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Cooperative Models in Action: Simulation of a Nash-bargaining Model of Household Labor Supply with Taxation*

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Abstract

Empirical evidence suggests that spouses incorporate their outside options – and in particular their situation in case of separation – in the household negotiation process. Then, tax-benefit instruments which affect living standards of single and divorced individuals, e.g. social benefits to lone mothers, may influence intrahousehold distribution via effects on fall-back options. To study this question, we implement a cooperative Nash-bargaining model on French couples. Data on divorced individuals are used to predict outside options of spouses. Individual preferences in marriage are allowed to display *caring* between spouses and are calibrated according to observed behaviors and regularity conditions. We simulate the effects of exogenous shocks on threat points as well as a realistic reform targeted at lone mothers.

Key Words : collective model, Nash-bargaining model, intrahousehold allocation, household labor supply, tax reform, microsimulation.

JEL Classification : C25, C52, C71, D11, D12, H31, J22.

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1 Introduction

Recent empirical evidence tends to confirm the wide-spread intuition that spouses incorporate their outside options – and in particular their situation in case of separation – in the household negotiation process. In these circumstances, taxes and benefits may have an effect on outside options. In particular, social benefits targeted to single mothers, as the *Aid to Families with Dependent Children* (AFDC) in the US, may affect fall back options of married women with children and the probability of divorce. As a matter of fact, Rubalcava and Thomas (2000) find that variations in AFDC levels over time and across US states directly affect the bargaining position of married mother with low incomes and subsequently household decisions on consumption and time allocation. A similar exercise by González (2004), using European cross-country comparisons, suggests that higher levels of social benefits imply a higher occurrence of single motherhood. Results from Wolfers (2005) on the effects of divorce law liberalization are also suggestive of spouses bargaining within marriage with an eye to their partner's divorce threat.

At the same time, empirical attempts to characterize the effect of tax-benefit instruments on intrahousehold distribution have recently relied on cooperative models which challenge the traditional 'unitary' representation of household behavior by accounting for the presence of several decision-makers with possibly specific preferences. Most applications have relied on Chiappori's collective model (1988a, 1992) which remains very general as it postulates only the efficiency of household decisions. In particular, Laisney (2002), Vermeulen (2004) and Bargain and Moreau (2004) have attempted to characterize the specific role of tax-benefit reforms on the negotiation rule. Yet the semi-structural nature of the model gives hardly any guidance concerning the factors that could affect negotiation and prevents from a clear representation of the role of taxes and transfers on the bargaining process (cf. Browning and Lechene, 2001).

In contrast to previous approaches, we explicitly assume here that household members follow a cooperative Nash-bargaining solution in which outside options refer to the divorce situation. This model originates from the seminal contributions of Manser and Brown (1980) and McElroy and Horney (1981) (MB-MH hereafter).[1] It represents a special case of the collective model

[1] Important theoretical contributions elaborate on this model. Some authors, arguing that divorce threats may be too costly to matter in every-day negotiation, have notably explored the case where threat points result from a non-cooperative behavior in the household. See Lundberg and Pollak (1993), Haddad and Kanbur (1994), Konrad and Lommerud (2000) and Chen and Woolley (2001).

since a specific location on the Pareto frontier is determined by the Nash game. Interestingly, this additional structure allows investigating the incidence of reforms which *do not affect the budget set of couples*, e.g. the aforementioned variations in social transfers to lone mothers. These 'non-budget' reforms – which are irrelevant from the unitary perspective – are supposed to influence the household behavior only through a shift in spouses' outside options.[2]

The contribution of the paper is to provide a framework to characterize the impact of these 'non-budget' reforms on couples' joint labor supply decisions. The simulation-based approach we rely on seems well appropriate for a first attempt in this direction. The identification of the structure of cooperative Nash-bargaining models, required to perform estimations, indeed raises some difficulties.[3] In principle, it is possible to estimate the Nash product directly using the maximum likelihood technique. However, identification requires the use of simple functional forms.[4] Instead, we suggest the use of simulations to allow for a more general representation of individual preferences, together with nonlinear taxation and participation decisions. We also follow the suggestion of McElroy (1991) and use preferences estimated on divorced individuals to predict outside options. For spouses, we depart from singles' preferences by generating a series of preference regimes, calibrated to be consistent with observed behaviors and regularity conditions.

We analyze the effects of uniform shocks on spouses' outside options and labor supply behaviors. These results are then compared with the effect of a plausible reform which consists of a dramatic increase in child benefit targeted at single parent families.

The outline of the paper is as follows. Section 2 presents the Nash-bargaining setting and the identification hypothesis. In section 3, we describe the implementation of the model. Section 4 analyses the impact of exogenous variations in outside options. In Section 5, we assess the effect

[2] Note that Chiappori et al. (2002) have recently estimated a collective model of labor supply in which environmental factors related to divorce and the (re-)marriage market (divorce laws and the sex ratio) play a significant role. This result rejects unitary models as well as cooperative models in which threat points result from a non-cooperation equilibrium within marriage.

[3] No closed forms of labor supply functions are available for the Nash-bargaining model, except for highly restrictive functional forms such as a linear form $W^i(c, h^i) = c + \eta^i(T - h^i)$. In the case of egoistic partners with Stone-Geary preferences, for instance, Barmby (1996) proves that it is not possible to derive the corresponding labor supplies.

[4] In Barmby (1996), the same Cobb-Douglas utility function is used for single individuals and 'Nash-bargaining spouses', assuming that individuals in couples are egoistic and have the same preferences as singles. Egoism is also assumed in Del Boca and Flinn (2004).

of a 'non-budget' reform on outside options and labor supply behaviors. Section 6 concludes the text.

2 A Cooperative Nash-bargaining Model of Labor supply with Discrete Choices

2.1 The Model

Following MB-MH, the model postulates two individuals, f and m, who, if they live as a couple (*i.e.* married or cohabiting), jointly allocate resources according to the solution of a two-person, cooperative Nash-bargaining model. As is well-known, the particular allocation reached is likely to depend on individual fall back situations in the case marriage/cooperation breaks. As for MB-MH, we define the threat points of f and m as the maximum utility she (he) can obtain in case of divorce. For this purpose, we predict threat points using estimations on sub-samples of divorced men and women.

To be more specific, let U_0^i be member i's level of utility when divorced, $i = f, m$. Let U^i and W^i respectively denote member i's egoistic sub-utility and welfare index when she (he) lives in a couple; both terms are explained in the next sub-section. Let c denote total household consumption, h^i member i's labor supply and w_i member i's wage rate. We model the household's decision as the solution to the following problem:

$$\underset{c,h_f,h_m}{\text{Max}} \quad \left[W^f(c,h^f,h^m) - U_0^f\right]\left[W^m(c,h^f,h^m) - U_0^m\right] \tag{1}$$

$$\text{s.t.} \qquad c = g(w_f h^f, w_m h^m, y_0, \zeta).$$

Total consumption, equivalent to total disposable income in such a static framework, depends not only on individual earnings but also on non-labor income y_0, on household socio-demographic characteristics ζ (that can influence the computation of the taxes paid or the benefits received) and on the tax-benefit system symbolized by function g.

2.2 Specification of Preferences

For a divorced individual i, we choose a quadratic representation of his/her preferences:

$$U_0^i(c^i,h^i) = \alpha_{10}^i c^i + \alpha_{20}^i (T-h^i) + \alpha_{12}^i c^i (T-h^i) + \alpha_{11}^i (c^i)^2 + \alpha_{22}^i (T-h^i)^2, \tag{2}$$

where c^i represents individual consumption and T total time endowment. This specification turns out to be flexible enough to be considered as a second order approximation to any type of utility. Some parameters are agent-specific since observed demographic heterogeneity and unobserved heterogeneity can be taken into account.

Let us now turn to the preferences of individuals in couple. Primarily, marriage is likely to change individual preferences. Love, caring, etc., are aspects which imply a transformation of preferences as described in Manser and Brown (1980). Compared to single life, it is possible that married people face (i) a different overall level of welfare for a given consumption bundle (e.g. people are simply 'happier' because they are married), (ii) a different marginal tax rate of substitution between different goods and in particular between leisure and consumption (*i.e.*, tastes change after marriage), (iii) a redefinition of choice variables (e.g. leisure can now be private or shared), (iv) a change of welfare specifically due to the presence of the partner (altruism, externalities).

In the present exercise, we do not strive to cover all the transformations implied by marriage but suggest a setting which attempts to be as general as possible within the usual Nash-bargaining framework. On the one hand, we follow McElroy (1990) and assume that α parameters can be estimated on samples of divorced individuals to realistically predict threat points for individuals in couples. On the other hand, we allow marriage to have two effects on individual welfare, compared to single life.[5] *Firstly*, individual preferences become:

$$U^i(c,h^i) = \beta^i_{10}c + \beta^i_{20}(T-h^i) + \beta^i_{12}c(T-h^i) + \beta^i_{11}(c)^2 + \beta^i_{22}(T-h^i)^2 \quad \text{for } i = f,m, \qquad (3)$$

where $\underline{\beta}^i = \underline{\alpha}^i + \underline{\Delta}^i$. That is, spouses' preferences depart from the single life's reference situation (α parameters) through variations Δs. These variations are calibrated as described thereafter, ensuring that preference regimes of 'Nash-bargaining spouses' are consistent with observed behaviors. Note that varying the values in vector $\underline{\beta}$ around those of vector $\underline{\alpha}$ provides a way to conduct a sensitivity analysis of the results to various regimes of preferences. *Secondly*, we assume that each spouse considers a welfare index that depends on both partners' egoistic utilities:

$$W^i = U^i(c,h^i) + k^i U^j(c,h^j),$$

where $k^i \in [0,1]$, with $i \neq j$.[6]. In other words, each partner cares about the other's welfare, not

[5] In the following, the term 'married' concerns married couples as well as cohabiting couples.

[6] We assume that the functions U_0^i, U^i and W^i are all strictly quasi-concave and strictly monotonic in their

her (his) consumption choices *per se*. Preferences of this type are often called 'caring' preferences in the sense of Becker (1981). Hereafter, we will refer to k^i as member i's *degree of caring*. This way, we account to some extent for altruistic behaviors mentioned in point (iv) above. Naturally, points (iii) and (iv) would require to account for all types of externalities and in particular for possible complementarity in leisure.

Notice that Chen and Woolley (2001) fully explore the theoretical implication of the Nash-bargaining model using a similar specification in the case of internal threat points, modeled as non-cooperative equilibria. Note also that the utilities depend on total consumption. This assumption, also made by Ashworth and Ulph (1981), Barmby (1994, 1996) or Kooreman and Kapteyn (1990), is chosen for practical purposes. In effect, with the complex specification of the model, we cannot retrieve analytically individual private consumptions as functions of total consumption.

A realistic approach also requires the impact of the demographic structure of the household to be modeled in several ways (see Browning, 1992). As often in the related literature, children have no decision-making power in the household and their preferences are internalized in those of the parents whereas expenditures on children are included in total household consumption. For households with small children, childcare represents a substantial potential cost of work. Therefore, we deduct from total consumption c a cost for childcare depending on the number and age of the children in the household, according to published related information.[7] Still, allowing for expenditures on children and time for childcare to be decision variables is an important subject of further research.

Two issues must be discussed at this stage: cardinalization and utility comparability. A first debatable assumption, inherent to the cooperative Nash-bargaining model, is that it requires a cardinal representation of preferences, i.e. the Nash solution is not invariant to some arbitrary monotonic transformation of utilities, threat points or both. See McElroy (1990), Chiappori (1992) and Chiappori and Donni (2003) for specific discussions on this point. A particular cardinal representation must be arbitrarily chosen, from the infinity compatible with observed

arguments.

[7] This cost of childcare is computed according to the French Budget Survey (INSEE). In addition to the number and age of children, its amount depends on female labor supply. For instance, for children younger than two, the annual cost of child care is $2,036$ euros if the mother works 20 hours a week, $2,526$ euros if she works 30 hours a week, $2,806$ euros if she works 40 hours a week, and so on.

labor supply, and the conclusion then crucially depends on this choice.[8]

A second issue relates to the comparability between the different indices of welfare in the current specification, namely (a) between individual levels of welfare when single and when married, (b) between male and female sub-utilities in 'caring' preferences. To be generally consistent on both accounts, we suggest the following normalization:

$$\begin{aligned} \beta_{10}^f+\beta_{20}^f+\beta_{12}^f+\beta_{11}^f+\beta_{22}^f &= \beta_{10}^m+\beta_{20}^m+\beta_{12}^m+\beta_{11}^m+\beta_{22}^m \\ \alpha_{10}^i+\alpha_{20}^i+\alpha_{12}^i+\alpha_{11}^i+\alpha_{22}^i &= 1 \qquad i=f,m. \end{aligned} \tag{4}$$

The βs do not have to sum up to unity in (4) since marriage may lead to larger levels of welfare as argued in point (i).

2.3 Gains to Marriage

In addition to the aforementioned (potential) gains related to a change in preferences, marriage also implies well-known economic advantages that should be accounted for. Gains usually relate to taxation, economies of scale and division of labor in the household.

Firstly, the splitting system in France (extended to the presence of children) allows large tax reductions for married couples, all the larger as the spouses' earnings differ. For the present exercise, we use the microsimulation model SYSIFF described in Bargain and Terraz (2003). It covers the complete French tax and benefit rules so that differences in the tax treatment of couples and divorced individuals are accounted for in a truthful way.

Secondly, the hypothesis of pure public consumption implies large economies of scale, probably too large however. The same hypothesis is made implicitly in all the literature using equivalence scales. Ideally, one should consider both public goods (leading to economies of scale) and private goods in the household. This goes far beyond the present exercise related to labor supply.

Thirdly, the traditional view on marriage argues that households benefit from a division of labor with one spouse specializing in market production while the other specializes in domestic

[8] As suggested by one referee, the representation of preferences for divorced individuals (obtained by estimation) is ordinal. It would be possible to introduce explicitly the cardinality of preferences, for instance through a calibrated parameter ϕ so that the threat point of member i becomes $\overline{U}_0^i = (U_0^i)^\phi$, with U_0^i predicted as explained in the Appendices. The implicit cardinalization retained here is $\phi = 1$.

production. This view has changed in the recent decades but household production is an important aspect too often neglected. Unfortunately, we follow the bulk of the literature on that account, since the incorporation of domestic production would require many more assumptions here.

2.4 Discrete Choices and the Tax-Benefit System

The recent literature tends to treat labor supply as discrete. There are three main advantages of this approach in the present case. Firstly, discrete choices allow accounting easily for joint decisions in a couple (see Van Soest, 1995, in the unitary case). Secondly, the introduction of taxes and benefits becomes simple, even when they lead to non-linear and non-convex budget sets. Thirdly, this model offers an easy way to model simultaneously choices of hours and participation decisions. In addition, a discrete choice model seems very appropriate in our case. In effect, hours are fairly concentrated on a small number of working hours in France, probably due to demand-side and institutional rigidities (see the distribution of hours in Figure 2 in the Appendices).

Nonetheless, we have accounted for the observed variability of hours by choosing a rather thin discretization. It consists of $h^f = 0, 20, 25, 30, 35, 40, 45, 50, 55$ hours per week and of $h^m = 20, 30, 35, 40, 45, 50, 55$ hours per week, hence a total of 63 possible combinations per couple. There is no 0 option for men as they are never observed inactive in our selection, and in particular once we exclude job-seekers. Non-participation of men is largely determined by exogenous (demand-side) constraints. There is no hour choices between 0 and 20 hours as hardly anyone is observed in that range.

Taking into account wage rates, non-labor income, household characteristics and the tax-benefit system as represented by function g in (1), total household disposable income c (i.e. consumption) is computed for each combination (h^f, h^m), using the microsimulation program.[9] Problem (1) then boils down to the choice of the optimal labor supply combination.

[9] Wage prediction is needed for non-participants and is performed using the standard Heckman technique. Results are available upon request.

3 Implementation of the Model

3.1 Prediction of Threat Points

To be consistent with the assumption that divorce is the reference situation, we predict threat points using estimations on sub-samples of divorced men and women. A selection argument usually applies when one attempts to use information on single individuals to identify threat points of individuals in couples. Indeed, if the selection into marital status is not random, estimation on singles is biased unless the so-called selectivity bias is accounted for. However, it is not clear what could identify the marital relation rules. Therefore, we do not address this question in this paper. It certainly deserves further attention.

The technique used consists of directly estimating the parameters of vector $\underline{\alpha}^i$ in expression (2). This is done simply by direct estimation of the utility function, using a discrete choice model of labor supply. We assume that the utility derived by divorced individual s for each choice $j = 1, ..J$ of labor supply and for each subsequent level of consumption is a random function:

$$V^s(c_j^s, h_j^s; \gamma^s) = U^s(c_j^s, h_j^s; \gamma^s) + \varepsilon_{sj},$$

where the deterministic part $U^s(c_j^s, h_j^s; \gamma^s)$ is specified according to the quadratic form in (2), and where ε_{sj} is a random term following an EV-I distribution. The parameters can then be estimated using the maximum likelihood technique for the multinomial/conditional logit. Following common practice, we also allow the coefficients α_{10}^s and α_{20}^s to vary with observed heterogeneity (age, number of children and place of residence). In addition, we extend the multinomial logit specification so that preference parameters vary randomly over individuals rather than being fixed. Some of the parameters are then specified as $\alpha^s = \alpha + \sigma\gamma^s$, with γ^s following a standard normal distribution. This allows for random taste heterogeneity and unrestricted substitution patterns between alternatives. A clear and comprehensive statement of this technique is provided in Train (2002). Measurement errors due to the discretization are also accounted for in the way described by MaCurdy, Green and Paarch (1990). Results are reported in Table 4 in the Appendices.

To compute the reservation utility U_0^i, we need to allocate to each partner what would be her (his) optimal labor supply in case of separation. We do so by assuming that expression (2), with α-parameters estimated on divorced individuals, can be used to predict the behavior of individuals in couples in case of divorce. The methodology is explained in details in the Appendices. We further assume that children go systematically with the mother in case of a divorce. As a matter of fact, in France, children go with their mother nine times out of ten.

In the Appendices, the statistics of the distribution of preference parameters for threat points are shown in Tables 5 and 6 while Table 7 reports the distribution of labor supply for married and 'divorced' states. It turns out that in case of separation, most of the inactive women would start working while men below full time would increase their labor supply. On the contrary, men working overtime would reduce working hours.

3.2 Calibration of Spouses' Preferences

3.2.1 Benchmark Simulation

For $i = f, m$ in a given household, we compute the preference parameters $\underline{\beta}^i$ using $\underline{\alpha}^i$ and a particular pair $(\underline{\Delta}^f, \underline{\Delta}^m)$, drawn from two independent normal distributions with zero mean and covariance matrices estimated on divorced individuals. We simultaneously draw combinations $\left(k^f,\ k^m\right)$ from $[0, 1]$ uniform distributions. Among infinite possibilities, we choose for each household the first set of parameters which is consistent with observed behaviors and well-behaved preferences. More precisely, we select a draw for which (i) optimal choices (h^f, h^m) obtained with program (1) match observed labor supplies, and (ii) the resulting set of preference parameters respects the conditions of strict quasi-concavity and strict monotonicity of the different utility functions.[10]

We do not mean that the resulting parameters $\underline{\beta}^i$ allocated to a given household are the 'true' ones nor that they are the only ones to meet the selection criteria. Simply, they correspond to plausible values which depart from the preferences of single individuals and are consistent with the Nash-bargaining hypothesis, the individual rationality and the observed labor supplies for individuals in couples. This constitutes our benchmark simulation – a consistent 'Nash-

[10] It would probably be desirable to embed such calibration in a well-defined statistical methodology, as the semi-parametric indirect inference (SPII) approach of Dridi and Renault (2000). It is based on the simultaneous use of a misspecified structural model and a misspecified auxiliary model, in order to identify and consistently estimate some parameters of interest in the structural model, via simulations of that model. An interesting candidate for the auxiliary models is the misspecified unitary model. Here the parameters of interest are the individual preference parameters and, possibly, a term of cardinalization for reservation utilities.

bargaining world' – on which we can build a sensitivity analysis.[11]

Table 8 reports the marginal distributions of the calibrated degrees of caring k^f and k^m. Albeit these two parameters are drawn independently from $[0, 1]$ uniform distributions, the marginal distribution of k^m is right-skewed.

With predicted outside options U_0^f and U_0^m and the benchmark regime of preferences, we compute the surplus from cooperation/marriage. Figure 1 represents the distribution of the relative surplus $\frac{U^i - U_0^i}{U_0^i}$. The first five boxplots depict the distribution of wives' relative surplus.[12] The first boxplot, labeled "All women", is computed on the whole sample of households, the second ("women$-s1$") on the sample of households with ($k^f \leq 0.2$, $k^m \leq 0.2$), referred to as 'egoistic couples' in the following, the third on households with ($k^f \leq 0.2$, $k^m \geq 0.8$), the fourth on households with ($k^f \geq 0.8$, $k^m \leq 0.2$) and the fifth on households with ($k^f \geq 0.8$, $k^m \geq 0.8$), referred to as 'altruistic couples' in the following. The remaining boxplots refer to the distribution of husbands' relative surplus for the same combinations of caring. On average, the simulated surpluses are higher for women than for men, due to larger degrees of caring for women. As expected, egoistic individuals (*i.e.* $k^i \leq 0.2$) exhibit a smaller surplus.

3.2.2 Alternative Simulations

We generate alternative simulations as follows. Previous calibrated values for β parameters are transformed by $\pm 5\%$, $\pm 10\%$, $\pm 50\%$ or $\pm 100\%$ variations, with unchanged calibrated values for k^f and k^m. *For a given magnitude of change*, e.g. 5%, we consider all the combinations of changes of the β parameters; with 10 parameters and 2 possible variations for each parameter ($+5\%$ or -5%), this sums up to 2^{10} new possible vectors of βs (only 2^9 when constraint (4) is accounted for). Among those alternative vectors of parameters, we then keep only those which meet the regularity conditions and which are consistent with observed behaviors, *i.e.* which

[11] The Nash-bargaining solution considerably restricts the range of possible values for the draws. For a given set $(\underline{\alpha}^i, U_0^i)_{i=f,m}$ and a specific budget constraint, each draw of (Δ, k) parameters defines one optimal allocation on the Pareto frontier. It is possible that even for a large number of draws (up to 1 million), the allocation corresponding to observed labor supplies will never be found. This is the case for 4.1% of the $2,464$ households in our original sample. These are dropped from the analysis. On average, $32,609$ repetitive draws per household were necessary to meet all the conditions (min: 1, for the lower 25%: less than 149, for the upper 25%: more than $9,949$, max: $936,485$).

[12] The length of the box represents the interquartile range. The marker inside the box is the mean and the horizontal line the median. The vertical lines reach the minimum and maximum values.

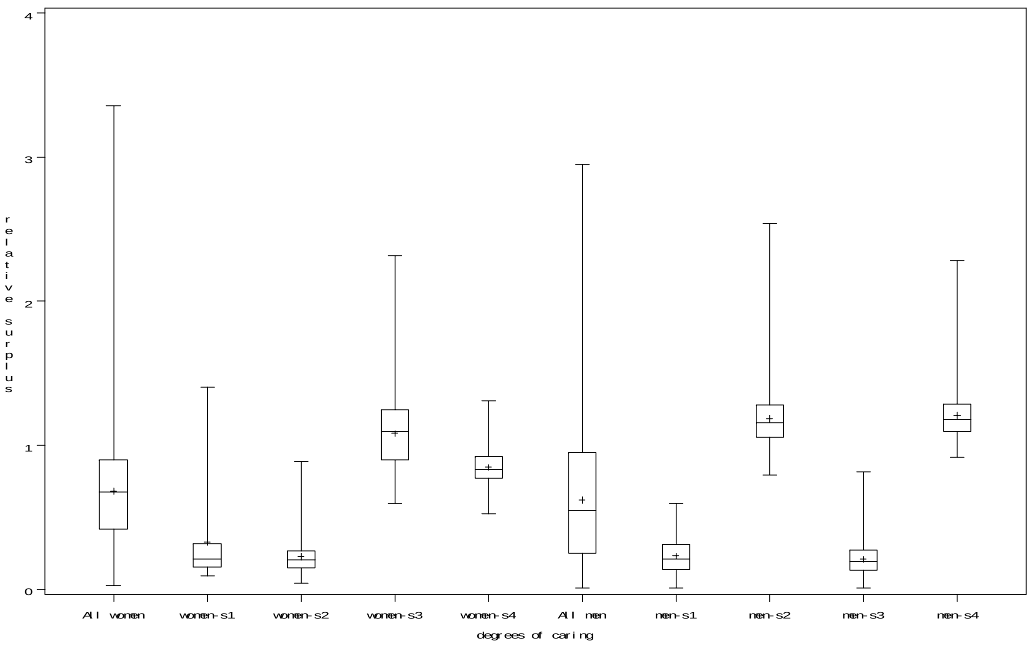

Figure 1: Distribution of Relative Surpluses (Benchmark Simulation)

lead to the maximization of the Nash product for the observed labor supplies for both spouses. Table 9 in the Appendices reports the distribution of the number of alternative simulations by household. It can be seen, for instance, that when considering all $\beta \pm 5\%$ combinations, hence a small departure from the benchmark situation, at most 54 alternative vectors of parameters could be generated for 25% of the population and at least 94 alternative vectors for another 25% of the population.

As the magnitude of the variations increases, the number of households for which no alternative vector can be found increases. In particular, larger variations of the parameters lead more frequently to negative surpluses for the observed labor supplies (and to the rejection of the alternative set of parameters). It results that among remaining simulations, larger variations correspond to larger direct utilities on average. In the group of egoistic couples for instance, the average gain to cooperation represents 52% of the reservation utility in $\beta \pm 50\%$ situations, while it represents only 4% in the $\beta \pm 5\%$ situations.

4 Household Responses to Exogenous Shocks on Outside Options

We now assess the impact of exogenous changes in the threat points on the labor supply of men and women. We simulate relative variations of the reservation utilities from -50% to $+50\%$ with steps of 1%.

Primary remarks are required concerning the effect of the shocks on marriage. In principle, there are 63 combinations of labor supply available. Yet, the number of choices is restricted by the fact that only some of them ensure that the cooperation surplus $W^i(c, h^f, h^m) - U_0^i$ remains positive for both spouses. An increase in the threat points induces smaller surpluses and the number of possible choices might even fall to zero (*i.e.* any choice leads the couple to divorce).

Naturally, these effects depend on the final specification of individual welfare indices since surpluses are all the smaller the more egoistic the spouses are.[13] In the benchmark simulation for egoistic spouses, a 20% uniform increase of female threat points in the population leads 60% of the households to divorce for any labor supply combination. Conversely, for altruistic spouses, almost all the households have 63 possible choices, even when female threat points increase by 50%.

In alternative simulations, larger variations of the βs imply larger direct utilities – as mentioned above – then smaller risk of divorce in case of a shock on the outside options. For instance, over the whole set of alternative simulations for egoistic spouses, a 10% increase in male threat points never leads to divorce in the $\beta \pm 100\%$ case, but implies divorce at least once for 44% of the households in the $\beta \pm 10\%$ case.

4.1 Labor Supply Responses with the Benchmark Simulation

The following analysis is close to the idea of comparative statics, here with non-marginal changes in exogenous parameters (outside options). Table 1 shows the result of the exercise for the whole population and different groups according to their degrees of caring. For instance, a uniform decrease of 1% of female outside options induces a change of labor supply for at least one of the two spouses – the household is a 'mover' – in 1% of the households overall and in 3% of the couples with egoistic wives (*i.e.* the $k^f \leq 0.2$ group).

[13] In the benchmark for egoistic spouses (resp. altruistic spouses), female welfare represents 1.21 (resp. 1.83) times the female reservation utility level at the median. Orders of magnitude are similar for men.

Interestingly, some regularities seem to appear. For negative shocks, the proportion of movers increases with the magnitude of the shock. At the same time, for a given magnitude, the proportion of movers decreases with the level of caring of the spouse concerned by the shock. It is indeed rather intuitive to think that shocks will matter less in marriages with large initial surpluses from cooperation. For positive shocks the trend is similar with one exception: the number of movers decreases for egoistic spouses when shocks become larger. In effect, large increases of the threat point are likely to (i) shrink the number of labor supply alternatives hence the probability of a move and (ii) reduce the number of married couples.[14] This is all the more true as the spouse concerned by the shock is egoistic. On the whole, the signs of the labor supply responses are in accordance with intuition. When U_0^f falls or U_0^m increases, the most frequent reaction is a rise in female labor supply and a decrease in male labor supply. When U_0^f rises or U_0^m falls, male labor supply most often increases while female activity remains constant.

4.2 Labor Supply Responses with Alternative Simulations

The previous exercise is repeated with the alternative vectors of parameters. For the sake of brevity, we only report the results concerning a shock on female outside options; similar conclusions can be drawn for male threat points and results are available upon request. Table 2 reports the percentages of movers for different variations of the threat point. For each order of magnitude of parameter changes, the first row shows the number of households experiencing a move at least once over the whole set of alternative vectors.[15] Values are unsurprisingly large, since for a given couple, it is often possible to find one alternative vector of βs for which it will react to the shock.

We suggest two definitions to rationalize the number of movers. With the '*discrete movers' rule*, a couple is considered as a mover if a move occurs in more than half of the alternative simulations. With the '*frequency of moves' rule*, we attribute to each household its frequency of moves over the whole set of alternative simulations and aggregate this result over all the households. Results are reported in the second and third rows for each parameter variation in

[14] Couples for which cooperation breaks are not counted as movers here (whatever their labor supply is after divorce).

[15] For instance, with the $\beta \pm 10\%$ variation and for a +10% increase of U_0^f, 66% of the households move at least once over the whole set of alternative parameter vectors.

Table 1: *Proportion of Movers According to the Type of Caring and the Size and Sign of the Shock*

	1	2	3	4	5	10	20	30	40	50	All
$\Delta U_0^f < 0$ and $\Delta U_0^m = 0$											
all couples	1	2	3	4	5	8	15	21	25	30	11
couples with $k^f \leq 0.2$	3	5	8	9	11	21	37	49	54	61	39
couples with $0.2 < k^f \leq 0.4$	2	4	5	8	9	12	21	27	31	36	23
couples with $0.4 < k^f \leq 0.6$	0.2	1	2	2	3	7	12	18	24	31	15
couples with $0.6 < k^f \leq 0.8$	0.3	0.5	1	2	2	5	10	15	18	23	12
couples with $k^f > 0.8$	0.2	0.5	1	2	2	3	6	9	12	14	8
$\Delta U_0^f > 0$ and $\Delta U_0^m = 0$											
all couples	2	4	6	8	10	18	29	36	39	40	18
couples with $k^f \leq 0.2$	4	6	10	15	17	28	28	10	6	4	15
couples with $0.2 < k^f \leq 0.4$	2	4	8	9	11	20	38	45	25	13	28
couples with $0.4 < k^f \leq 0.6$	1	4	6	8	9	18	31	47	58	53	37
couples with $0.6 < k^f \leq 0.8$	2	3	4	5	7	14	26	35	46	55	30
couples with $k^f > 0.8$	1	3	4	6	8	15	27	38	46	54	31
$\Delta U_0^m < 0$ and $\Delta U_0^f = 0$											
all couples	6	11	14	17	20	27	35	39	43	45	26
couples with $k^m \leq 0.2$	15	25	33	39	45	61	74	79	84	85	71
couples with $0.2 < k^m \leq 0.4$	3	5	5	8	10	16	24	29	34	39	25
couples with $0.4 < k^m \leq 0.6$	1	1	2	3	4	8	13	16	19	23	14
couples with $0.6 < k^m \leq 0.8$	0.3	0.5	0.5	0.5	1	2	5	7	9	10	6
couples with $k^m > 0.8$	0	0	0.3	0.3	1	2	2	3	3	4	2
$\Delta U_0^m > 0$ and $\Delta U_0^f = 0$											
all couples	2	3	5	6	8	20	23	20	18	16	11
couples with $k^m \leq 0.2$	3	7	10	13	18	43	39	18	4	1	21
couples with $0.2 < k^m \leq 0.4$	1	2	3	4	5	11	27	46	51	34	31
couples with $0.4 < k^m \leq 0.6$	1	1	2	4	4	6	12	18	27	36	17
couples with $0.6 < k^m \leq 0.8$	0	0.3	0.3	0.3	1	2	4	7	12	16	7
couples with $k^m > 0.8$	0	0	0.3	0.3	0.3	1	2	4	6	10	4

Note: all figures are percentages; the first row indicates the absolute percentage increase of the threat point; the first column tells us which spouse is affected and the sign of this shock; the core of the table represents the proportion of movers for the whole population and for each caring configuration.

Table 2. For instance, with $\beta \pm 10\%$ variations and a 10% increase of U_0^f, the proportion of movers represents only 8% of the population according to the first rule and 14% according to the second. Results with small variations of the parameters ($\beta \pm 5\%$) compare well, in order, with those in the benchmark situation (Table 1). Larger variations imply larger gains to marriage so that shocks on the threat point matter less, e.g. a 10% increase of U_0^f leads to 8% of movers with $\beta \pm 5\%$, but only to 3% with $\beta \pm 50\%$ (according to the first rule).[16]

Table 2: *Alternative Simulations: Percentage of Movers*

	Variations of female outside options					
	−10%	−5%	−1%	1%	5%	10%
$\beta \pm 5\%$	55%	47%	25%	36%	59%	68%
‘discrete movers’ rule	4%	1%	0%	0%	2%	8%
‘frequency of move’ rule	9%	5%	1%	1%	7%	14%
$\beta \pm 10\%$	57%	45%	19%	24%	55%	66%
‘discrete movers’ rule	4%	2%	0%	0%	2%	8%
‘frequency of move’ rule	9%	5%	1%	1%	7%	14%
$\beta \pm 50\%$	14%	8%	2%	3%	12%	21%
‘discrete movers’ rule	2%	1%	0%	0%	1%	3%
‘frequency of move’ rule	3%	2%	0%	0%	3%	6%
$\beta \pm 100\%$	7%	3%	1%	1%	5%	9%
‘discrete movers’ rule	1%	0%	0%	0%	1%	3%
‘frequency of move’ rule	2%	1%	0%	0%	2%	3%

Note : for each variation of the betas, the first row corresponds to the proportion of households which move at least once over the whole set of alternative beta vectors; the second and third rows correspond to the number of movers according to the rules described in the text.

[16] More detailed results depending on caring are not reported in Table 2. Similarly to the benchmark situation, a shock is more likely to produce labor supply variations when the wife is egoistic.

5 Tax-Benefit Reform and Threat Point Variations

The reform corresponds to an increase in child benefit for single individuals, positively related to work duration. The idea is to decrease the cost of working for lone parents (and notably the purchase of childcare). The actual level of benefits is increased by 100% in case of inactivity, by 120% for part-time workers (between 20 and 30 hours), by 130% in case of full-time activity (between 35 and 45 hours) and by 140% in case of over-time activity (50 hours and over). As described in Table 3, this reform implies substantial financial gains for married mothers with children in case of divorce. The reform thus represents a pure distribution effect for couples, interestingly driven by tax-benefit rules for single parents.

Table 3: *Consumption Variation for Mothers in Case of Divorce*

h^f	0	20	25	30	35	40	45	50	55
10%	8.78	9.69	8.73	7.96	7.85	7.16	6.62	6.76	6.28
50%	15.89	17.95	16.04	14.52	14.29	13.09	12.14	12.60	11.79
90%	29.73	33.39	30.54	28.05	27.96	26.00	24.43	25.01	23.75

Note : for 50% of the women, the level of consumption at the outside option increases by 13.09% when they work 40 hours per week.

Among the 1,075 women concerned by the reform, 84% work at least 30 hours a week in case of separation. However, given our estimates, the marginal utility of consumption appears to be significantly higher for inactive women and those at part-time women than for full time workers. For this reason, the large increase in consumption due to the reform translates only in a small welfare improvement. In effect, the reservation utility increases only by 1.05% on average, by 3.75% at most and 0.01% at least. Note also that among women concerned by the reform, 15% change their labor supply in case of divorce. In two third of these cases, they reduce their working time due to the income effect of the reform. For the last third of the movers, the reform reduces costs of work and those women, working part-time initially, raise their labor supply.

According to the results above, the effect of the reform on married women's bargaining position is small and so are the subsequent labor supply effects. For the benchmark simulation, 1.9% of the couples react to this reform. The order of magnitude of the results is consistent with findings in Table 1 where a 1% uniform increase in female outside options generates 2% of movers.

As noted before, the number of movers in couples is heavily dependent on the calibrated parameters. For 43% (resp. 4%, 1.7%) of the households, it is possible to find at least one set of parameters $\beta \pm 5\%$ (resp. $\beta \pm 50\%$, $\beta \pm 100\%$) for which households display a labor supply response. However, using the two 'averaging' measures suggested previously, we find that the number of movers is 0.1% (resp. 0.5%, 0.1%) according to the 'discrete movers' rule and 1.9% (resp. 0.007%, 0.003%) according to the 'frequency of moves' rule. Again, these figures are consistent with the previous simulations and can be compared to the '1%' column of Table 2 for the appropriate alternative (in particular for $\beta \pm 5\%$, the orders of magnitude 43, 0.1 and 1.9 above compare well to 36, 0 and 1 in Table 2).

The signs of the labor supply responses are in accordance with intuition. The most frequent reaction with the benchmark model and with the alternative parameters is a decreased (i.e. -5) or stable female labor supply and an increased male labor supply (i.e. $+5$).

6 Conclusion

This paper consists of an original exercise to study some of the implications of the Nash-bargaining model on household labor supply with taxation. In particular, we gauge the possible effects on labor supply resulting from shocks on spouses' external outside options, including the pure distribution effect coming from a realistic reform of the child benefits for lone parents.

The contribution remains modest, while it constitutes one of the very first attempts to implement a cooperative model of labor supply with taxation and participation decisions. The calibration technique presented here has been designed to fit the Nash-bargaining model with observed behaviors. Future research should rely on estimations, even if many other hypotheses must be made on preferences in that case. In particular, simple functional forms must often be chosen for convenience rather than for realism and are hardly supported by empirical arguments. On the other hand, the calibration strategy allows for both flexible functional forms and general preferences of spouses, departing from those when single in several ways.

Moreover, the results of our simulations seem to hold throughout an extensive sensitivity analysis on the calibrated preference parameters. Firstly, it turns out that the effects on labor supply stemming from variations in the outside option necessarily depend on the level of altruism in the household. Only egoistic spouses seem to respond substantially to these shocks. Secondly, it seems that important variations in fall back situations – when taken as divorce – are required in order to dramatically change the levels of labor supply, while such variations do not seem achievable by the suggested reform.

Several improvements are required to account for the presence of children, for domestic production or for both private and public goods. Fundamentally, it seems that this branch of research – due to its intrinsic cardinal nature – should ultimately resort to richer data than those which can be derived from the observation of demand behavior, as suggested by Van Praag (1994).

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7 Appendices

7.1 Data Selection

The sample of couples is extracted from the French Household Budget Survey 2001, which contains information on $10,305$ households. We select married and cohabiting couples between 25 and 55 of age and available for the labor market, *i.e.* not disabled, retired or in education. Households with self-employed workers or farmers are also excluded since their labor supply behavior may be rather different from salary workers; they are also subject to income tax rules which are substantially different and which require additional information not available here. Employees not reporting important pieces of information (e.g. number of working hours) are excluded from each sample. To further increase data homogeneity, ‘extreme households’ are selected out, notably those receiving important amounts of non-labor income, those with more than 3 children and those whose children earn substantial labor income. Households with more than two decision-makers (*i.e.* other adults than the basic couple) are also discarded. Browning and Chiappori (1998) argue that the hypothesis of efficiency in the intra-household decision process is more likely to be satisfied in stable couples. Following this idea, we further restrict our sample to households with at least two years of conjugal life.

Descriptive statistics are available upon request and distribution of hours for couples are shown in Figures 2, where the vertical axis represents frequencies (percentages) and the horizontal axis weekly working hours.

7.2 Estimation on Divorced Individuals and Optimal Labor Supply in Case of Divorce

To obtain reasonable sample sizes for samples of divorce men and women, we have pooled data from the French Household Budget Surveys 1994 and 2001. The 1994 dataset contains information on $11,220$ households. Divorced individuals are selected according to similar criteria as described above for couples. To account for the difference in time of observation, we include in the estimation a dummy variable which equals one if the individual belongs to the latest survey.

Results of the estimation are presented in Table 4. Unobserved heterogeneity appears to be significant for the consumption term (α_{10}^{s}) for both divorced men and women. For men,

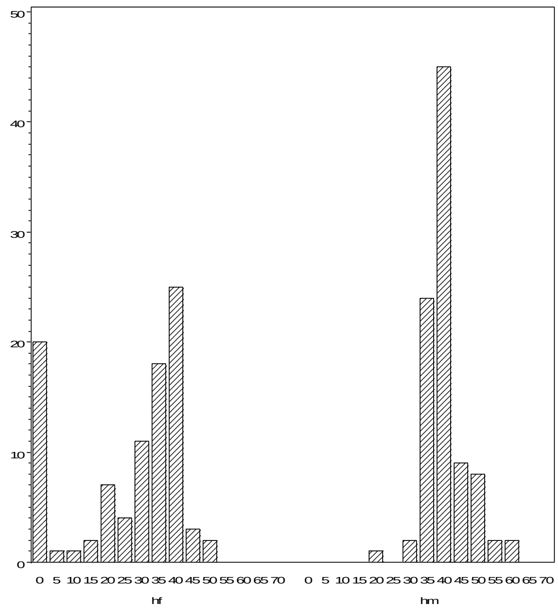

Figure 2: Couples' Weekly Labor Supply (Family Budget Survey, France 2001)

the interaction between leisure and consumption together with the square of consumption, the sample year and the number of children in the leisure term have no impact at conventional levels. For women, the sample year and Paris region in the consumption term have no effect.

To allocate to each partner her (his) optimal labor supply in case of separation we proceed as follows. To respect the stochastic nature of the random utility model used, we generate 200 series of residuals ε_{ij} $(j = 1, ...J)$ by drawing independently (across series and across hour choices) from an EV-I distribution. For each series, we also draw a value of the unobserved heterogeneity γ which assures that the 'divorced' individual respects usual regularity conditions for the optimal labor supply choice. The outside option U_0^i then corresponds to the deterministic utility generated by the most frequent optimal labor supply over the 200 draws, noted h_0^i. Post-reform optimal choices are defined in the same way, with retentions of the 200 sets of residuals generated in the first step.

Note that we also predict the level of rent/mortgage repayment each spouse should pay, using an estimation conducted on demographic characteristics and assuming that the individuals remain in the same area. This information is indeed necessary for the computation of household benefits. These intermediary results are available upon request.

Table 4: *Mixed Logit Estimates for Divorced Individuals*

Variable	coef. divorced women	coef. divorced men
c	0.578 (0.238)	−1.082 (0.699)
$c \times (age/40)$	0.306 (0.112)	1.467 (0.384)
$(c \times paris)$	0.063 (0.047)	0.489 (0.186)
$c \times kids$	0.154 (0.022)	−0.181 (0.103)
$c \times year$	0.006 (0.049)	0.099 (0.160)
l	1.295 (0.109)	3.026 (0.426)
$l \times (age/40)$	0.077 (0.028)	0.524 (0.140)
$l \times paris$	−0.052 (0.015)	0.144 (0.068)
$l \times kids$	0.046 (0.006)	−0.050 (0.044)
$l \times year$	0.009 (0.015)	0.059 (0.058)
$c \times l$	−0.002 (0.001)	−0.005 (0.005)
c^2	−0.026 (0.003)	−0.004 (0.005)
l^2	−0.005 (0.000)	−0.014 (0.002)
Unobserved heterogeneity on c :		
σ_c	0.001 (0.000)	0.002 (0.001)
Measurement error:		
σ_ε	0.100 (0.004)	0.114 (0.005)
number of observations	636	309

Notes : non-market time is $l = T - h$. Paris region equals 1 if the couple lives in the Paris region, 0 otherwise. Standard errors are given in brackets. For men and women, c is divided by 10^2.

7.3 Results of the Calibration

Table 5: *Distribution of Preference Parameters - Married Women*

	threat point					individual utility				
	$\widetilde{\alpha}_{10}^f$	$\widetilde{\alpha}_{20}^f$	$\widetilde{\alpha}_{12}^f$	$\widetilde{\alpha}_{11}^f$	$\widetilde{\alpha}_{22}^f$	$\widetilde{\beta}_{10}^f$	$\widetilde{\beta}_{20}^f$	$\widetilde{\beta}_{12}^f$	$\widetilde{\beta}_{11}^f$	$\widetilde{\beta}_{22}^f$
10%	6.69	0.99	−1.55	−0.94	−3.58	6.08	0.99	−2.24	−1.00	−3.56
50%	7.85	0.99	−1.45	−0.89	−3.37	7.93	0.99	−0.92	−0.89	−3.36
90%	8.97	0.99	−1.34	−0.85	−3.22	9.69	0.99	8.24	−0.76	−3.19

Notes: For 50% of the women in couples, $\widetilde{\alpha}_{10}^f$ is equal to 7.85 and $\widetilde{\beta}_{11}^f$ to −0.89. For 10% of them, $\widetilde{\beta}_{22}^f$ is less than −3.56. The parameters $\widetilde{\alpha}_{10}^f$ and $\widetilde{\beta}_{10}^f$ have by been multiplied 10^3, $\widetilde{\alpha}_{12}^f$ and $\widetilde{\beta}_{12}^f$ by 10^5, $\widetilde{\alpha}_{11}^f$ and $\widetilde{\beta}_{11}^f$ by 10^6 and $\widetilde{\alpha}_{22}^f$ and $\widetilde{\beta}_{22}^f$ by 10^3.

Table 6: *Distribution of Preference Parameters - Married Men*

	threat point					individual utility				
	$\widetilde{\alpha}_{10}^m$	$\widetilde{\alpha}_{20}^m$	$\widetilde{\alpha}_{12}^m$	$\widetilde{\alpha}_{11}^m$	$\widetilde{\alpha}_{22}^m$	$\widetilde{\beta}_{10}^m$	$\widetilde{\beta}_{20}^m$	$\widetilde{\beta}_{12}^m$	$\widetilde{\beta}_{11}^m$	$\widetilde{\beta}_{22}^m$
10%	0.18	1.00	0	0	−4.09	−2.66	1.00	−0.77	−0.11	−4.01
50%	0.57	1.00	0	0	−3.92	−0.29	1.00	0.74	−0.01	−3.81
90%	2.05	1.00	0	0	−3.76	1.99	1.01	2.16	0.09	−3.63

Notes: The parameters $\widetilde{\alpha}_{10}^m$ and $\widetilde{\beta}_{10}^m$ have been multiplied by 10^3, $\widetilde{\beta}_{12}^m$ by 10^5, $\widetilde{\beta}_{11}^m$ by 10^6 and $\widetilde{\alpha}_{22}^m$ and $\widetilde{\beta}_{22}^m$ by 10^3.

Table 7: *Simulated Distributions of Spouses' Labor Supplies in Couple and in case of Divorce*

Weekly labor supply	Men		Women	
	Married	Divorced	Married	Divorced
0	/	/	21.29%	3.47%
20	0.85%	0.42%	9.90%	/
25	/	/	4.95%	6.01%
30	2.03%	/	11.26%	11.98%
35	22.30%	26.66%	18.75%	36.06%
40	46.17%	53.28%	26.66%	29.62%
45	12.23%	8.29%	3.47%	11.51%
50	8.76%	7.41%	2.71%	1.35%
55	7.66%	3.94%	1.02%	/
no. of observations		2363		

Table 8: *Marginal Distributions of the Calibrated Degrees of Caring*

	calibrated k^m	calibrated k^f
≤ 0.1	25.86	7.79
$]0.1; 0.2]$	11.68	7.28
$]0.2; 0.3]$	10.03	7.58
$]0.3; 0.4]$	8.38	8.21
$]0.4; 0.5]$	8.63	9.31
$]0.5; 0.6]$	7.15	10.07
$]0.6; 0.7]$	8.42	11.55
$]0.7; 0.8]$	7.28	13.03
$]0.8; 0.9]$	8.55	15.74
≥ 0.9	4.02	9.44
Total	100	100

Note: all figures are percentages.

Table 9: *Distribution of the Number of Alternative Simulations per Household*

	Number of households	10%	25%	50%	75%	90%
$\beta \pm 5\%$	2356	36	54	70	94	128
$\beta \pm 10\%$	2326	15	25	39	55	75
$\beta \pm 50\%$	2178	1	3	5	10	16
$\beta \pm 100\%$	2020	1	1	3	3	10