Q'_{t_{f_i}}(t_{f_i}+t_{s_i})+U'_{t_{f_i}}(\sum_{i=1}^{24}t_{f_i})=Q'_{t_{s_j}}(t_{f_j}+t_{s_j})+U'_{t_{s_j}}(\sum_{j=1}^{24}t_{s_j})$$

$$U'_{t_{f_i}}(\sum_{i=1}^{24}t_{f_i})<U'_{t_{s_j}}(\sum_{j=1}^{24}t_{s_j})$$

At interior optimum it must be that $Q'_{t_{f_i}}(t_{f_i}+t_{s_i})>Q'_{t_{s_j}}(t_{f_j}+t_{s_j})$, i.e. t_{f_i} during each period *i* of time together is lower than t_{s_i}.

In empirical analysis I aggregate all periods of time together into one group, and time alone in another group. I group the corresponding childcare inputs by each partner according to whether they are home alone or together with the partner.

$$U=\sum^{T_1}Q(t_{f_j})+F(l_{f_j})+\sum^{T_2}Q(t_{f_j}+t_{s_j})+F(l_{f_j})+F(l_{s_j})+U(\sum_{j=1}^{24}t_{f_j})+U(\sum_{j=1}^{24}t_{s_j})=$$

$$=T_1Q(t_{f_{j:j\in T_1}})+T_1F(l_{f_{j:j\in T_1}})+T_2Q(t_{f_{j:j\in T_2}}+t_{s_{j:j\in T_2}})+T_2F(l_{f_{j:j\in T_2}})+T_2f(l_{s_{j:j\in T_2}})+U(\sum_{j=1}^{24}t_{f_j})+U(\sum_{j=1}^{24}t_{s_j})=$$

$$=T_1Q(\frac{t_{f1}}{T_1})+T_1F(\frac{l_{f1}}{T_N})+T_2Q(\frac{t_{f2}}{T_2}+\frac{t_{s2}}{T_2})+T_2F\ (\frac{l_{f2}}{T_2})+T_2F(\frac{l_{s2}}{T_2})+U(T_1\frac{t_{f_1}}{T_1}+T_2\frac{t_{f2}}{T_2})+U(T_2\frac{t_{s2}}{T_2})$$

with $t_{f1}=\sum_{j\in T_1}t_{f_j}$, $l_{f1}=\sum_{j\in T_1}l_{f_j}$, $t_{f2}=\sum_{j\in T2}t_{f_j}$, $l_{f2}=\sum_{j\in T2}l_{f_j}$, $t_{s2}=\sum_{j\in T2}t_{s_j}$, $l_{s2}=\sum_{j\in T2}l_{s_j}$. Further,

$$T_1Q(\frac{t_{f1}}{T_1})+T_1F(\frac{l_{f1}}{T_N})+T_2Q(\frac{t_{f2}}{T_2}+\frac{t_{s2}}{T_2})+T_2F\ (\frac{l_{f2}}{T_2})+T_2F(\frac{l_{s2}}{T_2})+U(T_1\frac{t_{f_1}}{T_1}+T_2\frac{t_{f2}}{T_2})+U(T_2\frac{t_{s2}}{T_2})=$$

$$=T_1Q(\frac{t_{f1}}{T_1})+T_1F(\frac{l_{f1}}{T_N})+T_2Q(\frac{t_{f2}}{T_2}+\frac{t_{s2}}{T_2})+T_2F\ (\frac{l_{f2}}{T_2})+T_2F(\frac{l_{s2}}{T_2})+U(t_{f1}+t_{f2})+U(t_{s2}).$$

Appendix 3.

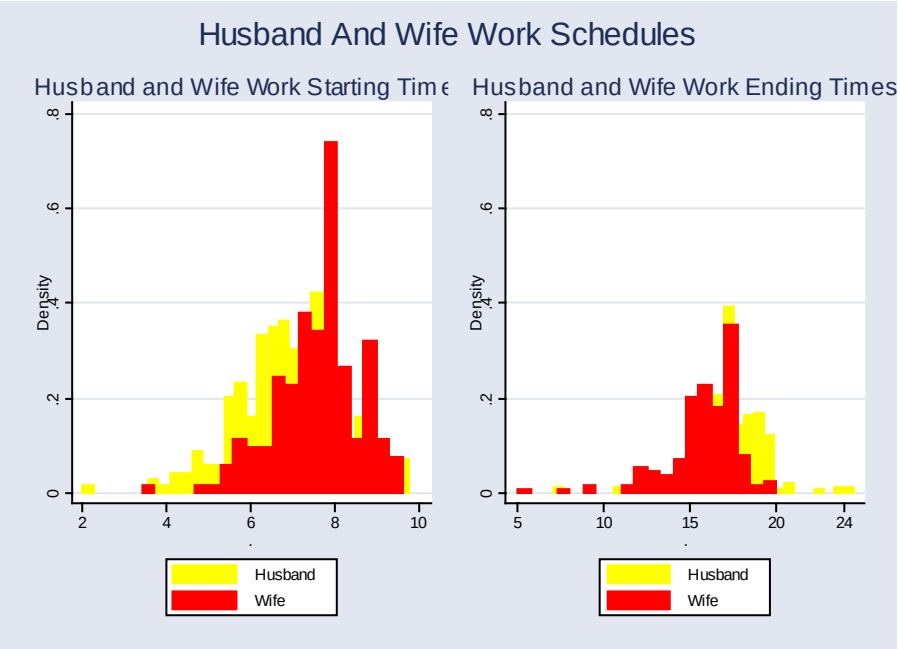
The key comparative static is presented below is the change in second arriver's childcare time in response to an increase in the first arriver's time alone. The remaining comparative statics are available from the author's web page.

$$\frac{\partial t_{s2}}{\partial T_1} = \frac{\overbrace{U''(t_{f1}+t_{f2})}^{\le 0}\overbrace{Q''(\frac{t_{f2}+t_{s2}}{T_2})}^{\le 0}\overbrace{(Q''(\frac{t_{f1}}{T_1})t_{f1}+F''(l_{f1})T_1^2}^{\le 0}}{\underbrace{G}_{\le 0}} \ge 0$$

where

$$G = T_1(U''_f\ Q_2''U''_s+U''_f\ Q''_2\ F''_{s2}+U''_{f2}\ F''_{f2}\ Q''_2\ )+$$
$$+T_2(Q''_1\ U''_f\ U''_{s2}+Q''_1\ U''_f\ F''_{s2}+Q''_1\ F''_{f2}\ U''_{s2}+Q''_1\ F''_{f2}\ F''_{s2}\ )+$$
$$+T_1(F''_{f1}\ U''_f\ Q''_2+F''_{f1}\ Q''_2\ U''_{s2}+F''_{f1}\ Q''_2\ F''_{s2}+F''_{f1}\ F''_{f2}\ Q''_2\ )+$$
$$+T_1T_2(U''_f\ F''_{f2}\ U''_{s2}+U''_f\ F''_{f2}\ F''_{s2}+F''_{f1}\ U''_f\ U''_{s2}+F''_{f1}\ U''_f\ F''_{s2}+F''_{f1}\ F''_{f2}\ U''_{s2}+F''_{f1}\ F''_{f2}\ F''_{s2}\ )+$$
$$+Q''_1\ Q''_2\ U''_{s2}+Q''_1\ U''_f\ Q''_2+Q''_1\ F''_{f2}\ Q''_2+T_1Q''_1\ Q''_2\ F''_{s2} \le 0$$

Appendix 4: Starting and Ending Time of Work for Husbands and Wives



Appendix 5: Summary Statistics

Variable	Obs	Mean	Std. Dev.
DEMOGRAPHIC VARIABLES			
age of focus child	266	6.20	3.53
number of children	266	2.22	1.02
sex of focus child	266	1.47	0.50
age of husband	266	37.55	6.38
age of wife	266	35.39	5.58
wealth94, including house value	266	141020.40	403389.20
wealth94, not including house value	266	111365.60	375806.20
dummy for "first arriver is male"	266	0.23	0.42
WAGES			
first arriver's wage, imputed	262	2.45	0.62
second arriver's wage, imputed	258	2.79	0.85
ln husband wage	254	2.85	0.78
ln wife wage	188	2.36	0.77
ln wife wage, imputed	266	2.40	0.67
HOURS WORKED, BY GENDER AND BY ORDER OF ARRIVAL			
first arriver's work hours per week	266	25.18	19.07
second arriver's work hours per week	266	45.61	10.04
husband's hours worked on the survey day	266	10.39	2.09
wife's hours worked on the survey day	171	8.39	2.19
first arriver's work hrs on the survey day	171	8.16	2.21
second arriver's work hrs on the survey day	266	10.54	1.92
INSTRUMENTS AND RELATED VARIABLES			
first arriver's commute	266	0.21	0.24
second arriver's commute	266	0.41	0.29
ave occurrence of regular daytime schedule in husband's industry-occupation group	261	1.16	0.10
standard deviation of occurrence of regular daytime schedule in husband's industry-occupation group	261	0.34	0.09
number of observations in head's industry-occupation group for calculating stats on regular daytime schedules	261	1240.43	1359.19
ave occurrence of flexible hours in husband's industry-occupation group	261	1.58	0.16
SD of occurrence of flexible hours in husband's industry-occupation group	261	0.47	0.05
number of observations in head's industry-occupation group for calculating stats on flexible hours	261	1238.28	1357.58

Appendix 6: Distribution of Industry and Occupation Groups in the Estimating Sample

Husband's ind - occ group: ind x occ (see definitions in Appendix 2)	Freq.	Percent	Husband's ind - occ group: ind x occ (see definitions in Appendix 2)	Freq.	Percent
n/a	4	1.5	7x1	7	2.63
.x12	1	0.38	7x2	2	0.75
1x2	1	0.38	7x4	3	1.13
1x12	2	0.75	7x5	3	1.13
1x13	8	3.01	8x1	2	0.75
3x1	3	1.13	8x2	12	4.51
3x2	2	0.75	8x4	1	0.38
3x9	5	1.88	8x9	12	4.51
3x11	1	0.38	9x1	2	0.75
4x1	18	6.77	9x8	1	0.38
4x2	23	8.65	9x9	1	0.38
4x4	3	1.13	10x1	1	0.38
4x5	3	1.13	10x12	1	0.38
4x9	16	6.02	11x1	8	3.01
4x10	9	3.38	11x2	17	6.39
4x11	6	2.26	11x8	1	0.38
4x12	2	0.75	11x9	2	0.75
5x1	8	3.01	11x12	1	0.38
5x2	7	2.63	12x1	1	0.38
5x4	1	0.38	12x5	3	1.13
5x9	6	2.26	12x8	3	1.13
5x11	1	0.38	12x9	5	1.88
5x12	1	0.38			
6x1	20	7.52	Total	266	100
6x4	6	2.26			
6x5	1	0.38			
6x8	1	0.38			
6x9	7	2.63			
6x10	5	1.88			
6x11	1	0.38			
6x12	5	1.88			

Appendix 7: Industry and Occupation Group Definitions

Industry group definitions

17-28 in PSID (20-32 in CPS): Agriculture, Forestry and Fisheries

47-57 (40-50) Mining

67-77 (60) Construction

107-398 (100-392) Manufacturing

407-479 (400-472) Transportation, Communications, and Other Public Utilities

507-698 (500-691) Wholesale and Retail Trade

707-718 (700-721) Finance, Insurance and Real Estate

727-759 (722-760) Business and Repair Services

769-798 (761-791) Personal Services

807-809 (800-810) Entertainment and Recreation Services

828-897 (812-893) Professional and Related Services

907-937 (900-932) Public Administration

Occupation group definitions

1-195 Professional, technical and kindred workers

201-245 Managers and Administrators, Except Farm

260-285 Sales Workers

301-395 Clerical and Kindred Workers

401-600 Craftsmen and Kindred Workers

601-695 Operatives Except Transport

701-715 Transport Equipment Operatives

740-785 Laborers Except Farm

801-802 Farmers and Farm Managers

821-824 Farm Laborers and Farm Foremen

901-965 Service Workers, Except Private Household