Intrafamily bargaining and love

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Abstract  Popular culture and common wisdom testify that the way partners in a relationship feel for one another very much depends on how they treat each other. This paper posits the hypothesis that altruism or love in a relationship is endogenous to the actions of the partners and studies how this influences allocations and efficiency in a bargaining model of household decision-making. The main results are that agents treat their partner in a kinder way than without endogenously evolving love, this leads to more equitable allocations in household decision making and greater intertemporal efficiency. There are two mechanisms at work: agents treat their partner nicely to avoid retribution by a less loving partner in the future; and they treat the partner nicely so that the kind reciprocal behavior raises their own love towards the partner, which lets them enjoy higher utility. As to love, two interpretations emerge: love is a commitment device by which couples can implement Pareto superior allocations; and love is an investment good in the sense that costly nice behavior towards the partner today may ensure higher levels of trust and efficiency in the future.

keywords  Family economics · Household bargaining · Altruism · Love · Bargaining power · Commitment

JEL Classification  C78 · D13 · D64 · J12

1 Introduction

Any cursory look at popular culture, from any age, suggests that love takes center stage at least at some point in the life of most people.
And yet the love between two people has received scant interest from economists. When it appears, it is usually either invoked to justify altruistic feelings within a household as in Nordblom (2004) or to describe the emotional benefit two agents gain when matched in a marriage as in Konrad and Lommerud (2008); while in Hess (2004) love is a public good in marriage that follows an exogenous process.

This paper takes a different view: while initial love or suitability upon the first meeting may be viewed as exogenous, love/altruism in a relationship is responsive to what is happening in that relationship. In particular, the way one partner treats the other will influence the love his partner feels for him and so love co-evolves with the relationship, strengthening or deteriorating depending on the choices of the partners. In more economic terms, love is endogenous to the decision-making within the family. The most closely related paper is Browning (2009) who explores how the fear of a drop in affection due to a ‘betrayal’ can help couples overcome commitment issues in their decision-making. Whereas his analysis focuses on the single decision of betrayal or no betrayal and a loss of love, I study the evolution of love as the spouses repeatedly interact. In so doing this paper can also be likened to Liu (2007) who looks for the optimal investment into the quality of a marriage in a dynamic setting—ignoring, however, issues of love and strategic interaction.

Following the received literature on household decision-making, I model the family as a couple who simultaneously and repeatedly decide how much of their time each should allocate to privately enjoyed leisure and to household public good production which, as indicated by the wording, benefits both members of the couple. As the allocation of work is endogenously determined, this setup can be interpreted as a stylized model of bargaining. The love an agent feels towards his partner is then assumed to be responsive to the time allocation decision of the partner.

From the Markov-perfect equilibrium I derive the steady states dependent on the parameter values and the initial state. It is then argued that agents, anticipating the endogenous change in their own and their partner’s incentives due to changes in the levels of love, invest into the relationship by working more than would be optimal considering the single period setup. They may share the burden of lifting their partnership to the full love state by playing strategies that are complementary in investment.

In cases in which agents are sufficiently patient and productive in household public good production as well as face sufficiently low risks of divorce, breakup or death, the initial levels of love therefore play no role in the steady state. For the less patient, less productive, and at higher risk, which one may perhaps interpret at less suited for one another, this does not hold and initial levels of love determine the utility levels of the steady state.

2 Related literature

In exploring a way of modeling the evolution of love in a relationship, the present paper builds on and contributes to the received literature on household decision-making.
In what McElroy and Horney (1981) called the “neoclassical” approach, economists have for a long time treated the decision-making within the household as resulting in the household behaving towards the outside world like a single individual. This was given a formal shape by Samuelson (1956) who looked for conditions under which the household acts like an individual; in doing so he posits a social welfare function which the household members agree to maximize, together with lump-sum transfers between the members.1

This unitary view of the household can also be found in parts of the work of Gary S. Becker, most explicitly in the so-called Rotten Kid Theorem, proposed in Becker (1974b) and elaborated in amongst others Bergstrom (1989), Bruce and Waldman (1990) and Johnson (1990).

Becker, however, was also among the first to explore non-unitary models of decision-making in households, foremost in his seminal paper on time allocation, Becker (1965), but also on his work on marriage, e.g. Becker (1973).2

Independently from each other, Manser and Brown (1980) and McElroy and Horney (1981) developed models of household decision-making based on the conception that households can be understood as two individuals bargaining over the distribution of the gains realized by entering the household (or marriage). Manser and Brown (1980) explore different bargaining setups such as Nash bargaining, bargaining according to Kalai and Smorodinsky (1975) as well as dictatorial bargaining while the analysis of McElroy and Horney (1981) focus on Nash bargaining and work out in detail the differences in implications for observable demand between Nash bargaining households and single households.

The underlying view of the household is one in which individuals may have different preferences, yet come together because there are gains from close cooperation. These may be due to differences in their productivity in household production processes3 or to the benefits of joint consumption like household public goods.4

The ensuing literature has given attention to non-cooperative aspects of household decision-making. Lundberg and Pollak (1993) define the threat point of the bargaining not by the utility in the single state but by the utility in a non-cooperative Cournot equilibrium in which the agents do not end the marriage but make only voluntary contributions to household public goods. Other papers that apply solution concepts of non-cooperative game theory to household decision-making problems include Bragstad (1991), Lundberg and Pollak (1996), Konrad and Lommerud (1995), Konrad and Lommerud (2000).

The literature has also been exploring the implications of explicitly modeling household behavior in a dynamic way; this includes for instance Ligon (2011), Konrad and Lommerud (2000), Lundberg and Pollak (2003), Basu (2006).

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1 As noted by Samuelson (1956), this model does not attempt explain how decision-making within households actually takes place.
2 For a discussion see Grossbard (2010).
3 See e.g. Becker (1965), Becker (1981), Pollak and Wachter (1975). A recent addition to this line of enquiry is given by Brown and Zhang (2013).
4 See the discussion in Manser and Brown (1980) p. 34.
Lundberg and Pollak (2003) exemplify the main point of this part of the literature; they consider a dual-earner couple deciding on the location at which to live and work which is modeled as a two stage game. If location choice influences the bargaining power of the household members in the second stage and this is foreseen in the first stage, then even Pareto optimal bargaining in the second period is not sufficient to ensure Pareto efficiency of the full game. This result is replicated in different guises across the literature: Endogenous bargaining power and limited commitment power induce inefficiency in the decision-making process of households.

Recently, Browning (2009) demonstrated that introducing love and a feeling of betrayal into the location problem discussed above may overcome this inefficiency. In particular, the advantaged spouse can choose not to exercise her increased bargaining power and she may be able to commit to this because reneging on the promise would cause the Beckerian caring, or love, of the partner to drop. This is described as the effect of betrayal and works as a commitment device because it is automatic and thus immune to renegotiation.

Approaching the problem from another angle, Dufwenberg (2002), who draws on insights of psychological games, shows that with beliefs based on forward induction an equivalent commitment device can be provided by a feeling of guilt. Yet another angle is chosen by Cigno (2012) who shows that the institutional setup of the marriage contract can ameliorate dynamic efficiency by handing the partner whose future bargaining position is weakened the credible threat of divorce.

The model developed in the next section builds on this last strand of literature: the evolution of love within marriage can be interpreted as the endogenous evolution of the bargaining power in the decision-making process of the household. It will be shown that it can also be interpreted as a commitment device in a similar fashion to Browning (2009).

3 The model

3.1 Utility function

Let the household consist of two agents, $A$ and $B$, who interact repeatedly. Agents consume leisure and a household specific public good which they produce using a constant returns to scale production function; let the level of the public good in period $t$ be denoted $G_t = \beta(w_{A,t} + w_{B,t})$ where $w_{i,t}$ is the amount of work that agent $i$ puts into the production of the public good and $\beta \in (\frac{1}{4}, 1)$ is the productivity of agents in this activity. Normalizing disposable time per period to 1 lets the decision variable be $w_{i,t} \in [0, 1]$ and yields leisure of $1 - w_{i,t} \geq 0$. To simplify the analysis I restrict the choice of the agents to the discrete set of $w_{i,t} \in \{0, 1\}$.

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5 The classic reference for psychological games is Geanakoplos et al. (1989). Their approach has been adapted to fairness (including reciprocity) in normal form games by Rabin (1993); extensions to sequential games can be found e.g. in Dufwenberg and Kirchsteiger (2004) and Falk and Fischbacher (2006). For a recent exposition of altruistic feelings dependent on intentions see Cox et al. (2007).
For his instantaneous self-regarding utility, agent $i$ values these two goods according to (where $j \neq i$):

$$u_{i,t} = u(G_t, 1 - w_{i,t}) = \beta(w_{i,t} + w_{j,t}) + (1 - w_{i,t}). \tag{1}$$

He also cares about the other agent in the household and so his total instantaneous utility is given by:

$$v_{i,t} = u_{i,t} + \alpha_{i,t}u_{j,t}, \tag{2}$$

where $\alpha_{i,t}$ measures his ‘love’ towards the other agent; note that this love is potentially time-varying. These are preferences that Becker (1974a) called “caring”. $\alpha_{i,t}$ must be an element of {0,1}.

Agents are assumed to be expected utility maximizers and thus agent $i$ in period $t$ seeks to maximize the following expression:

$$U_{i,t} = \sum_{s=1}^{\infty} \delta^{t-s}E_t(v_{i,s}) \tag{3}$$

$$= \sum_{s=1}^{\infty} \delta^{t-s}E_t\left[(1 + \alpha_{i,t})G_t + (1 - w_{i,t}) + \alpha_{i,t}(1 - w_{j,t})\right].$$

As fixed parameters we have the time discount factor $0 < \delta < 1$ and the productivity of agents in household good production $\beta$. Note that the discount factor can be interpreted as a reduced form in the sense that it collapses discount factors for time preference and risk, $\delta = \delta_{\text{time}} \cdot \delta_{\text{risk}}$, where risk includes mortality and breakup or divorce. As a shorthand, I shall refer to the collapsed $\delta$ as ‘patience’.

3.2 Stage game

If $\alpha_{A,t} = \alpha_{B,t} = 0$ and $\beta$ is in $\left(\frac{1}{2}, 1\right)$ the stage game is a classical prisoners’ dilemma: $\beta > \frac{1}{2}$ means that the Pareto efficient outcome is for both agents to put all their time into household public good production while $\beta < 1$ ensures that implementing this outcome is not the preferred strategy under any circumstance.

Non-zero levels of love change this: for an agent in love, putting all his effort into household public good production is the dominant strategy and so the prisoners’ dilemma disappears. Less obviously, the lower bound on $\beta$ for which the Pareto optimum involves both agents working changes from $\frac{1}{2}$ to $\frac{2}{3}$. This can be verified by an inspection of the social welfare function $W_t = U_{i,t} + U_{j,t}$ which after rearranging can be written as:

$$W_t = (2 + \alpha_{t,i} + \alpha_{t,j})\beta(w_{t,i} + w_{t,j}) + (1 + \alpha_{t,i})(1 - w_{i,t}) + (1 + \alpha_{t,j})(1 - w_{j,t}) \tag{4}$$

Clearly, the work leisure trade-off, from a social planner’s point of view, is summarized by the marginal payoff from work in household public good production, $(2 + \alpha_{t,i} + \alpha_{t,j})\beta$, and the marginal payoff from leisure, $1 + \alpha_{t,i}$ and $1 + \alpha_{t,j}$, respectively.

As long as $\alpha_{t,i} = \alpha_{t,j} = \alpha_{t}$ we have that $(2 + \alpha_{t} + \alpha_{t})\beta > 1 + \alpha_{t}$ (so that $w_{t,i} = w_{t,j} = 1$ is socially optimal) if $\beta > \frac{1}{2}$ and the reverse if $\beta < \frac{1}{2}$; this follows
from the public good nature of the household good and the fact that we are looking at a household of two agents.

When the two levels of love are not the same \( \alpha_{i,t} \neq \alpha_{j,t} \) then things are complicated by the fact that the agent with the higher level of love, say \( i \), internalizes the self-regarding well-being of his partner more than vice-versa. This internalization gives the object of affection the characteristic of a public good and therefore the leisure consumed by better loved agent receives greater weight in the social welfare function: the marginal payoff of \( j \)'s leisure increases proportionally with \( \alpha_{i,t} \), while the payoff of his work increases only proportionally to \( \alpha_{i,t} \). In this case, \( \beta > \frac{1}{2} \) is not a sufficient condition for \( w_{i,t} = w_{j,t} = 1 \) being socially optimal.

If \( \beta > \frac{2}{3} \), however, the effect of differential love is dominated by the effect of the household good being a public good. Noting that \( \max_{\alpha_{i,t}, \alpha_{j,t}} \left[ \frac{1 + \max(\alpha_{i,t}, \alpha_{j,t})}{2 + \alpha_{i,t} + \alpha_{j,t}} \right] = \frac{1+1}{2+1+0} \) we have:

\[
\beta > \frac{2}{3} \implies (2 + \alpha_{i,t} + \alpha_{j,t})\beta > 1 + \max(\alpha_{i,t}, \alpha_{j,t}).
\]  

(5)

3.3 Game structure

In each period or round of the game, agents independently and simultaneously decide on how much to work in household public good production. Then their levels of love are recalculated and the next round begins. Agents play an infinite number of rounds of this game. It should be noted that this infinite discounted game is equivalent to one with random termination.\(^6\)

Love of agent \( i \) towards the partner in period \( t \) is captured by \( \alpha_{i,t} \). Love is assumed to vary with the amount of work that the partner puts into household public good production: if \( j \) works a lot in household public good production, which benefits agent \( i \), then \( i \)'s love for \( j \) increases/stays high. To simplify the notation, I set \( \alpha_{i,t} = w_{j,t-1} \) and vice versa for \( \alpha_{j,t} \).\(^7\)

In order to ease the language I shall refer to an agent’s love being ‘high’ when his \( \alpha \) is one and shall say he ‘works’ if his \( w \) is one and that he does not otherwise.

3.4 Equilibrium

The solution concept is Markov-perfect equilibrium so that the state-dependent strategies of the agents must constitute a Nash equilibrium in every state. State-dependency implies that the history of the play of the two players enters their strategy only implicitly through the levels of love of the two agents.

There are then four possible states of love in the relationship of the two agents: writing \( (\alpha_{i,t}, \alpha_{j,t}) \) we can have \((0,0), (1,0), (0,1)\) or \((1,1)\).

\(^6\) If agents are mortal and do not know the exact time of their death then their expectation can be modeled as an infinite life with a certain probability of death every period.

\(^7\) In the evolution of love, I am abstracting from factors other the partner’s treatment. Other factors would for instance include the presence or absence of children as studied in Grossbard and Mukhopadhyay (2013).
We can construct a table of all possible strategies of agent $i$, this is done in Table 1 where for each of the 16 possible strategies I list the value of $w_i$ depending on the four states.

The last line of Table 1 marks the strategies that are not dominated by some other strategy. The logic behind is the following: in states $II$ and $IV$, when agent $i$'s love is high, he is intrinsically motivated to work in the sense that it maximizes his period utility; working also raises the partner’s love which is beneficial to $i$ by potentially inducing $j$ to work more than otherwise. Therefore in these states agent $i$ will always choose to work.

The four remaining strategies can be characterized as follows:

- **Strategy number 10**, renamed to $S$: This is the “selfish strategy”. The agent acts as if he was maximizing his current period utility.
- **Strategy number 13**, renamed to $O$: This is the “optimistic initial investment strategy”. When there is no love in the relationship, the agent invests by working.
- **Strategy number 15**, renamed to $F$: This is the “keep the flame alive strategy”. The agent keeps the partner in a loving state.
- **Strategy number 16**, renamed to $W$: This is the “unconditional work strategy”. The agent works under any circumstance.

The same exercise can be conducted for agent $j$ reaching the mirror outcome.

For a pair of strategies to form a Nash equilibrium they must be best responses (BRs) to one another. It will be instructive to calculate the best response function of one agent to any of the four strategies that his partner may follow.

Suppose first that agent $j$ is playing strategy $S$ (defined analogously to how we defined $S$ for agent $i$). When computing the best response for $i$ we now need only consider states $I$ and $III$ as in the other two states all strategies imply the same course of action and thus lead to the same utility. Consider the possibilities in turn.

- **State $I$, $i$ plays $S$:**
  Agents will play $w_{1,t} = w_{2,t} = 0$ and therefore perpetuate state $I$. Total expected utility of $i$ is therefore $U_{i,t} = \frac{1}{1-\delta}$.
• State I, i plays O:
Agent i playing O results in a sequence of high and low love alternating; agent i, following strategy O, starts with working full time since there is no love in the relationship and then in the next period does not as the partner loves him then. The resulting work by partner makes i loving in the following period while the partner will have lost his love. Therefore the cycle alternates between i being in love while j is not and the other way round. This is illustrated in Table 2. Total expected utility of i will thus be $U_{i,t} = \beta + \delta \frac{(\beta + 1) + \delta (2\beta + 1)}{1 - \delta^2}$.

• State I, i plays F:
This leads to the same situation as when i plays S, so we have $U_{i,t} = \frac{1}{1 - \delta}$.

• State I, i plays W:
By unconditionally working, agent i raises his partner’s love and keeps it high; when his partner has fallen in love as well he switches to working as well so that the couple enter a steady state of high love with both working. This is illustrated in Table 3; periods after $t + 3$ will have the same stage game action and payoff as $t + 3$. The total expected utility of i will then be $U_{i,t} = \beta + 2\beta + \delta^2 \frac{4\beta}{1 - \delta}$.

• State III, i plays S:
Here, the agents also enter a sequence of alternating love and work; total expected utility of i will be $U_{i,t} = \frac{(\beta + 1) + \delta (2\beta + 1)}{1 - \delta^2}$. See Table 4.

• State III, i plays O:
The result is the same as if i played S.

• State III, i plays F:
In this case, agent i keeps his partner’s love high and thus the couple enters the high love steady state with both working. Total expected utility is $U_{i,t} = 2\beta + \delta \frac{4\beta}{1 - \delta}$; see Table 5.
State III, i plays W:
The result is the same as if i played F.

For state I we can construct the following rankings of total expected utility:

\[
\{S, F\} > O \iff \frac{1}{1 - \delta} > \beta + \delta \frac{(\beta + 1) + \delta(2\beta + 1)}{1 - \delta^2} \iff \delta < \hat{\delta}_{A1} \tag{6}
\]

\[
O > W \iff \beta + \delta \frac{(\beta + 1) + \delta(2\beta + 1)}{1 - \delta^2} > \beta + 2\delta\beta + \delta^2 \frac{4\beta}{1 - \delta} \iff \delta < \hat{\delta}_{A2} \tag{7}
\]

It can be shown that \(\hat{\delta}_{A1} = -\frac{\beta}{2(1+\beta)} + \sqrt{\left(\frac{\beta}{2(1+\beta)}\right)^2 + \frac{1-\beta}{1+\beta}} = -\frac{2\beta-1}{4\beta} + \sqrt{\frac{(2\beta-1)^2}{4\beta^2} - \frac{1}{2} + \frac{1}{2\beta}} = \hat{\delta}_{A2}.

And for state III we have the following ranking:

\[
\{S, O\} > \{F, W\} \iff \frac{(\beta + 1) + \delta(2\beta + 1)}{1 - \delta^2} > 2\beta + \delta \frac{4\beta}{1 - \delta} \iff \delta < \hat{\delta}_{A3}. \tag{8}
\]

It is easy to see that \(\hat{\delta}_{A3} = \hat{\delta}_{A2}\).

We arrive at the following best response function of i to j playing S:

\[
BR_i(S_j)
\]

| state | \(\hat{\delta}_{A1}\) | \(\hat{\delta}_{A2}\) | 1 |
|-------|-----------------|-----------------|---|
| state I | S/F | O | W |
| state III | S/O | S/O | F/W |

Both states | S | O | W |

In the above manner we can likewise derive the best response functions of i to j playing some other strategy; the results are listed below. For a derivation see the section “Appendix”.

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**Table 4** Outcome in state I if j plays S and i plays S

| \(a_{i,t}\) | \(a_{j,t}\) | \(w_{i,t}\) | \(w_{j,t}\) | \(u_{i,t}\) |
|--------|--------|--------|--------|--------|
| t      | 0      | 1      | 0      | 1      | \(\beta + 1\) |
| t + 1  | 1      | 0      | 1      | 0      | \(2\beta + 1\) |
| t + 2  | 0      | 1      | 0      | 1      | \(\beta + 1\) |
| t + 3  | 1      | 0      | 1      | 0      | \(2\beta + 1\) |

**Table 5** Outcome in state I if j plays S and i plays F

| \(a_{i,t}\) | \(a_{j,t}\) | \(w_{i,t}\) | \(w_{j,t}\) | \(u_{i,t}\) |
|--------|--------|--------|--------|--------|
| t      | 0      | 1      | 1      | 1      | \(2\beta\) |
| t + 1  | 1      | 1      | 1      | 1      | \(4\beta\) |
| t + 2  | 1      | 1      | 1      | 1      | \(4\beta\) |
We can now take these best responses together and work out which equilibria may emerge in this game. The result is plotted in Fig. 1.

**Proposition 1  Characterization Theorem** We have the following equilibria depending on which area in the allowable \((\beta, \delta)\) space the game is set in (for the numbering of areas refer to the right part of Fig. 1). The equilibrium strategy pairs are depicted in \((\beta, \delta)\) space in Fig. 2.

| Area  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------|---|---|---|---|---|---|---|
| \(BR_i(O_j)\) | S | S | S | S | O | W | W |
| \(BR_i(F_j)\) | S | F | S | F | F | W | W |
| \(BR_i(W_j)\) | S | S | O | O | O | O | W |

**Proof** Follows immediately from the best responses.

The intuition for this result is that when agents are impatient, they do not invest into the relationship and rather resort to the ‘selfish strategy’ that yields the highest immediate satisfaction. This means that agents who initially feel no love towards
each other remain trapped in that state. If one agent feels love and the other does not then they enter a sequence of alternating love. In the latter case neither is willing to sacrifice current period utility in order to lift the couple to the full love steady state. Unless the agents happen to start in the full love state, they will never get there.

When agents are more patient, they may co-ordinate on the selfish strategy equilibrium but may also co-ordinate on the $O-F$ equilibrium. In the latter, the partners can escape the state of no love by sharing the burden of investment: in the first period one makes the initial investment while the other invests into his partner’s love two periods later, saving the agents from entering an alternating sequence of love and no love. The ‘optimistic initial investment strategy’ and the ‘keep the flame
alive strategy’ are thus complementary in their effort to move agents from the no love to the full love state. This equilibrium is the closest that the agents may get to a symmetric investment equilibrium.

Yet more patient agents will always play the shared-burden equilibrium of $O–F$. If one of the agents played the selfish strategy ($S$), then the other would want move in to make the initial investment thereby destroying the selfish strategy equilibrium.

When agents are very patient then one will choose the ‘unconditional work strategy’ meaning he will work whatever the levels of love and so propel the couple to the state of full love. The other agent’s best response will be to, figuratively speaking, lay back and let the partner do the work, i.e. the selfish strategy. The underlying reason for this best response is that the speed with which agents reach the full love state cannot be increased by the agent whose partner is playing the unconditional work strategy and therefore there can be no incentive for the agent to invest. It is for this reason that even very patient agents cannot play a symmetric investment equilibrium.

The burden sharing equilibrium is destroyed when agents are very patient: the best response to the optimistic initial investment strategy ($O$) is no longer the keep the flame alive strategy ($F$) but the unconditional work strategy. This is so because the partner that would have played $F$ before now is patient enough to invest early on.

It is worth noting that $\beta$ is a substitute for $\delta$ in that the threshold levels of patience that separate the discussed areas from each other are strictly decreasing functions of the productivity of agents in household public good production. In fact even the most impatient pair of agents may play the strategy pair $S–W$, i.e. reaching the full love steady state from an initial state of no love, if $\beta$ is close enough to unity. The intuition to this result is simple: the higher the productivity in household public good production, the lower the negative utility differential between work and leisure for a non-loving agent and hence the lower the cost of investing into the love of the partner.

4 Outlook: potential for testing

It is possible to derive testable hypotheses from the model and link these to existing data sources.

As to the data, one can refer to a household survey panel such as the British Household Panel Survey (BHPS) or the National Longitudinal Survey of Youth 1997 (NLSY). From their questions an approximation of the savings rate of a household can be derived which, potentially mediated by some control variables, one can take to be a proxy for the patience of the couple ($\delta$).\(^8\) It is also possible to

\(^8\) See Leece (2004) and van de Ven (2009) for similar interpretations of the BHPS data.
extract the approximate amount of time not dedicated to paid work which one can take to be a proxy for the productivity of household public goods production (β)—as more time outside work should by virtue of diminishing marginal utility of non-spouse related activities ceteris paribus lower the opportunity costs of spending time on things that please the partner.

In recent waves of BHPS, Self Completion Questionnaire question 3 part d) asks the interviewee to rate how satisfied he or she is with ‘Your husband/wife/partner’ on a scale from 1 to 10. Similarly, the NLSY asks the interviewee “How do you feel that [your current spouse/partner] cares about you?” While these questions are not exactly aimed at the level of love or affection towards the partner, one can take them to be at least correlated to love (α). In order to control for preference heterogeneity not accounted for in the model, in the BHPS data one could bin observations by the responses to Individual Questionnaire question RV94 which asks the interviewee to rate the importance of ‘Having a good marriage or partnership’ on a scale from 1 to 10.

Hypotheses could include the following: a higher savings rate is associated ceteris paribus with a higher score on the question serving as a proxy for love as more patient partners have been shown to arrive in a high love equilibrium given a wider range of values of β than less patient couples. Exogenous variance of leisure hours, e.g. by instrumenting out with regional cyclical ups and downs or with average of the profession, on the other hand should give an indication of exogenous variation in β where again high values should ceteris paribus correspond to higher levels of love for reasons analogous to before.

Applied for instance to an empirical framework such as Grossbard and Mukhopadhyay (2013), one would expect to find that these proxies for δ and β explain part of the unobserved heterogeneity across people that is controlled for by a fixed effects setting.

If one were to interpret BHPS question RV94 not as being informative about preferences but rather as being a description or rationalisation of compromise in household decision-making, then its score would be an indication of time spent in household public good production (w). One could then compute the difference in difference of love and time spent in household public good production which according to the assumptions of the model should indicate that the latter increases the former.

5 Conclusions

The purpose of the model presented here was to illustrate the dynamics that two people enter when they form a couple. If their mutual feelings are endogenous to their relationship then the treatments of the respective partner, which is exemplified in the choice of how much time one invests in household public good production, are a strategic interaction: the better I treat him/her the more he/she will love me,

9 For related empirical papers working on this question in the BHPS data see Powdthavee (2009) and Anand et al. (2005).
which alters his/her incentives in the future. The parameters were chosen such that loving agents would intrinsically want to treat their partner nicely while unloving agents would prefer not to treat their partner nicely.

Not surprisingly, in equilibrium agents are able to lift themselves out of the no-love state into a loving state if the costs of doing so are low enough and if they are patient enough. From an incentive point of view, agents may be said to realize that their partner’s and their own love is an investment good which pays dividends by altering the agents preferences so that their utility is higher in the loving state. Interestingly, agents do not only invest into their partner’s love so that the partner treats them nicely—which could be interpreted as love being a currency that facilitates the non-simultaneous exchange of goods—but also in order to have their own love grow in response to this nice treatment. In a strongly simplified form, the model thus illustrates the arduous process of building deep mutual feelings of affection, caring, trust, dependability—or, in one, love. It also illustrates the complementarity of investments specific to one person which makes such love hard to build and thus worth preserving. From an application point of view, it is worth noting that for less patient agents who face greater risk of divorce or breakup the initial level of love play a greater role in the long run well-being of the partner. Hence, perhaps, the greater emphasis on these in recent times.10

If human preferences are indeed structured in such or similar fashion, love could be interpreted as the facilitator that allows two people to form a productive partnership. And this for two reasons: firstly, in a setting with little institutional background, it provides a commitment device that makes opportunistic behavior costly in a relationship; secondly, investment into love creates a positive feedback into the productivity of such investment by raising one’s own love, and this strategic complementarity focuses efforts on a single individual partner further strengthening the couple as a productive unit.11

Promising avenues for future research include widening the scope of the model to more explicitly include aspects like risk and long term decisions. In the former domain one could study the effect of the possibility of divorce or unemployment; in the latter domain joint ownership of the home and having children could be investigated. Both these domains would take the model closer to the central issues in empirical household economics and would thus sharpen the empirical implications of the presented model. For now, these implications are that exogenous variation in patience as well as in ease and leisure to please the partner of one or both partners of a relationship will partly explain levels of affection and love of both partners.

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10 This refers only to a relative shift in importance, not to any ranking in terms of well-being. For the latter, see e.g. Xiaohe and Whyte (1990) for an empirical investigation.

11 This latter point is perhaps what separates the analysis of love from the one of friendship and affection.
Appendix

Derivation of best responses of $i$ to $j$ playing $O$, $F$ or $W$

Suppose $j$ plays $O$

- State $I$, $i$ plays $S$:
  Agents will enter a cycle of alternating love such that total expected utility of $i$ is $U_{i,t} = \frac{(\beta + 1) + \delta(2\beta + 1)}{1 - \delta^2}$.

| $t$   | $\alpha_{i,t}$ | $\alpha_{j,t}$ | $w_{i,t}$ | $w_{j,t}$ | $u_{i,t}$ |
|------|----------------|----------------|-----------|-----------|-----------|
| $t$  | 0              | 0              | 0         | 1         | $\beta + 1$ |
| $t + 1$ | 1              | 0              | 1         | 0         | $2\beta + 1$ |
| $t + 2$ | 0              | 1              | 0         | 1         | $\beta + 1$ |
| $t + 3$ | 1              | 0              | 1         | 0         | $2\beta + 1$ |

- State $I$, $i$ plays $O$:
  Agents jump to the full love equilibrium within one period and total expected utility therefore is $U_{i,t} = 2\beta + \frac{\delta^{4\beta}}{1-\delta}$.

| $t$   | $\alpha_{i,t}$ | $\alpha_{j,t}$ | $w_{i,t}$ | $w_{j,t}$ | $u_{i,t}$ |
|------|----------------|----------------|-----------|-----------|-----------|
| $t$  | 0              | 0              | 1         | 1         | $2\beta$  |
| $t + 1$ | 1              | 1              | 1         | 1         | $4\beta$  |
| $t + 2$ | 1              | 1              | 1         | 1         | $4\beta$  |

- State $I$, $i$ plays $F$:
  This leads the agents to the full love steady state, but takes longer than when $i$ plays $W$. Total expected utility is $U_{i,t} = (\beta + 1) + \delta(2\beta + 1) + \delta^22\beta + \delta^3\frac{4\beta}{1-\delta}$.

| $t$   | $\alpha_{i,t}$ | $\alpha_{j,t}$ | $w_{i,t}$ | $w_{j,t}$ | $u_{i,t}$ |
|------|----------------|----------------|-----------|-----------|-----------|
| $t$  | 0              | 0              | 0         | 1         | $\beta + 1$ |
| $t + 1$ | 1              | 0              | 1         | 0         | $2\beta + 1$ |
| $t + 2$ | 0              | 1              | 1         | 1         | $2\beta$  |
| $t + 3$ | 1              | 1              | 1         | 1         | $4\beta$  |
• State I, i plays W:
  This leads to the same situation as when i plays O.

• State III, i plays S:
  The utility outcome is the same as in state I.

• State III, i plays O:
  The outcome is the same as for strategy S.

• State III, i plays F:
  The outcome is the same as for strategy W.

• State III, i plays W:
  The utility outcome is the same as in state I.

We can now construct a strategy ranking. For state I we have:

\[
S > F \iff \frac{(\beta + 1) + \delta(2\beta + 1)}{1 - \delta^2} > \frac{(\beta + 1) + \delta(2\beta + 1) + \delta^22\beta + \delta^3\frac{4\beta}{1 - \delta}}{1 - \delta} \\
\iff \delta < \hat{\delta}_{B1}
\]

(9)

\[
F > \{O, W\} \iff \frac{(\beta + 1) + \delta(2\beta + 1) + \delta^22\beta + \delta^3\frac{4\beta}{1 - \beta}}{1 - \beta} > 2\beta + \delta\frac{4\beta}{1 - \delta} \\
\iff \delta < \hat{\delta}_{B2} = \hat{\delta}_{A2}
\]

(10)

Where \(\hat{\delta}_{B1} = \frac{1 - 3\beta}{2\beta} + \sqrt{\frac{(1 - 3\beta)^2}{2\beta^2} + \frac{1 - \beta}{\beta}}\). For state III we have:

\[
\{S, O\} > \{F, W\} \\
\iff \frac{(\beta + 1) + \delta(2\beta + 1)}{1 - \delta^2} > \frac{(\beta + 1) + \delta(2\beta + 1) + \delta^22\beta + \delta^3\frac{4\beta}{1 - \delta}}{1 - \delta} \\
\iff \delta < \hat{\delta}_{B3} = \hat{\delta}_{B1}.
\]

(11)

Suppose j plays F

• State I, i plays S:
  The outcome is the same as when j plays S and i plays S.

• State I, i plays O:
  Here, within a couple of periods the agents reach the full love steady state, total expected utility is \(U_{i,t} = \beta + \delta(1 + \delta) + \delta^2(2\beta + 1) + \delta^3\frac{4\beta}{1 - \delta}\).

| t   | \(\alpha_{i,t}\) | \(\alpha_{j,t}\) | \(w_{i,t}\) | \(w_{j,t}\) | \(U_{i,t}\) |
|-----|-------------------|-------------------|-------------|-------------|-------------|
| t   | 0                 | 0                 | 1           | 0           | \(\beta\)   |
| t + 1| 0                 | 1                 | 0           | 1           | \(\beta + 1\) |
| t + 2| 1                 | 0                 | 1           | 1           | \(2\beta + 1\) |
| t + 3| 1                 | 1                 | 1           | 1           | \(4\beta\)   |

• State I, i plays F:
  The outcome is the same as when j plays S and i plays S.
State I, i plays $W$:
The outcome is the same as when $j$ plays $S$ and $i$ plays $W$.

State III, i plays $S$:
Agents go to the full love equilibrium in two steps and total expected utility therefore is $U_{i,t} = (\beta + 1) + \delta(2\beta + 1) + \delta^2 \frac{4\beta}{1-\delta}$.

State III, i plays $O$:
The outcome is the same as if $i$ played $S$.

State III, i plays $F$:
The outcome is the same as when $j$ plays $S$ and $i$ plays $F$.

State III, i plays $W$:
The outcome is the same as when $j$ plays $S$ and $i$ plays $W$.

The strategy ranking for state I can be constructed in two steps:

\[
\{S, F\} \succ O \iff \frac{1}{1-\delta} > \beta + \delta(1+\delta) + \delta^2(2\beta + 1) + \delta^3 \frac{4\beta}{1-\delta} \iff \delta < \hat{\delta}_{C1} \quad (12)
\]

\[
O \succ W \iff \beta + \delta(1+\delta) + \delta^2(2\beta + 1) + \delta^3 \frac{4\beta}{1-\delta} > \beta + \delta(2\beta + 1) + \delta^2 \frac{4\beta}{1-\delta} \iff \delta < \hat{\delta}_{C2} = \frac{1-\beta}{2\beta - 1} \quad (13)
\]

Where $\hat{\delta}_{C1}$ cannot be determined analytically. It can be shown numerically, however, that $\hat{\delta}_{C1} > \hat{\delta}_{B1}$ for low levels of $\beta$ and the other way around for high levels and that $\hat{\delta}_{C1} < \hat{\delta}_{A1}$ for all levels of $\beta$.

For state III, the strategy ranking is the following:

\[
\{S, O\} \succ \{F, W\} \iff \beta + 1 + \delta(2\beta + 1) + \delta^2 \frac{4\beta}{1-\delta} > 2\beta + \delta \frac{4\beta}{1-\delta} \iff \delta < \hat{\delta}_{C3} = \hat{\delta}_{C2}.
\quad (14)
\]

Suppose $j$ plays $W$

State I, i plays $S$:
Agents go to the full love equilibrium within two periods and total expected utility therefore is $U_{i,t} = \beta + 1 + \delta \frac{4\beta}{1-\delta}$.
State $I$, $i$ plays $O$:

Agents jump to the full love equilibrium within one period and total expected utility therefore is

$$U_{i,t} = 2\beta + \delta \frac{4\beta}{1-\delta}.$$

State $I$, $i$ plays $F$:
The outcome is the same as when $i$ plays $S$.

State $I$, $i$ plays $W$:
The outcome is the same as when $i$ plays $O$.

State $III$:
For strategies $S$ and $W$ the outcomes are the same as in state $I$. Here strategy $O$ is equivalent to $S$ and $F$ is equivalent to $W$.

It is immediate that $\beta + 1 + \delta \frac{4\beta}{1-\delta} \geq 2\beta + \delta \frac{4\beta}{1-\delta}$ can be reduced to $1 > \beta$ which has been assumed.

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