

Marriage and Divorce: Value of Waiting

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- Very Preliminary -

Abstract: This paper uses principles from option pricing theory to characterize the marriage and divorce decision. The framework is used to help interpret recent trends in marriage rates, divorce rates, and the mean and median ages of first marriage. In the presence of sunk costs of marriage and divorce, and amid uncertainty about the quality of a marriage match, individuals place a value on waiting before deciding whether to marry or divorce. The paper also considers what the consequences of recent marriage and divorce trends are on long run economic growth.

A Theory of Marriage and Divorce Based On Option-Pricing

-- Preliminary --

i) Why have marriage rates declined during the past two decades? Why have divorce rates increased over the same period? ii) What are the effects of these trends in family formation on long-run economic growth?

I investigate these questions in this paper. Using a simple household production model, I first characterize the gains from marriage and the gains from divorce. Both the decision to marry and divorce are analyzed jointly, whereas in previous work the focus has tended to be on one or the other, even though intuition suggests that the two kinds of decisions are not independent (eg. knowledge of a positive probability of divorce affects marriage behavior). Secondly I introduce (a) '**uncertainty**' and (b) **sunk** costs of marrying ('entry' cost) and of divorcing ('exit' cost). The role of sunk costs is to make a decision (whether it be to marry or divorce) costly to reverse. The uncertainty is over the productivity of household production after marriage. Couples with given traits are not certain how their traits will interact if they marry (or even during marriage). This uncertainty makes the "value" of marriage uncertain to a single individual, and makes the "value" of divorcing uncertain to a couple (since "things may improve later on"). The effect of uncertainty and sunk costs is to raise the hurdle above which a person decides to marry and lowers the hurdle below which a person decides to divorce. In other words, there is a value to "waiting".. As a result, people may not marry even if it is "profitable" to be married and remain married even if it is "profitable" to be divorced. A 'zone of inaction' or inertia arises (or the status quo maintained). In the literature, this is known as "hysteresis": the failure of an effect to reverse itself as its underlying cause is reversed (see Dixit (1991)).

The object is to try to explain the recent marriage and divorce trends using some principles from option pricing theory. A higher sunk cost of marrying and greater uncertainty could explain the declining rates of marriage and increasing median and mean ages of first marriage (for both sexes). Lower sunk costs of divorcing could explain the higher incidence of divorce. Uncertainty could also explain why divorces mostly occur after a duration of 8-9 years (since people wait to see if things do improve). Lower household productivity may explain both the declining marriage and rising divorce rates. A changing expected productivity of marriage also suggests that people will wait for "better" mates. A potential mate that seems inferior to another may appear better after more information is received or if changes in the person take place (ie. in the person's income, looks, status, education, character, and values). This simple framework cannot explain all the special cases or major trends in family stability and dissolution. Sociological, anthropological, and other economic theories also have a bearing, for example increased search costs (of finding a mate) may have delayed marriages for some because the opportunity cost of searching is higher: every hour spent searching is an hour away from productive market (or non-market) work. For others, increased search costs may stimulate early marriage since people will settle for second or third-best

mates for themselves¹. Nevertheless, the theory of "options" presents some insights that cannot be ignored. The option-based theory holds most strongly if individuals are (i) rational, (ii) forward-looking, and (iii) viewing family formation as an investment.

Again, this paper is not a comprehensive analysis of the economics of marriage and divorce. The aim is to focus on a narrow set of issues, and to lay the groundwork for further thought and research. The long term goal of this research project is to integrate the economic analysis of the "family" and growth theory. Already some work has been done linking endogenous growth and fertility (see Barro-Becker (1989)). After the determinants of marriage and divorce are analyzed, the next step is to ask what the consequences of recent trends in family formation and dissolution are for long run growth. A microeconomic model of the family will be used to derive aggregate implications for productivity growth trends across countries and across U.S. states. There are many reasons why there might be an important relationship between growth and family stability: (1) Studies (see Zill et. al. (1993)) show that a stable family is most conducive for human capital investments in children - not only in their skills but their values. Children of divorced parents, *ceterus paribus*, do less well in school than children of parents who are (happily) married. A divorced parent may invest less in the human capital of his/her children if the children stay with the other spouse who remarries. The benefits of human capital investment in children will be spread out among people who do not share their lives and interests. (2) Furthermore, if there are gains from marriage, marriage ought to increase the market and household productivity of married individuals, whether these gains are based on comparative advantage (i.e. specialization and division of labour) or on economies of scale. Thus, marriage has the potential to raise both market and non-market productivity. (3) Divorce activities take up scarce resources and time - for dividing assets and other property, and for determining the responsibilities over the caring of any children. Thus, the rent-seeking activities associated with divorce are likely to have an adverse effect on long run growth. (4) If there are asymmetric gains from divorce, that is, if one spouse is well off after divorce and the other worse off, and if the one who is worse off goes on welfare, adverse impacts on growth at the aggregate level may arise if divorces expand the ranks of welfare-recipients².

¹ Changes in search costs should be ambiguous because while they affect the time spent searching, there is no guarantee which decision the individual will choose (marriage or the single life). A good marriage yields positive net expected benefits while a bad marriage may yield negative net expected benefits, so that, for a risk-neutral individual, the ultimate decision is uncertain. Becker et al. assume that not marrying yields a normalized return of zero, so that the weighted average of zero and a positive net benefit of marriage causes a person to choose marriage if search costs are higher. But once the probability of divorce is allowed for, and the individual is forward-looking, this conclusion will not hold.

² It is possible for an economy to be trapped in a low "inefficient" equilibrium in which there are few families forming (and remaining). Slow expected growth may itself generate lower gains from marriage and magnify the existing effects of uncertainty and sunk costs.

The outline of this paper is as follows:

- (I) I present a simple household production model, and apply the theory of option pricing to it to show how the value of waiting affects marriage and divorce behavior under uncertainty and sunk costs.
- (II) I discuss some empirical issues - namely, is there evidence in favour of the predictions of the model? The model predicts (a) how the option elements affect the prevalence and timing of marriage and divorce, and (b) how family formation affects market production, which can be tested using a cross-section of 65 countries.

(I) Model and Analysis

-- Household Production Model --

Throughout I will be focusing on one agent's decision problem. Future work could model, game-theoretically, a two-agent decision-making problem (following Manser-Brown (1980) and McElroy-Horney (1981)), in which even if one person wants to marry another, the other may not, and vice versa. While the latter is more realistic (and ambitious), the essential insights concerning the value of waiting are captured in our simpler setting.

The **Single** individual considers the following problem:

$$(1) \quad \max_{\{c_M, c_N\}} V_s = \int_0^{\infty} e^{-\rho t} u(c_M, c_N) dt$$

subject to

$$(i) \quad c_N = A f(l) = A l^{\beta}, \quad 0 < \beta < 1$$

$$A = A(e)$$

$$(ii) \quad l + L = T$$

$$(iii) \quad wL = p c_M$$

$$(iv) \quad u(c_M, c_N) = \log c_M + \log c_N = \log A + \log c_M + \beta \log l$$

where ρ is the discount rate, c_M market good, c_N household (non-market) good, l leisure, L labour hours (in market work), w wage, p price of market good, e individual's ability or trait, and A the efficiency of household production. e can represent education, talents, religious and cultural heritage, and character. Equation (i) is the household production function, (ii) time endowment and allocation, (iii) the budget constraint, and (iv) the instantaneous flow of felicity.

Let the total endowment of time $T = 1$. Note from (iii) that we are not allowing for any lending and borrowing. One of the limitations of existing household production models is that the dynamics of household asset accumulation are ignored.

The first-order condition (F.O.C.) is $pc_M = \frac{wl}{\beta}$

Thus the solutions are:

$$l = \frac{\beta}{1 + \beta}, \quad c_M = \frac{w}{p} \left(\frac{1}{1 + \beta} \right), \quad c_N = A \left(\frac{\beta}{1 + \beta} \right)^\beta$$

Substituting these into $u(c_M, c_N)$ and the result into (1) yields

$$(2) \quad V_s = \frac{a + \omega + k_s}{\rho}$$

where

$$a = \log A$$

$$\omega = \log (w/p)$$

$$k_s = \log \left[\beta \left(\frac{1}{1 + \beta} \right)^{1 + \beta} \right]$$

Now consider the welfare-maximization problem when the individual is **married**. Replace (i), (iii) by

$$(i)' \quad c_N = A (1 + l^*)^\beta, \quad A = A(e, e^*)$$

$$(iii)' \quad wL + wL^* = p (c_M + c_M^*)$$

where the asterisks refer to the spouse.

Here I have assumed that couples earn the same w and face the same market price (even though men and women often purchase different kinds of products, eg. clothes and toiletries). The purpose is to focus on economies of scale. Like standard international trade theory, there are (at least) two kinds of gains from trade (or marriage): comparative advantage and economies of scale. Empirically in the trade literature, the gains from economies of scale are at least three times those from comparative advantage.

The main feature that makes marriage different from say cohabitation is that couples can better pool resources (as assumed in the new budget constraint

(iii)'), with access to legal recourse in the event of break-up. The same legal privileges and protection are not usually available to non-married couples. The gains from marriage are driven by the integration of l and l^* in (i)'. The new total factor productivity of household production, A , depends on how e and e^* interact. Some combinations of e and e^* are better than others. One couple's e and e^* may not be compatible, but those same e and e^* can be very productive when combined with those of other persons. The resulting effect on A therefore depends on the draw of who meets whom.

The married individual maximizes (1) subject to (i)', (ii), (iii)', (iv), and the F.O.C. of his/her spouse. Since l , l^* are perfect substitutes, I cannot at this level of simplicity, determine the exact composition of l , l^* - just the sum. Also, to both spouses, c_N is a public good (within the household). The solutions are:

$$l + l^* = \frac{2\beta}{2 + \beta}, \quad c_M = \frac{w}{p} \left(\frac{2}{2 + \beta} \right) = c_M^*, \quad c_N = A \left(\frac{2\beta}{2 + \beta} \right)^\beta = c_N^*$$

The discounted welfare of the married individual is:

$$(3) \quad V_M = \frac{a_M + \omega + k_M}{\rho}$$

where

$$a_M = \log A$$

$$\omega = \log (w/p)$$

$$k_M = \log \left[\beta \left(\frac{2}{2 + \beta} \right)^{1 + \beta} \right]$$

As long as $a_M = a$ (when single), and there are no changes in w , p , then $V_M > V_s$ because $k_M > k_s$. Of course the value of a_M may change upon marriage; it may fall if the quality of the match of e and e^* is poor - that is, the traits of the couple are not compatible³.

For simplicity, let us normalize $A = 1$ for the single individual, so that $\log A = 0$. Henceforth, $a_M = a$.

Under certainty, $V_M \geq V_s$ if $a \geq (k_M - k_s)$.

³ Note that compatibility can be either a positive or negative assortative mating.

Note that in the case where a is no worse than when single (say $a = a_M = 0$), definitely $V_M > V_S$ ⁴. Also average leisure - ie. $(l + l^*)/2$ - is less than the leisure devoted by either partner before marriage. This means that more labour hours are devoted to market production by each partner. The intuition for this is that economies of scale are in operation. The combined sum of leisure $(l + l^*)$ inputted into household production enables each spouse to consume at least the same quantity of c_N (the household good) that each consumed before marriage. In fact because $(2\beta/2 + \beta) > (\beta/1 + \beta)$, the two each consume more c_N and more of the market good c_M than when single. Being married enables each to reduce the costs of producing the household good and devote more time to market work (and thereby earn more income).

From an aggregate point of view, aggregate hours worked should increase (ceteris paribus) and aggregate market output should be higher if more people exploit economies of scale by marrying. Hence the level of GDP should be higher. Part II of this paper investigates this implication.

-- Introducing Modifications --

Now that the household model has been specified, I can address three problems associated with the marriage decision rule thus far (ie. marry if $V_M \geq V_S$): (1) it ignores Sunk Costs of Marrying (and Divorcing); (2) it does not allow for uncertainty about a , the total factor productivity of household production (and thus the gains from matrimony); (3) it assumes that marriage and divorce decisions are independent. The possibility of divorce and the feedback effect on the marriage decision should be considered⁵.

I will consider each of these points (1) - (3) in turn.

First, let us introduce sunk costs of marrying, I . The new critical condition is marry if

$$(4) \quad V_M - I \geq V_S \quad \text{or if} \quad a \geq \rho I + (k_S - k_M)$$

where ρI is the annuitized value of the sunk costs of investing in marriage.

To fix ideas, here is a list of what might constitute sunk costs of

a) Marriage: 1) Emotional and Financial Commitment (to and by

⁴ Some suggest that we should not be comparing V_M , V_S , but V_M and V_M' where the latter is the present value of marrying an alternative mate. This change in specification is easy to accommodate. One can either replace V_S by V_M' or define $\Delta_M = (V_M - V_M')$ and $\Delta_S = (V_S - V_M')$. The techniques of analysis are similar as are the insights to be derived.

⁵ Lommerud (1989) considers the risk of divorce on household division of labour and time, but does not integrate his analysis with the decision to marry. Also the probability of divorce in his model is exogenous.

- a) Marriage:
 - i) Emotional and Financial Commitment (to Friends and Family)
 - ii) Legal Costs, Wedding Ceremony
 - iii) Change of Status (for one can never be a 'Never Married' again, which may be a luxury in a world where there is a social stigma to being divorced)
 - iv) Costs of Relocation or other Start-up costs
- b) Divorce:
 - i) Initial Trauma, Disappointment, Possible Loss in Self-Esteem and Faith
 - ii) Legal Costs, Time at Court
 - iii) Initial Impact on Children, Friends, and other Family
 - iv) Relocation and Dismantling Costs; Loss of any Household-Specific Capital Accumulated
 - v) Permanent Alienation by Previous Acquaintances

Secondly, let us introduce uncertainty about $a = a_M$. The condition (4), ie. $V_M - I \geq V_s$, no longer applies. It is naive. There is an option to wait, search, and learn. The combination of uncertainty and sunk costs will lead to a significant postponement of marriage (and later, of divorce).

Assume 'a' evolves stochastically. That is, the TFP (total factor productivity) of household production is uncertain. It depends on whom one marries. After marriage, the TFP can change due to unexpected circumstances that are external or internal to the family (say, a meeting of new acquaintances, a move, a change in income/wealth, a change in health, appearance, character, or psychological condition, or children who are "rotten"). The couple may start out as a good match, but the quality of the match can deteriorate or improve over time. Thus one can think of 'a' as representing the stochastic evolution of the quality of the match. For simplicity, let:

$$(5) \frac{da}{a} = \theta dt + \sigma dz,$$

where dz is the increment of a standard Wiener process, uncorrelated over time, and $E(dz) = 0$ and $E(dz^2) = dt$.

The idea is that uncertainty about 'a' arises from small or gradual shocks, as opposed to big shocks (for example, where the spouse's character, identity, and ability are radically different after marriage or after divorce). This specification implies that the logarithm of 'a' has a variance of $(100 \sigma^2)\%$ per year.

In (5), θ represents the trend growth in the quality of the match, which may improve over time (exogenously) as the couple gets better acquainted before and during marriage (of course θ could be small or even negative). This parameter can also represent the effect of a couple becoming emotionally attached to each other over time, which makes it difficult for them to switch their emotional attachment to other persons and is assumed to enhance household productivity as both are more willing to work together.

The third step is to study the marriage and divorce decision jointly. An important weakness of existing work is that it does not bring these two facets of family-formation and decision-making together. In what follows, the marriage or divorce decision essentially reduces to a stochastic dynamic programming-optimal stopping problem. Let

(6a) $V_{ws}(a)$ = Expected Present Value of Being Single, Behaving Optimally - with the Option to Marry

(6b) $V_{wM}(a)$ = Expected Present Value of Being Married, Behaving Optimally - with the Option to Divorce

Being single yields a Dividend flow V_s , while being Married yields a Dividend flow V_M . Applying standard asset-pricing formulae gives:

$$E\left(\frac{dV_{wi}(a)}{dt}\right) = \rho V_{wi}(a) - V_i, \quad i = M, s$$

That is, the rate of return to "waiting" for an opportunity = the rate of capital gains plus the rate of dividends = the discount rate, ρ . V_{wi} can be thought of as the price of an intangible asset/investment.

Substituting (5) into the asset pricing formulae, applying Ito's lemma, and solving the resulting stochastic differential equations for the homogeneous and non-homogeneous parts, yields:

$$\begin{aligned} (7a) \quad V_{ws}(a) &= \text{Value of Being Single} & + & \text{Value of Option to Marry} \\ &= V_s(a) & + & B_s a^{\lambda_2} \\ (7a) \quad V_{wM}(a) &= \text{Value of Being Married} & + & \text{Value of Option to } \overset{\text{Divorce}}{\cancel{\text{Marry}}} \\ &= V_M(a) & + & B_M a^{-\lambda_1} \end{aligned}$$

where $V_s(a) = (\omega + k_s)/\rho$, $V_M(a) = a/(\rho - \theta) + (\omega + k_M)/\rho$ (where I used the fact that $E(dz) = 0$ and $E(\frac{da/dt}{a}) = \theta$). The roots of the stochastic differential equations from which V_{wi} ($i = s, M$) are derived are given by $\lambda_2 > 1$ and $-\lambda_1 < 0$. Both roots are functions of θ , σ , and ρ . In the solutions (7a-b), some parameter

restrictions were made so that if 'a' tends to zero, $V_w = V_s$ because there would be no value to marrying, and if 'a' tends to infinity, $V_w = V_M$ because there would be no value to divorcing.

Two kinds of optimality conditions are needed to determine the value of the positive constants⁶ B_s , B_M , and the trigger conditions a_H and a_L , where if $a > a_H$, the agent chooses to marry, and if $a < a_L$, the agent chooses to divorce.

The first kind of condition is the Value Matching Condition (VMC):

$$(8a) \quad V_{ws}(a_H) = V_{wM}(a_H) - I$$

$$(8b) \quad V_{wM}(a_L) = V_{ws}(a_L) - D$$

where D is the sunk cost of divorcing.

[Under certainty, we have instead:

$$V_s(a_H^*) = V_M(a_H^*) - I$$

$$V_M(a_L^*) = V_s(a_L^*) - D$$

Uncertainty drives wedges between the values under certainty and under uncertainty - namely $V_{ws} > V_s$ and $V_{wM} > V_M$.]

The second type of optimality (or efficiency) condition is the Smooth-Pasting Condition (SPC). At the "trigger" points, a_H and a_L :

$$(8c) \quad V_{wM}'(a_H) = V_{ws}'(a_H)$$

$$(8d) \quad V_{wM}''(a_L) = V_{ws}''(a_L)$$

otherwise a change in the value of 'a' can either prolong waiting or hasten a decision and thereby raise the lifetime welfare of an agent.

Substituting the expressions for V_s , V_M into the VMCs and SPCs, we can solve the **four** equations (ie. 8a-d) for the **four** unknowns (ie. B_M , B_s , a_H , and a_L) - but this must be solved numerically since the four conditions are highly non-linear.

Let a_H^* , a_L^* be the decision rules under certainty; that is,

$a > a_H^*$ - MARRY

$a_L^* < a < a_H^*$ - if single, WAIT - do not marry yet;
if married, WAIT - do not divorce yet.

⁶ Note that the B's are positive as long as the option to wait has value.

$$a_L^* < a \quad - \text{DIVORCE}$$

where $a_H^* = (I + (k_S - k_M)/\rho)(\rho - \theta)$, $a_L^* = (-D + (k_S - k_M)/\rho)(\rho - \theta)$.

If $B_S = B_M = 0$, then trivially, $a_H = a_H^*$ and $a_L = a_L^*$, since $V_{ws} = V_S$ and $V_{wM} = V_M$. But for $B_S \neq 0$ or $B_M \neq 0$, or both:

$$a_H = a_H^* - (1,2)\sigma^2 a_H^2 \Gamma''(a_H) > a_H^*$$

$$a_L = a_L^* - (1,2)\sigma^2 a_L^2 \Gamma''(a_L) < a_L^*$$

where $\Gamma(a) = V_{wM}(a) - V_{ws}(a)$, and $\Gamma'(a_H) < 0$ and $\Gamma'(a_L) > 0$.

In other words,

$$(9) \quad a_L < a_L^* < a_H^* < a_H$$

The zone of inaction is wider (or extra 'inertia' is created). This zone is of course defined by the region $a_L < a < a_H$ within which the agent does not marry (if single) and does not divorce (if married).

-- Comparative Statics --

Most of these results are intuitive:

- i) If $(k_M - k_S)$ increases, the economies of scale are larger, and thus V_M is higher so that a_H and a_L decrease, meaning that the agent stays married longer or marries sooner.
- ii) If V_S increases (that is, if the value of the 'Single Life' increases), both a_H and a_L increase; the agent stays single longer or divorces sooner.
- iii) If either of the sunk costs (D or I) increase, a_H increases while a_L decreases, thereby widening the zone of inaction. For example, if D is higher, it not only makes exiting costs higher for married persons, but it impacts negatively on single people. The single person is likely to wait longer if it is tougher to exit a marriage. Likewise, if I is higher, a married person is likely to wait before divorcing because remarrying costs are higher. This illustrates that there is an interdependence between factors affecting marriage and divorce behavior.
- iv) If σ increases, this especially widens the zone of inaction (or increases 'inertia'). Small increases in σ can cause the trigger points (a_H and a_L) to deviate significantly from their certainty counterparts.

v) If θ (the trend rate of "attachment") increases, marriage occurs with a lower threshold level of a_H , and once married, the individual is willing to hang on longer.

vi) If ρ increases, that is, if the individual becomes more impatient, a_H decreases while a_L increases. The agent would marry sooner and divorce more easily.

-- Discussion and Implications --

The Value of Waiting (to exercise the call options to marry or divorce) has not been formally incorporated in the existing literature, even though sociology studies find that this is an important factor in human relationships (ie. dating and mate selection) -- (see Clayton, 1978, Chapter 13). An exception is a recent analysis by Bergstrom-Bagnoli (1993) who attribute the value of waiting to signalling - that is, a person needs some time to reveal his/her type to a potential mate (or play a strategy to pretend to be of a different type). Informally, other previous works (see Becker et al. (1978) in particular) have argued that imperfect information and uncertainty (especially about finding the right mate or best available mate) may lead individuals to "rush into marriage", and thereby face higher probabilities of divorce (assuming rushed decisions are correlated with poor decisions)⁷.

This analysis, in contrast, cautions that if individuals are rational and treat marriage as a kind of investment, they will wait rather than rush into marriage. For singles, Marriage is an investment Option. By exercising the Option to Marry, an individual loses the possibility of exercising it later in possibly more favourable circumstances or with possibly better mates.

Greater uncertainty raises the value of the option to wait, meaning that, if the individual is single, the present value of marrying a particular spouse must be sufficiently high in order to compensate for the loss of the increased option value of waiting. Similarly, if the individual is married, the value of turning single again (and possibly marrying someone else) must be sufficiently high enough to compensate for the loss of the option to wait before exercising the Option to Divorce. The theory of option pricing helps determine when it is optimal to exercise these options; the decision rules are given by the relevant pair of triggers (a_H and a_L).

Another way to understand the intuition is to compare the benefits of waiting versus making a decision. Suppose that $V_M - I = V_S$. If the person marries, the benefits are $V_M - I = V_S$. Suppose the person waits, and 'a' improves next instant with 50% probability. If the individual marries then, the benefits are $V_M - I > V_S$. If 'a' deteriorates instead with 50% probability, the person does not marry and the benefits of this decision remain V_S . Thus, for a risk-neutral

⁷ which may be why "many a good hanging prevents a bad marriage." (Shakespeare *Twelfth Night*).

individual, the expected (weighted average) net benefits of waiting exceed V_s . Hence the individual will wait. At some point, the opportunity cost of waiting to marry is too high⁸, and a decision is made. That is, the 'holding premium' falls the longer one waits. There is a risk that someone else will marry that person (or that that person will be interested in someone else). The same thought experiment can be carried out for the divorce decision.

Hence one explanation for why marriage rates have declined and why median and mean ages of first marriage have risen may be that individuals have chosen to wait, and that this choice is an optimal response to uncertainty (about the value of marriage and/or about potential spouses) and to increased sunk costs of marrying.

Next, how can we explain the rising divorce rates using this option-based model? There are several possibilities:

i) Low exit costs, D . (There may be some psychological or other reason for an asymmetry here - namely that marriage is perceived as a decision that is very costly to reverse while the decision to divorce is perceived as less costly to reverse. One reason may be that divorced couples can keep in touch with one another and with the rest of the family. Another may be that there is always the chance of reconciliation because of the commitments and investments made during marriage which divorced couples later regret losing and want to restore, something they can probably do more cheaply than can couples who begin a new marriage).

ii) A downward bias in ' a ', the quality of the match (or the productivity of household production). Over time, ' a ' may follow an inverted U-shaped path over time. That is, ' a ' rises initially to induce marriage and eventually falls. Rational agents know that possibility but marry nonetheless because the present value of marrying and later divorcing may still exceed the present value of staying single. For example, consider the marriage patterns of Hollywood actors and actresses, who face higher risks of divorce but marry among themselves nonetheless. There must therefore be net present value gains from this strategy. For many of them, ' a ' may eventually fall because their occupation leads them to spend less time with one another and to meet new people frequently. A lower ' a ' generally would explain both the low marriage and divorce rates. Are people really less compatible these days - that is, do they make poorer matches? Why? These questions are beyond the scope of this paper.

iii) A rise in V_s , the value of being single. The 1980s and early 1990s were periods of change, of a 'revolution' in dating patterns and lifestyles. I suspect that the new attitudes, new tastes, and new lifestyles of this generation have affected V_s . More and more people are cohabiting, or have children out of wedlock. There are now close substitutes for activities that traditionally have

⁸ For example when the individual observes $V_M - I \gg V_s$, the forgone benefits of marrying outweigh the benefits of waiting.

taken place within the (legally and/or religiously sanctioned) family - such as intimate physical and emotional relations, household production and resource-pooling, child rearing, and joint human and financial asset accumulation. In addition, there is no "commitment" (from a legal, as opposed to moral, point of view) on the part of singles who cohabit. For them, switching partners is less costly than divorcing.

Despite the higher rates of divorce, there is some evidence of WAITING before divorcing - which is a feature of the option-based model of marriage and divorce. A plot of the distribution of divorces against the duration of marriages is seen to be hump-shaped (ie. an inverted-U) -- see Chart 2 and Figures 6, 7. That is, for each age group at first marriage, the majority (roughly 25-30%) divorce after 9 years of marriage. Even for people who marry when they are 40-44 years of age, the majority of those who divorce do so after a duration of 8-9 years. Thus this is mild evidence for inertia (that is, for people preferring to wait before divorcing). After the peak of 9 years, a greater percentage would rather call it quits than that preferring to stay married longer.

Across age groups, a greater percentage of the age group that is older at the time of marriage tends to have a shorter duration of marriage. For example, 10% of those who are 40-44 years old^{at the time of marriage} divorce^{in one year} while 10% of those who are 20 years old^{at the time of marriage} divorce^{after 2-4 years}. This may indicate that the cost of giving up is smaller at the higher age of marriage group. But as the duration of marriage is lengthened, the older groups are more willing to hang on. Perhaps reaching retirement makes the exit costs higher.

(xx & later divorce)

(II) Empirical Issues

This section contains some tentative empirical results concerning some predictions of the household model and concerning the consequences of reduced family formation rates on long-term productivity growth, as measured by changes in the logarithm of real per-capita Gross Domestic Product.

Regression Equations 1 - 6 are cross-country regressions of the growth of per-capita real GDP and marriage and divorce variables. An implication of the household production model, in which the marrying individuals have the same preferences and earn the same real market wage, is that marriages will increase both market and non-market productivity because of economies of scale. While the model is very simple, it is worth taking a glance at what the international data can tell us.

I have based the regressions on the standard Solow growth model, in which family formation rates affect the aggregate Total Factor Productivity term:

$$(10) \quad \Delta y = \text{constant} + \alpha_0 y_0 + \alpha_1 [(1/y) - (n + g + \delta)] + \alpha_2 [\text{marriage/divorce variables}]$$

where n is the population growth rate, $g = 0.02$ the exogenous efficiency growth rate, and $\delta = 0.03$ the depreciation rate. y is per-capita output and i per-capita real investment. y_0 is the initial level of per-capita income; if per-capita incomes and growth rates of countries converge in the long run, we should expect $\alpha_0 < 0$.

Future research should model human capital investment, fertility, and include a discussion of the conditions for aggregation across families.

The sample period is 1960-85. The full sample consists of 65 countries (developing and advanced). Most of the data are from the World Bank and the Marriage/Divorce data are from the U.N.'s Statistical Yearbook. In the regressions, the variables are:

C	--	constant
Y0	--	log of initial per-capita GDP (1960)
IYNGD	--	log ($i/y - (n + g + \delta)$)
M	--	log of mean age of first marriage (men)
F	--	log mean age of first marriage (women)
MLESSF	--	$M - F$
MAR	--	log of marriage rates (per 1000 population)
DIV	--	log of divorce rates (per 1000 population)
LGDIF	--	log (per-capita GDP (1985)) - log (per-capita GDP (1960))

The results indicate that a higher mean age of women at first marriage is conducive to growth. This finding is related to a study by the World Bank⁹ that finds that increased educational attainment of females and a reduction in the gap between educational attainment levels of males and females ~~are~~ ^{are} conducive to economic growth. The mean ages of marriage are likely to be picking up the effects of educational attainment since those who marry later have a chance to complete or increase their education. Consequently, the positive impact on economic growth of a higher mean age of women at first marriage may be proxying the higher rates of human capital accumulation by women. As the World Bank study finds, this latter development has contributed positively to growth.

This finding weakens the case that "comparative advantage" constitutes the main gains from marriage. Some researchers expected higher female education

⁹ see the World Bank's Development Report 1991, Chapter 2.

attainment levels to slow growth as women may spend less time in non-market work, thus reducing the gains from the division of labour. Instead, the economies of scale effects from having both husbands and wives being better educated seem to dominate; well-educated couples (and thus couples who are relatively older at the time of first marriage) are likely to enjoy more intra-family human capital spillovers. It is interesting to note that empirical work in the international trade literature finds that the gains from trade due to economies of scale tend to be larger than the gains from trade due to comparative advantage.

Note though that the mean age of men at first marriage does not contribute significantly to growth. One reason might be that a higher mean age of marriage is correlated with, and therefore reflecting, reduced marriage rates of men - and reduced marriage rates are expected to affect growth negatively since economies of scale and human capital investments in the next generation are forgone. Another reason might be that this variable (ie. mean age of men at first marriage) is imperfectly proxying for educational attainment. Keeley (1979) finds that male education has no statistically significant effect on men's age at entry into the 'marriage market'. However the interaction of the ages of men and women at first marriage is significant (see the variable $M \cdot F$ in regression equations 2 and 3); that is, if both men and women marry at an older age, GDP growth can be enhanced. In addition, the narrower the gap between the ages of men and women at first marriage (ie. $M - F$), the better for growth. Again, I believe that these latter two variables are picking up the effects of higher educational attainment of women and of the narrowing of the educational attainment gap between men and women, both of which have been found to promote economic growth and development.

Regarding the ages at first marriage, one could also argue that if people wait too long to marry, they would not create the economies of scale that make increased non-market and market productivity possible. One suggestion has been to model quadratic terms in the regression equations (ie. M^2 or F^2). This way we could see if growth peaks at a certain age at first marriage and falls thereafter. I have tried this and have found the quadratic terms to be insignificant. One reason is that the data show that most ages at first marriage are 30 years or below - and mostly between 23-25 years of age. If say a mean age at first marriage of 38 years is theoretically bad for growth, there are no countries in the sample for which we can test this hypothesis. More importantly, one cannot infer from the ages at first marriage whether marriage rates are higher. It is possible for people to marry late and yet for society to experience higher rates of marriage. What matters for growth is the rate of aggregate family formation, particularly of the formation of "good" families in the sense that compatible individuals (ie. those who make a high quality match) are brought together who raise their market and non-market productivity, who invest in the human capital of the next generation, and who avoid the rent-seeking and resource-redistribution activities of families that dissolve or whose union is "unstable".

But if higher mean ages of first marriage do translate into a significant economy-wide postponement of the decision to form families, long run growth will be adversely affected. It is therefore important to note that ages of first marriage and marriage rates per se are different variables. The option-based model predicts that 'uncertainty' combined with sunk costs will reduce marriage rates; and where marriages occur, the persons will generally be older because they have been waiting. Thus, to determine if more families in the aggregate are formed, one must focus on the marriage rate less the divorce rate; to see how the quality of marrying individuals plays a role (that is, to examine their pre-marital accumulations of human and other capital), one should also focus on the ages at the time of marriage.

In any event, the regressions show that higher marriage rates contribute positively to long run growth. I doubt that the correlation implies the reverse explanation - namely, that higher growth drives marriages. If agents are forward-looking, they are likely to base their decisions on expected future income, not current. The more plausible story is the "investment" effect of family formation on long run growth.

Divorce rates are not significant in these regressions. I expected a negative contribution to growth given our discussion of the rent-seeking activities (such as legal battles) that take place during divorce proceedings. I plan to examine the relationship between divorce rates and economic growth using developed country data only - for example a panel data set of OECD countries and a cross-sectional data set of U.S. states. The reason is that in many developing countries, divorces rarely take place. This may have something to do with their conditions of political and civil liberties or their cultural and religious practices. Figure 21 indicates that divorce rates are highest among advanced nations - hence the interest in narrowing the sample to developed countries only. It is possible then to capture a significant negative relationship between growth and divorces.

In conclusion, more research work should follow. There is much scope for examining the impact of family behavior and formation on macroeconomic performance.

Guide to the Figures and Charts

Fig 1. Marriage Rate of Men, 15 years +
(Rate per 1,000 Population)

Fig 2. Marriage Rate of Women, 15 years+
(Rate per 1,000 Population)

Fig 3. Median Age of Men at Marriage (years)

Fig 4. Median Age of Women at Marriage (years)

Fig 5. Divorce Rate U.S.A.
(Rate per 1,000 married women 15 years of age +)

Chart 1. Divorce Rates by Age of Men and Women at time of Decree
(Rates are Divorces per 1,000 married population)

Chart 2. Percentage Distribution of Divorce by duration of marriage,
U.S.A 1986.

Fig 6 Percentage of Distribution of Divorce by duration for each Age
Group at time of marriage, Men 1986(U.S.A.)

Fig 7 Percentage of Distribution of Divorce by duration for each Age
Group at time of marriage, Women 1986(U.S.A.)

Fig 8 Trends in Singulate mean Age at Marriage, North America,
Oceania, and the USSR, 1950 - 1985.

Fig 9 Northern Europe.

Fig 10 Southern Europe.

Fig 11 Western Europe.

Fig 12 Northern Africa.

Fig 13 Southern Africa.

Fig 14 Trends in Singulate mean Age at Marriage Asia 1945 - 1987
Eastern Asia.

Fig 15 Western Asia.

Fig 16 Southern Asia.

Fig 17 South - Eastern Asia.

Fig 18 Mean Age of First Marriage (Men) and Per-Capita GDP 1960-85, International.

Fig 19 Mean Age of First Marriage (Women) and Per-Capita GDP 1960-85, International.

Fig 20 Marriage Rates and Per-Capita GDP 1960-85, International.

Fig 21 Divorce Rates and Per-Capita GDP 1960-85, International.

Fig 1

Marriage Rates of Men, 15 years +
(Rate per 1,000 Population)

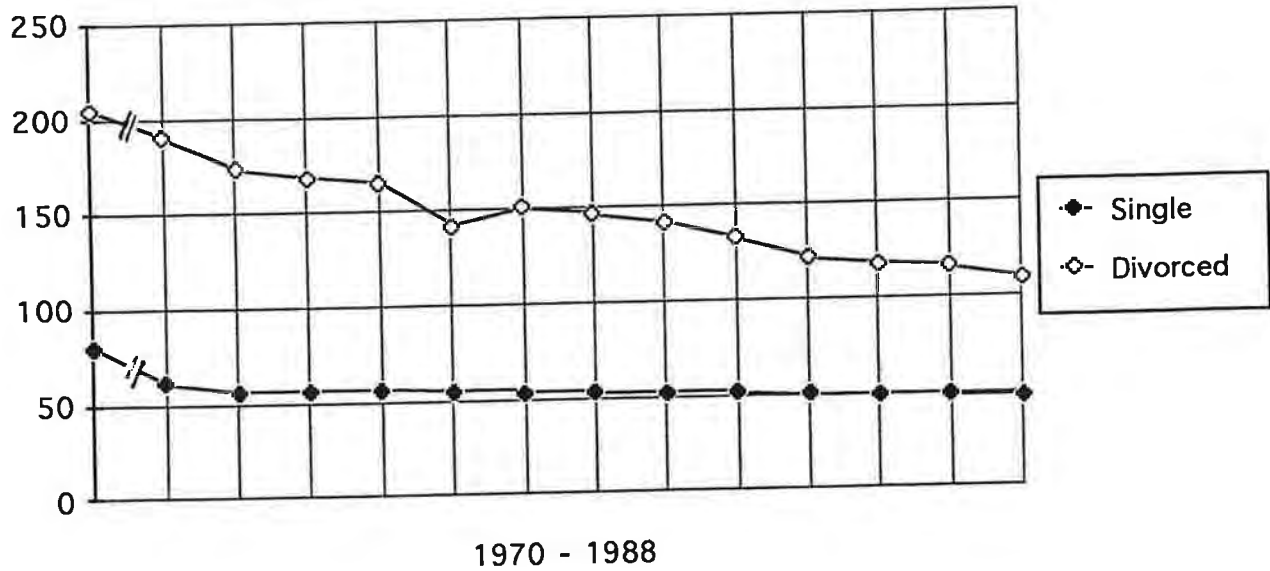


Fig 2

Marriage Rates of Women, 15 years +
(Rate per 1,000 Population)

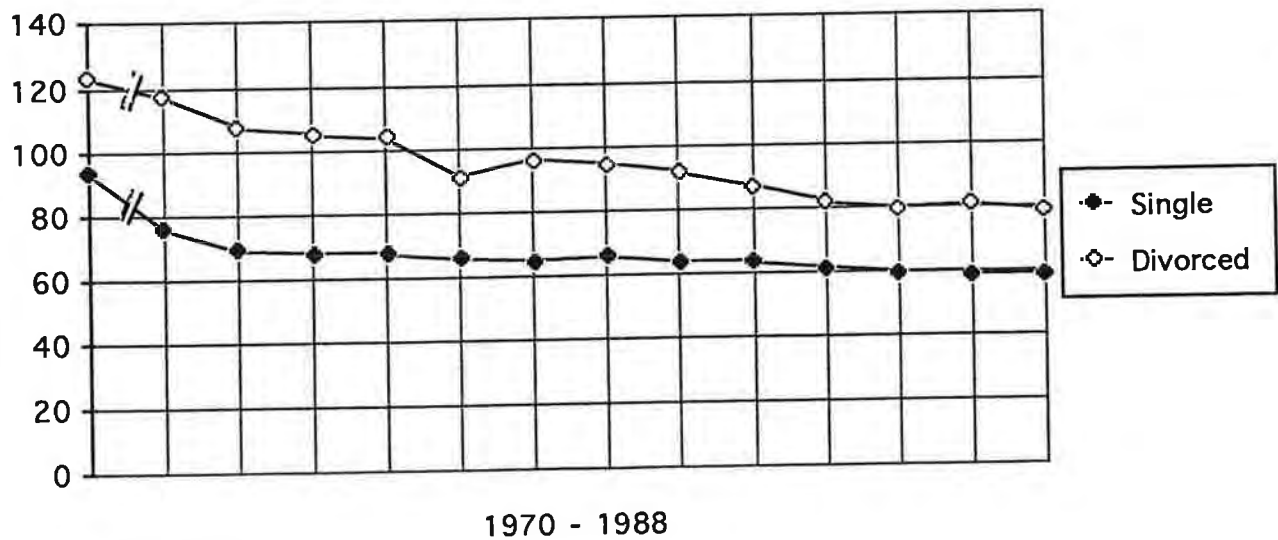


Fig 3

Median Age of Men at Marriage (years)

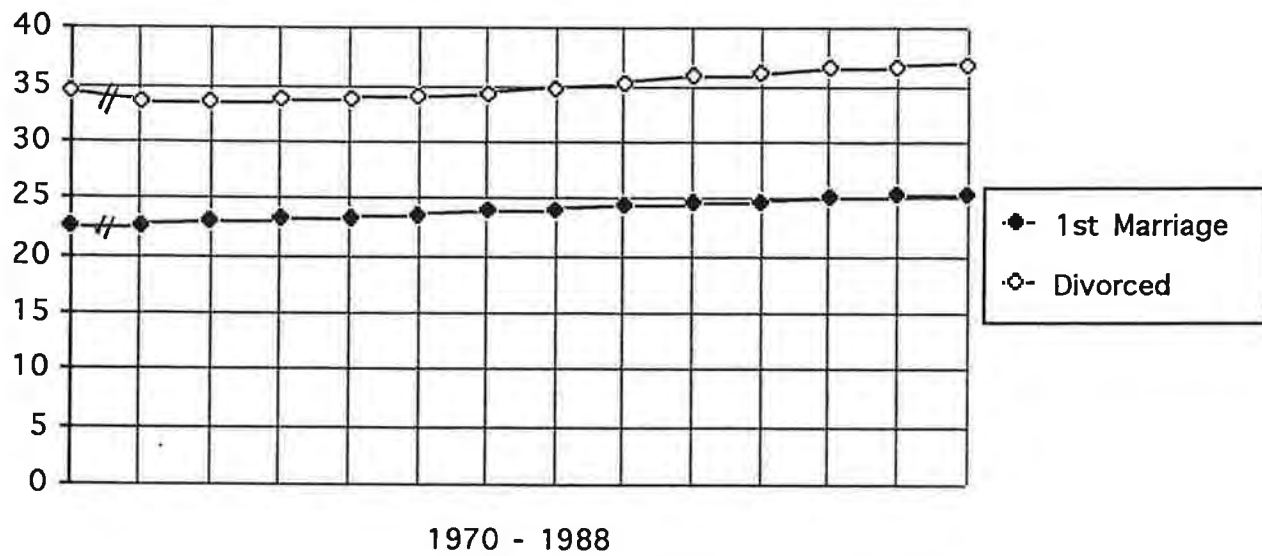


Fig 4

Median Age of Women at Marriage (years)

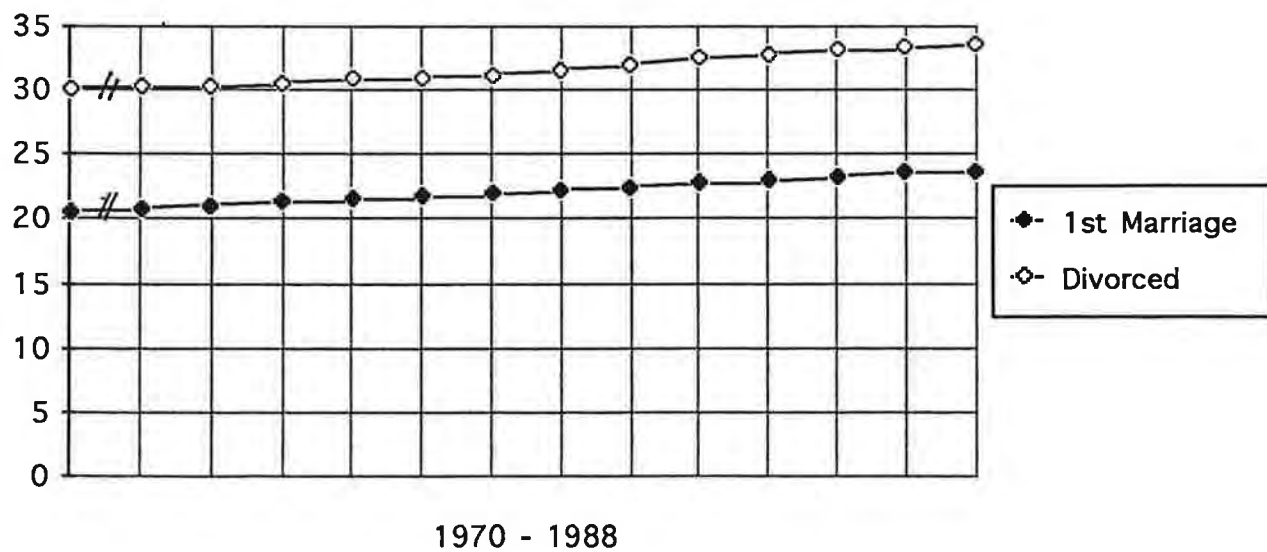


Fig 5

Divorce Rate USA
(Rate per 1000 Married Women 15 yrs of Age +)

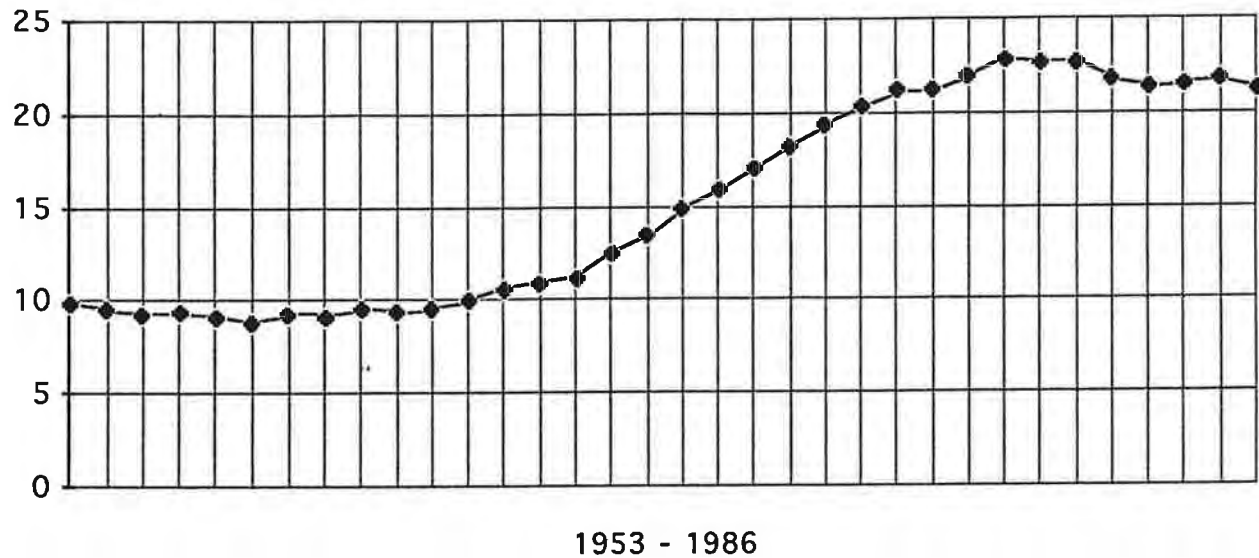


chart 1

Divorce Rates by Age of Men and Women at Time of Decree

(Rates are divorces per 1,000 married population)

Age at Time of Decree:	Men			Women		
	1980	1983	1986	1980	1983	1986
19 years and under	29.3	43.3	41.2	42.4	48.1	51.4
20 - 24 years	46.9	45.2	49.5	47.2	43.3	46.2
25 - 29 years	41.4	40	38.2	37.8	35.7	34.8
30 - 34 years	33.8	32.4	30.6	29.2	27.7	27.7
35 - 39 years	26.8	27.3	25.4	23.3	23.9	23
40 - 44 years	21	21.5	22.2	16.7	18.2	18.8
45 - 49 years	14.5	15.9	17.2	10.8	12.1	12.8
50 - 54 years	9.5	10.7	10.8	6.6	7.3	7.6
55 - 59 years	5.8	6.2	6.4	3.9	4.1	4.2
60 - 64 years	3.7	3.9	4.2	2.7	2.8	2.8
65 years and over	1.9	2	2	1.4	1.5	1.5

Chart 2

Percentage Distribution of Divorces by Duration of Marriage, USA 1986

Age at Time of Marriage:	Duration of Marriage at Time of Divorce Decree								
	under 1 year	1-2 years	3-4 years	5-9 years	10-14 years	15-19 years	20-24 years	25-29 years	30 years +
MEN									
under 20 years	1.88	12.45	13.87	26.18	17.51	12.26	7.42	4.49	3.95
20-24 years	2.12	13.50	14.79	25.64	15.83	11.95	7.95	4.16	4.06
25-29 years	3.34	18.26	17.90	28.62	14.04	7.80	4.56	2.70	2.77
30-34 years	4.98	21.43	20.73	29.52	12.14	5.39	2.75	1.68	1.38
35-39 years	7.27	23.83	21.16	27.29	10.88	5.01	2.57	1.02	0.98
40-44 years	9.32	26.27	20.26	26.24	10.84	4.64	1.50	0.59	0.34
45 years and over	13.26	28.47	18.45	24.88	9.90	3.24	1.24	0.20	0.36
WOMEN									
under 20 years	1.71	12.45	13.79	25.47	16.98	11.86	8.31	4.81	4.30
20-24 years	2.47	14.90	16.24	26.78	14.98	11.13	6.73	3.45	3.32
25-29 years	4.30	20.37	20.09	29.88	13.44	6.13	2.60	1.44	1.75
30-34 years	6.65	24.45	20.66	29.36	10.79	4.08	1.97	1.07	0.99
35-39 years	10.69	28.51	20.27	24.53	9.06	3.44	1.78	0.85	0.88
40-44 years	11.22	27.89	20.05	24.47	9.73	4.39	1.39	0.47	0.39
45 years and over	14.89	29.26	18.81	22.57	9.40	3.48	1.04	0.32	0.24

(Based on those who reported duration of and age at marriage)

Fig 6

Percentage Distribution of Divorces By Duration for Each Age Group at Time of Marriage, MEN 1986 (USA)

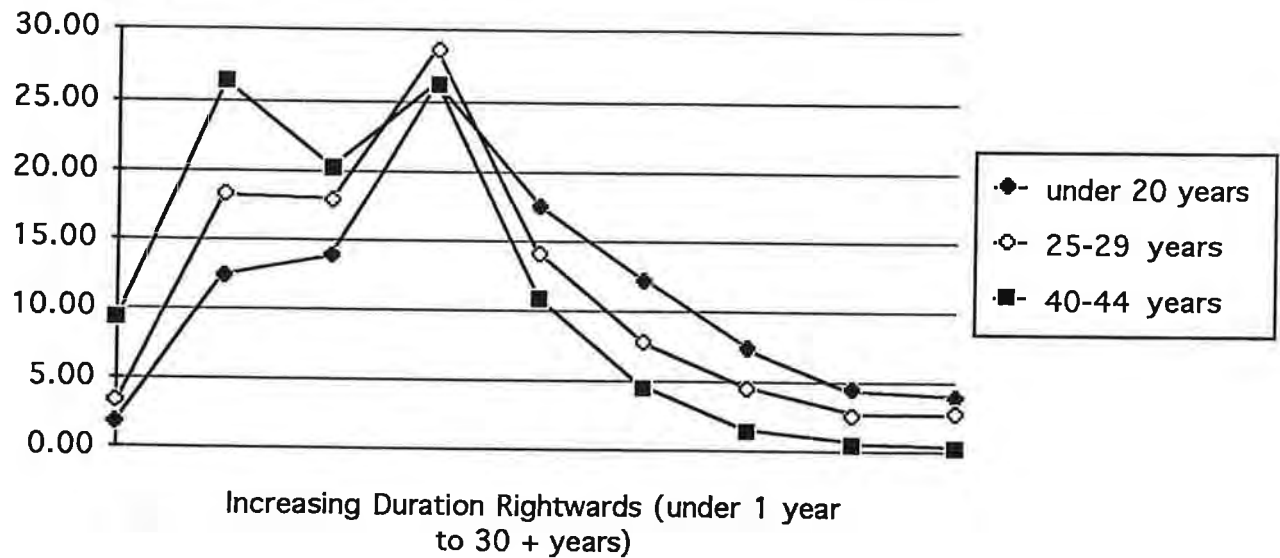
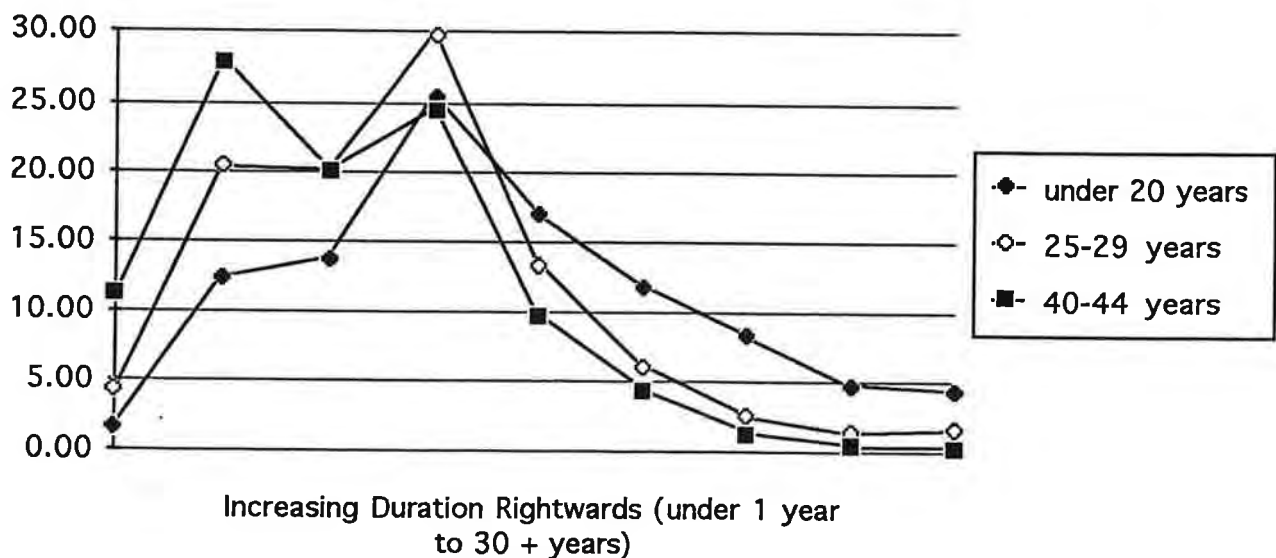


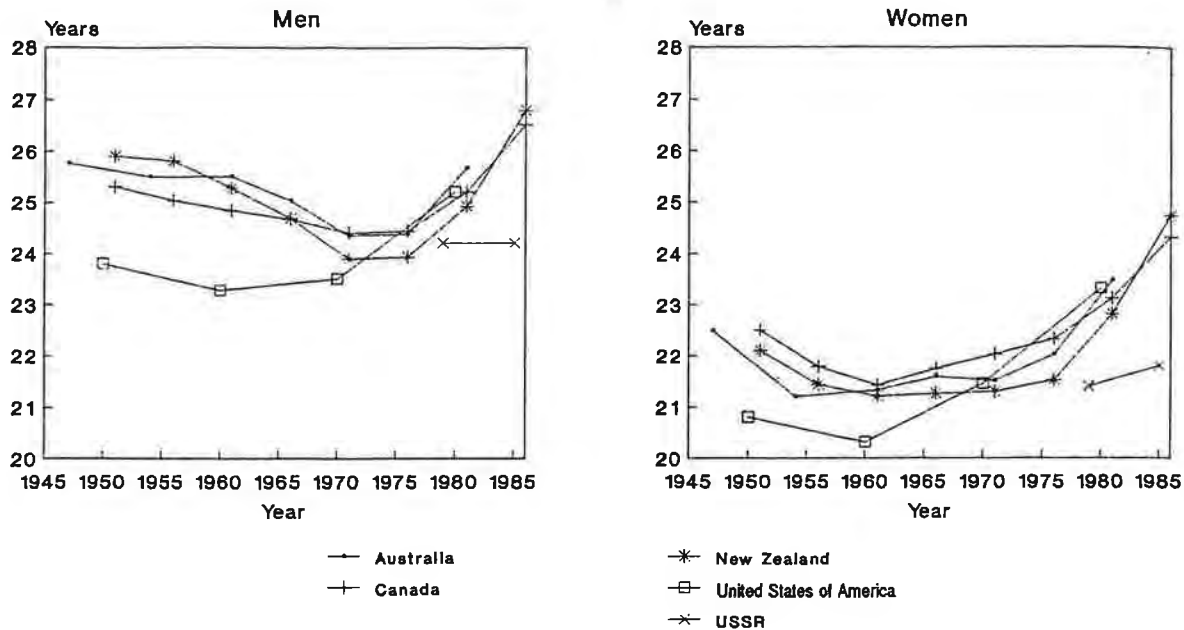
Fig 7

Percentage Distribution of Divorces By Duration for Each Age Group at Time of Marriage, WOMEN 1986 (USA)



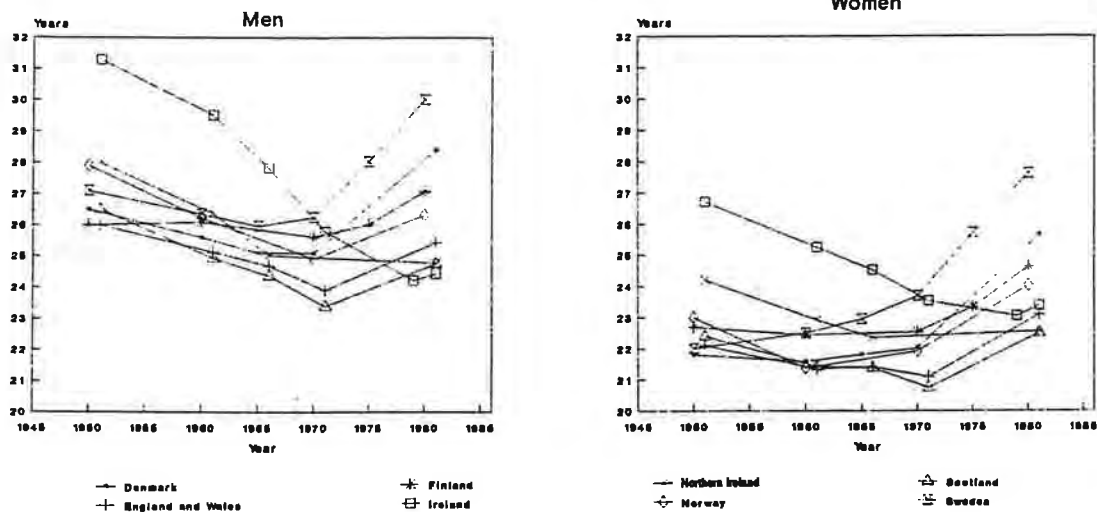
Trends in singulate mean age at marriage, Northern America, Oceania and the USSR, 1950-1985

Fig 8



Northern Europe

Fig 9



Southern Europe

Fig 10

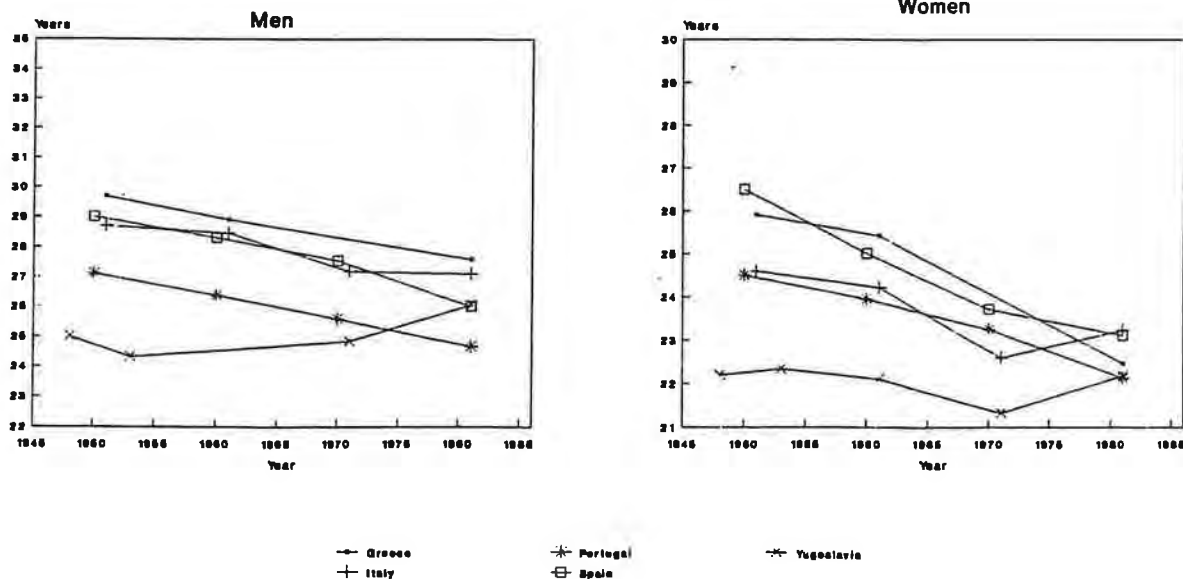


Fig 11

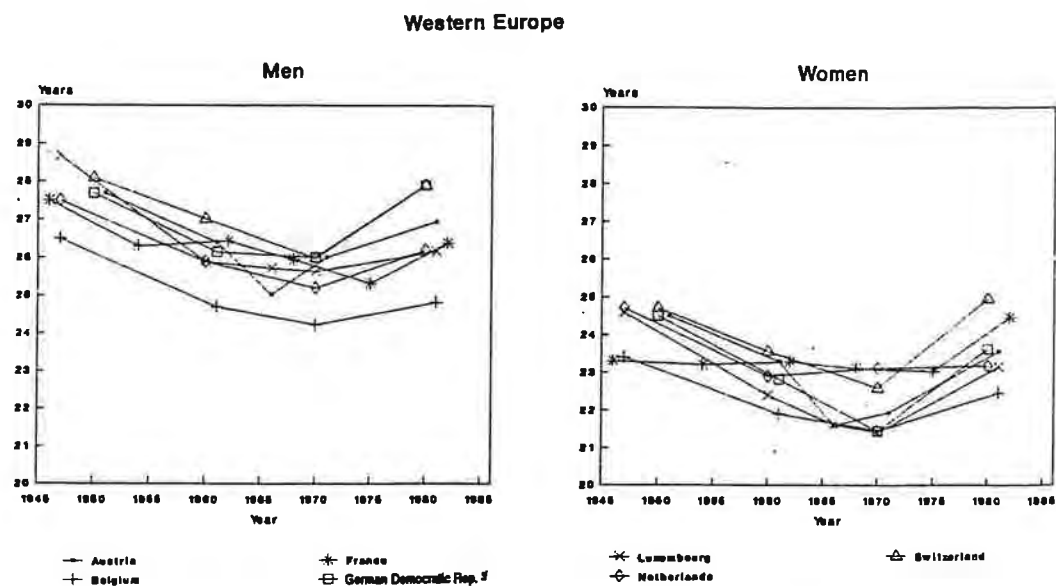


Fig 12

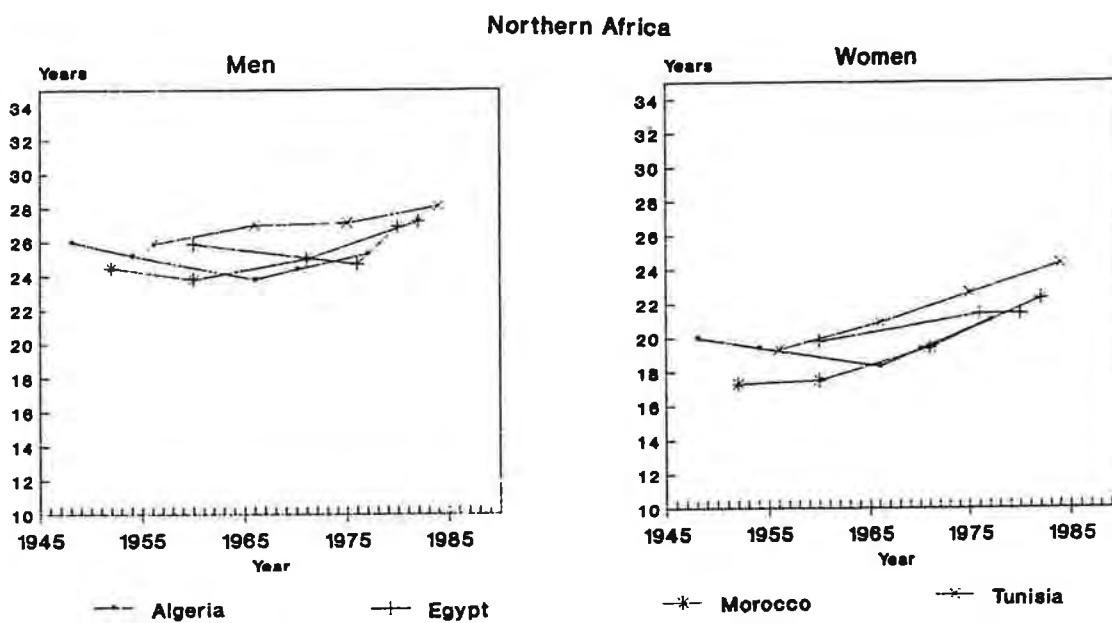


Fig 13

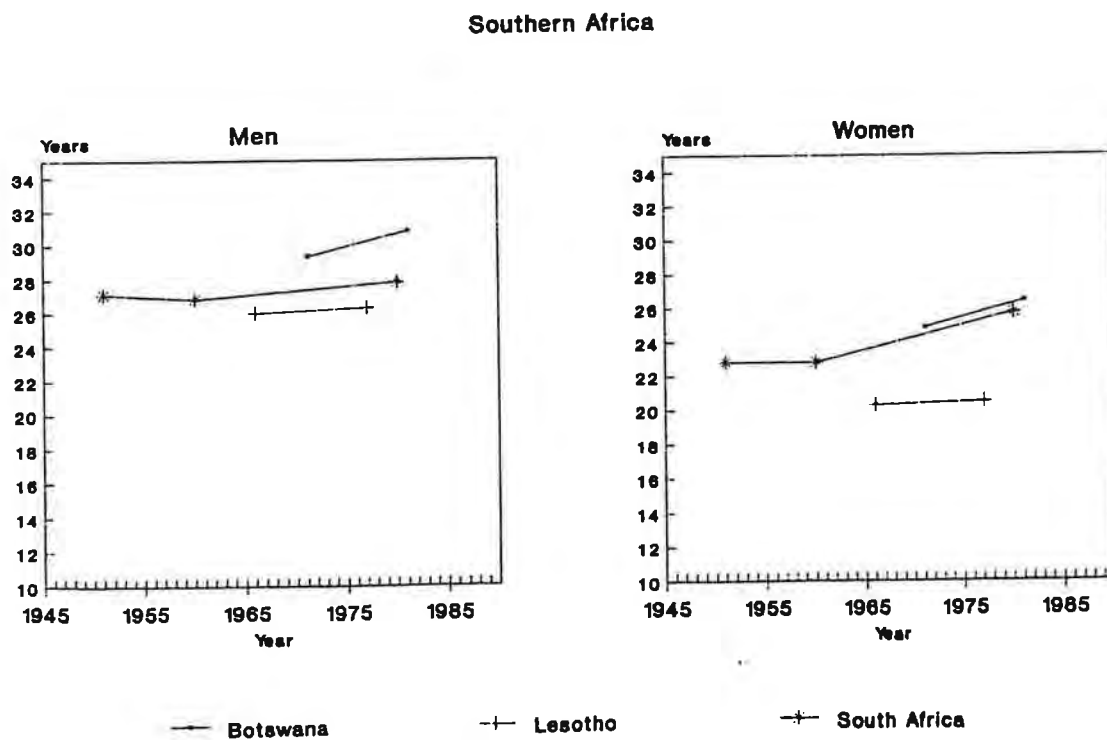
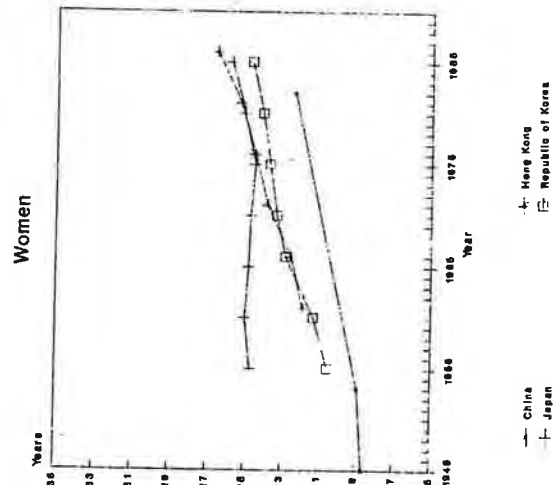
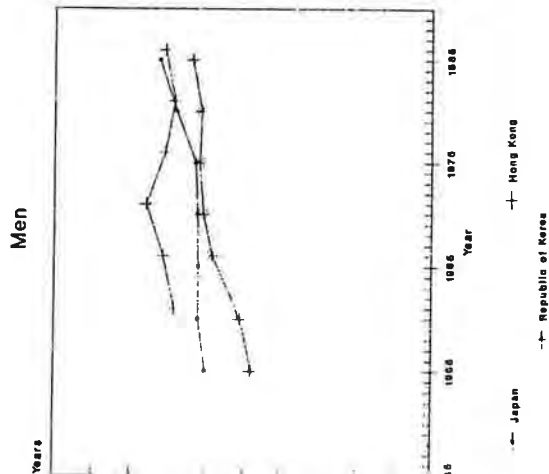


Fig 14

Eastern Asia



Western Asia

Fig 15

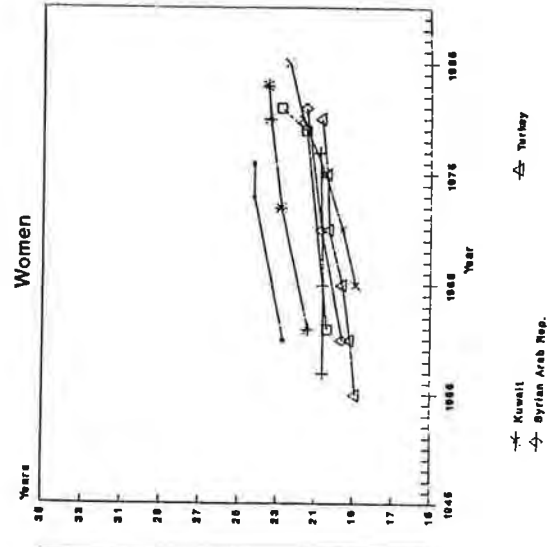
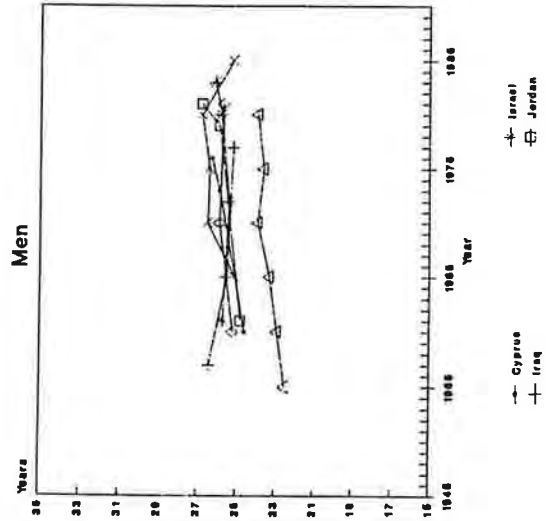


Fig 16

Southern Asia

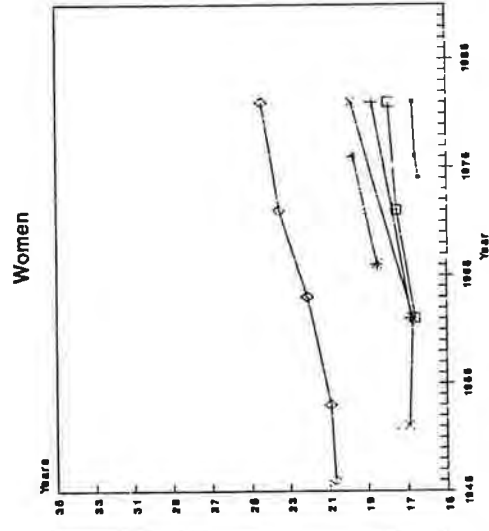
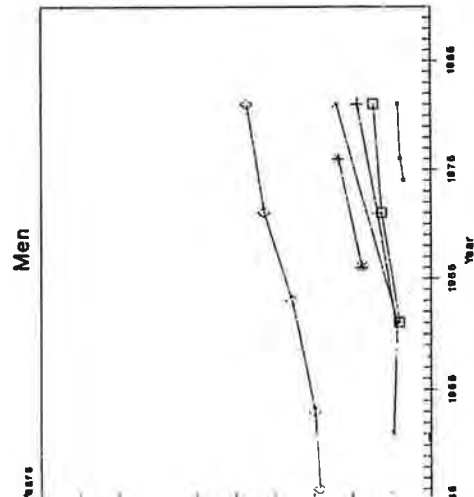


Fig 17

South-eastern Asia

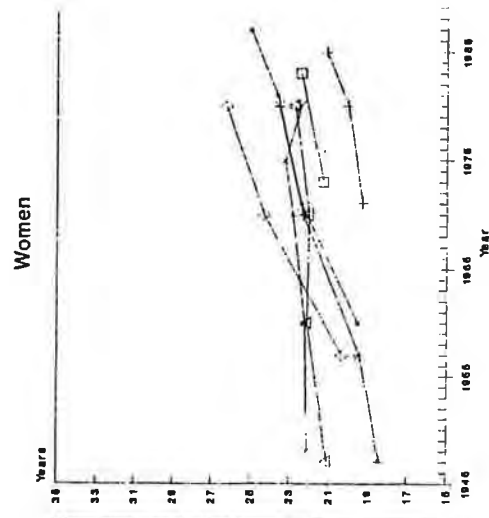
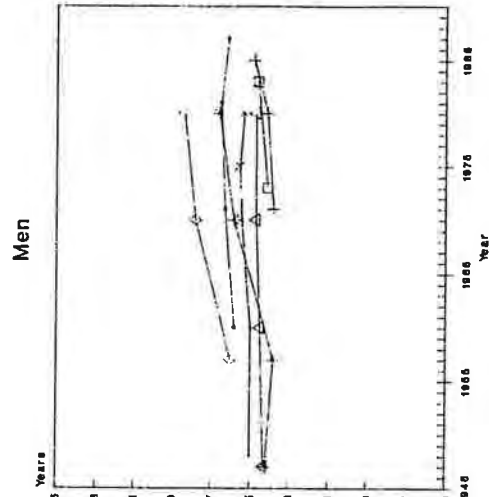


Fig 18

Mean Age of First Marriage (Men) and Per-Capita GDP 1960-85, International

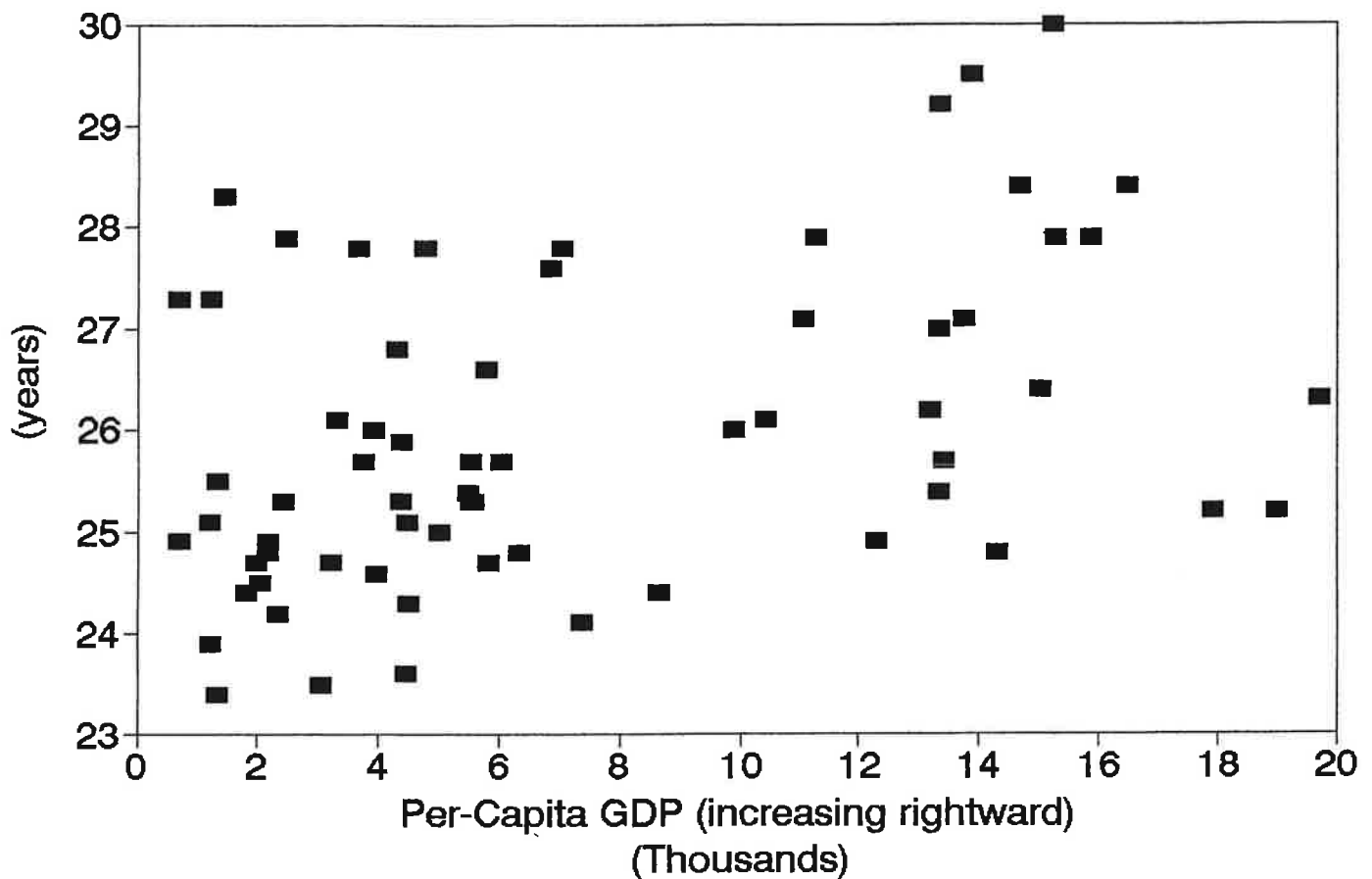


Fig 19

Mean Age of First Marriage (Women) and Per-Capita GDP 1960-85, International

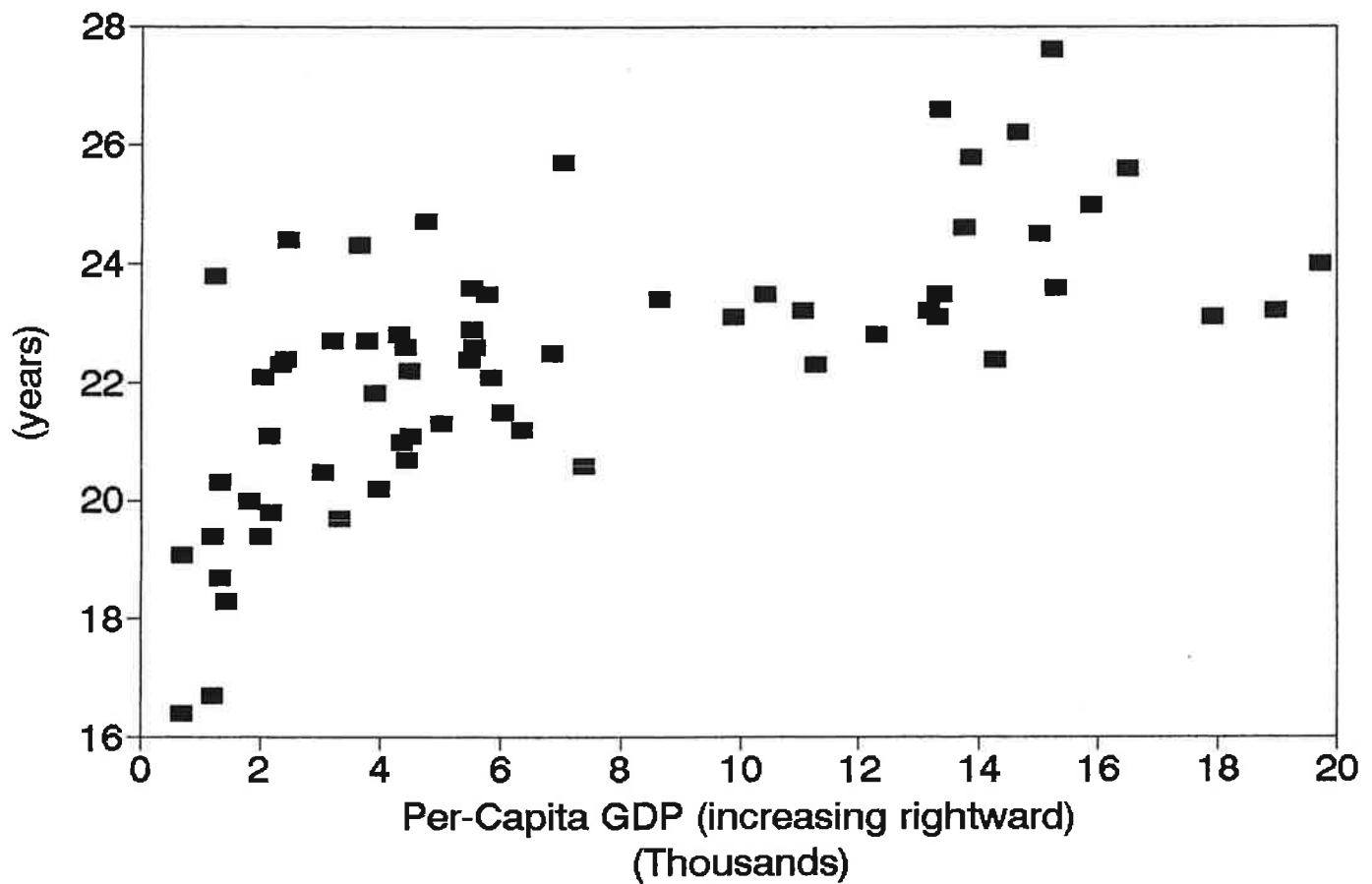


Fig 20

Marriage Rates and Per-Capita GDP 1960-85, International

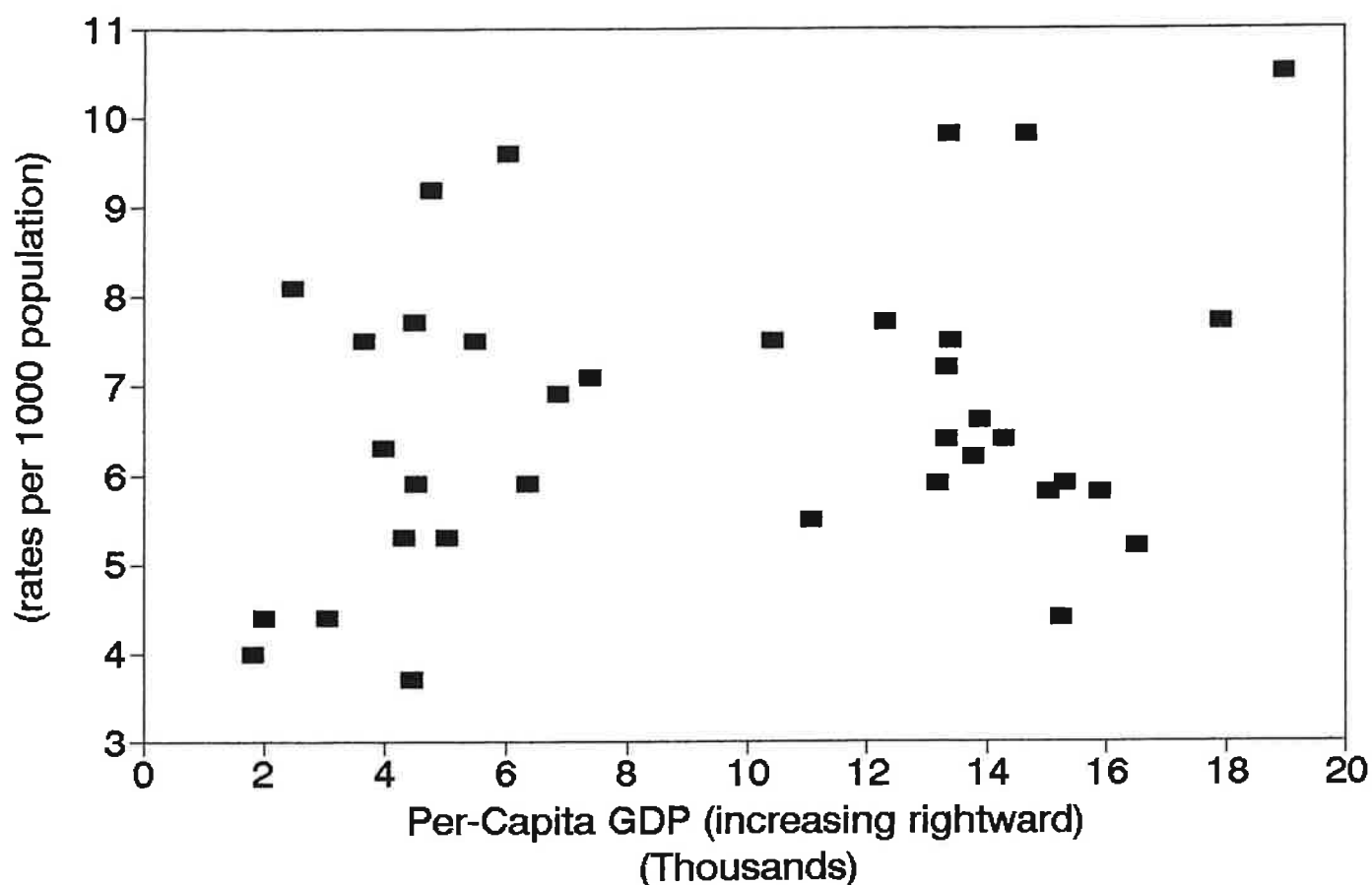
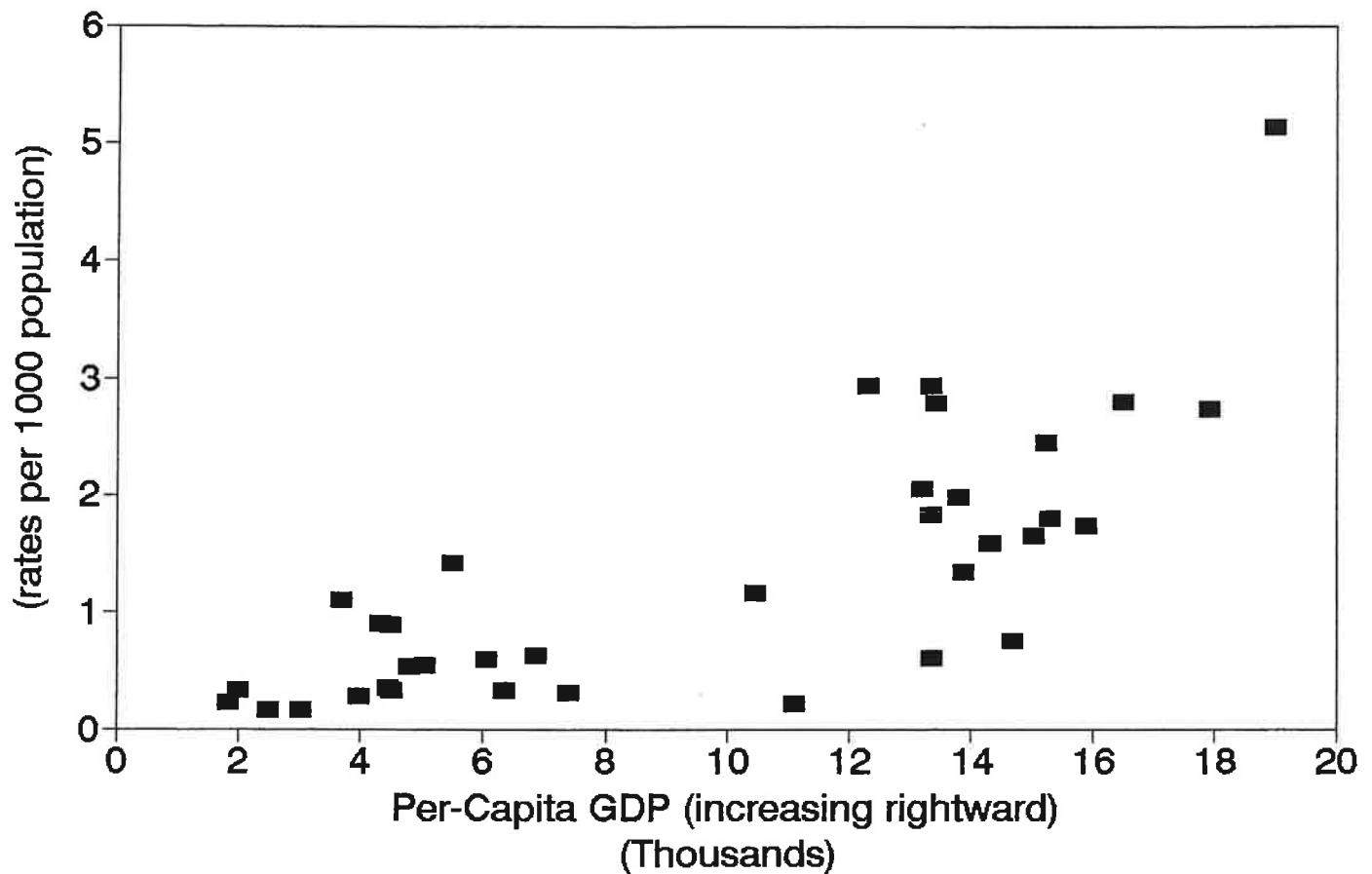


Fig 21

Divorce Rates and Per-Capita GDP 1960-85, International



Equation 1

Method of estimation = Ordinary Least Squares

Dependent variable: LGDIF
Current sample: 1 to 65
Number of observations: 65

Mean of dependent variable = .570709 Adjusted R-squared = .482760
Std. dev. of dependent var. = .397321 Durbin-Watson statistic = 1.93626
Sum of squared residuals = 4.89921 F-statistic (zero slopes) = 15.9334
Variance of residuals = .081653 Schwarz Bayes. Info. Crit. = -2.26421
Std. error of regression = .285751 Log of likelihood function = -8.20831
R-squared = .515087

Variable	Estimated Coefficient	Standard Error	t-statistic
C	-3.64059	2.14022	-1.70104
Y0	-.326583	.059639	-5.47600
IYNGD	.399509	.099212	4.02681
M	-.140097	.763585	-.183473
F	2.22099	.546882	4.06119

Equation 2

Method of estimation = Ordinary Least Squares

Dependent variable: LGDIF
Current sample: 1 to 65
Number of observations: 65

Mean of dependent variable = .570709 Adjusted R-squared = .458411
Std. dev. of dependent var. = .397321 Durbin-Watson statistic = 1.97618
Sum of squared residuals = 5.21533 F-statistic (zero slopes) = 19.0570
Variance of residuals = .085497 Schwarz Bayes. Info. Crit. = -2.26590
Std. error of regression = .292399 Log of likelihood function = -10.2405
R-squared = .483798

Variable	Estimated Coefficient	Standard Error	t-statistic
C	-1.60677	.946408	-1.69776
Y0	-.293164	.058631	-5.00018
IYNGD	.419007	.101000	4.14857
MF	.407281	.099407	4.09712

Equation 3

Method of estimation = Ordinary Least Squares

Dependent variable: LGDIF

Current sample: 1 to 65

Number of observations: 65

Mean of dependent variable = .570709

Adjusted R-squared = .483590

Std. dev. of dependent var. = .397321

Durbin-Watson statistic = 1.93426

Sum of squared residuals = 4.89135

F-statistic (zero slopes) = 15.9831

Variance of residuals = .081522

Schwarz Bayes. Info. Crit. = -2.26581

Std. error of regression = .285521

Log of likelihood function = -8.15614

R-squared = .515865

Variable	Estimated Coefficient	Standard Error	t-statistic
C	-.339928	1.12155	-.303087
Y0	-.325938	.059565	-5.47194
IYNGD	.398972	.099135	4.02451
MLESSF	-1.14796	.575848	-1.99352
MF	.327098	.105072	3.11308

Equation 4

Method of estimation = Ordinary Least Squares

Dependent variable: LGDIF

Current sample: 1 to 53

Number of observations: 53

Mean of dependent variable = .597368

Adjusted R-squared = .577483

Std. dev. of dependent var. = .401399

Durbin-Watson statistic = 2.31947

Sum of squared residuals = 3.33574

F-statistic (zero slopes) = 24.6907

Variance of residuals = .068076

Schwarz Bayes. Info. Crit. = -2.46595

Std. error of regression = .260914

Log of likelihood function = -1.91541

R-squared = .601859

Variable	Estimated Coefficient	Standard Error	t-statistic
C	2.21203	.543640	4.06892
Y0	-.390324	.064121	-6.08732
IYNGD	.683378	.091858	7.43952
MAR	.472036	.145022	3.25492

Equation 5

Method of estimation = Ordinary Least Squares

Dependent variable: LGDIF

Current sample: 1 to 36

Number of observations: 36

Mean of dependent variable = .631506 Adjusted R-squared = .644793
 Std. dev. of dependent var. = .423534 Durbin-Watson statistic = 2.67934
 Sum of squared residuals = 2.03896 F-statistic (zero slopes) = 22.1780
 Variance of residuals = .063717 Schwarz Bayes. Info. Crit. = -2.47291
 Std. error of regression = .252423 Log of likelihood function = .597680
 R-squared = .675239

Variable	Estimated Coefficient	Standard Error	t-statistic
C	4.11590	.788374	5.22075
Y0	-.508132	.093238	-5.44986
IYNGD	.698863	.112481	6.21317
DIV	.093395	.073090	1.27780

Equation 6

Method of estimation = Ordinary Least Squares

Dependent variable: LGDIF

Current sample: 1 to 36

Number of observations: 36

Mean of dependent variable = .631506 Adjusted R-squared = .737252
 Std. dev. of dependent var. = .423534 Durbin-Watson statistic = 2.92324
 Sum of squared residuals = 1.46109 F-statistic (zero slopes) = 25.5519
 Variance of residuals = .047132 Schwarz Bayes. Info. Crit. = -2.70663
 Std. error of regression = .217099 Log of likelihood function = 6.59628
 R-squared = .767281

Variable	Estimated Coefficient	Standard Error	t-statistic
C	2.69815	.789742	3.41649
Y0	-.460282	.081346	-5.65833
IYNGD	.718979	.096911	7.41897
MAR	.529413	.151195	3.50152
DIV	.022105	.066077	.334536

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