Why do Smokers Divorce?
Time Preference and Marital Stability

Janice Compton*
Department of Economics
University of Manitoba

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Abstract

The importance of time preferences in economic decisions such as job choice and savings behaviour has been discussed widely. I argue here that time preference is also an important determinant of marriage stability and its omission from economic models of marriage and divorce may lead to an overstatement of the effect of education, health status and wealth accumulation on marriage stability. I present a simple game theoretic model of divorce with heterogeneous time preferences with a simple hypothesis: patient individuals are more likely to remain in a marriage following a marital shock, in the hopes that the shock is temporary. Impatient individuals will seek to exit a marriage as soon as a shock occurs. This has implications for the timing of divorce and assortative mating patterns under different divorce regimes. The hypothesis is tested using NLSY data under a number of hazard and survival model specifications. Quantitative and qualitative characteristics are used as proxies for time preference, both separately and in the construction of an overall patience indicator. The results show that individuals with patient characteristics are less likely to divorce than those with impatient characteristics, and the effect is stronger in earlier years of marriage. Moreover while a labour shock increases the probability of divorce, the negative effect of the shock is weaker for patient individuals.

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* Department of Economics, 542 Fletcher Argue Bldg. University of Manitoba, Winnipeg, MB R3T 5V5 *comptonj@cc.umanitoba.ca*

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1. Introduction

Individual rates of time preference are key determinants of both investment decisions and the sustainability of cooperation in repeated games. Yet, although marriage is typically modelled as an investment or a repeated prisoner's dilemma game, an examination of individual rates of time preference has been largely absent from theoretical and empirical models of marriage in the economic literature[1]. Allowing for heterogeneity of time preferences in models of marriage stability helps clarify the effect of education, health status and wealth accumulation on divorce. The hypothesis is simple: patient individuals – those who place a high relative weight on future utility - are more likely to stay in a troubled marriage, hoping for an improvement in the relationship. Impatient individuals – those who place a relatively low weight on future outcomes - are quick to exit a sour relationship.

Three trends in marriage and divorce behaviour are indicative of a time preference effect. First, in recent decades divorces are occurring earlier within marriage, suggesting a time dimension that is not currently captured in economic models. Second, behavioural and demographic variables that are positively correlated with divorce are often those that are – in separate research – negatively correlated with patience. High time preference (impatience) has been linked to a number of behaviour and outcomes, including smoking (Munasinghe and Sicherman (Forthcoming), Evans and Montgomery (1994), Becker and Murphy (1988), Fersterer and Winter-Ebmer (2000)), not owning a home (Evans and Montgomery (1994), Donkers and Soest (1999)), alcohol abuse (Bishai (2001), Becker and Murphy (1988)), not holding life insurance (Della Vigna and Passerman (2005), Drago (2006)), low education (Fersterer and Winter-Ebmer (2000), Mecker and Mulligan (1997), Lawrance (1991)), poor health (Fuchs (1980), Becker and Mulligan (1997), Komlos et al (2003)), low income (Lawrence (1991)), job displacement (Belzil and Hansen (1999)) and parental divorce (Bishai (1999), Booth and Amato (2001)). In separate research, similar characteristics are found to be positively correlated with an increased probability of divorce: smoking (Fu and Goldman (2000)), alcohol abuse (Abma (1991), Burgess and Propper (1998), not holding life insurance (Brining and Buckley (1997), poor health (Marks (2003)), low income (Gruber (2000)), job displacement (Charles and Stevens (2001), Gruber (2000)), and parental divorce (Gruber (2000), McLanahan and Bumpass (1988), Corak (2001) and Amato (1996)). While there are clear mechanisms through which some of these traits affect divorce – i.e. low asset holdings will increase the impact of a negative income shock – others, such as smoking and education, are not obvious. Becker et al (1977) note that there is no clear theoretical prediction concerning the net effect of education on the probability of divorce. The higher market and non-market skills of educated persons increase the gains from marriage, but the higher outside options may increase the probability of divorce.

Finally, contrary to the old adage "opposites attract," married couples tend to be alike along a number of characteristics that are linked to time preference. Previous explanations for these patterns of positive assortative mating assume that similarity in attributes leads to similarity in tastes for household public goods. Positive assortative mating on these attributes may reduce the

[1] In the sociology literature, Booth and Amato (2001) find that individuals who end a low-conflict marriage have characteristics consistent with high time preferences, although a causal interpretation is not explored. In the Psychology literature, Mischel et al (1999) tested the time preference of young children and followed the children into adulthood. Those who resisted immediate temptation enjoyed higher incomes, greater career satisfaction, better health and more successful marriages than those who did not resist immediate consumption temptation.

probability of negative marital shocks. If time preferences impact marital stability decisions *once a shock occurs*, there is an incentive for assortative matching on time preference itself.

To demonstrate the importance of time preference for relationship duration, I outline a simple game theoretic model of divorce in which shocks are uncertain, bargaining is not fully efficient and time preferences are heterogeneous but unobservable. I test the main hypothesis – that impatient individuals are more likely to divorce - using the U.S. National Longitudinal Survey of Youth (NLSY). Since time preference is not measured directly, a number of variables are used as proxies for patience, both individually and in weighted measures of impatience constructed through factor analysis. The regression results show a consistent positive correlation between impatience and the probability of divorce. The effect is empirically important: increasing aggregate impatience by one standard deviation above the mean increases the divorce hazard by 18 percent. As a more concrete measure, individuals who smoked prior to marriage are 22 percent more likely to divorce compared to individuals who never smoked.

This paper adds to two strands of economic literature. First, a number of recent papers have outlined the importance of time preference on economic decisions. The econometric analysis used here is similar to that of DellaVigna and Paserman (2005) who consider the impact of time preference on the duration of unemployment and Drago (2006) who consider the impact of time preference on job mobility. Also closely related is a recent paper by Munasinghe and Sicherman (forthcoming) in which time preference is linked to job choice. Second, as economics moves further into the areas of marriage, divorce and fertility there is growing interest in the link between psychological variables and these decisions. For example, both Spivey (2008) and Schmidt (2008) consider the impact of risk preferences on marriage and, in the latter case, fertility. In a recent paper, Del Boca and Flinn (2009) present a model intra-household labour supply decisions, noting the importance of the discount rate in reaching an efficient outcome, but assume the rate is common across spouses.

2. A Model of Divorce with Heterogeneous Time Preferences

In this section, I outline a simple game theoretic model of divorce that incorporates heterogeneous time preferences.[2] For simplification, time preferences (TP) are assumed to be exogenous, constant and exponential.[3] The model is based on the divorce model of Weiss and Willis (1997) and is a model of first marriages. If an individual divorces, they remain divorced forever. There are two sets of individuals, *I* (men) and *J* (women). Men and women are homogenous in all aspects except their discount factors, which are unobservable.[4] The

[2] An alternative modeling strategy would be to use the Folk theorem and model marital cooperative bargaining in a repeated game. Noting that cooperation in a repeated game can be sustained only when discount rates are sufficiently low, we could present a model in which efficient marriages and divorces are realized only when couples are sufficiently patient, but that inefficient outcomes can occur when one or both members of the couple are impatient.

[3] This is for simplification. While there is little empirical evidence to support this structure (see Thaler (1981), Loewenstein and Prelec (1992)), the aim here is simply to describe a simple mechanism through which time preferences affect marriage decisions. Allowing for hyperbolic time preferences would not alter the results of this simple model.

[4] Time preferences are defined as 1/(1-T) where T is the discount rate. Thus, individuals with a high time preference (patient people) have low discount factors, while individuals with a low time preference (impatient people) have a high discount factors.

distributions of discount factors for each sex follow known distributions that are bounded by zero and one and have the cumulative distribution function $F_k(\delta)$, k=i,j .[5]

2.1 Description of the Model

Figure 1a and 1b show the game theoretic structure of the divorce decision under unilateral and mutual law regimes, respectively.[6] Married couples receive a per-period benefit α, which is assumed to be greater than the sum of their per-period benefits received if divorced, $\alpha > D_i + D_j$, with $D_k > 0$. The distribution of α between husband and wife is determined by Nash bargaining, with bargaining weights τ_k independent of time preferences and constant through time.

After the first period of marriage, couples may by hit with a negative shock. The shock occurs with probability p_1 and reduces the per period marriage benefit to zero. With probability p_2 the shock is permanent; otherwise it is temporary and lasts only one period. This uncertainty in the type of shock allows for the distinction between early and late divorces but is not necessary to derive behavioural differences by time preference rate. The random shock occurs only once. If the couple escapes it, they live happily ever after, earning α each period. If the couple is hit with the shock, each spouse has a preference for either (i) divorcing immediately and earning an expected per-period benefit of D_k forever, or (ii) remaining in the marriage and earning zero utility for one period until the type of shock is revealed. When the type of shock is revealed, if the shock is temporary, the couple returns to marital bliss, earning α forever. If the shock is permanent, the couple will divorce immediately.

Whether the couple remains married or not depends on the divorce regime in place and the ability of the couple to make transfers. We assume that couples cannot alter their bargaining positions, write enforceable contracts or transfer utility across time periods.[7] Therefore when couples disagree over whether to stay or leave, there is no opportunity for them to bargain and the divorce law regime alone determines whether disagreeing couples divorce or remain married.[8]

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[5] I assume that time preferences are exogenous and constant over one's adult life. This assumption is consistent with most economic literature on time preferences (Becker and Mulligan (1997) and Bishai (2004) being notable exceptions, however see Skog (2001) for a rebuttal).

[6] The diagrams are simplified for ease of exposition. Payoffs are shown each period rather than at the end of the game. The standard game theoretic version is provided in appendix 1.

[7] The inability of couples to credibly commit to allocations across time has recently been discussed in Lundberg and Pollak (2003).

[8] The debate among economists over whether or not divorce institutions affect divorce rates rests on the ability of spouses to bargain. But even with bargaining between spouses, the efficient outcome may not be achieved if transactions costs of bargaining are high and/or if spouses are unable to make binding agreements. Peters (1986) states that the law should have no effect on divorce. She assumes that marriages, as a two-person, multi-period relationship, induce cooperation and the Coase Theorem holds. Allen (1992, 1998) argues instead that transactions costs in marriages are positive. As a result, inefficient marriages will survive under fault divorce regimes, while inefficient divorces will occur under no-fault divorce regimes. Much empirical evidence (see above plus Brinig and Buckley (1997), Friedberg (1998) and Wolfers (2006)) shows an increase in the divorce rate following the regime switch to unilateral (or no-fault) divorce law, suggesting that the transactions costs of bargaining within marriage are substantial enough that efficiency cannot be assumed.

Figure 1a: Divorce with Random Shocks, Unilateral Divorce Laws

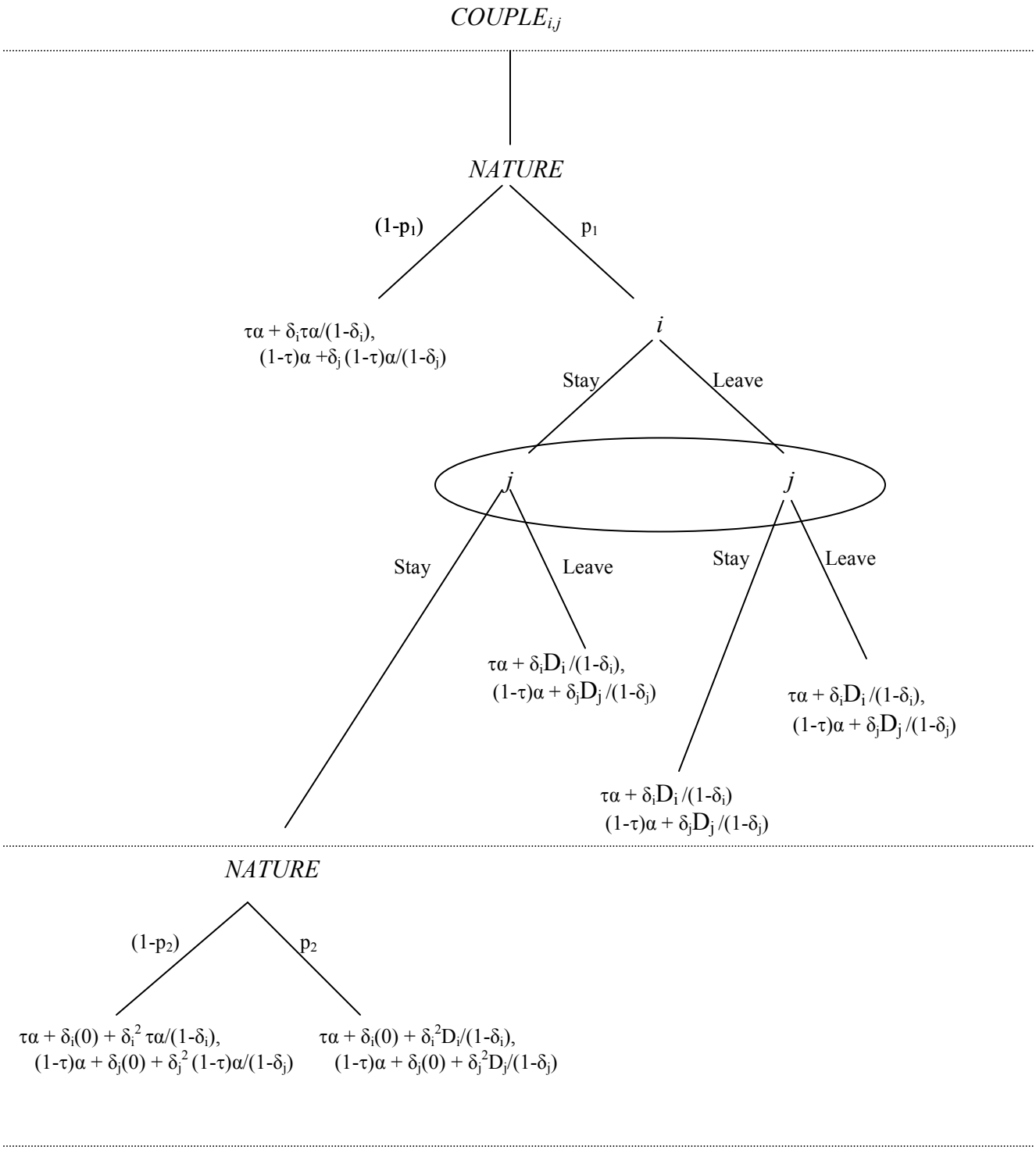
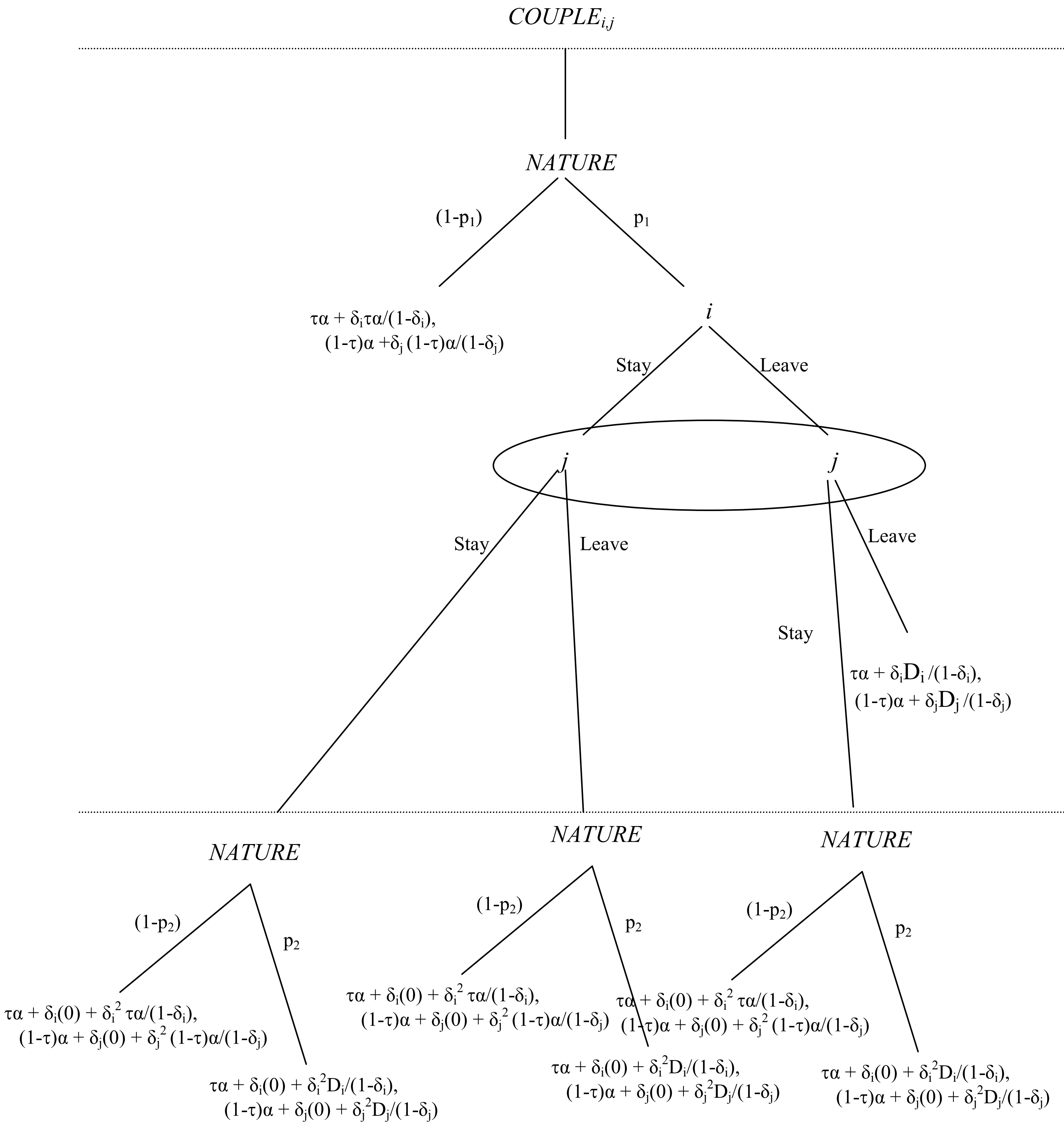


Figure 1b: Divorce with Random Shocks, Mutual Divorce Laws



2.1.1 Choice to stay or leave

If a shock hits, individuals choose the "stay" or "leave" option that provides them with the highest expected outcome. For each individual, there exists a TP rate δ_k^* , k=i,j defined

$$(1) \quad \delta_k^* = \frac{D_k}{(1-p_2)*\tau_k\alpha + p_2 D_k}$$

such that individuals with a TP rate $\delta_k < \delta_k^*$ is defined as 'impatient' – she prefers to leave a marriage if a shock occurs. If $\delta_k > \delta_k^*$ the individual is defined as 'patient' – she prefers to stay in the marriage until the type of shock has been revealed.[9] Note that the labels 'patient' and 'impatient' are situational. They depend on the relative benefits of marriage and divorce, and the probability that the shock is permanent. An individual may be "impatient" when α is relatively low, D_k is relatively high and p_2 is relatively high, "patient" when α is relatively high, D_k is relatively low and p_2 is relatively low. Holding the parameters constant across the population, we define T_k as the proportion of each sex that are 'patient' as

$$(2) \quad T_k = \int_{\delta_{-k}^*}^{1} F_{-k}(\delta) d\delta \; ; -k = j,i.$$

2.2.2 Early and Late Divorces

The uncertainty about the type of shock allows for the distinction between early and late divorces. The ability to quickly end a troubled marriage may have real effects on the household. Stevenson and Wolfers (2006) find that following the introduction of unilateral divorce, there was a significant decline in the number of women committing suicide and a decline in domestic violence against both men and women. Alternatively, sociologists have found that children have the most difficulty after divorce when they are unable to anticipate their parent's divorce (Booth and Amato, 2001). Analyzing the different effects of early and late divorces is beyond the scope of this paper, but it is important to acknowledge that the timing of divorce may have real effects on families.

The uncertainty over whether the shock is permanent creates type I and type II errors. Type I errors occur when a marriage ends early due to a shock that is temporary. These types of errors are never revealed but are errors from the viewpoint of an outside, time neutral, observer.[10] Type II errors occur when a marriage ends late, only after a shock is revealed to be permanent. These types of errors are revealed to the couple.

Consider the three types of couples: couples in which both spouses are patient, couples in which both spouses are impatient, and couples comprised of one patient and one impatient spouse. If a patient couple divorces, it will be a late divorce and will always indicate a type II error – they would have been better off if they divorced earlier. If an impatient couple divorces, it

[9] I assume that in the boundary case, where one spouse is indifferent between staying and leaving, the outcome of the game is determined by the preferences of the other spouse. If both spouses are indifferent, I assume that they remain in the marriage.

[10] The irrationality of discounting is sometimes used as a rationale for government intervention. Goodin (1982, p. 54-55) notes "There is no more reason that public policy should reflect people's inability to weight time neutrally than that it should reflect people's incapacity to think rationally about large numbers or perform fancy arithmetic." (Quoted in Frederick, 1999, p. 17)

will be an early divorce and will be a type I error with probability p_2 – under time neutrality, a proportion of these divorces should not have happened. For a mixed couple, the type of divorce depends on the legal regime. In a mutual regime, divorces of mixed couples will be late while in a unilateral regime, divorces of mixed couples will be early. Assuming that some mixed couples exist and *holding assortative mating patterns constant*, a move from a mutual to a unilateral divorce regime causes an increase in the proportion of marriages ending in divorce, a rise in early divorces and a decline in late divorce.

Holding the divorce regime constant, it is possible to determine expected population divorce rates along a continuum of assortative mating rules, from perfect negative assortative mating to perfect positive assortative mating.. An increase in positive assortative mating reduces the proportion of mixed couples and increases the proportion of like couples. Under a mutual divorce law regime the divorce rate increases with positive assortative mating on time preferences. This occurs because under mutual divorce law, mixed couples do not divorce until the type of shock is revealed. As the proportion of mixed couples is replaced in part by impatient couples, who divorce as soon as a shock occurs, the divorce rate will rise. In contrast, under a unilateral divorce law regime the divorce rate decreases positive assortative mating on time preferences.

2.2.3 Incentives for Positive Assortative Mating

Although the marriage market is not explicit in the model, we can determine the expected benefit of assortative mating for both patient and impatient individuals under both regimes. Recall that T_k is defined as the proportion of each sex that is 'patient'. Consider now that individuals can segment their pool of potential spouses by observable characteristics that are correlated with δ – i.e. high or low education, smoking or non-smoking, etc – and alter the distribution of δ that they face in the marriage market. If the composition of the mating pool , T_k , has a large impact on the expected benefit of marriage, there is an incentive to segment the marriage market in order to increase or decrease T_k .

Under a unilateral divorce regime, the expected value of marriage for a patient individual is:

$$(3)\quad E(V_k|\delta_k \geq \delta_k^*, U) = (1-\delta_k p_1)\frac{\tau\alpha}{1-\delta_k} + \delta_k p_1 \frac{D_k}{1-\delta_k} + \delta_k p_1 T_k\left(\delta_k(1-p_2)\frac{\tau\alpha}{1-\delta_k} - (1-\delta_k p_2)\frac{D_k}{1-\delta_k}\right)$$

Similarly, we can define:

$$(4)\quad E(V_k|\delta_k < \delta_k^*, U) = (1-\delta_k p_1)\frac{\tau\alpha}{1-\delta_k} + \delta_k p_1 \frac{D_k}{1-\delta_k}$$

$$(5)\quad E(V_k|\delta_k \geq \delta_k^*, M) = (1-\delta_k p_1)\frac{\tau\alpha}{1-\delta_k} + \delta_k p_1\left(\delta_k(1-p_2)\frac{\tau\alpha}{1-\delta_k} + \delta_j p_2 \frac{D_k}{1-\delta_k}\right)$$

$$(6)\quad E(V_k|\delta_k < \delta_k^*, M) = (1-\delta_k p_1)\frac{\tau\alpha}{1-\delta_k} + \delta_k p_1\left(\frac{D_k}{1-\delta_k} + T_k\left(\delta_k(1-p_2)\frac{\tau\alpha}{1-\delta_k} - (1-\delta_k p_2)\frac{D_k}{1-\delta_k}\right)\right)$$

where (3) is the expected value of marriage for an impatient individual under a unilateral divorce regime; (4) is the expected value of marriage for a patient individual under a mutual divorce regime; and (5) is the expected value of marriage for an impatient individual under a mutual divorce regime.

Remark 1: The expected values of marriage for an impatient person under a unilateral regime [4] and a patient person under a mutual regime [5] do not depend on T_k. Since the divorce law regime favours the stay/leave preference of these individuals, the time preference of a potential spouse is irrelevant.

Remark 2: The expected value of marriage is the same for a patient individual under a unilateral regime and an impatient person under a mutual regime. However, an increase in the proportion of patient potential spouses (an increase in T_k) will cause an increase the expected value of marriage in the former case, and a decrease in the latter. That is,

$$(7) \quad \frac{\partial E(V_k)}{\partial T_k} = \frac{\delta_k p_1}{1-\delta_k}\left(\delta_k(1-p_2)\tau\alpha - (1-\delta_k p_2)D_k\right)$$

which is negative if $\delta<\delta_k$ and non-negative otherwise. This is illustrated in appendix 1.

The above remarks indicate that under each divorce law exactly one type has an incentive to segregate its marriage market. Under the mutual divorce regime, impatient individuals would do better if they could reduce the probability of marrying a patient spouse; under the unilateral divorce regime, patient individuals would do better if they could increase the probability of marrying a patient spouse. But for both types the benefit of assortative mating comes in the future. Thus, the incentive to segment the marriage market is higher under a unilateral divorce regime. The impatient type are by definition less concerned with future payoffs, hence, the benefits of segregating the market under a mutual divorce regime are relatively low. This result implies that we can expect an increased segmentation of the marriage market along time preference characteristics when there is a shift from mutual divorce law to unilateral divorce law.

An increase in assortative mating may also be due to exogenous increases in the frequency of marital shocks (an increase in p_1). Allen (1998) suggests that increases in women's labor force participation raised the probability of shocks in marriage. McKinnish (2007) argues that a reduction in occupational segregation of the sexes has raised the probability of shocks. Regardless of the reason behind the increased probability of shocks, an increase in p_1 heightens the desire to marry a spouse with similar preferences over when to end the marriage.

Note that the incentives for assortative mating remain even when we relax the assumption of no side-payments between spouses. Under mutual divorce law, impatient types may divorce their patient spouses if doing so is efficient, but they would have to pay for the privilege. All else equal, an impatient spouse would be preferred. Under unilateral divorce law, patient types may be able to bribe their impatient spouses to remain married, but it is less costly to marry a patient spouse.

2.2.4 Individual Probability of Divorce and Positive Assortative Mating

The model's predictions on the aggregate divorce rate depend on the initial assumption that positive assortative mating on time preference affects the probability of divorce differently than positive assortative mating on other types of characteristics. Under preference-based assortative mating, the probability of divorce is lower for similar couples, regardless of the direction of their similarity. (Lich-Tyler (2004)) The explanation is that the similarity of preferences – or similarity of characteristics that affect preferences – will reduce disagreements over the allocation of resources on household public goods. One way to incorporate this directly in the model is to allow the arrival of marital shocks to be endogenous to the similarity of preferences, thus p_1 would fall with couple similarity. This alteration strengthens the hypothesis that patient couples

will have a lower probability of divorce compared to mixed couples. Not only are shocks less likely to occur but if they do, the couple is less likely to divorce. For impatient individuals, however, there are two opposing effects. Positive assortative mating reduces the likelihood of a shock, but increases the probability of divorce if a shock occurs. As a result, the effect of positive assortative mating on the probability of divorce is ambiguous for impatient types.

2.2.5 Time Preference and Age of Marriage

The divorce model presented is structured such that time preference has a direct effect on divorce. An indirect relationship is also plausible. If time preferences affect age at marriage and age at marriage affects the probability of divorce, then patience may have an indirect effect. This hypothesis appears to line up with empirical findings. Age of marriage is correlated with time preference variables, notably education and parental divorce (for education see Bergstrom and Bagnoli (1993), Drewianka (2007), Rose (2001); for divorce see Gruber (2004) and McLanahan and Bumpass (1998)). However, a direct theoretical relationship between age of marriage and time preference is ambiguous. In a search model context, an impatient individual may match earlier– have a lower reservation match quality level - than a comparable patient individual. On the other hand, impatient individuals assign a lower value to the future benefits of marriage and so may exert less effort in finding a match, increasing the time to marriage.[11,12] In the empirical work that follows, I control for age of marriage, but do not explicitly model the impact of time preference on age of marriage.

To summarize, by making some small adjustments to the Weiss/Willis model it is possible to derive some hypotheses concerning time preference and divorce. The results rest on the assumption that individuals with relatively high time preference rates (patient individuals) are more likely wait out a negative marriage shock until the type is revealed. If this is valid, we would expect to see (1) a higher rate of divorce, and earlier divorces, among impatient individuals compared to patient individuals; (2) lower rates of divorce for patient couples, compared to mixed couples; (3) an increase in the overall divorce rate and an increase in early divorces with a switch from mutual to unilateral divorce regimes; (4) an increase in positive assortative mating on time preferences following a switch from a mutual to a unilateral divorce regime, which in turn would lower the divorce rate.

In what follows, I test empirically the main hypothesis that time preference impacts the probability and timing of divorce. The model's predictions concerning assortative mating and aggregate trends all rest on this primary result. [1] The second result concerning the stability of marriage for patient versus mixed couples is tested empirically using the NLSY and PSID in

[11] Mullin and Wang (2002) consider a similar question - the impact of impatience on fertility. They argue that an increase in impatience causes women to substitute away from investment in human capital and into current consumption, creating two opposing effects on fertility. The present value loss in future productivity associated with childbearing falls, causing earlier births, while the loss in current production increases, triggering later births. To the extent that fertility timing is correlated with age of marriage, their result would also suggest that patience has an ambiguous effect on age of marriage.

[12] Following DellaVigna and Paserman (2005), signing the impact of impatience on age of marriage may provide information about the functional form of time preference, which is not considered here. They consider the effect of time preference on search for employment, noting that if an exponential discount rate is assumed, then impatient workers enter employment sooner than patient workers. If time preferences are hyperbolic, impatient individuals enter employment later than patient individuals. Their empirical results, using the NLSY and similar time preference variables used here, are consistent with the hypothesis of hyperbolic time preferences.

Compton (2008). The final two aggregate results are consistent with U.S. aggregate trends (Gruber (2004)).

3. Empirical Analysis

The model presented above suggests that the inclusion of time preference indicators may help explain the variation of divorce behaviours across couples. In this section, I use hazard regression analyses to test the main hypothesis of the model - conditional on being married, an individual with low patience is more likely to fall below the cut-off, δ_k^*, and thus more likely to get divorced, compared to an individual with high patience.

Two sets of regression analyses are presented. In the first, I consider the effect of time preferences under the assumption that shocks to a marriage are unobservable and of varying impact. I expect impatience to be positively correlated with divorce, with the effect stronger in earlier years of marriage. This time dimension arises from the model's result that even among divorcees, impatient individuals have shorter expected marriage durations than patient individuals.

The second set of regressions explicitly model the impact of a shock on the hazard into divorce. Time preference measures are interacted with a variable that indicates whether the individual was laid off in the previous year. We would expect that the shock would destabilize all marriages but this effect should be stronger for impatient individuals.

3.1 Data

The data used in these analyses are from the U.S. National Longitudinal Survey of Youth (NLSY). The NLSY is a nationally representative sample of 12,686 individuals aged 14-22 in 1979 who were surveyed annually until 1994, and then bi-annually until 2006. Individuals are questioned on a variety of topics, including marital status, family background, labour experiences and health.

The full regression sample includes 8820 observations. These include all individuals in the original NLSY sample of 12684 who meet the following criterion: (1) they are not married, divorced or widowed at the time of the first interview; (2) they are observed entering a first marriage; and (3) their marriage history is consistent.[13] Of the 8820 observations, we observe 2477 divorces (28%). Due to the nature of the time preference variables, which are asked in 1985 and 1984, we lose some sample due to attrition. The full and reduced samples are very similar (means are provided in the appendices).

3.2 Time Preference Variables

The main difficulty in estimating the effect of time preference on divorce is that the key parameter is unobservable. Time preference may be estimated from consumption and savings behaviour (Lawrance, 1991) however this information is not available in the NLSY.[14] Instead, following Della Vigna and Passerman (2006) and Drago (2006), I rely on proxy variables and a

[13] Individuals are deleted if they reported two marriage start dates in a row without listing a divorce date (actual date of marriage is unclear), if they transition from marriage to separation to new marriage without listing a divorce date (unclear whether this is reuniting first marriage or divorce), or if they report being divorced prior to a marriage start date.

[14] The 2006 wave of the NLSY includes time preference variables. This variable is not included here for two reasons. First, the availability of the response limits the analysis to only those individuals who remained in the survey from 1979-2006 which may severely bias the results. Second, preliminary analysis of the variable suggests that the question was not well understood by approximately 30% of the sample.

summary variable to capture time preference. The validity of these proxy measures requires two assumptions. First, time preferences are consistent across different activities, If an individual highly discounts his future health or future earnings, he also highly discounts future benefits from marriage. Second, individuals' ranking with respect to time preference does not vary across time.[15] The proxy variables are coded such that higher values of the variables reflect more impatience and are measured prior to the beginning of the marriage spell. I focus on three variables. The first two are commonly used proxies for time preference (see DellaVigna and Paserman (2005) and Drago (2006)). The third is a qualitative variable selected as a more direct measure of time preference[16].

(1) Smoking Daily Prior to Marriage. Fuchs (1982) argued that the high correlation between education and health outcomes is due to differences in time preferences. Individuals who heavily discount the future are more likely to engage in negative health behaviours – smoking, drinking, not exercising – and are also less likely to invest in human capital. Following this logic, I create an indicator variable equal to one if the individual has smoked prior to marriage, zero otherwise. Regressions are run with and without controls for whether the individual smokes after marriage, capturing any effect that the current act of smoking may have on marriage stability[17].

(2) No Contraceptive Use: In 1985, respondents are asked whether they are currently sexually active and if so, what if any type of contraceptives they are using. An individual who is more future oriented may be more likely to use contraceptives, as they would place a higher weight on avoiding sexually transmitted diseases and unwanted pregnancies. An indicator variable is included to capture this proxy. The variable is equal to one if the individual does not use any type of contraceptive and is sexually active, and zero otherwise. Individuals who are not sexually active are coded as missing. Using this variable restricts the sample to marriage spells that began post 1985.

(3) Rotter_Plan:: This qualitative measure is derived from one of four questions included in the Rotter Internal-External Locus of Control Scale. The Rotter scale is designed to evaluate the extent to which individuals believe they have control over their lives rather than being determined by luck or fate. In 1979, interviewees were asked which of the following statements better reflected their beliefs:

(a) When I make plans, I am almost certain that I can make them work; or
(b) It is not always wise to plan too far ahead, because many things turn out to be a matter of good or bad fortune anyhow.

Becker and Mulligan (1994) argue that planning for the future signals high time preference. Thus the constructed time preference variable indicates impatience (equals one) if the individual feels it is not wise to plan too far ahead.

Summary statistics for the five time preference variables are provided in table 1. For every impatience indicator, observations of individuals who divorce are less patient than those who do not divorce, although the differences are not statistically significant. Appendix 2 shows the pairwise correlations of all time preference variables, as well as the level of education attained

[15] Mischel et al (1989) show that although time preferences may change over time, they are stable across individuals.

[16] A number of other variables were tested as time preference variables, but not included. DellaVigna and Paserman (2005) also include savings behaviour, and an indicator of whether the interviewer felt the individual was impatient during the interview. I chose not to include these variables. Both were found to be strong indicators of risk, and neither were positively correlated with the other chosen time preference variables.

[17] An alternative smoking measure – whether the individual ever smoked – was also used with very little change in the results.

prior to marriage. All time preference variables are positively correlated to each other and negatively correlated with education. While the correlations among the time preference variables are low, this is not uncommon for different measures of an individual trait (see Fuchs (1980), DellaVigna and Paserman (2005)). Each of these variables has a link with time preference, although they are noisy measures. An aggregate measure of time preference constructed using factor analysis captures the common element of the three variables, which is assumed to be time preference. Each individual is assigned a summary patience score, based on the scoring coefficients for the four time preference variables (details are found in Appendix 3). Unless there is another common thread between these variables, this aggregate measure provides a good estimate of time preference.

Table 1: NLSY Time Preference Variables

Variable	Description	All Spells	Spells that end in Divorce
Smoked Before Marriage	Smoked daily before marriage	0.523 (0.499) [4832]	0.621 (0.486) [1372]
Rotter_Plan	From initial interview, indicated that it is "not always wise to plan too far ahead".	0.480 (0.499) [9480]	0.503 (0.500) [2470]
No Contraception	Did not use contraception prior to marriage. Missing for respondents not engaging in sexual activity, missing for respondents married after 1981.	0.586 (0.492) [5701]	0.610 (0.488) [1387]
Summary Measure	Constructed using factor analysis scores for the five variables. Normalized.	0.0127 (1.012) [2971]	0.184 (0.956) [790]

Standard deviations are in parentheses, and the number of observations are in square brackets.

3.2 Time Preference or Risk Aversion

Contraceptive use and smoking behaviour may contain information about an individual's risk preferences as well as their time preferences. If they are strong measures of risk aversion, their use as time preference measures may be questionable. To test their relationship to risk aversion, I regress the time preference variables against two measures of risk preferences. First, Fairlie (2002) shows that risk preferences are a strong component of self-employment. Therefore, I construct an indicator variable equal to one if the respondent is ever observed to be self-employed. Second, the 1993 wave of the NLSY asks questions directly aimed at risk preferences, in which respondents are asked their preferences over gambles related to their current earnings (see Spivey (2008) for details). The questions allow the delineation of respondents into four risk aversion groups (very risk averse, strong risk aversion, moderate risk aversion and weak risk aversion). The regress results are shown in table 3. The results do not support a positive correlation between the time preference variables and risk. The qualitative variable (Rotter_plan) is negatively associated with risk, as is smoking before marriage, although the latter is not significant. The coefficients on no contraceptive use suggest a positive relationship with risk, although again the significance level is weak. Nevertheless, the divorce results for contraception use should be read with caution, as they may be capturing some element of risk.

Table 3: Risk Preference Regressions

Dependent Variable (Regression)	**Self-Employment (Logit regression)**	**Risk Aversion 1993 Categories (Ordered Logit)**
Rotter_Plan	0.838*	1.193***
	(0.050)	(0.001)
Smoked Before Marriage	0.820	1.091
	(0.157)	(0.216)
No Contraceptive Use	1.005	0.919
	(0.967)	(0.153)
Summary Measure	0.914	1.009
	(0.285)	(0.826)
CONTROLS	YES	YES

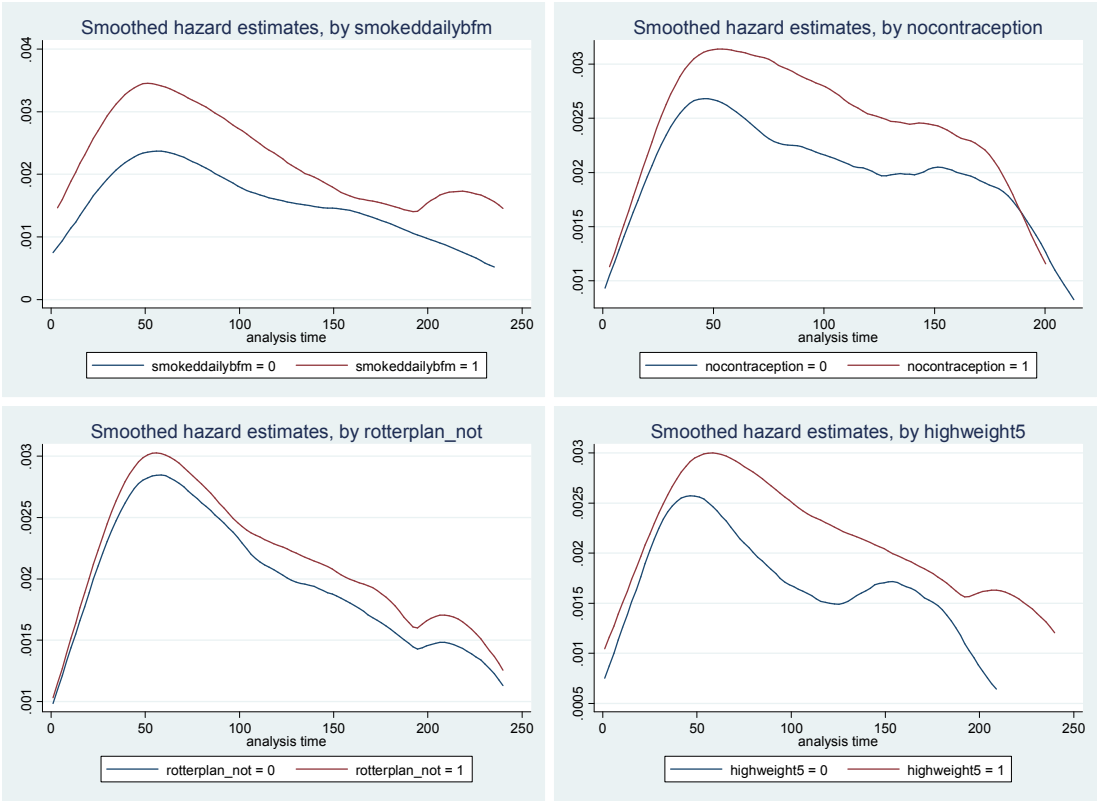
Odds Ratios presented. P>|t| in parenthesis. Each cell is the coefficient of interest from a separate regression. Controls for the logit regression include sex, age, Black, Hispanic, Other race, education, intelligence score (AFQT). Controls for the ordered logit regression include sex, live with parents, marital status, family assets in 1993, family size, family net income, current employment status, education, age, number of jobs held since 1979. Smoked after marriage is included as a control for the third regression.

3.3 Kaplan-Meier Estimates

Figure 3 plots the Kaplan-Meier estimates of the hazard function by each of the time preference variables. In all cases the exit rates for individuals who are more impatient (attribute=1) are higher than those more patient (attribute=0). The patterns of exit for smoking behaviour is most consistent with the predictions of the model, with a larger negative effect of impatience on divorce in early stages of marriage followed by a convergence of the two groups.

The Kaplan-Meier estimates are indicative of a simple correlation between patience and divorce rates. However, these estimates may be biased if the patience measures are correlated with omitted attributes that impact the divorce rate. Therefore, demographic and family background controls are added to the estimation. Controls for all regressions include: a female dummy variable, age at 1979 interview, age at marriage, AFQT percentile score, race indicators (black, Hispanic, other; white is omitted category), whether children were present before marriage, whether children were present within the first nine months of marriage, whether the respondent attends church weekly prior to marriage, education prior to marriage, whether the individuals parents were married when the respondent was 14 years of age, age of youngest child, number of children in the household, the socio-economic index of current occupation, an indicator for current home ownership. All control variables, except for the last four, which are time variant, are measured prior to the beginning of the marriage spell.

Figure 3: Smoothed Hazard Estimates by Time Preference Variables



3.4 Regression Models

I estimate the models using both Cox proportional hazard models and accelerated failure-time (AFT) survival models. This section provides a brief description of the models and their attributes. Both models are based on the hazard function *h(t)* which is the instantaneous probability of failure in time *t*, given survival in *t-1*. In this estimation, the hazard function measures the probability of divorce in month *t*, given survival to month *t-1*. Covariates alter the hazard function differently in the two models.

(i) Cox Proportional Hazards Model

The Cox proportional hazards model is an easily interpretable model in which covariates act to shift the baseline hazard in a parallel manner. The hazard *h(t)* is assumed to be

$$h(t) = h_0(t)\exp(\beta X_{i,t})$$

where the function $h_0(t)$ is the baseline hazard, $X_{i,t}$ is a vector of covariates and β is a vector of coefficients. The advantages of this model are (i) the functional form of the baseline hazard does not have to be specified; (ii) the covariates $X_{i,t}$ may be constant or time-varying; and (iii) coefficients are easily converted into hazard ratios for interpretation. The disadvantage of this model is that it requires a proportionality assumption –covariates shift the hazard parallel to the baseline, thus the effect of a variable is the same in year one as in year twenty. The hypothesis that time preference will have a stronger effect on divorce in early years of the marriage cannot be captured with this model.

(ii) AFT survival model

As an alternative to the Cox proportional hazard model, the regressions were also estimated as accelerated failure-time (AFT) survival models. This model is less flexible in one sense (the form of the baseline hazard (survival) must be specified) but is more flexible in another (there is no proportionality assumption). The AFT model expresses the natural logarithm of the survival time ln t as a linear function of the covariates:

$$\ln t_j = X_j \beta + z_j$$

where X_j is a vector of covariates, β is a vector of coefficients. In this model, the form of the baseline hazard needs to be specified, and I assume that the error term z_j is a log-logistic density function. This distribution is chosen as it allows for the increasing and then decreasing pattern of the Kaplan-Meier hazard function.

The AFT model allows coefficients to change the time scale by a factor of $\exp(x_j\beta)$. An increase in the covariate implies an increase in the expected waiting time for failure, or increased expected survival in marriage. The log-logistic survival function is

$$S(t) = \{1 + (\lambda t)^{1/\gamma}\}^{-1}$$

where $\lambda=\exp(-X_j\beta)$ and γ is an ancillary parameter estimated from the data.

Another advantage of the AFT model is that it is easily adjusted to control for unobserved heterogeneity, or the 'frailty effect'. Over time, the more 'frail' individuals will fail (divorce)

leaving a more robust population.[18] As this is a survival model, the coefficients are interpreted as time ratios, measuring the impact of the covariate on the expected duration of marriage. With the dummy variables, the coefficients are the expected duration when the variable equals one over the expected duration when the variable equals zero. For continuous variables, the coefficient indicates the expected impact of a change of one standard deviation from the mean.

4 Regression Results

The regression results for the Cox proportional hazard model and the AFT survival model are presented in table 4.[19] Each cell shows the time preference coefficient from a separate regression. In the absence of control variables (columns A and C), each measure of impatience reduces the probability of divorce at each time period. The magnitudes are high: those who smoked prior to marriage are 33 percent more likely to divorce at each month compared to non-smokers. The AFT model results indicate that the average expected time to divorce is 38 percent sooner for past smokers than for those who have never smoked. Slightly smaller effects are found for the other time preference variables. Columns B and D add the full set of control variables. Here again, each row represents a separate regression. As expected, the estimated impacts of the patience indicators fall (the hazard ratios are closer to one) due to the inclusion of control variables that are also related to patience, such as education and whether parents divorced.[20] Still, the magnitudes on the time preference variables are high: smokers are 23% more likely to divorce (and the expected time to divorce is increases by 18%) with the other variables all indicating an 18-20% effect of impatience. These magnitudes are comparable to the estimated effects of the control variables (see Appendix 2). For example, having a child before marriage increases the divorce hazard by 35%, while having a child within the first nine months of marriage increases the divorce hazard by 17%. Overall, the consistency of the results from both models suggests that whether we constrain the time variation or the functional form, the impact of time preference on divorce is robust.

4.1 Interaction with Labour Shock

In the Cox regressions presented in table 5, the time preference variables are interacted with a dummy variable that is equal to one if the individual was laid off from employment in the previous year. This allows a direct test of whether impatience heightens the effect of a shock on the probability of divorce. Each row corresponds to a separate regression, and each regression includes the full set of control variables, the layoff indicator, the patience indicator for that row and the interaction term. The results presented are for the full sample. Perhaps surprisingly, when the sample is split by gender, we find no substantial gender differences in the effects of

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[18] The frailty is assumed to be a unobservable multiplicative effect, ω, on the hazard function: $h(t \mid \omega) = \omega h(t)$ which yields the survival function $S(t \mid \omega) = \{S(t)\}^{\omega}$. I assume that ω follows a gamma distribution. To obtain the unconditional survival function, $S_\theta(t \mid \omega)$, ω is integrated out of $S(t \mid \omega)$, yielding $S_\theta(t \mid \omega) = [1-\theta \ln\{S(t)\}]^{-1/\theta}$ where θ is estimated from the data.

[19] For space considerations, I do not include full regression results. Appendix 3 shows full regression results for a subset of regressions from table 4. The coefficients on the non-time-preference variables are consistent across regressions.

[20] Becker and Mulligan (1997) explain that time preference may be influenced by spending time and effort imagining the future and that spending time with older persons – particularly parents – may influence the capacity to consider one's own future.

Table 4: Divorce Regression Results

	Cox Proportional Hazard Models		AFT Survival Model	
	(A) Without Control Variables	(B) With Control Variables	(C) Without Control Variables	(D) With Control Variables
Rotter_Plan	1.248***	1.180***	0.823***	0.897***
	(0.000)	(0.000)	(0.000)	(0.000)
Smoked Daily Before Marriage	1.327***	1.229***	0.721***	0.833***
	(0.000)	(0.003)	(0.000)	(0.000)
No Contraception	1.189***	1.191***	0.878**	0.895**
	(0.002)	(0.007)	(0.023)	(0.011)
Summary	1.248***	1.180***	0.823***	0.897***
	(0.000)	(0.000)	(0.000)	(0.000)

Hazard Ratios presented. Significance (p-value) in parentheses. Each coefficient is from a separate regression. In columns B and D, controls are included for female, age at 1979 interview, age at marriage AFQT percentile, race indicators (black, Hispanic, other), whether children before marriage, whether children within 9 months of marriage, age of youngest child, number of children in household, SEI of current occupation, whether own home, whether attends church weekly and intact family at age 14, education, smoked after marriage.

layoffs. The model suggests that the coefficients on the interaction term should be positive – i.e. layoffs increase the probability of divorce, and this increase is greater for impatient individuals compared to patient individuals.

The results are decidedly mixed. Without including the time preference variables (but including all other controls) I find a strong impact of a job layoff on the probability of divorce. The three time preference variables, added individually to the regression, indicate different patterns for the interaction. When time preference is proxied by the qualitative variable Rotter_plan, the regression results suggest that although impatience does not increase the probability of divorce in the absence of a layoff, a layoff has a stronger effect on impatient individuals compared to patient individuals. When time preference is proxied by smoking prior to marriage, we find that a layoff impacts only impatient individuals and not patient individuals. Finally when time preference is proxied by no contraception, we find the counterintuitive result that impatience buffers the impact of a layoff such that patient individuals are more likely compared to impatient individuals to divorce following a layoff. Unsurprisingly with these mixed results, the interaction term on the summary measure is insignificant.

Overall, the results of the regressions are largely consistent with the implications of the model. Individuals who smoked prior to marriage and individuals who answered that it is "not always wise to plan for the future" have a higher probability of divorce and are more likely to divorce following a negative labour shock, compared to their counterparts. Those who did not use contraceptives prior to marriage have a higher probability of divorce, but the impact of a labour shock is opposite expectations. The magnitude of the effects suggest that impatience may be an important predictor of marital stability.

Table 5: Cox Proportional Hazard Model, with Layoff Interaction Terms

Variables	Layoff	TP Variable	Interaction
None	1.437***		
	(0.000)		
Rotter_Plan	1.324***	0.940	1.152*
	(0.005)	(0.191)	(0.095)
Smoked Daily Before Marriage	1.185	1.161**	1.177***
	(0.294)	(0.038)	(0.001)
No Contraception	1.656***	1.215***	0.756**
	(0.000)	(0.004)	(0.011)
Summary Measure	1.617***	1.169***	0.988
	(0.000)	(0.000)	(0.955)

Hazard ratios presented. Significance (p-value) in parentheses, with adjustments made for interaction effects. Controls are included for female, age at 1979 interview, age at marriage AFQT percentile, race indicators (black, Hispanic, other), whether children before marriage, whether children within 9 months of marriage, age of youngest child, number of children in household, SEI of current occupation, whether own home, education, whether attends church weekly and intact family at age 14, and smoking after marriage.

5. Conclusions

I have argued that time preference is an important determinant of marital stability, one that has been ignored in the economics literature. Extending the typical model of marriage and divorce to allow for heterogeneous time preferences and temporary shocks suggests that those who are impatient are more likely to divorce, and they will divorce earlier than more patient individuals. Although the model is simple, it yields a number of testable results concerning the relationship between assortative mating on time preference variables and divorce regimes. Empirical evidence from the NLSY is consistent with the main hypothesis – that time preference impacts divorce.

The inclusion of time preference heterogeneity in divorce models is important. Without controlling for this psychological variable, we run the risk of overestimating the direct effect of education, health status, asset accumulation and family history on the probability of divorce. This overestimation can have serious consequences for policy makers. Moreover, as economics moves further into analysing behaviours that have previously been the domain of sociology and psychology, we need to expand our models to account for more qualitative characteristics of individuals, even when imperfectly observed.

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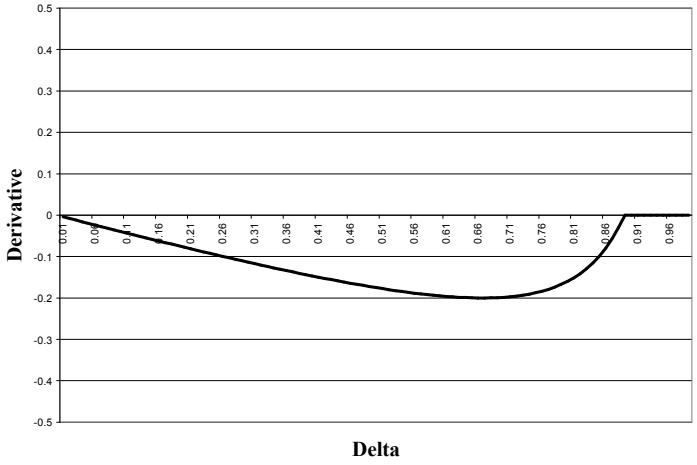
Appendix 1: Effect of a Rise in the Proportion of Patient Spouses on the Expected Value of Marriage

(A) Mutual Divorce Regime

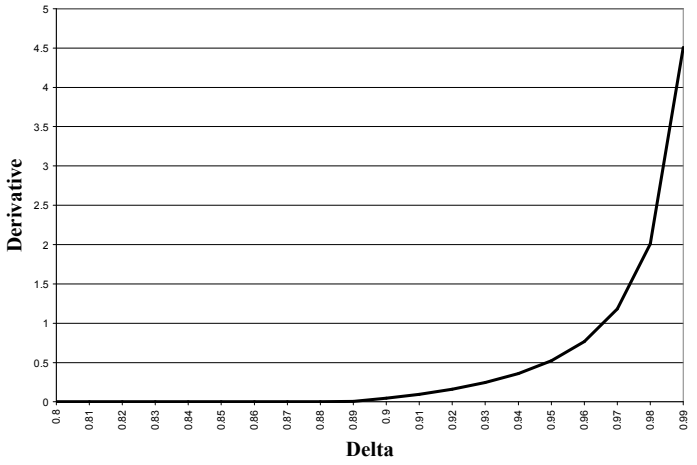
$$\frac{\partial E(V_k)}{\partial J_{-k}} = \begin{cases} \frac{\delta_k p_1}{1-\delta_k}\left(\delta_k(1-p_2)\tau\alpha - (1-\delta_k p_2)D_k\right) & if\ \delta_k < \delta_k^* \\ 0 & if\ \delta_k \geq \delta_k^* \end{cases}$$



The change in the expected value of marriage due to an increase in the proportion of spouses who are patient is negative for impatient individuals. Thus, they have an incentive to segment their market to reduce J_k.

(B) Unilateral Divorce Regime

$$\frac{\partial E(V_k)}{\partial J_{-k}} = \begin{cases} 0 & if\ \delta_k < \delta_k^* \\ \frac{\delta_k p_1}{1-\delta_k}\left(\delta_k(1-p_2)\tau\alpha - (1-\delta_k p_2)D_k\right) & if\ \delta_k \geq \delta_k^* \end{cases}$$



The change in the expected value of marriage due to an increase in the proportion of spouses who are patient is positive for patient individuals. Thus, they have an incentive to segment their market to increase J_k.

For both examples, parameters are set to: p_1=0.5; p_2=0.5; τα=1.0; D_k=0.8. The cutoff time preference is δ_k^*=0.88889.

Appendix 2: NLSY Time Preference Variables – Correlations

	(1)	(2)	(3)	(4)
(1) School Before Marriage	1.000			
(2) Rotter_Plan	**-0.1942**	1.000		
(3) Smoked Daily Before Marriage	**-0.2467**	**0.0452**	1.000	
(4) No Contraception	**-0.1062**	0.0163	**0.1557**	1.000

Pairwise correlations. Bolded correlaitions are statistically different from zero with $p<0.0001$.

Appendix 3: NLSY Time Preference Variables – Factor Analysis

	Factor Loadings	Uniqueness	Scoring Coefficient on the Aggregate Measure of Patience
Rotter_Plan	0.1057	0.9888	0.08913
Smoked Daily Before Marriage	0.2971	0.9117	0.25618
No Contraception Before Marriage	0.2903	0.9157	0.25003

Maximum likelihood estimates for a factor analysis model with one factor retained

Appendix 4: Selected Full Regression Results (Table 4)

	Cox Proportional Hazard		AFT Survival Model	
	No TP Variables	TP: Smoking	No TP Variables	TP: Smoking
Smoked daily before Marriage		1.229		0.833
		(0.003)		(0.000)
Smoked daily after Marriage		1.185		0.894
		(0.031)		(0.060)
Female	0.911	0.910	1.050	1.048
	(0.124)	(0.120)	(0.269)	(0.283)
Age in 1979	0.988	0.988	1.008	1.008
	(0.000)	(0.000)	(0.000)	(0.000)
Age at Marriage	1.000	1.000	1.000	1.000
	(0.606)	(0.740)	(0.565)	(0.789)
Black	0.972	1.019	1.008	0.961
	(0.743)	(0.833)	(0.900)	(0.539)
Hispanic	0.754	0.802	1.230	1.158
	(0.001)	(0.010)	(0.000)	(0.015)
Other Race	1.293	1.304	0.916	0.892
	(0.216)	(0.208)	(0.627)	(0.527)
Children before Marriage	1.355	1.308	0.676	0.685
	(0.001)	(0.004)	(0.000)	(0.000)
Children within 9 months of Marriage	1.169	1.159	0.898	0.907
	(0.067)	(0.082)	(0.073)	(0.106)
Attends Church Weekly	0.871	0.900	1.106	1.085
	(0.034)	(0.108)	(0.031)	(0.084)
Intact Family at age 14	0.926	0.935	1.079	1.059
	(0.244)	(0.312)	(0.114)	(0.230)
AFQT Percentile	0.998	0.998	1.002	1.002
	(0.084)	(0.123)	(0.030)	(0.041)
Years of Schooling	1.006	1.023	1.000	0.986
	(0.734)	(0.194)	(0.989)	(0.308)
Own Home	0.503	0.519	1.583	1.559
	(0.000)	(0.000)	(0.000)	(0.000)
Age of Youngest Child	0.972	0.971	1.039	1.040
	(0.007)	(0.005)	(0.000)	(0.000)
Number of Children in Household	0.671	0.678	1.389	1.384
	(0.000)	(0.000)	(0.000)	(0.000)
Number of Observations	93399			
Number of Subjects	4197			
Number of Failures	1238			
Wald Chi2 /LR Chi2	479.21	507.57	529.1	558.32

Hazard Ratios presented. Significance (p-value) in parentheses.

Appendix 5: Means, Standard Deviations

	1979 Sample*	After Attrition Loss
Female	0.512	0.519
	(0.500)	(0.500)
Age in 1979 (in months)	223.174	220.958
	(26.477)	(27.290)
Age at Marriage (in months)	292.219	286.426
	(60.067)	(56.970)
Black	0.232	0.202
	(0.422)	(0.401)
Hispanic	0.198	0.158
	(0.398)	(0.365)
Other Race	0.012	0.019
	(0.109)	(0.137)
Children before Marriage	0.184	0.177
	(0.388)	(0.382)
Children within 9 months of Marriage	0.152	0.165
	(0.359)	(0.371)
Attends Church Weekly	0.314	0.323
	(0.464)	(0.468)
Intact Family at age 14	0.696	0.704
	(0.460)	(0.457)
AFQT Percentile	43.703	43.660
	(28.615)	(28.583)
Years of Schooling	12.639	12.537
	(2.375)	(2.351)
Own Home	0.457	0.406
	(0.498)	(0.491)
Age of Youngest Child	2.262	1.870
	(3.617)	(3.252)
Number of Children in Household	1.126	1.013
	(1.171)	(1.135)
Number of Subjects	8820	4137
Number of Failures	2477	1238