

Dufwenberg, Martin

Working Paper

Time Consistent Matrimony with Endogenous Trust

Working Paper, No. 1997:1

Provided in Cooperation with:

Department of Economics, Uppsala University

Suggested Citation: Dufwenberg, Martin (1996) : Time Consistent Matrimony with Endogenous Trust, Working Paper, No. 1997:1, Uppsala University, Department of Economics, Uppsala, <https://nbn-resolving.de/urn:nbn:se:uu:diva-2377>

This Version is available at:

<https://hdl.handle.net/10419/82854>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

December 30, 1996

Time Consistent Matrimony with Endogenous Trust*

Martin Dufwenberg**

ABSTRACT:

A simple model of marriage and divorce predicts that no marriages occur. Yet, in real life, people marry all the time in seemingly similar situations. This discordance is explained using psychological game theory. An emotional guilt effect is explicitly modeled and multiple belief-dependent equilibria become possible: some marriages don't happen, some are formed but end in divorce, some last a lifetime. For certain parameterizations a lifelong efficient marriage is guaranteed; one spouse's approval to marry signals a trust so strong as to force the other spouse to hold beliefs which make divorce exceedingly emotionally unattractive. These results may have some bearing also on other partnerships than marriage.

* I am grateful to Yoram Weiss who has introduced me to this topic and has given me helpful advice. I thank also Jan Bouckaert, Eric van Damme, Eddie Dekel, Tone Dieckmann, David Frankel, Uri Gneezy, Bo Larsson, Michael Lundholm, Phil Reny, Bradley Ruffle, Frank Verboven, and Jörgen Weibull for very helpful comments or discussion. The paper is a significant revision of a chapter in my Ph.D. thesis. Part of the subsequent research was supported by a research grant from Handelsbankens forskningsstiftelser.

** CentER for Economic Research, Tilburg University, The Netherlands, and Department of Economics, Uppsala University, Sweden. Mailing address: Dept. of Economics, Uppsala Univ., Box 513, S-75120 Uppsala, Sweden. Phone: +46-18-182309, Fax: +46-18-181478, E-mail: martin.dufwenberg@nek.uu.se

I. Introduction

Married couples making human capital investments often concentrate on developing one spouse's skills more than the other's. At first glance such asymmetric arrangements may seem profitable.¹ However, a closer game theoretic scrutiny suggests that this "educational motive" for marriage is not so convincing: Suppose a wife supports her husband towards a costly education. When the husband receives his valuable degree he has an incentive to divorce his wife and reap the benefits from his enhanced earnings capacity all by himself. Of course, a clever prospective wife anticipates this opportunistic behavior, and therefore does not agree to enter wedlock in the first place. Marriage is not "subgame perfect".

From this perspective, real life marital interaction is a puzzle. Spouses often support one another towards educations. More generally, marriages frequently occur in situations where the marital gains appear to be asymmetrically distributed between the spouses across time. Spouses trust one another not to pursue divorce and, at least sometimes, the spouse to whom the gains from marriage come early does not divorce the domestic partner.

The purpose of this paper is to offer a solution to this puzzle. To focus issues, the analysis is centered on the "educated husband—supporting wife" example.² However, the insights that are gained have some bearing on any marriage where the marital gains are asymmetrically distributed between the spouses across time, and may even extend to other types of partnerships (see Section V).

The key idea in solving the puzzle is based on the idea that not only monetary concerns are payoff relevant in marital situations. Love, disappointment, gratitude, guilt, pride, anger,

¹There may be increasing returns to scale in the production of household welfare (Weiss 1994, Sect. 2, Ex. 2.1); differential investments may bring about comparative advantages in household production (Becker, 1991, Ch. 2); credit from external sources may be more expensive than what the spouses can provide for each other (Borenstein & Courant (1989, Sect. I) and Weiss (1994, Sect. 2, Ex. 2.2)).

² The assumption that the educated spouse is the husband will be kept throughout. This is consistent with Weitzman's (1986, p 67) observation that "[h]usbands and wives typically invest in careers—most particularly in the husband's education and career—and the products of such investments are often a family's major assets", with the observation in Borenstein & Courant (1989, fn 3) that a medical student with a supporting spouse typically is a husband with a wife, with evidence concerning divorce cases decided in U.S. courts (Polsby & Zelder, 1994, fn 4), and with the general finding by Cohen (1987) that gains from marriage tend to accrue to men early on in a relationship and to women towards the end.

and other emotions may also be important. In this paper, an emotional element is incorporated using techniques introduced by Geanakoplos, Pearce & Stacchetti (1989) (henceforth GPS). The marriage-divorce game is rebuilt as a *psychological game*, in which a spouse's payoff may depend not only on what strategy profile is played (as in a standard game) but also on the spouse's beliefs. Such structures are quite convenient for modeling certain emotions.³ Here, it is assumed that the educated husband is averse to letting his wife down in the following sense: The stronger he expects his supporting wife to *trust* (expect) him to stay in the marriage, the more *guilty* he feels by forcing divorce.

When in this way an "emotion is added" a *psychological marriage-divorce game* is created. If the parameter describing the husband's guilt sensitivity takes a high enough value the *only* equilibrium which is viable involves an efficient lifelong marriage. This is because an approval of marriage signals a degree of bridal trust so strong as to "force" the educated husband to hold beliefs such that he would feel exceedingly guilty pursuing divorce.

In general this happy ending is not guaranteed, however. A distinctive feature of the psychological marriage-divorce game is that for a range of parameter values multiple equilibria are possible. Which one is relevant depends crucially on the spouses' expectations in a way that could not have been captured in a standard game. Different expectations make guilt differ in importance, and accordingly both the "no marriage" and the "lifelong marriage" outcomes become possible. Indeed, there is also a possibility of *realized* divorce.

That divorce may occur is important, since in real life some marriages are dissolved in situations resembling the model in this paper. Marianne Takas (1986, p 48) tells her story:

[W]hen I got divorced my husband and I quickly agreed on financial arrangements. ... We split everything down the middle. Everything, that is, except what could be the single most lucrative asset of our marriage—his newly earned postprofessional degree. I'd put him through school, yet he would keep an earning power that had doubled while my own stood still.

³ Yet, psychological games have not been widely applied. Rabin (1993) uses it to develop a theory of fairness, and Ruffle (1995) studies gift giving with emotions.

The psychological marriage-divorce game permits realized divorce as part of a mixed strategy equilibrium. This explanation of divorce differs from most others in the literature which make reference to the resolution of some kind of exogenous uncertainty (like the "quality of a match"; see e.g. Weiss & Willis 1993). The model below abstracts from such features in order to highlight the tension between emotional factors and divorce incentives that arise because the gains from marriage accrue asymmetrically to the spouses across time.⁴

Borenstein & Courant (1989) study a structurally similar model. However, they focus on how various kinds of divorce legislation affects education, efficiency, and equity, and therefore make less elaborate behavioral assumptions (by assumption the supporting spouse acts as if the probability of divorce is zero). In the model below assumptions regarding the spouses rationality are not relaxed. The spouses anticipate one another's opportunistic actions, and their decisions are required to be *time consistent* in the sense of being optimal when taken for some belief with a reasonable foundation.

Family economists sometimes note that emotions and other "non-material" concerns may affect family behavior.⁵ However, with the exception of altruism (see e.g. Becker 1991, Ch. 8 and Stark 1995), such effects are seldom explicitly formalized. Recent findings in social psychology suggest that guilt plays an important role in close *interpersonal* relationships (Baumeister, Stillwell & Heatherton 1995). A marriage is certainly such a relationship, and psychological game theory provides a convenient framework for modeling a guilt effect.

The paper is set up as follows: Section II contains the benchmark model in which emotions play no role. These are added in Section III, which is the main part of the paper. Section IV contains a discussion of several aspects and extensions of the results. Section V concludes.

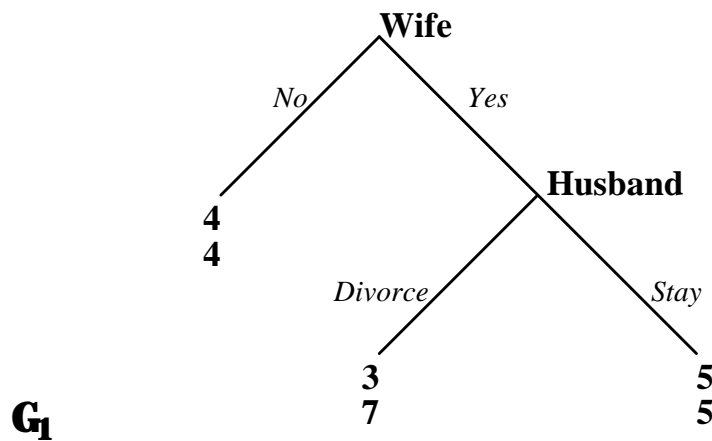
⁴ It is interesting to note that in theoretical biology similar asymmetries are discussed in relation to "mate desertion games" where parents either invest time in raising their offspring's viability, or desert their families to produce more offspring. Dawkins & Carlisle (1976) is an early reference.

⁵ Sociologists always emphasize these aspects but very seldom work with formal models. See Price & McKenry (1988, Ch. 2) or Collins & Coltrane (1991, Chapters 8,9,12) for interesting discussions of companionship, esteem for spouse, erotic ties, love, etc.

II. A Marriage-Divorce Game without Emotions

I study the following two-period situation: A man and a woman are matched, each of whom has a given earnings capacity of two monetary units per period. The man proposes marriage to the woman, verbally promising to love and to cherish her till death do them part. If the woman says *Yes*, the *wife* supports her *husband* towards a costly education which neither spouse could have afforded alone. The husband's second period earnings capacity thereby triples, but he earns nothing in the first period and the spouses then split the wife's income. If the spouses stay married in the second period they share all their joint income. If they divorce each spouse retains the personal earnings (the husband's promise is not binding) in the second period. Each spouse's total payoff equals the sum of the personal gains across periods.

This situation can be modeled as the following extensive marriage-divorce game with perfect information Γ_1 , in which the players' names refer to their roles if they marry:



The root of the game tree specifies the actions that can be taken in the first stage after the husband has proposed. The wife decides whether to say *Yes* or *No* to a marriage proposal. The second stage is then entered and the husband is called upon to *Divorce* or *Stay* with the wife. No divorce decision is modeled for the wife since conditional on the relevant information set being reached such a choice would be dominated. Note how the payoffs in Γ_1 match the assumptions concerning earnings capacities and sharing rules. For example, if the wife

chooses *Yes* and the husband *Divorces* her each spouse's first period payoff is 1, or half of the wife's first period earnings. In period two each spouse gets his or her own earnings, that is 2 to the wife and 6 to the husband. Summing up yields the payoff vector (3,7).

Due to the education opportunity there are potential gains from marriage; both spouses prefer to play (*Yes, Stay*) to an outcome where the wife says *No*. In this respect, Γ_1 is related to other models of marriage (see e.g. Weiss 1994, p 7-9). However, a key feature of Γ_1 is the explicit attention paid to the possibility of divorce. When this is taken into account, the marriage-divorce game has an obvious time consistent solution. If the husband is called upon to play, to *Divorce* is a dominant choice. The wife figures this out, and hence says *No* to marriage. This argument is captured by the solution concept of *subgame perfect equilibrium*. In Γ_1 , there is a unique such strategy profile: (*No, Divorce*). This outcome is *inefficient*.

III. Adding Emotions

"Emotions" may affect the spouses' payoffs in marriage-divorce situations: When a husband suddenly divorces his wife it is possible that the more she trusted (expected) her husband to stay, the more *disappointed* she will be. The husband may be averse to letting a trusting wife down and the more he expects that she trust him to stay, the more *guilty* he feels by forcing divorce. On the other hand, the more the husband expects that his wife trusts him to stay, the more *gratifying* he may find it to do so.

Note that in each of these examples a spouse's payoff depends not only on actions taken (as in standard games), but also on the spouse's beliefs about the counterpart's strategic choice or beliefs. Such effects can be modeled in a *psychological game*, a notion due to GPS. In Section III.A a psychological marriage-divorce game is constructed which incorporates some emotional concerns. The psychological marriage-divorce game is solved in Sections III.B-C.

A. A Psychological Marriage-Divorce Game

In the psychological marriage-divorce game the spouses have the same strategy sets as in Γ_1 and they move in the same order. However, in Γ_1 the unique solution involved pure strategies but in what follows mixed strategies may be relevant. Moreover, beliefs in the form of certain expectations are important. Some new notation is needed in order to represent mixed strategies, to formalize the psychological assumption that will be used, and to calculate equilibrium behavior. The spouses' actions will be denoted as follows:

$\sigma \in [0,1]$ is the probability with which the wife says *Yes*
 $\tau \in [0,1]$ is the probability with which the husband *Stays*

Some data concerning the spouses' beliefs, will be denoted as follows:

$\sigma' \in [0,1]$ is the husband's expectation of σ
 $\sigma'' \in [0,1]$ is the wife's expectation of σ'
 $\tau' \in [0,1]$ is the wife's expectation of τ (her *trust*)
 $\tau'' \in [0,1]$ is the husband's expectation of τ'

These expectations are beliefs the spouses hold when making their respective choices. They play a crucial role when the psychological marriage-divorce game below is solved (Sections III.B-C). Note that τ' is interpreted as the wife's *trust*. There is a large literature (spanning many fields) which attempts to define and analyze the notion of trust. The usage of the term here (recall the husband's promise) is consistent for example with that of Rotter (1980) who defines (interpersonal) trust as an "expectancy held by an individual that the word, promise, oral or written statement of another individual or group can be relied on" (p 1).⁶

The second-order expectation τ'' , interpreted as the husband's belief in his wife's trust, is used to model an "emotion". Specifically, the following assumption will be made:

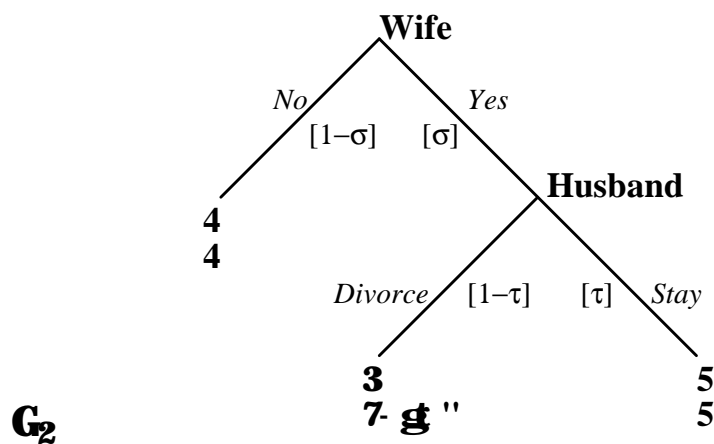
⁶ I am grateful to Niels Noorderhaven for turning my attention to Rotter's (1980) article.

ASSUMPTION 1 (psychological): When the husband makes his choice, the stronger he expects that his wife trusts him to *Stay* the more disutility of guilt he experiences by choosing *Divorce*. That is, if the *(Yes, Divorce)* profile is implemented, the husband's utility is decreasing in τ .

This assumption reflects the aforementioned example with a husband who is prone to remorse if he lets his trusting wife down. It is moreover consistent with Baumeister *et al's* (1995, p 174) finding that "the prototypical cause of guilt is inflicting harm on a relationship partner. For simplicity, attention will be confined to this psychological guilt effect. However, the following assumption will also be made for technical convenience:

ASSUMPTION 2 (technical): The guilt effect of Assumption (i) enters additively into the husband's utility function. Moreover, the "marginal effect", or the husbands "guilt sensitivity", is constant at $\gamma \geq 0$.

Now an extensive psychological marriage-divorce game Γ_2 can be constructed which captures the Assumptions 1 and 2. It is convenient to indicate explicitly in connection to the game tree that $\sigma, \tau \in [0, 1]$ are probabilities chosen by the respective spouses:



Given any $\gamma > 0$, Γ_2 is *not* a standard game in which a unique payoff vector is associated with each strategy profile. The husband's payoff following the profile (*Yes*, *Divorce*) depends on τ , his expectation of his wife's trust, in line with the Assumptions (i) and (ii). To illustrate, assume the marginal guilt sensitivity equals three, i.e. $\gamma = 3$. Say the profile (*Yes*, *Divorce*) occurs. Depending on τ his payoff may vary from 4 to 7.

Note that if $\gamma = 0$, the payoffs in Γ_2 collapse to those in Γ_1 .

B. Solving \mathbf{G}_2 : Preliminary Observations

With a subjective belief affecting payoffs in Γ_2 , at first glance, this psychological game may seem difficult to analyze. However, careful inspection suggests that for some parameterizations sharp predictions appear quite reasonable. First, consider the cases where $\gamma < 2$. Since $\tau \in [0, 1]$, it must hold that $7 - \gamma\tau > 5$, and hence the husband will rationally choose to *Divorce* irrespective of his beliefs. The wife should figure this out, and hence say *No* to marriage from start, just like in the subgame perfect equilibrium of Γ_1 .

What happens for larger values of γ ? Leave intermediate cases aside for the moment and consider the case where $\gamma = 5$. Suppose that the wife says *Yes*. She then maximizes her expected payoff only if she expects to get at least a payoff of 4. This means that her expectation of τ is at least $\frac{1}{2}$, or equivalently that $\tau' \geq \frac{1}{2}$. Hence, if the husband believes that the wife is rational in this sense he must believe that $\tau' \geq \frac{1}{2}$ if he is called upon to play. But this means that $\tau \geq \frac{1}{2}$, and if this belief affects his payoff he should *Stay* (since $5 + 5 \cdot \frac{1}{2} > 7$). So, if the wife believes that her husband believes that she is rational, then she must believe that $\tau = 1$, in which case she will of course indeed say *Yes*. A lifelong efficient marriage is guaranteed!

What goes on in this example is an instance of what might be dubbed "psychological forward induction". With $\gamma = 5$, the husband is so sensitive to feeling guilty that when his wife says *Yes* she signals a trust so strong as to force the husband to hold a belief that makes *Staying* a dominant choice. Rabin (1993) raises the issue that effects of this nature may obtain in psychological games, although he does not deal explicitly with games with a dynamic structure. He asks: "can players 'force' emotions; that is, can a first mover do something that

will compel a second mover to regard him positively?" The example discussed here illustrates that the answer to this question may be *yes*.

The reader may verify that an analogous psychological forward induction argument can be applied whenever $\gamma > 4$, but not for lower values of γ . Consider, for example, the case where $\gamma = 3$. Again, the trust signaled by the wife equals $\frac{1}{2}$. However, the husband is now not forced to hold a belief that makes *Stay* a dominant choice (since $5 + 3 \cdot \frac{1}{2} < 7$), so it seems that a *Divorce* choice is not out of the question. On the other hand, nothing seems to exclude the possibility that τ takes a value such that $5 + 3 \cdot \tau > 7$, so perhaps also his choice to *Stay* can be justified.

By analogous reasoning the reader may verify that whenever $\gamma \in [2, 4]$ some belief $\tau \in [\frac{1}{2}, 1]$, impregnable to a psychological forward induction argument, can be found such that any particular choice is optimal for the husband. Hence, it is not obvious what the wife should do. In order to get more definite conclusions in the case where $\gamma \in [2, 4]$, it is necessary to introduce some techniques which are inspired by GPS. This will be done in the next section where a general solution is proposed for Γ_2 .

C. Solving G_2 : Marital Equilibria

In the previous section it was suggested that no marriage obtains if $\gamma < 2$, a lifelong marriage obtains if $\gamma > 4$, while it is unclear what happens for intermediate values of γ . So far no presumption of equilibrium has been made. Here, a solution concept of "marital equilibrium" will be introduced which formally captures the heuristic arguments brought forth in the previous section as well as adds some structure to the cases where $\gamma \in [2, 4]$.

In the spirit of GPS, it will be assumed that the spouses beliefs σ , σ' , τ , τ' are in line with reality, and that the spouses optimize at all decision nodes given their beliefs and one another's actions. To this end, note that *given* τ , Γ_2 has real numbers characterizing payoffs at each endnode. In this sense, it reduces to a "standard game", to be denoted $\Gamma_2(\tau)$. A time consistent solution must fulfill several requirements: The spouses must optimize at all decision nodes given their beliefs. This means that they must play a subgame perfect

equilibrium in $\Gamma_2(\tau)$. Moreover, this equilibrium should be impregnable to a psychological forward induction argument as sketched in the previous section.

The following definition, in which (σ, τ) indicates the strategy profile in which the wife says *Yes* with probability σ and the husband *Divorces* with probability τ , imposes these requirements formally:

DEFINITION: The profile (σ, τ) is a *marital equilibrium* in Γ_2 if

$$(i) \sigma = \sigma' = \sigma''$$

$$(ii) \tau = \tau' = \tau''$$

(iii) (σ, τ) is a subgame perfect equilibrium in the standard game $\Gamma_2(\tau)$

$$(iv) 5 + \gamma \cdot \frac{1}{2} > 7 \Rightarrow \tau = 1.$$

The conditions (i) and (ii) require some accordance between the spouses' beliefs and their strategy choices. Condition (iii) requires "subgame perfection" for given beliefs. Condition (iv) requires robustness against a psychological forward induction argument as sketched in Section III.B: If the husband is called upon to move he must believe that $\tau' \geq \frac{1}{2}$. Therefore $\tau'' \geq \frac{1}{2}$, and so condition (iv) captures the idea that he must choose to *Stay* whenever $\gamma > 4$.

In Section IV.A various aspects of the solution concept of marital equilibrium are discussed in more detail. Here the Definition will be used to solve Γ_2 for different values of γ . It is convenient to group the marital equilibria into three qualitatively different cases:

1. THE SUSPICIOUS SINGLES (NO, DIVORCE): In this equilibrium the spouses choose the same strategies as in the game without emotions. The equilibrium exists whenever $\gamma \in [0, 4]$, and it is the unique equilibrium whenever $\gamma \in [0, 2)$. The spouses do not trust each other at all and there will be no marriage. The equilibrium entails that $0 = \sigma = \sigma' = \sigma'' = \tau = \tau' = \tau''$.

2. THE TRUSTING TWOSOME (YES, STAY): This equilibrium exists whenever $\gamma \geq 2$ and it is the unique equilibrium whenever $\gamma > 4$. It entails that $1 = \sigma = \sigma' = \sigma'' = \tau = \tau' = \tau''$. The spouses have full

trust in each other and they live happily ever after. The payoffs are (5,5), which Pareto dominates the *suspicious singles* equilibrium in which payoffs are only (4,4).

3. THE MIXED MATRIMONY: This equilibrium exists whenever $\gamma \in (2,4]$ and entails that $2/\gamma = \tau = \tau' = \tau''$. The wife says *Yes* in all the cases where $\gamma \in (2,4)$, since then $\tau' = 2/\gamma > 1/2$.

These equilibria match the outcomes hinted at in Section III.B: If $\gamma < 2$, only the suspicious singles equilibrium is possible. If $\gamma > 4$, only the trusting twosome equilibrium is viable. Multiple types of equilibria are possible when $\gamma \in [2,4]$, and which one is relevant depends on the spouses beliefs. To exemplify, suppose $\gamma = 3$. A psychological forward induction argument has no bite and there are precisely three equilibria, one for each of the marital equilibrium types. The mixed matrimony may result in a realized divorce. The wife says *Yes*, the husband *Stays* with probability $2/3$ and chooses *Divorce* with probability $1/3$. The probability of a successfully completed marriage is $2/3$, and the probability of an established divorce is $1/3$.

IV. Discussion

This section comments on several aspects and extensions of the results: The marital equilibrium concept is scrutinized in more detail (IV.A). It is argued that the psychological guilt effect cannot be adequately captured in a standard game (IV.B). Some issues of empirical testing (IV.C) are discussed, as is the scope for prenuptial agreements (IV.D), and some possible extensions of the model (IV.E).

A. Comments on the Marital Equilibrium Concept

Why is not GPS' solution concept of "subgame perfect psychological equilibrium" applied to Γ_2 ? The answer is that this can not successfully be done because GPS presume that only *initial* (pre-play) beliefs are allowed to affect payoffs (they mention on p 78 that it may be desirable to relax this restriction.). In their framework a psychological forward induction

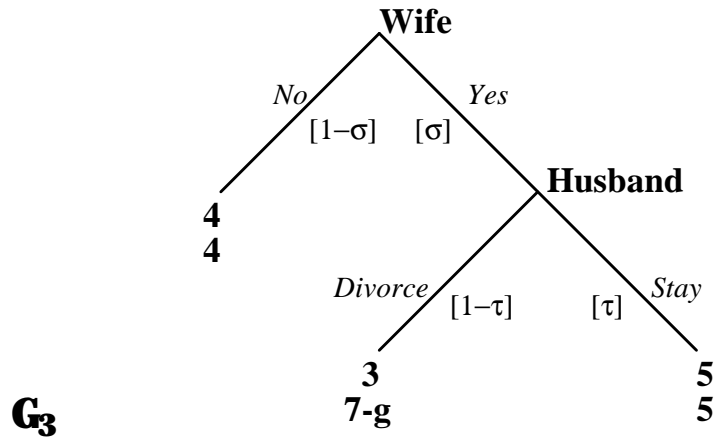
argument is inconceivable; if a player revises his beliefs as play proceeds this will have no bearing on his payoff perception. By contrast, here the psychological Assumption (i) is built on the idea that the husband's payoff depends on his belief *at the time he moves*, and the solution concept of marital equilibrium takes this into account.

Most solution concepts in standard game theory impose no explicit requirements on beliefs. The solutions for psychological games offered by GPS by contrast explicitly require equilibrium profiles to be common knowledge. The marital equilibrium concept imposes weaker restrictions on beliefs. Beliefs therefore need not be totally accurate, in particular in mixed equilibria. For example, say that in some equilibrium $\mathbf{s} = \frac{1}{2}$. The requirement $\mathbf{s}' = \frac{1}{2}$ then allows the husband to be convinced that the wife uses a pure strategy if he assigns probability $\frac{1}{2}$ to each of these. GPS' solutions exclude such a case. However, the Definition of a marital equilibrium cuts down a lot on technicalities, and in the current context affects neither equilibrium play nor payoffs.

The solution concept of marital equilibrium is specifically designed with the psychological marriage-divorce game in mind. However, at the cost of considerable mathematical complexity it is possible to define a solution concept which is applicable to a more general class of psychological games, while still capturing the spirit of marital equilibrium in Γ_2 (see Dufwenberg 1995, Definition 2).

B. Psychological Effects are Special

In standard game theory, the exogenously given payoffs are often said to reflect all aspects relevant to the strategic situation being modeled. It is argued that if emotions matter, these can and should be included explicitly in the utilities. However, the emotional effects of the previous section could *not* in general have been adequately captured in a standard game. To illustrate this, consider the following standard game Γ_3 , in which g is a non-negative number representing the husband's propensity to feel guilty:



In all cases except where $g=2$, there is a *unique* subgame perfect equilibrium. Independently of the spouses' beliefs, for every value of g , each subgame perfect equilibrium can be found by backward induction.

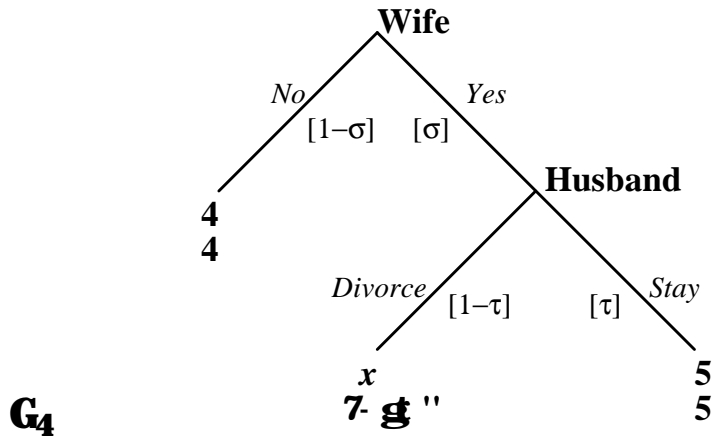
By contrast, Γ_2 permits a richer and belief-dependent set of marital equilibria for a range of values of γ . To exemplify, recall the case discussed in the end of Section II.C, with $\gamma=3$, where *three* distinct belief-dependent marital equilibria are possible.⁷ In each of the marital equilibria involving only pure strategies the husband has a *unique* best response if he is called upon to play, quite unlike the degenerate case with multiple subgame perfect equilibria in Γ_3 (with $g=2$) where the husband has multiple best replies (anything goes). Moreover, the three marital equilibria cannot be found using backward induction, since in Γ_2 the optimal choice for the husband at his node depends on τ ". In GPS' words (p63), "in psychological games...a node...does not capture adequately the state of a game: the node identifies a history of play, but not the players' beliefs."

C. Empirical Work

Γ_2 is designed to highlight the tension between the key issues of time consistency and emotions and is therefore quite stylized. Only γ is a free parameter. A drawback of this is that

⁷ On the technical side, note that for every value of g in Γ_3 , the set of subgame perfect equilibria is connected. With $g=2$, (σ, τ) is a subgame perfect equilibrium in Γ_3 iff $(\sigma, \tau) \in \{0\} \times [0, \frac{1}{2}] \cup \{1\} \times [\frac{1}{2}, 1] \cup [0, 1] \times \{\frac{1}{2}\}$. This set is connected. By contrast, in Γ_2 the set of marital equilibria is not in general connected. For example, with $\gamma=3$, (σ, τ) is a marital equilibrium iff $(\sigma, \tau) \in \{(0, 0), (1, 2/3), (1, 1)\}$. This set is not connected.

an empiricist may find the model of limited use, since he probably cannot observe γ .⁸ However, modifications of Γ_2 which are more useful for empirical work may be easy to construct. Consider the following case: Suppose a married woman devotes a lot of attention to household-specific work ("homemaking"), thereby losing touch with and skill for labor outside marriage. This means that her total payoff given the profile *(Yes, Divorce)* does not add up to 3. The following psychological game Γ_3 , where $x \in [0,3]$, is general enough to cover this case, as well as the cases of Section III:



The key thing to note in analyzing Γ_4 is that as x assumes different values the force of a psychological forward induction argument changes. The "trust signaled" by a wife saying *Yes* is $(4-x)/(5-x)$, which is *decreasing* in x . *Mutatis mutandis*, a strategy profile (σ, τ) may be called a marital equilibrium in Γ_4 if it satisfies the Definition in Section III.C with the condition that $5 + \gamma(4-x)/(5-x) > 7 \Rightarrow \tau = 1$ substituted for condition (iv). This means that the more vulnerable a wife is to a divorce, the less sensitivity to guilt is required on behalf of her husband for a lifelong efficient marriage to be guaranteed.

This prediction may be useful to an empiricist. Suppose for example he observes sets of marriages for different countries in which the nuptial "non-emotional" gains resemble those

⁸ See, however, Grossbard-Shechtman (1993) for ideas on how to infer unobservable qualities (in her case "virtue") from observable actions which may be applicable to γ .

of Γ_4 , and that he has country-specific data corresponding to the value of x . Assuming that the distribution of values of γ do not differ too much between husband's of different countries he may derive the following testable prediction: The lower is x in any given country, the less likely is divorce in any given marriage in that country.

Perhaps the most prompting empirical task, however, is to establish experimentally that psychological effects are important. Dufwenberg & Gneezy (1996) study an experimental game stripped of all institutional detail but with a structure quite similar to the marriage-divorce game. They explicitly measure the subjects' beliefs and report evidence of a "guilt effect" similar to that modeled here (there is positive correlation between what subjects in a position similar to the husband's "give away" and their expectations of what other subjects in a position similar to the wife's expect to get from them).⁹

D. Prenuptial Bargaining and Divorce Legislation

A *suspicious singles* equilibrium (*No, Divorce*) is inefficient. Hence, there may be potential gains to the spouses from signing some clever prenuptial marital contract. However, the above analysis does not explicitly consider this possibility. This can be justified in at least two ways: First, contracting may be too costly, financially or even emotionally. As noted by Cohen (1987, p 291), explicit discussion of marriage contracts may be considered "indelicate during courtship". Second, as argued by Ulph (1988), even if one wishes to admit Nash bargaining it seems reasonable that the relevant threat points are determined by a non-cooperative solution, a clear understanding of which then is crucial to the bargaining process.

Note that in the absence of a prenuptial contract, divorce legislation may provide default rules that affect the non-cooperative outcome. There are many conceivable kinds of such legislation, and typically each one has its own virtues and drawbacks (see Cohen (1987) for a penetrating discussion). The above analysis implicitly presumes a particular given

⁹ See also Berg, Dickhaut & McCabe (1995) who report experimental evidence from a similar game. They do not measure beliefs, but find that trust and reciprocity are basic elements of human behavior and suggest that psychological game theory might possibly explain such findings.

context of "no-fault" divorce legislation under which a spouse may walk out of marriage without the partner's consent. Over the past twenty-five years, no-fault has become the most common sort of legislation in the western world.¹⁰

E. Extensions

It may be interesting to modify the spouses' strategy spaces in a marriage-divorce game in order to analyze more complicated family situations. For example, say that upon entering wedlock a wife has the option to make a costly household specific investment that pays off only if the husband *Stays*. This action may change the cutting power of a psychological forward induction argument, and the action may then be chosen or avoided for this reason.

Another activity which it may be interesting to incorporate is child production. The presence of children may affect the payoffs that the spouses will get if they, for instance, divorce one another. This, in turn, may have an impact on strategic behavior.

V. Concluding Remarks

I have analyzed a problem of marriage sustainability when the nuptial gains accrue asymmetrically to the spouses across time. If the spouses are motivated solely by material self-interest, opportunistic divorce behavior will be foreseen and efficient marriage formation precluded. However, also emotional considerations are important in marital situations and in many cases these relate to *beliefs* the spouses harbour about one another's behavior and beliefs. In this paper it is assumed that an educated husband pursuing divorce feels guilty to the extent that he expects his supporting wife to trust him to stay in the marriage. When this effect is taken into account (using psychological game theory) the model gets in line with real life observations: Some marriages don't happen, some last, and some end in divorce.

¹⁰ The trend towards no-fault legislation is reflected for example in Price & McKenry's (1988, Ch. 6) account of the history of U.S. divorce legislation.

With a high enough guilt sensitivity a life-long marriage is guaranteed. By approving marriage the wife forces her husband into an emotional state where divorce is unattractive. She agrees to marriage precisely for this reason, fully expecting her husband to stay. This effect is captured by the solution concept of marital equilibrium; the wife's trust and both spouses behavior is endogenously and unambiguously determined.

In closing, I note that the emotional "safeguard" (to allude to a term used by Williamson (1989, p 167)) against opportunistic behavior modeled in the psychological marriage-divorce game may be relevant not only in a context of marital interaction. Similar situations arise in business ventures, employment relationships, and when an inventor presents an invention to a potential producer. Another example might be athletic sponsoring, where a young athlete is financially supported in his early career with the implicit understanding that the sponsor will get reimbursed if the athlete becomes a successful professional. However, emotional concerns are more likely to be important in some partnerships than in others, and perhaps in marriages these are particularly salient.

References

- Baumeister, Roy F., Stillwell, Arlene M. and Heatherton, Todd F., "Personal Narratives about Guilt: Role in Action Control and Interpersonal Relationships", *Basic and Applied Social Psychology* 17 (1&2, 1995): 173–198.
- Becker, Gary S., *A Treatise on the Family*, Harvard University Press, 1991.
- Berg, Joyce, Dickhaut, John and McCabe, Kevin, "Trust, Reciprocity, and Social History" *Games and Economic Behavior* 10 (1995): 122–142.
- Borenstein, Severin and Courant, Paul N., "How to Carve a Medical Degree: Human Capital Assets in Divorce Settlements", *American Economic Review* 79 (December 1989): 992–1009.
- Cohen, Lloyd, "Marriage, Divorce, and Quasi Rents; or, I Gave Him the Best Years of My Life", *Journal of Legal Studies* 16 (June 1987): 267–303.
- Collins, Randall and Coltrane, Scott, *Sociology of Marriage and the Family: Gender, Love, and Property*, Nelson-Hall, 1991.
- Dawkins, Richard and Carlisle, Tamsin R., "Parental Investment, Mate Desertion and a Fallacy", *Nature* 262 (July 8 1976): 131–133.

Dufwenberg, Martin, "Time Consistent Wedlock with Endogenous Trust", Essay I in Ph.D. thesis, *Economic Studies* 22, Department of Economics, Uppsala University, 1995.

Dufwenberg, Martin and Gneezy, Uri "Efficiency, Reciprocity, and Expectations in an Experimental Game", CentER Discussion Paper #9679, Tilburg University, 1996.

Geanakoplos, John, Pearce, David and Stacchetti, Ennio, "Psychological Games and Sequential Rationality", *Games and Economic Behavior* 1 (March 1989): 60–79.

Grossbard-Shectman, Shoshana, *On the Economics of Marriage*, Westview Press, 1993.

Polsby, Daniel D. and Martin Zelder, "Risk-Adjusted Valuation of Professional Degrees in Divorce", *Journal of Legal Studies* 33 (January 1994): 273–285.

Price, Sharon J. and McKenry, Patrick C., *Divorce*, Sage Publications, 1988.

Rabin, Matthew, "Incorporating Fairness into Game Theory and Economics", *American Economic Review* 83 (December 1993): 1281–1302.

Rotter, Julian B., "Interpersonal Trust, Trustworthiness, and Gullibility", *American Psychologist* 35 (January 1980): 1–7.

Ruffle, Bradley J., "Gift Giving with Emotions", Mimeo, Department of Economics, Princeton University, 1995.

Stark, Oded, *Altruism and Beyond*, MIT Press, 1995.

Takas, Marianne, "Divorce: Who Gets the Blame in 'No-Fault'", *Ms. Magazine* (February 1986): 48-52, 82-83.

Ulph, David, "A General Model of Household Consumption Behaviour", Discussion Paper 1988/205, University of Bristol.

Weiss, Yoram, "The Formation and Dissolution of Families: Why Marry? Who Marries Whom? and What Happens upon Divorce?", 1994, Forthcoming in *Handbook of Population Economics*.

Weiss, Yoram and Willis, Robert J., "Transfer among Divorced Couples: Evidence and Interpretation", *Journal of Labor Economics* 11 (October 1993): 629–679.

Weitzman, Lenore J., "A New Look at Career Assets", *Ms. Magazine* (February 1986): 67-8.

Williamson, Oliver E., "Transaction Cost Economics", Ch. 3 in Richard Schmalensee & Robert D. Willig (eds.), *The Handbook of Industrial Organization*, North-Holland, 1989.