



Marital investments, time consistency and emotions

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Received 26 October 1999; accepted 10 November 2000

Abstract

A benchmark model of a married couple's educational investment yields an inefficient outcome due to the possibility of opportunistic divorce. Motivated by findings in social psychology, I use psychological game theory to incorporate belief-dependent guilt feelings. Multiple equilibria become possible. Some marriages have inefficient under-investment. Some have efficient outcomes and preclude divorce. If guilt is sufficiently important, a life-long efficient marriage is implied because a spouse may signal a trust so strong as to force the partner to hold beliefs that make divorce unattractive. © 2002 Elsevier Science B.V. All rights reserved.

JEL classification: C72; J12

Keywords: Marriage; Marital investment; Divorce; Time consistency; Emotions; Guilt; Trust; Psychological game theory; Forward induction

1. Introduction

Married couples making human capital investments often concentrate on developing one spouse's skills more than the other's. At first glance this may seem profitable.¹ However, a closer game theoretic scrutiny suggests that such arrangements are hard to sustain: suppose a wife supports her husband towards a very lucrative specialist education, instead of making a moderately remunerative investment in her own schooling. Once the husband receives his valuable degree he has an incentive to divorce his wife, reaping the benefits from his enhanced earnings capacity all by himself. Of course, a clever wife anticipates

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¹ There may be increasing returns to scale in the production of household welfare (Weiss, 1997, Section 2.1); differential investments may bring about comparative advantages in household production (Becker, 1991, Chapter 2); credit from external sources may be more expensive than what the spouses can provide for each other (Borenstein and Courant, 1989, Section 1 and Weiss, 1997, Section 2.2).

such opportunistic behavior and, therefore, invests in her own schooling. Specialization is not “subgame perfect”, and an inefficient outcome may result.

This dismal story reflects an implicit assumption that the spouses are motivated solely to maximize personal income. Such an assumption is often accepted in economics, but in the current context two sets of results suggest that it needs to be appended. First, some recent work in experimental economics concern games in which the structure resembles the situation with the investing spouses, and subjects often nevertheless manage to bring about efficient outcomes (see, e.g. Berg et al., 1995; Fehr et al., 1997; Dufwenberg and Gneezy, 2000). It seems clear that people do not selfishly maximize their personal income, but rather have some complementary objectives. The second set of results is suggestive of just *what* motivational force may be relevant in the context of marriage, or at least one such force. Recent findings in social psychology based on autobiographical accounts by Baumeister et al. (1993) document that a person who rejects a relationship partner often suffers from *guilt*. Baumeister et al. (1994, 1995, p. 174) report that: “the prototypical cause of guilt is inflicting harm or distress on a relationship partner”.

The purpose of this paper is to investigate how guilt may affect the problem of efficient marital investment in a model which explicitly admits opportunistic divorce. My aim is to isolate and highlight interesting connections that follow solely from this focus, and I shall, therefore, abstract from many other aspects that may be relevant for understanding marriage, divorce, and marital investment as a general matter (cf. Section 4). My model explicitly describes both, how decisions are taken across time and how guilt affects payoff perceptions and behavior. The first issue can be handled using game theory. However, accommodating the second one is more tricky. Geanakoplos et al. (1989) argue that standard games are unsuitable tools for incorporating emotions in strategic situations. The problem is that standard games mandate that players’ payoffs depend only on what strategy profile is played, while many emotions depend directly on the *beliefs* that the players harbor. In response, Geanakoplos et al. develop the ‘theory of psychological games’. I shall now argue that the guilt felt by a divorcer is likely to be a belief-dependent emotion, and propose that psychological game theory provides adequate tools for treating the problem at hand.

Suppose a husband divorces his wife, despite each spouse having vowed not to pursue opportunistic divorce.² In line with the findings by Baumeister et al. cited the previous paragraph, it is reasonable to expect the husband to feel guilty to the extent that he believes he “inflicts harm” on his wife. That harm should depend on the wife’s beliefs, since the stronger she believes that the marriage will last the worse off she will be following a divorce relative to her expected payoff before divorce.³ Effectively, this leads to the assumption that ‘the stronger the husband believes that his wife believes that he will stay in the marriage,

² I will throughout phrase the presentation in terms of an educated husband with a supporting wife. This asymmetric treatment of the sexes 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 Borenstein and Courant’s (1989; Footnote 3) observation that a medical student with a supporting spouse typically is a husband with a wife, with evidence concerning divorce cases decided in US courts (Polsby and Zelder, 1994, Footnote 4), and with Cohen’s (1987) general finding that nuptial gains tend to accrue to men early on in a marriage and to women towards the end.

³ Baumeister et al. (1995, p. 173) write: “Feeling guilty [is] associated with . . . recognizing how a relationship partner’s standards and *expectations* differ from one’s own” (my emphasis).

the more guilty he feels by divorcing her'. Note that a belief about a belief here directly motivates the husband in his decision making. Psychological game theory is called for!

As a starting point for my analysis, I design a 'marital investment game' in which the given payoffs reflect the spouses' personal incomes only. The unique subgame perfect equilibrium is inefficient and entails low marital investment. I then incorporate guilt along the lines described earlier, creating a 'psychological marital investment game'. A multitude of equilibria are possible if the husband is moderately sensitive to guilt. Who obtains depends crucially on what expectations the spouses harbor. One equilibrium is still inefficient, with low marital investment and a husband ready to divorce his wife if given the chance. However, there is also an efficient equilibrium with high marital investment and justified full belief in a life-long marriage.

If the husband's guilt sensitivity is very high, I argue that only the equilibrium with a life-long marriage is viable. This is because by agreeing to support her husband the wife "signals" a certain degree of belief that the husband will not divorce her. The husband realizes this and is "forced" to hold a corresponding belief about his wife's belief about his choice. With a high enough guilt sensitivity he would feel exceedingly guilty pursuing divorce. The wife understands this logic of "psychological forward induction", and hence she is quite happy to support her husband In the end, a happy outcome is brought about which reflects on Leith and Baumeister's (1998, p. 1) assertion that: "guilt serves many adaptive, beneficial, and prosocial functions", and that "guilt helps strengthen and maintain close relationships" (p. 2).

These results may have some bearing on other partnerships than marriage. A guilt effect similar to that modeled here can potentially explain the aforementioned experimental results.⁴ Moreover, such an emotional "safeguard" (to allude to a term used by Williamson (1989, p. 167) against opportunistic behavior may also be relevant in many other real world contexts. Situations in which the strategic possibilities and monetary incentives resemble the marital investment game may include business ventures, employment relationships, when an inventor presents a new idea to a potential producer, or in athletic or musical sponsoring when a young athlete is financially supported in his early career with the implicit understanding that the sponsor will get reimbursed if the prodigy becomes a successful professional. However, emotional concerns are more likely to be important in some partnerships than in others. Perhaps in marriages, where monetary transfer between the partners is not very prevalent, these are particularly salient.

As regards to related literature, Borenstein and Courant (1989) analyze how various kinds of divorce legislation affect marital investments, efficiency, and equity. As their focus is on the legal issues, they make less elaborate behavioral assumptions. By assumption, the supporting spouse forms quite naive expectations, acting as if the probability of divorce is 0. In contrast, in the model below assumptions regarding the spouses rationality have not been relaxed. They make marital investments or divorce whenever such actions maximize expected utility. Each decision is required to be time consistent, meaning that it is optimal at the time it is taken for some belief with a reasonable foundation. Outside family economics, Huang and Wu (1994) use psychological game theory to study corruption in principal-agent

⁴ Dufwenberg and Gneezy measure beliefs (about actions and beliefs) in an experimental game which resembles the marital investment game, and report evidence which is consistent with this claim.

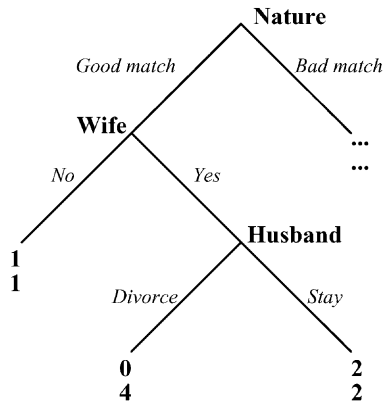


Fig. 1. The marital investment game Γ_1 .

relationships. They incorporate “remorse” similarly as I model guilt, but they do not examine the phenomena of belief signaling and psychological forward induction.

Section 2 contains the benchmark model of a marital investment game with selfish spouses who are unaffected by guilt. Such an emotion is incorporated in Section 3, which is the main part of the paper. Section 4 comments on the limitations of the model. Section 5 concludes.

2. The marital investment game

Consider the extensive game Γ_1 of Fig. 1 which models the following situation: first, nature determines the quality of a married couple’s match (according to some exogenously given probability distribution). With a *bad match*, the spouses agree to separate and the end node where payoffs have not been specified is reached. With a *good match*, the spouses must decide on investments in education, and the wife is temporarily in control. The default outcome is that each spouse makes a moderate investment in her or himself, but the wife may also let her husband pursue a very profitable education. If she says *no* to supporting her husband, each spouse’s lifetime income will be one monetary payoff unit. If she says *yes* to supporting her husband, she foregoes the opportunity to invest in herself. Her personal lifetime earnings will then be zero, but the husband’s lifetime earnings are quadrupled. To say *yes* is a good choice for the wife if the husband subsequently decides to *stay* with her and split his income. However, the husband also has the option to *divorce* his wife and reap all earnings by himself, in which case the wife would be best off saying *no*. Of course, when they married he vowed not to act so opportunistically. However, it is here understood that a “no-fault” divorce legislation applies under which the husband can walk out of the marriage without his wife’s consent, and that in the benchmark case there is no sanction involved.⁵

⁵ Over the past 25 years, no-fault has become the most common sort of divorce legislation in the western world. This trend is reflected, e.g. in Price and McKenry’s (1998, Chapter 6) account of the history of US divorce legislation. See Nakonezny et al. (1995) and Friedberg (1998) for empirical studies of how the introduction of no-fault divorce law has affected divorce rates in the US. For a penetrating discussion of the virtues and drawbacks of many different kinds of divorce legislation, see Cohen.

While the possibility of divorce figures prominently in Γ_1 , the purpose of this paper is not to explain why and when divorces come about as a general matter. The aim is rather to analyze how marital investments are made when the associated gains accrue asymmetrically to the spouses across time, and when the possibility of opportunistic divorce is taken into account. The first stage of Γ_1 , where nature moves, is included just to underscore what is and what is not the paper's objective. Many divorces come about because of the resolution of some kind of uncertainty. Nature's choice in Γ_1 corresponds to an exogenously realized "quality of match"—a shock often modeled in theoretical approaches to marriage and divorce (see, e.g. Weiss and Willis, 1993). Such a shock plays a role in Γ_1 , yes, and this may be realistic. However, from now on I will leave this shock aside and focus on what happens in the subgame reached 'after nature has selected a good match'.

The subgame of Γ_1 , where the wife starts to move has a very simple structure, yet it is rich enough to capture the basic tension between the efficient marital investment and time consistent decision making discussed in the introduction. There are potential efficiency gains from the educational investment that takes place if the wife says *yes*. Both spouses prefer the strategy profile (*yes, stay*) to any profile where the wife says *no*. In this respect, Γ_1 is related to other models of marriage (see, e.g. Weiss, 1997; Section 2.2). However, a key feature of Γ_1 is that, unlike many other models in the marriage and divorce literature, unilateral divorce appears as an explicit choice opportunity. When this is taken into account, Γ_1 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 supporting her husband. 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*. Note that the solution is robust in the sense that (*no, divorce*) remains the unique solution even if a small change is made to any payoff parameter in Γ_1 .

It may seem that the spouses could profit from signing some clever prenuptial agreements. I will, however, in this paper not discuss such contracts. This can be justified in at least two ways: first, contracts may be avoided because they are 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.

3. Adding guilt

In standard games, a player's payoff depends only on what strategy profile is played, and not on the player's belief. Geanakoplos et al. argue, however, that when emotions matter in strategic situations it is often the case that beliefs directly influence payoffs. In order to deal with such issues, they develop the theory of *psychological games*.

It is easy to imagine ways in which a divorce may evoke emotions which depend on beliefs: when a husband suddenly divorces his wife it is possible that the stronger the wife believed that her husband would stay, the more *disappointed* she is. The stronger the husband believes that his wife believes that he will stay, the more *gratifying* he may find

it to do so. The husband may be averse to letting a trusting wife down, and the stronger he believes that she believes that he will stay the more *guilty* he feels by forcing divorce. In the Introduction it was argued that the last of these cases may be relevant to the situation modeled in Γ_1 . In Section 3.1, the marital investment game Γ_1 will, therefore, be modified into a psychological marital investment game Γ_2 which incorporates an effect of divorcer guilt. The first stage where *nature* moves is no longer explicitly given. Γ_2 is solved in Sections 3.2 and 3.3.

3.1. A psychological marital investment game

In the psychological marital investment game Γ_2 to be constructed, the spouses have the same strategy sets as in Γ_1 and they move in the same order. 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 and beliefs, to formalize the psychological assumption that will be used, and to calculate equilibrium behavior. The spouses' actions will be denoted as follows:

$\sigma \in [0, 1]$: the probability with which the wife says *yes*;
 $\tau \in [0, 1]$: the probability with which the husband *stays*.

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

$\tau' \in [0, 1]$: the wife's expectation of τ (her *trust*);
 $\tau'' \in [0, 1]$: the husband's expectation of τ' .

These expectations are part of the beliefs the spouses hold when making their respective choices. They play a crucial role when the psychological marital investment game below is solved. 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 vow from the presentation of Γ_1) is consistent 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).

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.

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'' .

Assumption 1 reflects the idea that the husband is averse to letting his trusting wife down. I argued in the Section 1 that this idea is consistent with findings in social psychology. One can certainly conceive of some other motivational concerns that may have a bearing on the problem under study, and some of these are discussed in Section 4. However, since my

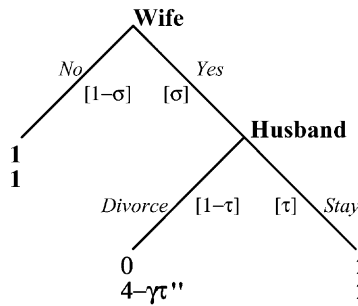


Fig. 2. The psychological marital investment game Γ_2 .

aim in this paper is to isolate and highlight interesting connections concerning how guilt affects marital investment in a model which admits opportunistic divorce I shall abstract from other aspects that may be relevant in many marriage contexts. The only way in which the transition from Γ_1 to Γ_2 involves a change in the spouses motivation is via Assumption 1. The following assumption only governs more specifically how this is implemented.

Assumption 2 (technical). The “guilt effect” of Assumption 1 enters additively into the husband’s utility function. The husband’s “guilt sensitivity”, is constant at $\gamma \geq 0$.

Now an extensive psychological marital investment game Γ_2 (see Fig. 2) can be constructed which captures the Assumptions 1 and 2. It is convenient to indicate explicitly in connection to the game tree that $\sigma \in [0, 1]$ 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) rather depends on τ'' , his expectation of his wife’s trust, which is in line with the Assumptions 1 and 2. To illustrate, assume the marginal guilt sensitivity equals 3, i.e. $\gamma = 3$. Say the profile (yes, divorce) occurs. Depending on τ'' , his payoff may vary from 1 to 4.

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

3.2. Solving Γ_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 $4 - \gamma\tau'' > 2$, and hence the husband will rationally choose to *divorce* irrespective of his beliefs. The wife should figure this out, and hence say *no* to supporting her husband, 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 1. This means that her expectation of τ is at least 1/2, or equivalently that her trust τ' is at least 1/2. Hence, if the

husband believes that the wife is rational in this sense, he must believe that $\tau' \geq 1/2$ if he is called upon to play. But this means that $\tau'' \geq 1/2$, and since this belief affects his payoff he should *stay* (since $4 - 5 \times 1/2 < 2$). 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 say *yes*. A life-long efficient marriage with full trust 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 be obtained in psychological games, although he does not deal explicitly with games with a dynamic structure. He asks: “can players ‘force’ emotions, i.e. 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 affirmative.

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, e.g. the case where $\gamma = 3$. Again, the trust signaled by the wife equals $1/2$. However, the husband is now not forced to hold a belief that makes *stay* a dominant choice (since $4 - 3 \times 1/2 > 2$), so it seems that a *divorce* is not out of the question. On the other hand, nothing seems to exclude the possibility that τ'' takes a value such that $4 - 3 \times \tau'' < 2$, so it seems that also his choice to *stay* can be justified.

By analogous reasoning the reader may verify that whenever $\gamma \in [2, 4]$ some belief $\tau'' \in [1/2, 1]$, 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 cases where $\gamma \in [2, 4]$, it is necessary to introduce some techniques which are inspired by Geanakoplos et al.’s theory. This will be done in the Section 3.3 where a general solution is proposed for Γ_2 .

3.3. Solving Γ_2 : marital equilibria

In the previous section, it was suggested that no marriage obtains if $\gamma < 2$, that a life-long marriage obtains if $\gamma > 4$, and that it is unclear what happens for intermediate values of γ . So far, no presumption of equilibrium has been made. Here, a solution will be presented 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 standard games payoffs depend on actions chosen only, and it is therefore not necessary to explicitly write down the requirement that beliefs are correct in equilibrium, even if this is usually implicitly understood to be the case. The spirit of subgame perfection entails that players optimize at all decision nodes given their correct beliefs about one another’s actions. In Γ_2 , however, the husbands’ payoff depends directly on τ'' , and it is necessary to impose explicitly that the beliefs τ' and τ'' are correct in equilibrium. To this end, note that *given* τ'' , Γ_2 has real numbers characterizing payoffs at each end-node. In this sense, it reduces to a “standard game”, to be denoted $\Gamma_2(\tau'')$. A time consistent equilibrium solution of Γ_2 must fulfill three requirements: first, the spouses must optimize their beliefs and choices at all given decision nodes. This means that they must play a subgame perfect equilibrium in $\Gamma_2(\tau'')$. Second, the beliefs must be consistent what is actually

happening, so that $\tau'' = \tau' = \tau$.⁶ Third, the equilibrium must be impregnable to a psychological forward induction argument as sketched in the previous section.

The following definition, in which (σ, τ) denotes the strategy profile in which the wife says *yes* with probability σ and the husband *divorces* with probability τ , imposes these requirements formally.

Definition 1. The profile (σ, τ) is a *marital equilibrium* in Γ_2 if:

1. (σ, τ) is a subgame perfect equilibrium in the standard game $\Gamma_2(\tau'')$;
2. $\tau'' = \tau' = \tau$ and
3. $4 - \gamma \times 1/2 < 2 \Rightarrow \tau = 1$.

Condition 1 is the “subgame perfection” requirement. Condition 2 guarantees that the husband is motivated by a belief which is consistent with what is actually happening. Condition 3 requires robustness against a psychological forward induction argument as sketched in Section 3.2. If the husband is called upon to move he must believe that $\tau' \geq 1/2$. Therefore, $\tau' \geq 1/2$, and so condition 3 captures the idea that he must choose to *stay* whenever $\gamma > 4$.

The definition will now 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 spouses (no, divorce)*: In this equilibrium the spouses choose the same strategies as in the subgame perfect equilibrium of the game Γ_1 . The equilibrium exists whenever $\gamma \in [0, 4]$, and it is the unique equilibrium whenever $\gamma \in [0, 2]$. The wife does not trust her husband at all ($\tau' = 0$) and she does not support him. The equilibrium entails that $\tau'' = \tau' = \tau = 0$.
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 $\tau'' = \tau' = \tau = 1$. There is full trust ($\tau' = 1$) and the spouses live happily ever after. The payoffs are (2, 2), which Pareto dominates the suspicious spouses equilibrium in which payoffs are only (1, 1).
3. *The mixed matrimony*: This equilibrium exists whenever $\gamma \in (2, 4)$ and entails that $\tau = \tau' = \tau'' = 2/\gamma$. The wife supports her husband (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 3.2: if $\gamma < 2$, only the suspicious spouses equilibrium is possible. Multiple types of equilibria are possible when $\gamma \in [2, 4]$, and which one is relevant depends on the spouses beliefs. If $\gamma > 4$, only the trusting twosome equilibrium is viable.⁷

⁶ Geanakoplos et al. impose explicitly the strong restriction that equilibrium profiles be common knowledge. It simplifies the presentation, and affects no conclusion in the current context, to be explicit only about those parts of the players' beliefs which have a direct bearing on some players' payoff perception. Only τ'' appears at an end node in G_2 , and therefore $\tau'' = \tau' = \tau$ is the only explicit restriction on beliefs that is made.

⁷ Note that this conclusion is robust in the sense that small changes to any payoff parameter in G_2 will (making obvious changes to condition 3 of the definition) qualitatively leave the pattern of possible equilibria unaffected: for γ small enough, only the suspicious spouses equilibrium is possible, for γ large enough only the trusting twosome equilibrium is viable, and in between there are multiple equilibria.

This solution invites two further comments. First, the emotional effects modeled in Section 3 could *not* have been adequately captured using standard (non-psychological) game theory. In any standard extensive game with the same tree as Γ_1 or Γ_2 , subgame perfect equilibrium choices can be determined by backward induction. If in such a game the husband strictly prefers to *divorce*, there cannot also be a subgame perfect equilibrium where he *stays*. Contrast this with the case of Γ_2 with $\gamma \in (2, 4)$. In the suspicious spouses equilibrium, the husband strictly prefers to *divorce*, and yet there is also the trusting twosome equilibrium where he strictly prefers to *stay*. Neither of these equilibria can be identified using backward induction, since the optimal choice for the husband at his node depends on τ'' . In Geanakoplos et al.'s words (p. 63), “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”.

Second, it is noteworthy that a unique equilibrium outcome is implied when $\gamma > 4$. It is the psychological forward induction requirement imposed via condition 3 of the definition of a marital equilibrium that is responsible for this. The reader familiar with the work of Geanakoplos et al. may have wondered why their notion of a “subgame perfect psychological equilibrium” is not applied to Γ_2 . The answer is that their theory is not adequate for capturing the logic of psychological forward induction. They restrict attention to psychological games where only *initial* (pre-play) beliefs are allowed to directly affect the payoffs (although they mention on p. 78 that it may be desirable to consider alternatives). This restriction makes a forward induction argument inconceivable—if a player is forced to revise his beliefs as play proceeds this will have no bearing on his relative valuation of different strategy profiles. By contrast, the psychological forward induction argument is built around the idea that the husband's payoff depends on his belief ‘at the time he moves’ (as specified in Assumption 1), and the solution concept of marital equilibrium takes this into account.

4. Extensions

The purpose of this paper is not to propose a fully realistic account of marriage, divorce and marital investment. I have focused on how the presence of a psychological guilt effect influences marital investment behavior in a context which admits unilateral divorce and where the investment gains accrue asymmetrically to the spouses across time. For the sake of clarity, I have abstracted from all other issues. This section offers some brief comments on aspects of reality that I have disregarded, but which it may be interesting to consider in future work.

There are emotional or other motivational concerns besides guilt that may influence behavior. Sociologists typically emphasize various non-monetary considerations seldom touched upon by economists. See, e.g. Price and McKenry (1998, Chapter 2) or Collins and Coltrane (1991, Chapters 8, 9 and 12) for interesting discussions of companionship, esteem for spouse, erotic ties, love, etc. Elster (1998) discusses how a vast array of emotions may influence economic behavior. I refer the reader to his Section 2 for an extensive listing and classification, and here mention only a specific emotion which may have particular relevance in the current context. Baumeister et al. (1995) report evidence that: “people who induce guilt sometimes seem to feel guilty themselves over doing so” (p. 188), a phenomenon they

term *meta-guilt*. It may be worthwhile to investigate how behavior in the marital investment game is affected if such an emotion influences the wife's motivation.

One assumption which is made rather often in the economics of the family literature is that decision makers are altruistic; their well-being depends positively on other persons' well-being. Altruism typically does not depend on beliefs, and can, therefore, be handled using conventional tools of economics or game theory (see, e.g. Becker, 1991, Chapter 8; or Stark, 1995). However, it is conceivable that altruism can interplay in interesting ways with a belief-dependent emotion like the guilt feelings modeled in this paper, and that it could be interesting to incorporate these things simultaneously in one model.

My model fails to capture why in some marriages divorce occurs *after* marital investments have taken place. Consider the following story told by Takas (1986, p. 48):

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

It is true that the model of Section 3 permits a limited possibility of post-investment divorce, as part of a mixed matrimony equilibrium. However, such an explanation may appear contrived, as it portrays the husband as indifferent between divorcing or staying in marriage. I suggest that this points to the following problem: it is implicitly assumed in Section 3 that all parameters of Γ_2 are common knowledge between the two spouses. It may be more realistic to analyze a game of incomplete information. For example, one may assume that while the husband knows the value of γ , the wife has incomplete information about this parameter. With proper adjustments, one can, e.g. develop an equilibrium where the wife's a priori expectation of a life-long marriage is good enough that she agrees to support her husband, yet she may at times be unlucky and catch a husband with little guilt sensitivity who will force divorce (details of an explicit example are available on request). There are some findings in social psychology which lend support to such an approach. According to Tangney (1995, p. 1138), "there are stable individual differences in the degree to which people are prone to shame and guilt". If a person's trait is not perfectly observable to others, this justifies assuming incomplete information.

Finally, I note that my model abstracts from many other strategic considerations that may be of relevance in a context of marriage. It may thus be interesting to modify the spouses' strategy spaces in a marital investment game in order to analyze more complicated family situations. For example, child production could be incorporated. The presence of children may affect the payoffs that the spouses will get if they if they stay married or divorce each other. This, in turn, may have an impact on the decision to enter wedlock, on fertility, and on welfare.

5. Concluding remarks

This paper may be viewed as a contribution to a research program recently promoted by Elster (1998). He asks (p. 48), "[H]ow can emotions help us explain behavior for which

good explanations seem to be lacking?” I have used psychological game theory to analyze how guilt may help sustain efficient marital investment in marriage where the gains from this investment activity accrue asymmetrically to the spouses across time, and there is the possibility of opportunistic unilateral divorce. The introduction of guilt affects the nature of equilibrium play dramatically, as it may allow the spouses to benefit from efficient investment activities which would not materialize were each spouse selfishly maximizing monetary income. Behavior-wise, I have argued that both experimental evidence and casual observation of real life marriages suggests that people indeed manage to reach efficient outcomes in similar situations. Motivation-wise, the specific guilt effect modeled was motivated with reference to findings in social psychology.

As can be sensed from Elster’s article, not much research has been done which introduces emotions in economic analysis. While pinpointing which motivational amalgam really applies in some situation may be one of the ultimate goals of this line of research (if that goal is at all attainable), when the first steps are taken into this arena it may be wise to go slowly and introduce only a limited number of carefully motivated emotional elements. Accordingly, in this paper only money and the guilt effect influence payoffs. I hope there are two lessons to learn. First, there are insights directly related to the specific belief-dependent guilt effect being modeled. The way, this arguably important emotion influences the outcome sheds light on interaction in real life marriages and possibly also other partnerships. Second, I also hope to have promoted the idea that Geanakoplos et al.’s theory of psychological games is a useful tool for work on incorporating emotions in economic analysis. Many emotions depend on beliefs. I have given some examples, Geanakoplos et al.’s text contains several others, as does Ruffle’s (1999) psychological games-based study of gift-giving with emotions. Elster (1998, p. 49) writes that: “[e]motions . . . are triggered by beliefs”. Psychological game theory, unlike standard game theory, goes to the heart of this matter by using utility functions that are defined on domains that specify beliefs in addition to strategic choices.

Acknowledgements

I am most grateful to Yoram Weiss who introduced me to this topic and has given me helpful advice. I thank Jan Bouckaert, Gary Charness, Eric van Damme, Eddie Dekel, Tone Dieckmann, David Frankel, Uri Gneezy, Bo Larsson, Michael Lundholm, Niels Noorderhaven, Roald Ramer, Phil Reny, Bradley Ruffle, Frank Verboven, Jörgen Weibull, Shi-Young Lee, Robin Pope and participants in many seminars for valuable suggestions and discussion. The paper is a revised version of a chapter in my thesis.

References

- Baumeister, R.F., Wotman, S.R., Stillwell, A.M., 1993. Unrequited love: on heartbreak, anger, guilt, scriptlessness, and humiliation. *Journal of Personality and Social Psychology* 64, 377–394.
- Baumeister, R.F., Stillwell, A.M., Heatherton, T.F., 1994. Guilt: an interpersonal approach. *Psychological Bulletin* 115, 243–267.

- Baumeister, R.F., Stillwell, A.M., Heatherton, T.F., 1995. Personal narratives about guilt: role in action control and interpersonal relationships. *Basic and Applied Social Psychology* 17, 173–198.
- Becker, G.S., 1991. *A Treatise on the Family*. Harvard University Press, Cambridge, MA.
- Berg, J., Dickhaut, J., McCabe, K., 1995. Trust, reciprocity, and social history. *Games and Economic Behavior* 10, 122–142.
- Borenstein, S., Courant, P.N., 1989. How to carve a medical degree: human capital assets in divorce settlements. *American Economic Review* 79, 992–1009.
- Cohen, L., 1987. Marriage, divorce, and quasi rents; or, I gave him the best years of my life. *Journal of Legal Studies* 16, 267–303.
- Collins, R., Coltrane, S., 1991. *Sociology of Marriage and the Family: Gender, Love, and Property*. 3rd edition. Nelson-Hall, Chicago.
- Dufwenberg, M., Gneezy, U., 2000. Measuring beliefs in an experimental lost wallet game. *Games and Economic Behavior* 30, 163–182.
- Elster, J., 1998. Emotions and economic theory. *Journal of Economic Literature* 36, 47–74.
- Fehr, E., Gächter, S., Kirchsteiger, G., 1997. Reciprocity as a contract enforcement device: experimental evidence. *Econometrica* 65, 833–860.
- Friedberg, L., 1998. Did unilateral divorce raise divorce rates? Evidence from panel data. *American Economic Review* 88, 608–627.
- Geanakoplos, J., Pearce, D., Stacchetti, E., 1989. Psychological games and sequential rationality. *Games and Economic Behavior* 1, 60–79.
- Huang, P.H., Wu, H.-M., 1994. More order without more law: a theory of social norms and organizational cultures. *Journal of Law, Economics and Organization* 12, 390–406.
- Leith, K.P., Baumeister, R.F., 1998. Empathy, shame, guilt, and narratives of interpersonal conflicts: guilt-prone people are better at perspective taking. *Journal of Personality* 66, 1–37.
- Nakonezny, P.A., Shull, R.D., Rodgers, J.L., 1995. The effect of no-fault divorce law on the divorce rates across the 50 states and its relation to income, education, and religiosity. *Journal of Marriage and the Family* 57, 477–488.
- Polsby, D.D., Zelder, M., 1994. Risk-adjusted valuation of professional degrees in divorce. *Journal of Legal Studies* 33, 273–285.
- Price, S.J., McKenry, P.C., 1998. *Divorce*. Sage, Beverly Hills, CA.
- Rabin, M., 1993. Incorporating fairness into game theory and economics. *American Economic Review* 83, 1281–1302.
- Rotter, J.B., 1980. Interpersonal trust, trustworthiness, and gullibility. *American Psychologist* 35, 1–7.
- Ruffle, B.J., 1999. Gift giving with emotions. *Journal of Economic Behavior and Organization* 39, 399–420.
- Stark, O., 1995. *Altruism and Beyond*. MIT Press, Cambridge, MA.
- Takas, M., 1986. Divorce: who gets the blame in ‘no-fault’. *Ms. Magazine*, Feb., 48–52, 82–83.
- Tangney, J.P., 1995. Recent advances in the empirical study of shame and guilt. *American Behavioral Scientist* 38, 1132–1145.
- Ulph, D., 1988. A general model of household consumption behavior. Discussion Paper 1988/205, University of Bristol.
- Weiss, Y., 1997. The formation and dissolution of families: why marry? who marries whom? and what happens upon divorce? In: Rosenzweig, M.R., Stark, O. (Eds.), *The Handbook of Population and Family Economics*, Vol. 1A. North-Holland, Amsterdam (Chapter 3).
- Weiss, Y., Willis, R.J., 1993. Transfer among divorced couples: evidence and interpretation. *Journal of Labor Economics* 11, 629–679.
- Weitzman, L.J., 1986. A new look at career assets. *Ms. Magazine*, Feb., 67–68.
- Williamson, O.E., 1989. Transaction cost economics. In: Schmalensee, R., Willig, R.D. (Eds.), *The Handbook of Industrial Organization*, Vol. 1. North-Holland, Amsterdam (Chapter 3).