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INEFFICIENCIES IN DYNAMIC FAMILY DECIONS:
AN INCOMPLETE CONTRACTS APPROACH TO LABOR SUPPLY

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Inefficiencies in Dynamic Family Decisions: An Incomplete Contracts Approach to Labor Supply.

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Abstract

We study marital arrangements with enforceability problems. The result is a simple dynamic model that uses a contractual approach to marriage and shows how inefficiencies can arise in intra-household time allocations determination. The contractual approach appears to be particularly fruitful in interpreting some anomalies in the observed US labor supply patterns. We believe this model can represent a useful tool for the analysis of the process of intra-household decision making in intertemporal settings which views the family institution as characterized by long term relationships with symmetric information.

1 Introduction

Virtually all models of the household assume that the allocation of resources within the family is Pareto efficient. During the 80s the *consensus* model of Samuelson[26] and Becker's[4][5] *altruistic* model were challenged by the development of models that recognize the specificity of preferences of each family member and determine intra-household allocations as an efficient solution to a cooperative bargaining game between spouses[1]. In the early 90s Chiappori [10][11] generalized those models using an approach which does not rely on any particular cooperative solution and requires only Pareto efficiency. However, Udry[31] recently found inefficiencies in land and

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[1]See Lundberg and Pollak[21] for a quick review.

working time allocations within African households caused by commitment problems between spouses[2].

The present paper presents a dynamic model that uses a contractual approach to marriage and shows how inefficiencies arise in intra-household time allocation determination. We agree with the common wisdom, interpreting the household as an institution characterized by long term relationships with symmetric information. However, we believe that the marriage contract and the intra-household arrangements have a strong character of incompleteness. Partners cannot commit on not recontracting, ex-post, on previously agreed arrangements. If law does not require the verification of the reasons of divorce, then renegotiation-proof first best contracts are not feasible. As a consequence, we show that if agents cannot remarry, then spouses tend to work less than the efficient level (*underwork*). Moreover, we show that remarriage opportunities can offset this inefficiency and, actually reverse the result inducing spouses to *overwork* with respect to the efficient level.

In section 2 we first study a model without remarriage or inter-temporal considerations. In this model spouses tend to work less than the efficient level because ex-post bargaining makes agents only partial residual claimants of their labor income (hold-up problem). We then solve the dynamic version of our model, in which we allow for marriage market effects and we find sufficient conditions leading to inefficiently high levels of labor supply decisions for both partners. In a world where there are no despotic marriage relationships and where the relative bargaining position depends on outside opportunities, both partners can tend to work more in order to accumulate marketable human capital and improve remarriage opportunities. This result suggests that inter-temporal considerations may lead to inefficiencies that in a static setting cannot be detected. Moreover we can use our model to give a normative content of the term *overworking* linked to some recent findings for the US economy (Schor[27][3]).

In section 3 we use our model to explore some puzzling features of the US labor sector. Smith and Ward [28] have noted that real wage growth explains most of the increase in the post war female labor supply. However, in the period after 1970, the female-labor-supply growth rate rose, while the real-wage growth rate fell. Michael [22]provides a partial explanation by identifying a positive effect of divorce probability on the labor-market decisions of married women[4]. Nevertheless, this does not seem

[2]Udry suggests also the possibility of existence of asymmetric information. As we will see, in our framework, this is not required for the inefficiency result.

[3]Schor found a consistent decline in US leisure and supported the debate about overworked Americans. To the weak decline in middle aged men labor-force-participation rate Schor opposed the sharp increase of labor supply of both young men and women, especially after the 70s. Moreover she presents results supporting the hypothesis that also working hours per employed agent raised. However, demand side issues are beyond the scope of this paper.

[4]The articles by Peters[24] and Johnson and Skinner[17] seem to provide additional insights into this anomaly.

to be the whole story. Peters, on one hand, argues that the change in US divorce law, during the 70s, induced no variation of the probability of divorce. On the other hand, she found that the change from fault to no-fault divorce raised the labor-force-participation rate of married women (see also Parkman[23]). So there should be some element omitted in Michael's analysis. Trying to reconcile those anomalies we show that the change from fault to no-fault divorce law reduced the ex-ante renegotiation-proof contracts set. With both divorce laws it is possible to implement a contract which induces efficient divorce. But, with no-fault divorce, some inefficiencies in labor decisions cannot be eliminated and the result is that both partners overwork.

Pollack[25] initiated the transaction costs literature giving a theoretical foundation to collective bargaining models. A work closely related to ours is that of Cohen[12]. He analyzes the role of existing and potential divorce contracts in limiting the possibility of opportunistic behavior of married men in quasi-rents appropriation[5].

None of those papers presents a formal model for the analysis and, to our knowledge, there are few papers which formally analyze family decisions in an environment with significant transaction costs. Allen[3] suggests that the existence of monitoring costs may cause inefficient sharing within marriage and analyzes the effects of those transaction costs in marriage market. Konrad *et al.*[19] assume agents decide opportunistically prior to marriage human capital endowments and show that the inefficient over-accumulation can arise both when agents forecast a cooperative behavior during marriage and when they forecast an opportunistic behavior. Weiss *et al.*[29][30] interpret the inefficiencies in children support between divorced couples as a consequence of the impossibility to enforce ex-ante Pareto optimal marital contracts. In Weiss *et al.*[30] they look at the (empirically detected) positive relationship between divorce transfers and the couple differentials in earnings during marriage as a test in favor of the existence of transactions costs within the family. King[18] and Borenstein *et al.*[9] develop rudimental dynamic frameworks in which they analyze how the during marriage investments in human capital are affected by the risk of divorce. In both models human capital return is assumed exogenous and the distortions come because property rights are not perfectly defined (hedging purpose). Only in Echevarria *et al.*[14] we find a fully dynamic framework. In their OLG model parents behave altruistically with their children, and decide children human capital endowments taking as given that during marriage spouses will play a cooperative Nash bargaining game. They apply their model to study human capital accumulation and fertility in US economy; however, in Echevarria *et al.* time allocations are assumed exogenous[6].

In our model labor supply decisions are endogenous and the outside opportunities

[5]Other references are Allen[2] and Becker *et al.*[7] who focused on the role of the state in marriage. Generally speaking they argue that the state intervention can be welfare improving because it reduces some of the transaction costs existing within the family. Moreover see Becker *et al.*[6].

[6]Another related paper is Lommerud[20]. He assumes that, during marriage, decisions are Pareto optimal because arrangements between-spouses can be enforced by "voice".

are changing over time through *on-the-job-training* human capital accumulation. We think the model can represent a useful tool for the analysis of the process of intra-household decision making in inter-temporal settings.

As said, in section 2 we analyze the nature of inefficiencies. In section 3 we pursue the policy exercise. The last section concludes and presents our future research agenda.

2 The basic model

In this section we present our basic model. The principal results of this section are the following. First, in proposition 1 we show that the one-stage game predicts *under*working. Moreover, proposition 2 shows that intertemporal considerations are not enough to overcome this kind of inefficiencies. However, in proposition 3, we will see that the dynamic model, joint with the possibility of remarriage, can reverse the results and predicts *over*working.

2.1 Pareto optimal decisions

The family relationship lasts for two stages and agents have the following intertemporal utility function:

$$u(c,l) = c_1 - v(l_1) + \delta\left[c_2 - v(l_2)\right]$$

where c_t is consumption, l_t is working time at time t $(t = 1, 2)$ and δ is the usual discount factor. Note that our agents are risk neutral and that we assume the cost function $v(.)$ to be increasing, differentiable, strictly convex[7] and $v'(0) = 0$.

Working time provides labor income and allows to accumulate human capital via on-the-job training. The law of motion for human capital is implicit in the following wage equation:

$$w_2 = h(w_1, l_1), \tag{1}$$

where w_t is the t-stage wage and $h(w_1, .)$ is increasing and weakly concave in l_1.

Efficient decisions maximize the total family welfare. Under our assumptions we can determine any Pareto optimal allocation assuming that consumption among agents is allocated using lump sum transfers (τ_t). So each spouse solves the following problem:

[7]It is worth noting that actually we will require something more than this. $v(.)$ has to be such that the problem for l_1 is concave. This is required for two important reasons. First we will use only first order conditions assuming their sufficiency. Second, we will use this assumption in Proposition 2.

$$
\begin{aligned}
& Max_{\{l_t,c_t\}_{t=1}^{2}} c_1 - v(l_1) + \delta\left[c_2 - v(l_2)\right] && (2)\\
sub &: && (3)\\
c_t &= w_t l_t + \tau_t, \quad t = 1, 2, && (4)\\
& (1), \quad \text{and} \quad w_1 \text{ given.} && (5)
\end{aligned}
$$

The conditions on $v(.)$ guarantee interiority for every positive wage level. Assuming concavity, the solution is defined by the following first order conditions:

$$
\frac{dv(l_2^0)}{dl_2} = w_2 \tag{6}
$$

$$
and
$$

$$
\frac{dv(l_1^0)}{dl_1} = w_1 + \delta \frac{\partial h}{\partial l_1} \frac{dV(w_2)}{dw_2} \tag{7}
$$

where $V(w_2)$ is the last stage utility and is given by:

$$
V(w_2) = w_2 l_2^0 + \tau_2 - v(l_2^0) \tag{8}
$$

where $l_2^0 = l_2(w_2)$ and from (6) $l_2(.)$ is the inverse of the first derivative of $v(.)$; τ_2 is exogenous[8].

Two remarks are worth making. First, note that applying envelope theorem to (8) and totally differentiating (6) we obtain $V''(w_2) = l_2'(.) = \frac{1}{v''(.)} > 0$, $V(w_2)$ is convex in w_2. This implies that the assumption of concavity in l_1 is not innocuous[9]. Second, note that since there are no income effects the Pareto optimal labor supply decision is unique for every lump sum transfer choice. So we can always set a feasible transfer scheme in such a way that both the male and the female participation constraints are satisfied. Given that preferences are quasilinear in consumption, then we can use the τ_ts to transfer utility between the spouses and reach any Pareto optimal allocation. Feasibility only requires the sum of transfers not bigger than the total marriage gains.

[8] Using Bellman's principle, the problem for l_1 is:

$$
\begin{aligned}
& Max_{l_1} \quad w_1 l_1 + \tau_1 - v(l_1) + \delta V(w_2)\\
sub &: (1), \quad \text{and} \quad w_1 \text{ given.}
\end{aligned}
$$

[9] However, for example, the quadratic cost function $-v(l) = -l^2$ and the linear accumulation rule $w_2 = w_1 + a * l_1$ meet all the concavity requirements for $a < 2$.

2.2 The "no-planning" case

In the inefficient case we should be more careful in describing the timing of the game and we have to enrich our notation using superscripts for genders. In our familiar economy we assume there are no problems of informational asymmetries between spouses. We will focus on a specific class of transaction costs: the costs of enforcing the agreements. As a first approximation we can obtain the intuition for our result assuming that marriage contracts are not binding.

Divide each stage t in two sections: the production and the bargaining section. During the production section, agents decide simultaneously (and non-cooperatively) their labor decisions $l_t^i, i = m, f$. Once labor decisions are taken, labor incomes $w_t^i l_t^i$ are realized and agents start the bargaining section. In the bargaining section spouses' consumption assignments c_t^i are determined by an (ex-post) efficient division of the total surplus $I_t = w_t^m l_t^m + w_t^f l_t^f + y_t$. We define y_t as a flow of utility that comes simply from the fact that agents are married[10]. This for both stages 1 and 2. The timing of this game is summarized in Figure 1 for the case without remarriage. Figure 2 extends the game to the remarriage case.

If we adopt the incomplete contracts perspective of Hart and Moore[16] and Hart[15], the timing described above can be seen as a reduced form of a renegotiation-proof (second-best) contracts between spouses. The idea is as follows. The basic assumption is that time allocations are too complex to be specified in an ex-ante contract, hence those variables are decided non-cooperatively by the agents. Within each stage the role of time is the resolution of uncertainty and we assume when labor decisions are taken the couple is uncertain of the quality of the match, y_t[11]. When this random variable is realized the partners reevaluate their original decisions and, in particular, decide whether or not to remain married. We assume enforceability problems in the ex-ante contract setting are such that agents cannot avoid renegotiation. In particular, since law allows unilateral divorce (*no-fault*), then each partner can threaten divorce, ex-post, in order to renegotiate the initial surplus divisions. In this case the ex-post consumption assignments will be determined during the bargaining process, whatever was the initial agreement. Rational agents will take this bargaining process outcome as given when deciding their working hours, leading to the usual hold-up problem. In this basic model the specific investment nature of labor supply decisions depends on the divorce rule, exogenously given in our framework. In section 3 we will study the role played by different divorce laws in the familiar contractual

[10] In our basic model, y_t exogenous guarantees gains from marriage without introducing other sources of inefficiency. We will interpret y_t as an indicator of the quality of the match for the couple. Since single agents are supposed to obtain utility only from consuming their labor income, then a positive expected value of y_t implies that there are (aggregate) gains from marriage.

[11] In order to simplify the analysis we do not introduce a particular distribution for y_t. However, we implicitly assume that y_t is both the expected and the (a.s.) realized one. The non verifiability characteristic of y_t allows agents to threaten divorce ex-post. For a similar simplification see Hart[15].

setting.

In order to determine the equilibrium decisions we proceed backwards. Given ex-post bargaining, the consumption levels at the end of stage 2 are obtained dividing the familiar income I_2 according to the following rule[12]:

$$c_2^m = O_2^m + \beta \left[I_2 - O_2^m - O_2^f \right] \tag{9}$$

where $I_2 = w_2^m l_2^m + w_2^f l_2^f + y_2$, is the family income realized at the beginning of stage-two bargaining section; y_2 represents the marriage gains and O_2^i are the outside opportunities at the end of the period for agent $i = m, f$. O_2^i are defined by the following divorce rule. In case of divorce, the couple looses y_2. Moreover, the husband is forced to pay an alimony transfer $\tau(.)$ to the wife (for example, a child support) and the size of such transfer is increasing in the within marriage labor income $w_2^m l_2^m$[13]. So the (static) outside opportunities of the spouses are:

$$\begin{array}{c} O_2^m = w_2^m l_2^m - \tau(w_2^m l_2^m), \\ O_2^f = w_2^f l_2^f + \tau(w_2^m l_2^m). \end{array} \tag{10}$$

Notice that when the husband has to decide working time he has to consider also the effect of his decision on his wife's outside opportunity. Substituting (10) into (9) we obtain $c_2^m = O_2^m + \beta y_2$. So, at the beginning of stage two the agent will choose his working time[14] according to:

$$\frac{dv(l_2^{*,m})}{dl_2^m} = (1 - \tau'(w_2^m l_2^{*,m})) w_2^m, \tag{11}$$

[12]This is the usual generalized Nash Bargaining solution with parameter β, i.e. (9) solves:

$$\begin{array}{rcl} & & Max_{c_2^m, c_2^f} (c_2^m - O_2^m)^\beta (c_2^f - O_2^f)^{1-\beta} \\ sub & : & \\ I_2 & \geq & c_2^m + c_2^f \\ & & O_2^m, O_2^f \quad given. \end{array}$$

The Nash solution can be non-cooperatively founded by an alternating offer game with exogenous probability of termination (Binmore *et al.*[8]).

[13]Empirical evidence for this assumption can be found in Weiss *et al.*[30].

[14]Soving the problem:

$$\begin{array}{rcl} & & M = Max_{l_1^m} \quad c_2^m - v(l_2^m) \\ sub & : & (9)(10) \quad w_2 \text{ given.} \end{array}$$

$\tau'(.) > 0$ implies a *marginal* specificity of the labor time and the result will be underworking[15](we will assume $\tau'(.) < 1$ for interiority), as is summarized in the following proposition.

Proposition 1 *Given a positive wage level w. If $\tau'(.) > 0$ for any positive income level, then the one-stage version of the model leads to underworking, i.e. the equilibrium labor level l_2^m is lower than the Pareto optimal one.*

Proof. Consider (equal) initial conditions $w = w_2 = w_2^m > 0$. Interiority implies income is positive, so by assumption $\tau'(.) > 0$. Because of backward solving, the conditions (6) and (11) define the efficient and inefficient solutions of the one-stage game starting at the end of stage 1, respectively. With $\tau'(.) > 0$ the right hand side of equation (11) is strictly less than the right hand side of equation (6). From interiority the same inequality has to be true also for the left hand sides. The convexity of $v(.)$ gives our result. ■

We have seen that without intertemporal considerations the model predicts undoubtedly underworking for the husband (In this special case the wife will supply the Pareto optimal level of labor. The wife's problem is solved in the section 3.)[16]. In an intertemporal setting the endogeneity. of the outside opportunity not only affects the marginal specificity of the labor time investment. Human capital accumulation affects the agents' position in the ex-post bargaining process. The following analysis will be mainly focused on the study of this *bargaining effect.*

In order to distinguish from the Pareto optimal problem notation ($V(.)$) define husband's value function while married at the beginning of stage 2 as $M(.,.)$, where:

$$M(w_2^m, w_2^f) = c_2^{*,m} - v(l_2^{*,m}) = Max_{l_2} \ \ c_2^m - v(l_2^m), \tag{12}$$

$c_2^{*,m} = c^m(w_2^m, w_2^f)$ is the optimal decisions according to equation (9), with l_2^f taken as given and $l_2^{*,m} = \tilde{l}_2\ (w_2^m)$, $\tilde{l}_2\ (.)$ defined implicitly by equation (11). The wife's value function $F(.,.)$ is defined analogously. In stage 1, at the beginning of the bargaining section, the initial labor decisions for both partners are known (and sunk). Agents start bargaining and the outcome will assign to agent m the following level of utility:

[15]An alternative assumption could be to assume that divorce will imply one or both parties to pay a fraction of labor income as divorce costs, in this case:

$$O^i = w^i l^i (1 - k^i),$$

where k^i is the cost of divorce, proportional to labor income. The solution for this case can be found in a previous draft of the paper.

[16]In the alternative case presented in footnote 15 also the wife's labor decision will be inefficiently lower than the Pareto optimal one.

$$u^m = W^m + \beta \left[I_1 + \delta \left(M(w_2^m, w_2^f) + F(w_2^m, w_2^f) \right) - W^m - W^f \right]. \qquad (13)$$

Note that, now, both the total surplus $I_1 + \delta (M + F)$ and the outside opportunities W^i have intertemporal nature, in particular we have:

$$W^i = O_1^i + \delta D^i(w_2^i)$$

with $w_2^i = h(w_1^i, l_1^i)$ and, similarly to (10):

$$\begin{aligned} O_1^m &= w_1^m l_1^m - \tau(w_1^m l_1^m), \\ O_1^f &= w_1^f l_1^f + \tau(w_1^m l_1^m). \end{aligned}$$

$D^i(w_2^i)$ is the utility of agent i while divorced, at the beginning of stage 2 (see Figure 2). Note that $D^i(.)$ depends only on the wage of agent i. This is because we assume the alimony transfer $\tau(.)$ is eventually payed only once. We will define $D^i(.)$ later according to two different assumptions.

At the beginning of the production section in stage 1, agent m decides his labor supply taking as given the bargaining outcome in (13) and the female labor decision in current stage. So the first order condition satisfies:

$$\frac{dv(l_1^{*,m})}{dl_1^m} = (1 - \tau'(.))w_1^m + \delta \frac{\partial h}{\partial l_1} \left[(1-\beta) \frac{dD^m(w_2^m)}{dw_2^m} + \beta \left(\frac{\partial M(w_2^m, w_2^f)}{\partial w_2^m} + \frac{\partial F(w_2^m, w_2^f)}{\partial w_2^m} \right) \right]. \qquad (14)$$

Comparing with equation (7) for $w_1 = w_1^m$ we can see that the first term of the right hand side of equation (14) represents the static effect that leads the inefficient result of Proposition 1. Moreover, recalling the definitions of $M(.,.)$, $F(.,.)$ in (12), by the envelope theorem we have:

$$\frac{\partial M(w_2^m, w_2^f)}{\partial w_2^m} + \frac{\partial F(w_2^m, w_2^f)}{\partial w_2^m} = l_2^{*,m} = \widetilde{l_2} \, (w_2^m) \qquad (15)$$

From Proposition 1 we have $l_2^{*,m} < l_2^0$, so it seems that the last term of equation (14) could never compensate the static (underworking) effect. Let us focus on the value function $D^i(.)$. In particular we are interested in determining how $D^m(w_2^m)$ varies as a function of w_2^m. Indeed we will see that what crucially determines the results are the assumptions on $D^i(.)$. In particular we will consider in turn two environments. Firstly, we will assume that there are no remarriage opportunities so that we can evaluate the *pure intertemporal effect* (Case A). After that, we will allow agents to remarry (Case B). The next proposition shows how intertemporal considerations alone are not enough to offset the (static) inefficiency stated in Proposition 1. In Proposition 3 we will see how marriage market considerations can change this first result.

Case A: No Remarriage Assume that if an agent decides to divorce then he will remain alone till the end of the game. Moreover, we assume that there is no change in preferences from being single and, for simplicity, assume that the alimony for the stage 1 divorce is not due after the end of stage 1. Then the agent m's divorce value function is defined:

$$D^m(w_2^m) = w_2^m l_2^{0,m} - v(l_2^{0,m}) = Max_{l_2} \;\; w_2^m l_2^m - v(l_2^m) \tag{16}$$

where $l_2^{0,m} = l_2(w_2^m)$, $l_2(.)$ is the inverse of the marginal cost of labor, given from (6) with $w_2 = w_2^m$. The problem faced by a single agent is the Pareto Optimal one. The only difference is the absence of marriage gains, so the consumption is reduced by the transfers. The following proposition summarizes the principal result for this first case.

Proposition 2 *Without remarriage the first stage husband labor supply decision l_1^m is less than the Pareto optimal one.*

Proof. Start with equal initial conditions $w_1^m = w_1$. Rewriting equation (14) we have:

$$\begin{aligned}\frac{dv(l_1^{*,m})}{dl_1^m} &= (1-\tau'(.))w_1 + \delta\frac{\partial h}{\partial l_1}\left[(1-\beta)\frac{dD^m(w_2^m)}{dw_2^m} + \beta\left(\frac{\partial M(w_2^m, w_2^f)}{\partial w_2^m} + \frac{\partial F(w_2^m, w_2^f)}{\partial w_2^m}\right)\right] \\ &= (1-\tau'(.))w_1 + \delta\frac{\partial h}{\partial l_1}\left[(1-\beta)l_2^{0,m} + \beta\left(l_2^{*,m}\right)\right], \end{aligned} \tag{17}$$

where the equality in (17) comes from (15) and from applying envelope theorem to (8) and (16). Now rearranging equation (17) we have:

$$\begin{aligned}\frac{dv(l_1^{*,m})}{dl_1^m} - \delta\frac{\partial h}{\partial l_1}\left[l_2^{0,m}\right] + \beta\delta\frac{\partial h}{\partial l_1}\left[l_2^{0,m} - l_2^{*,m}\right] &= (1-\tau'(.))w_1 \\ &< w_1 \\ &= \frac{dv(l_1^0)}{dl_1} - \delta\frac{\partial h}{\partial l_1}\left[l_2^0\right].\end{aligned} \tag{18}$$

The strict inequality holds because at an interior solution $\tau'(.) > 0$. The last equality comes from (7). From Proposition 1 (underworking in the last stage) we have that the last term in the left hand side of the first row is always positive (for any $w_2 > 0$ $l_2^{0,m} > l_2^{*,m}$), so the inequality in (18) implies the following:

$$\frac{dv(l_1^{*,m})}{dl_1^m} - \delta\frac{\partial h}{\partial l_1}\left[l_2^{0,m}\right] < \frac{dv(l_1^0)}{dl_1} - \delta\frac{\partial h}{\partial l_1}\left[l_2^0\right].$$

Now note that by the definition of $D^m(.)$ in (16) and $V(.)$ in (8), at the optimal solution, the functional forms of $l_2^{0,m}$ and l_2^0 are the same. So we can rewrite the previous inequality using the definition of w_2 in (1):

$$\frac{dv(l_1^{*,m})}{dl_1^m} - \delta\frac{\partial h}{\partial l_1}\left[l_2(h(w_1,l_1^{*,m})\right] < \frac{dv(l_1^0)}{dl_1} - \delta\frac{\partial h}{\partial l_1}\left[l_2(h(w_1,l_1^0))\right].$$

From the concavity in l_1 of the objective function in problem (2)-(5), we have that those first order conditions are increasing in l_1. So $l_1^{*,m} < l_1^0$ as stated. ■

Note that in the proof of Proposition 2 we have not required the concavity of the inefficient problem. Any stationary point, in particular any local or global optima, is characterized by underworking. From Proposition 1 we can say that the result is underworking in any stage of the game. Again in our example the female decision is efficient[17].

Remark 1 *By induction, it is possible to show that, without remarriage then for every T stages dynamic game, the husband labor supply decision l_t^m is less than the Pareto optimal one in any stage.*

Case B: Remarriage is Allowed Remark 1 seems quite strong result. The assumption of no-remarriage makes the problem quite simple but seems in contrast with some recent empirical fact documented by Schor[27]. We should incorporate remarriage opportunities in our analysis. For simplicity, assume that human capital accumulation increases the probability of matching another partner because of high earning capacities. In particular suppose that once an agent is married the utility is deterministic (no exogenous probability of divorce), but when divorced the agent enters in the marriage market. The agent is small compared with the (marriage) market and the equilibrium is such that agent i has probability λw_2^i of remarrying (state $s = 1$) and probability $(1 - \lambda w_2^i)$ of remaining alone (state $s = 0$), obviously λ is such that $0 \leq \lambda w_2^i \leq 1$. Note that in this case (B) the wage affects also the probability of getting the surplus y_2 deriving from (re)marriage. The parameter y_2 will be the driving force of the result in Proposition 3[18]. When y_2 is high, then the agents have a strong incentive to work hardly during the first stage in order to accumulate human capital and to increase the probability of receiving part of the remarriage surplus y_2.

In this new (stochastic) environment, while taking stage 1 labor decision l_1^i the agent faces the following problem:

$$Max_{l_1^i} \quad u^i - v(l_1^i). \tag{19}$$

[17] For the case in footnote 15 we have underworking for the wife also in intertemporal setting.

[18] A more accurate analysis should take into account assortative mating considerations in an equilibrium model of marriage market. For simplicity we have, further, ignored the possibility of positive correlation between agents' wage levels.

Let's focus again on agent m's problem. For the husband u^m is given by (13). The only difference from case (A) is that now the value function of agent m while divorced $D^m(w_2^m)$ is substituted by the one derived taking into account remarriage opportunities:

$$V^{D,m}(w_2^m) = E\left[\tilde{D}^m(w_2^m, s) \mid w_2^m\right] = \lambda w_2^m \tilde{D}^m(w_2^m, 1) + (1 - w_2^m \lambda) \tilde{D}^m(w_2^m, 0)$$

equation (14) becomes:

$$\frac{dv(l_1^{*,m})}{dl_1^m} = (1-\tau'(.))w_1 + \delta \frac{\partial h}{\partial l_1}\left[(1-\beta)\frac{dV^{D,m}(w_2^m)}{dw_2^m} + \beta\left(\frac{\partial M(w_2^m, w_2^f)}{\partial w_2^m} + \frac{\partial F(w_2^m, w_2^f)}{\partial w_2^m}\right)\right], \tag{20}$$

where we have simply substituted $D^m(w_2^m)$ with $V^{D,m}(w_2^m)$. Now we are ready to state the main result of this section.

Proposition 3 *Assume that problem (19) is concave for agent m. If remarriage is allowed then there is an expected match quality level $\widehat{y}_2$ that induces Pareto efficient labor choice in the first stage. Moreover any level $y_2 > \widehat{y}_2$ will lead to overwork in the first stage.*

Proof. First work out condition (20). For the new value function $V^{D,m}(w_2^m)$, we have:

$$\begin{aligned}\frac{dV^{D,m}(w_2^m)}{dw_2^m} &= \frac{dE\left[\tilde{D}^m(w_2^m, s) \mid w_2^m\right]}{dw_2^m} = \lambda \tilde{D}^m(w_2^m, 1) + \lambda w_2^m \frac{d\tilde{D}^m(w_2^m, 1)}{dw_2^m} + \\ &+ (1 - \lambda w_2^m)\frac{d\tilde{D}^m(w_2^m, 0)}{dw_2^m} - \lambda \tilde{D}^m(w_2^m, 0).\end{aligned} \tag{21}$$

The agent m's value functions in each of the two states are:

$$\tilde{D}^m(w_2^m, 1) = M(w_2^m) = w_2^m l_2^{*,m} - \tau(w_2^m l_2^{*,m}) + \beta y_2 - v(l_2^{*,m}) \tag{22}$$

and

$$\tilde{D}^m(w_2^m, 0) = D^m(w_2^m) = w_2^m l_2^{0,m} - v(l_2^{0,m}). \tag{23}$$

By the envelope theorem:

$$\frac{d\tilde{D}^m(w_2^m, 1)}{dw_2^m} = (1-\tau'(.))l_2^{*,m} = (1-\tau'(.))\,\widetilde{l}_2\,(w_2^m) \tag{24}$$

and

$$\frac{d\tilde{D}^m(w_2^m, 0)}{dw_2^m} = l_2^{0,m} = l_2(w_2^m), \tag{25}$$

where $\tilde{l}_2(.)$ and $l_2(.)$ defined, respectively by (11) and (6). Substituting (24), (25) into (21) and rearranging terms, we obtain:

$$\begin{aligned}\frac{dV^{D,m}(w_2^m)}{dw_2^m} &= \lambda\left[\tilde{D}^m(w_2^m,1) - \tilde{D}^m(w_2^m,0)\right] + \\ &+\lambda w_2^m\left[(1-\tau'(.))\,\tilde{l}_2(w_2^m) - l_2(w_2^m)\right] + l_2(w_2^m), \qquad (26)\end{aligned}$$

notice the first term is by assumption positive and its magnitude depends on y_2 but, by Proposition 1, the second term is negative. At an interior solution, the level $\widehat{y}_2$ is the one that satisfies (20) for the optimal level $l_1^{*,m} = l_1^{0,m} \equiv l_1^0$. Under concavity, (20) is also sufficient for the solution. The existence of such $\widehat{y}_2$ is given by construction. Set:

$$\begin{aligned}\widehat{y}_2 &= \frac{1}{(1-\beta)\lambda}\left[\frac{\tau'(.)w_1}{\delta\frac{\partial h}{\partial l_1}\beta} + l_2(w_2) - \tilde{l}_2(w_2) + \frac{\tilde{l}_2(w_2)}{\beta}\right] + \qquad (27)\\ &+\frac{v(l_2(w_2)) - v(\tilde{l}_2(w_2)) + (2+\tau'(.))w_2\left(l_2(w_2) - \tilde{l}_2(w_2)\right) + \tau(.)}{\beta}.\end{aligned}$$

Note $l_2(.)$ and $\tilde{l}_2(.)$ (defined by (11) and (6), respectively) are both evaluated at the efficient level of second stage wage w_2 because l_1^m is chosen efficiently and we started by the same initial condition $w_1^m = w_1$. The idea of the result is as follows. From (26) together with (22), (23), (24) and (25) we have that in (20) only $\frac{dV^{D,m}(w_2^m)}{dw_2^m}$ depends on y_2 and is increasing. In particular for any fixed level l_1^m the only element that depends on y_2 is $\tilde{D}^m(w_2^m,1)$ from (22). So the first part of proposition is proved.

Now start from $y_2 = \widehat{y}_2$ and consider the necessary and sufficient condition (20) at the Pareto optimal solution for l_1^m:

$$(1-\tau'(.))w_1+\delta\frac{\partial h}{\partial l_1^m}\left[(1-\beta)\frac{d\widehat{V}^{D,m}(w_2)}{dw_2} + \beta\left(\frac{\partial M(w_2,w_2^f)}{\partial w_2} + \frac{\partial F(w_2,w_2^f)}{\partial w_2}\right)\right] - \frac{dv(l_1^{0,m})}{dl_1^m} = 0,$$

where $\widehat{V}^{D,m}(.)$ is $V^{D,m}(w_2)$ evaluated at $\widehat{y}_2$. If $y_2 > \widehat{y}_2$then $\frac{dV^{D,m}(w_2)}{dw_2} > \frac{dV^{D,m}(w_2)}{dw_2}$ when l_1^m is held constant. From the concavity of the problem in l_1^m the expression in the left hand side of the previous equation is decreasing in l_1^m. So, with $y_2 > \widehat{y}_2$, in order to obtain again equality to zero l_1^m has to increase above the initial level $l_1^m = l_1^{0,m} \equiv l_1^0$. This proves the second part of the proposition. ■

Note that there is a caveat in the previous proof. In order to obtain the Pareto optimal labor decision we need to check if $\widehat{y}_2$ guarantees enough surplus so that both agents want to get married. Note, however, that this participation constraint does not preclude the overworking result. We can always choose bigger y_2 so that there are both gains from marriage and inefficiently high labor supply. We will see in section 3 that for any positive level of y_2, the wife will overwork.

We believe the conditions for overworking in the model presented in this section are minimal, for example, the introduction of household production will change the specificity investment character of the labor time toward overworking.

In the light of the results in this section we can identify three classes of reasons for which people may want to work more than the optimal. First, Proposition 1 suggests that in a static environment there is no room for overworking. This result can be extended to any intertemporal framework if there are no human capital accumulation opportunities, in particular it's easy to see that if $\frac{\partial h}{\partial l_1} = 0$, then any T stages problem will merely reproduce a T-repetition of the result in Proposition 1 (even with remarriage).

Second, comparing the results in Proposition 2 and 3 we have noted that human capital accumulation alone is not enough. We believe the overworking result emphasizes the importance of social norms in determining agents behavior. The existence of a significant remarriage market is already an assumption about social norms. If divorced agents were particularly stigmatized by society, then the remarriage market will be practically inexistent. In particular we can focus on three objects which determine the result in Proposition 3: w_2, λ and β. Our way of modelling (re)marriage market implies earning power w_2 is socially relevant. We know that in some societies job position is not important only for earning capacities. A good job is also a "social signal" and we have incorporate this features in our model[19]. The parameter λ is linked with the proportion of singles on the total. From equation (27) we can say the remarriage effect is more important in societies where there is an high number of singles also in the middle age. The importance of the parameter β is subtle, but it is easy to imagine strong patriarchal society in which Pareto optimal decisions can be implemented by a dictatorial husband that imposes wife actions and decides household resources allocation[20].

The third class of reasons is more technical and is linked with the limitations in marriage agreements in an unverifiable information environment. We believe the first two classes of reasons describe quite well the US environment. In the following section we develop the contractual aspects comparing the effects of two particular divorce rules historically related to US.

[19] In this we follow Cole *et al.*[13](see for example their *Wealth-Is-Status Equilibrium*).

[20] More rigorously, Aghion *et al.*[1] show how efficient decisions can be implemented in incomplete contract situations when the bargaining power is all allocated to one agent.

3 A policy exercise: the change in divorce law

In this section we will consider the implication of two different divorce laws on household time allocations. First we analyze the no-fault divorce model. In pure no-fault divorce states either spouse is allowed to initiate divorce unilaterally; actually most US states adopt the no-fault formula for divorce and the model of section 2 is consistent with the unilateral decision. After that, we will present the fault divorce model. Before 1970 in all US states divorce required either mutual consent or proof of "fault" in an adversary proceeding[21].

We will show that, while with common consensus agents can implement Pareto optimal labor decisions, the results presented in section 2 show that no-fault divorce causes inefficient time allocations. In particular, in the lights of the results in Proposition 3 of previous section we would expect that a change from fault to no-fault divorce increases labor supply.

During 70s female labor-force-participation rate rose while real wage growth rate fell. Labor economists tried to explain this anomaly with the increase in the probability of divorce occurred after the gender revolution. However, Peters[24] found that a woman who lived in a no-fault divorce state did not face a higher probability to divorce than a woman living in a fault divorce law state. Moreover, Peters used a Probit model to show that living in a no-fault divorce state increases the probability to participate in the labor market by two percentage points. We believe the results in this section give a formal explanation to those empirical findings[22].

As an independent result, in this section, it is shown that marriage contracts, under the two divorce laws, have an important normative property. In both regimes divorce is efficient, i.e. divorce occurs when the joint value of marriage is less then the sum of the values of opportunities which are faced by each spouse when divorcing.

3.1 The Basic Model: No-Fault Divorce

Recall briefly the model presented in section 2 (case B). We will focus on wife's stage 1 decisions. At the beginning of stage 1 agent f solves:

$$Max_{l_1^f} \quad u^f - v(l_1^f), \tag{28}$$

where, ex-post renegotiation, implies:

$$u^f = W^f + (1-\beta)\left[I_1 + \delta\left(M(w_2^m, w_2^f) + F(w_2^m, w_2^f)\right) - W^m - W^f\right], \tag{29}$$

[21]In 1970, California was the first state to adopt the no-fault approach to divorce. Other ten states went to no fault divorce before 1974. Between 1970 to 1985, all the American jurisdictions enhanced some form of no-fault divorce.

[22]Peters conjectured women increased labor supply because were worried about not being compensated for marriage specific investments in case of divorce. However, Parkman[23] showed that this was not the case. The effect of the change in divorce law on labor supply differed across woman depending on human capital accumulation possibilities.

and:

$$W^f = O_1^f + \delta V^{D,f}(w_2^f);$$

allowing remarriage the value function is given by:

$$V^{D,f}(w_2^f) = E\left[\widetilde{D}^f(w_2^f, s) \mid w_2^f\right] = \lambda w_2^f\, \widetilde{D}^f(w_2^f, 1) + (1 - w_2^f\lambda)\, \widetilde{D}^f(w_2^f, 0).$$

Assuming concavity and interiority, the necessary and sufficient condition is:

$$\frac{dv(l_1^{*,f})}{dl_1^f} = w_1 + \delta\frac{\partial h}{\partial l_1}\left[l_2(w_2^f) + \beta\lambda\left((1-\beta)y_2 + \tau(.)\right)\right] \tag{30}$$

where $l_2(w_2^f) = \frac{d\widetilde{D}^f(w_2^f,0)}{dw_2^f} = \frac{dD^f(w_2^f)}{dw_2^f} = \frac{dV(w_2^f)}{dw_2^f}$, and comes from applying the envelope theorem to (8). As long as $(1-\beta)y_2 > -\tau(.)$, from the concavity of the problem (28)-(29), we will have *overworking* for the wife[23]. The previous discussion is the proof of Proposition 3 for agent f.

In what follows we will present an optimality property of the marriage contract in our basic model. Ex-post renegotiation implies efficient divorce. As long as there are ex-post (aggregate) gains from marriage agents will redistribute those gains renegotiating the initial division and remain married.

Definition 1 *Efficient divorce occurs if and only if:*

$$TG < W^m + W^f,$$

where TG stay for total gains:

$$TG = u^m + u^f = I_1 + \delta\left(M(w_2^m, w_2^f) + F(w_2^m, w_2^f)\right)$$

and W^m, W^f are the (ex-post) outside opportunities.

Remark 2 *With no-fault regime divorce is efficient.*

Looking at (29) (and (13) for the husband) we can see that the individual rationality condition $u^i \geq W^i$, $i = m, f$ defines also to an efficient divorce rule. Agents divorce if and only if the expression in square brackets is negative, which corresponds to the condition that total marriage gains $TG = I_1 + \delta\left(M(w_2^m, w_2^f) + F(w_2^m, w_2^f)\right)$ be less then the sum of (ex-post) outside opportunities $W^m + W^f$.

[23]Note that in our model we assumed y_2 positive so as long as $\beta\lambda > 0$ wife's labor decisions are inefficient.

3.2 The "Fault" Divorce Model

Consider the same problem as the one defined is section 2. The only difference is that now agents face a different divorce rule. The so-called *fault divorce law.* We should define formally what it is meant for this term. Since it was almost never possible to show one partner's "fault" then the US divorce law prior 1970 was in fact a regime of *mutual consent.*

Definition 2 *Under mutual consent regime, agents divorce if both agree on divorce.*

If law requires mutual consent, some kind of severance pay or compensation at divorce will be necessary to convince the partner to agree on divorce. The following proposition summarizes the main result of this section. With mutual consent, agents can implement the first best labor and divorce decisions.

Proposition 4 *Under mutual consent agents can implement the Pareto optimal labor decision* $l_t^{i,0}, i = m, f, t = 1, 2$. *Moreover divorce is efficient, i.e. there will be divorce in the first stage if and only if* $u^m + u^f = TG < W^m + W^f$ *and in the second stage if and only if* $c_2^m + c_2^f < O_2^m + O_2^f$.

Proof. To prove efficiency of labor decisions. Suppose spouses agree on an ex-ante transfer scheme τ_t^i $i = m, f$; $t = 1, 2$ which divides the (expected) total gains in the two stages y and y_2 $(\tau_t^m + \tau_t^f = y_t; t = 1, 2)$[24]. Since we have seen in problem (2)-(5) of section 2 that this is precisely the way we implement the Pareto optimal decisions, then it will suffice to show that there will be no ex-post renegotiation. Equivalently we show that the ex-post division cannot be different from the ex-ante division. Start from the beginning of stage two bargaining section. Agent f has already decided her labor decision in current stage l_2^f, and, from the ex-ante agreed division, without renegotiation, her consumption level will be $c_2^f = w_2^f l_2^f + \tau_2^f$. Since wife must agree on divorce then f will accept a new division only if the new consumption level $\widehat{c}_2^f$ satisfy $\widehat{c}_2^f \geq c_2^f$. Similarly the ex-post renegotiated outcome for m has to satisfy $\widehat{c}_2^m \geq c_2^m$. Those two conditions together with the constraint $\widehat{c}_2^m + \widehat{c}_2^f \leq I_2 = w_2^f l_2^f + w_2^m l_2^m + \tau_2^f + \tau_2^m = w_2^f l_2^f + w_2^m l_2^m + y_2$ imply an ex-post bargaining process outcome, while married: $\widehat{c}_2^f = c_2^f$ and $\widehat{c}_2^m = c_2^m$. Following a similar argument it is easy to show that at the beginning of stage 1 bargaining section agents cannot change ex-ante division u^m, u^f of total gains TG, i.e. $\widehat{u}^m = u^m$ and $\widehat{u}^f = u^f$. This proves the first part of the proposition.

To prove efficient divorce. First, assume $u^m + u^f = TG < W^m + W^f$ if both $W^m > u^m$ and $W^f > u^f$ then we are done, otherwise w.l.o.g. suppose $W^m <$

[24] In general, the transfers does not have to be nonnegative, however the transfer scheme is not unconstrained. Since τ_t^i are decided ex-ante, then they should satisfy the participation constraints at the beginning of each stage.

u^m and $W^f > u^f$, then agent m can compensate f with a positive transfer $P^m = W^m - u^m + \beta \left[TG - W^m + W^f\right]$ in order to convince her to agree on divorce. He will gain $\beta \left[TG - W^m + W^f\right]$ and the wife will agree because her divorce payoff $W^f + P^m = u^f + (1-\beta)\left[W^m + W^f - TG\right]$ is strictly greater then the marriage payoff u^f, so they will divorce. Note we use β and $(1-\beta)$ to share divorce gains because we assume the bargaining position during marriage is the same as the one in case of divorce. Now suppose $u^m + u^f = TG \geq W^m + W^f$. Since cannot be that both $W^m > u^m$ and $W^f > u^f$ then we should show there not exists a compensation scheme that leads to divorce. Again assume the situation is $W^m < u^m$ and $W^f > u^f$. The maximum that agent m is disposed to offer is, $P^m = W^m - u^m$, however now $W^f + P^m = W^m + W^f - TG + u^f \leq u^f$, assuming that with indifference agents prefer remain married, then f will not accept they will remain married. For the second stage the proof is very much the same. ■

In Proposition 4 we showed that if divorce requires mutual consent then there is no room for ex-post renegotiation and family labor decisions are Pareto optimal. This result have a more general interpretation. It emphasizes the importance of the assumption of unilateral resolution in incomplete contracts literature (see Hart and Moore[16]). If contracts cannot be easily resolved then it is possible to implement Pareto efficient levels of (specific) investment.

The main implication of the present section analysis is that the change in divorce law caused inefficiencies in labor decisions. So the natural (though puzzling) question is: "why was there this change ?" One may be tempted to answer that previous fault law imposed too much constraints on agents' behavior. However, in Proposition 4 we showed that with common consensus divorce was efficient.

An independent result is Remark 2. The marriage contract in our (no-fault) basic model has an important property of optimality. With ex-post renegotiation divorce will be optimal.

Finally, our model suggests that the change in divorce law should affect intra-household resource allocation. Under fault divorce the within family allocations depend on the ex-ante partners' position, with no-fault divorce what matters is the ex-post position. Apart from the normative importance of this result, it would be interesting to check empirically if this redistributive effect was important.

4 Conclusions

As indicated by its title, this paper tries to explain some aspects of labor supply decisions in intertemporal setting using a contractual approach to marriage. In particular we analyze the effect of a particular kind of transaction costs on household dynamic labor decisions. In our model, consistently with the incomplete contracts literature, enforceability problems in within family arrangements cause inefficiencies in labor decision because of ex-post renegotiation.

We find sufficient conditions under which agents tend to work harder than the Pareto efficient level. To explain *overworking* three elements seem to be important. A relative symmetric situation between partners, the existence of remarriage opportunities and the social relevance of earning capacity. With this interpretation in mind we can give a normative explanation of some recent empirical findings about *overworked* Americans reported by Schor[27].

The contractual interpretation appears to be particularly effective while analyzing the effect of the 70s' change in US divorce law on woman labor force participation rate. We show that the change from fault to no-fault divorce law introduces problems of enforceability in familiar contractual arrangements creating the possibility of ex-post recontracting. This result seems consistent with the empirical findings of Peters[24] and Parkman[23].

It should be emphasized that the role of human capital accumulation as posed in this paper rests on the presumption that partners threaten to divorce in order to renegotiate previous arrangements. In principle it is possible that the agents use a different threat point during the bargaining section. However, the empirical problems for the identification of the threat point are already well known in efficient bargaining models of labor supply (see Lundberg and Pollak[21]).

The model presented in this paper is deliberately simplified in a number of ways in order to highlight the implications of the enforceability problems in an intertemporal setting. In future research it would be desirable to relax some of the simplifying assumptions in order to enrich its empirical applicability and relevance to policy. Several areas for future development are: (1) incorporation of household production; (2) introduction of collective consumed household goods such as children, housing and location; (3) considerations of the impact of property assignments and welfare programs into intra-household resource allocations; (4) explicit introduction of uncertainty and analysis of the risk sharing between (risk adverse) partners; (5) more complete treatment of renegotiation-proof equilibria, analyzing the role of reputation into family setting; (6) introduction of an equilibrium treatment of marriage and remarriage decisions; (7) analysis of the relationship between intertemporal time allocations, marriage contracts and fertility decisions.

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