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## Abstract

This paper considers family formation and reciprocity-based cooperation in the form of sharing of earnings-risk. While risk sharing is one benefit to marriage it is also limited by divorce risk. With search in the marriage market there may be multiple equilibria diering not only in divorce rates but also in the role of marriage in providing informal insurance. Publicly provided insurance, despite potential equilibrium multiplicity, is shown to aect family formation and financial cooperation monotonically. Some aspects of the model are then tested using international survey data and a bivariate probit model with sample selection.

Keywords: Marriage, divorce, risk-sharing.

JEL Classification: J12, D11, D83, H30.

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# I Introduction

Marriage as an institution has changed dramatically in the post-war era. The patterns are the same in many countries: age at first marriage has increased, cohabitation as a format for partnership has become more popular; but perhaps more pronounced than any other indicator is the rapid increase in the number of divorces. These trends continue to be controversial. In particular, the issue of increasing divorce rates is sensitive for very good reasons: most notably, the concern is for the children who are likely to become the victims of divorce.

Paralleling the rapid growth of divorce rates has been the expansion of welfare state arrangements in most developed countries. By providing a wide range of support such as e.g. unemployment insurance, benefits to lone parents etc. welfare state arrangements make it easier for individuals to cope on their own, and can therefore be expected to affect family structure.

Taking a negative view it is conceivable that a main effect of public benefits and transfers is to crowd out private informal transfers and to make couples less willing to "stick it out". Then if there are negative externalities associated with divorces – most notably on the children – there is a case for adopting a sceptical view. However, welfare state arrangements may also allow individuals to gain financial independence from their partners. In such an environment partnerships would be presumably be formed and maintained, not for financial security, but for "love". Thus, social policies may enable individuals to spend more time in healthy relationships.

Indeed, a number of recent contributions have started to consider the effects of welfare policy on family structure (see below). Many of these studies have used simulation models calibrated to US data; however, a casual look at the data reveals that the US is, in international comparison, exceptional by having a relatively low level of social expenditures compared to e.g. most European countries while still having the highest aggregate divorce rate. Figure 1 which plots social expenditures as percent of GDP against aggregate divorce rates for a number of OECD countries reveals at best a positive association.[1]

The purpose of this paper is to suggest a simple framework for analyzing some of the issues involved. The model incorporates marriage and divorce, and cooperation between partners in the form of voluntary sharing of earnings-risk. A main starting point for the model presented is that financial cooperation between partners is generally not legally enforced.

[1] Social expenditures include old-age cash transfers, disability cash benefits, occupational injury and disease, sickness benefits, family cash benefits, unemployment compensation, early retirement benefits, as well as expenditures on health and housing.

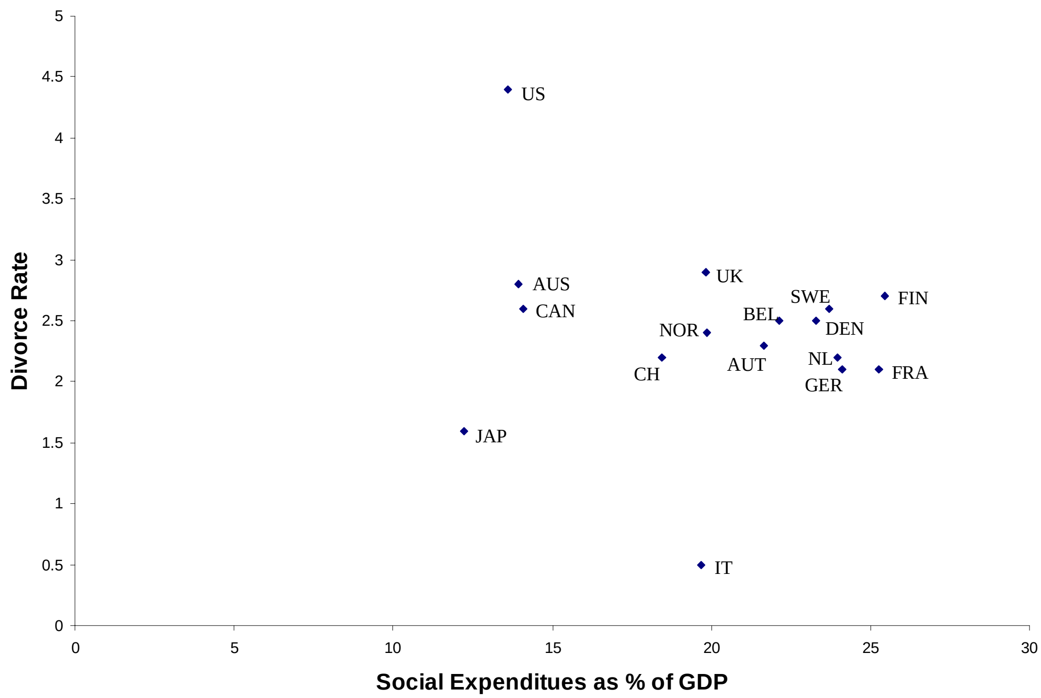


Figure 1: Social expenditures (% of GDP) and aggregate divorce rates for a number of OECD countries. Year: 1995. Source: OECD Social Expenditure Database 1980-1997 and Euromonitor.

The first part of the paper sets up a model with a couple who can cooperate by sharing earnings-risk but also have the option of divorcing. Match-quality varies over time and divorce occurs when the net benefit of remaining married (which includes the benefits from risk-sharing) becomes negative. The earnings of each partner fluctuates and a couple thus have the option of smoothing their individual consumption paths through voluntary transfers. However, absent legal enforcement risk-sharing is sustained by expected reciprocity, which in turn is limited by the presence of a divorce risk.

The model is closed by the introduction of a marriage market with search. Given "agglomeration" in search, multiple equilibria may occur; these will then exhibit qualitative differences: whereas one equilibrium may exhibit a low "turnover" in the marriage market and a high degree of financial cooperation, another equilibrium will exhibit the converse pattern of high "turnover" and less risk-sharing by partners. Equilibrium multiplicity thus offers a potential explanation for cross-country heterogeneity in divorce rates and attitudes towards the economic role of marriage.

The model is then used to consider the effects of policy. It is shown that, despite potential equilibrium multiplicity, publicly provided earnings insurance affects family formation monotonically, increasing turnover in the marriage market and reducing the role of the family in providing risk-sharing. Given that there are potentially multiple equilibria, a natural question is which is better: a high- or a low-turnover equilibrium? This answer to this question is argued to be ambiguous when cooperation is supported by reciprocity.

Finally I present an empirical analysis using international survey data. I estimate a bivariate probit model with sample selection, where in the first stage the dependent variable is whether or not the respondent is married (or has a steady life-partner) and in the second, for those individuals that do have partners, the dependent variable is whether they are pooling incomes with their partners.

The current paper draws on number of different strands of literature. The literature on marriage and divorce was pioneered in the seminal papers by Becker (1973) and Becker, Landes and Michael (1977) and is surveyed in Weiss (1997). Recently Drewianka (2000) has used a model somewhat similar to ours – albeit with a focus on relation-specific investments – to consider a number of proposals for reforms in the legislation surrounding marriage. Hess (2001) uses micro-level data to try to infer the importance of risk-sharing and love by considering how different properties of the individuals' income streams affect the probability of divorce.

There is a growing literature on marriage markets with search. An early contribution is Mortensen (1988). More recently search models of the marriage markets have been used to consider social phenomena; e.g. Burdett and Coles (1997) consider the possibility of endogenous assortative mating. Burdett et al. (1999) have considered the effect of continued search for better partners while matched and show that this option can create multiple equilibria. Chiappori and Weiss (2000) note that, if finding a new partner is uncertain, then divorcing individuals will find it privately optimal to enter insurance arrangements involving post-divorce transfers conditional on the event or "non-event" of remarriage.

A growing literature considers the effect of welfare policies on family structure and welfare. Aiyagari et al. (2000) use a model with marriage market search to consider intergenerational income mobility. The impact of social policies on income distribution, transmitted through a marriage market with search and through endogenous fertility, is also considered in Greenwood et al. (2000a). Neal (2000) looks at the interplay of marriage market conditions and government policy in determining the attractiveness of out-of-wedlock childbearing (See also Greenwood et al. (2000b)).

The current analysis also draws on the growing literature on voluntary risk-sharing. This literature originated with the contributions by Kimball (1988) and Coate and Ravallion (1993). Kocherlakota (1996) and Ligon et al. (1997) noted that optimal risk-sharing arrangements are generally not stationary (even when the underlying income-generating process is). Ligon et al. (1998) introduce savings and Foster and Rosenzweig (2000) introduce altruism between the agents sharing risk. The current paper contributes to this literature by allowing for endogenous breakups by partners sharing risk; on the other hand only "stationary" risk-sharing arrangements are considered – conditioning of current transfers on past transfers is not allowed.

The paper is organized as follows. Section II sets up the basic risk-sharing model. Section III studies the risk-sharing and divorce behavior of a given married couple. Section IV considers the effect of marginally extending formal insurance on risk-sharing and divorce while still ignoring family formation decisions (marriage and remarriage). Section V introduces the marriage market and Section VI considers the features of the steady state equilibria. Section VII discusses a number of extensions while Section VIII presents the empirical analysis. Finally Section IX concludes.

# II The Risk-Sharing Model

In this section the basic risk-sharing model is set up. The model is highly stylized and abstracts from a number of issues that can be expected to be important. E.g. I abstract from children and other relations-specific investments, as well and differences in earnings-expectations across individuals. The reason for doing so is to focus more clearly on the risk-sharing aspects of marriage, while keeping the model tractable. All of the above mentioned omission are, however, discussed in Section VII.

In this section, as well as the following two, the focus will be on a given married couple. The state of the marriage is described by a match-quality variable. This variable is intended to capture two aspects of the relationship. First, it is intended to capture feelings of love. Second, it is also intended to capture all economic gains from the marriage except risk-sharing; this can include e.g. benefits from specialization and the consumption of public goods. To capture the notion that "love comes and goes" the match-quality evolves stochastically as a simple Markov chain. The couple can then be expected to divorce when the match-quality falls sufficiently low.[2]

In each period, each partner also receives a random income; for simplicity incomes are assumed to be uncorrelated across time and individuals. The partners can smooth their consumption by engaging in risk-sharing through voluntary transfers. However, given that transfers between the partners are not legally enforced they must be based on expected reciprocity. As such the sustainability of voluntary risk-sharing will be limited by the divorce risk; however, since risk-sharing is one benefit from marriage it also influences the divorce decision. Each partner always has the option of walking away from the marriage ("no-fault divorce").

## Match Quality

Let $\theta \in R$ denote match-quality. For simplicity – and to focus on transfers between partners as a risk-sharing device – partners are assumed always to agree on the match-quality. There is a finite set of match qualities, $\Theta = \left\{\theta^0, ..., \theta^N\right\}$ which is ordered increasingly: $j > i$ implies $\theta^j > \theta^i$. Let $\pi_{ij}$ denote the probability that the match-quality will be $\theta^j$ next period given that it is $\theta^i$ in the current period.

Assumption 1. *The Markov transition matrix* $\Pi = \{\pi_{ij}\}_{i,j=0}^N$ *is regular and satisfies the following stochastic dominance condition:* $\sum_{k=0}^{j} \pi_{ik}$ *is weakly decreasing in* $i$ *for every* $j$.

The stochastic dominance property ensures that a good match-quality tomorrow is more likely the better is the match-quality today; it thus ensures a degree of "persistence".

## Incomes and Consumption

Utility of consumption, $u(\cdot)$, is increasing, concave and bounded. In each period each partner earns an income $y \in \left\{y^1, ..., y^M\right\}$. The probability that an individual earns $y^i$ in any given period is denoted $g_i$. There are no savings.

[2]The literature has put forward the idea that divorces are efficient in the sense that they occur when the utility from continued marriage falls short of the sum of the husband's and wife's outside opportunities. This efficiency result requires transferable utility and symmetric information (see Becker (1991) and Peters (1986)). In the current model outside opportunities are symmetric and common knowledge.

### Risk Sharing

Three assumptions about the risk-sharing will be made, all of which require some comments. First, risk-sharing is assumed to occur only between individuals who are currently married – all other relationships are assumed to be either too unstable or not to lend themselves easily to risk-sharing. Second, recent work on risk-sharing (in environments without breakups) has shown that it may be optimal to condition current transfers on past transfers. However, since the current analysis extends previous work by introducing endogenous breakups, it is natural to simplify the problem in another dimension; thus transfers are assumed to be conditioned only on current income and match-quality. Third, love does *not* come in the form of "altruism", only in the form of enjoyment of being together. Allowing the individuals sharing risk to care about each others consumption (or utility) is known to affect self-enforceable risk-sharing arrangements in two ways (see e.g. Foster and Rosenzweig, 2000). First it makes an individual more willing to make transfers to his/her partner, simply out of concern for the other person. This relaxes the incentive constraints (see below) and enables more transfers. However, there is also a second effect, *viz.* an altruistic individual will voluntarily make transfers even when there is no implicit cooperation; this limits the threat of non-cooperation, which in turn tightens the incentive constraints. Hence, the reason for not incorporating altruism is more conceptual then practical: while in the current formulation, an individual who decides to leave his or her partner simply gives up the enjoyment (positive or negative) of being with that other person; in contrast, if match-quality came in the form of altruism, then one would need to take a stance on the question whether an individual can consciously change his or her preferences by deciding to depart.

Given the current match-quality $\theta$ and consumption $c$, the period utility obtained by an individual is $u(c) + \theta$. An individual's consumption $c$ may deviate from his/her current income $y$ due to transfers to/from the partner. Each partner maximizes the own expected discounted stream of utility.

The partners agree on risk-sharing on a period-by-period basis – no long-term commitment is possible. This takes the following form: if one partner receives an income $y^m$ and the other an income $y^k$, where $y^k < y^m$, the former should transfer a non-negative fraction, $\alpha_{mk}$, of the difference $\left|y^m - y^k\right|$ to the latter. Transfers are assumed to be symmetric between the partners (i.e. the agreed on transfer does not depend on who receives $y^m$ and who receives $y^k$). A *risk-sharing agreement* is thus an agreement, for one period, on how much to transfer, for each pair of income realizations $y^m$,$y^k$ where $y^m > y^k$, from the partner with the higher income to the partner with the lower income. It is therefore fully described by a vector $\alpha$,

$$\alpha \equiv (\alpha_{mk})_{m>k} = (\alpha_{21}, \alpha_{31}, \alpha_{32}, ..., \alpha_{m1}, ..., \alpha_{mm-1}, ..., \alpha_{MM-1}) .$$

If half the earnings-difference is transferred, $\alpha_{mk} = 1/2$, the partners enjoy the same consumption; larger transfers than that will never be relevant. $\alpha$ can therefore be restricted to be in the set $A \equiv [0, 1/2]^{M(1-M)/2}$.

The agreement $\alpha$ determines each partner's (ex ante) expected utility from consumption in that period; denote this utility $v(\alpha)$,

$$\begin{aligned} v(\alpha) \quad &\equiv \quad \sum_{m=1}^{M} g_m^2 u(y^m) \\ &+ \sum_{m=2}^{M} \left[ \sum_{k=1}^{m-1} g_m g_k \left[ u\left(y^m - \alpha_{mk}\left(y^m - y^k\right)\right) + u\left(y^k + \alpha_{mk}\left(y^m - y^k\right)\right)\right]\right]. \end{aligned} \tag{1}$$

Note that $v(\alpha)$ is maximized when $\alpha_{mk} = 1/2$ for all $m > k$ reflecting the fact that the optimal private arrangement would be to share risk completely in each period. This may however not be incentive compatible.

## III The Decision Problem Facing a Married Couple

For now the utility of singlehood will treated as exogenous (and the same for both partners). Thus let $V(s)$ denote the discounted expected utility from starting a period as single; later on $V(s)$ will be endogenized by the introduction of a marriage market. The focus will be on steady states; hence time will not be included as argument in the Bellman equations.

### Incentive Compatible Plans

The timing within each period is as follows: first the couple learns the current match-quality $\theta$. Based on that observation they decide whether to stay together or to divorce. If they stay together they also decide on a risk-sharing agreement $\alpha$ for that period; finally earnings are realized. In the beginning of each period the partners are identical and are assumed to choose among plans so as to maximize their common discounted stream of future expected utilities. However, some risk-sharing agreements may not be incentive compatible. It is therefore necessary to consider the consequences of a partner failing to make an expected transfer. A failure to make an expected transfer is assumed to lead to an immediate divorce.[3]

A partner who is called upon to make a transfer must therefore be better off making the expected transfer – given that this leads to continued marriage – than unilaterally triggering divorce; noting that these incentive constraints are all forward-looking and seeing as the transitions between match-qualities follow a Markov chain, the decision problem facing the couple is identical at the beginning of any two periods where the match-quality is the same. A straightforward dynamic programming approach can therefore be adopted to characterize the couple's optimal decision. For each $\theta \in \Theta$, define $V(\theta)$ as the maximal (common) discounted stream of future expected utility given the current match-quality $\theta$ and let $\delta \in (0,1)$ denote the discount factor.

Since the couple can either divorce – which would give the value $V(s)$ – or stay together, $V(\cdot)$ must satisfy the following optimality equation: for all $i$,

$$V(\theta_i) = \max \left\{ V(s), \max_{\alpha \in A_i} \ v(\alpha) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} V(\theta_j) \right\}. \tag{2}$$

The second term in the large brackets represents the value of staying together; associated with this option is a choice of risk-sharing agreement $\alpha$ (prior to the resolution of earnings-uncertainty). If the couple decides to stay together $\alpha$ must also be such that no one will be better off, at any income realization, by unilaterally causing divorce through failing to make the agreed on transfer. The set of incentive compatible (or "self-enforceable") risk-sharing agreements, $A_i$ (a subset of $A$) generally depends on the current match-quality $\theta_i$ – in particular $A_i$ can be expected to be smaller the worse is the current match-quality, a conjecture that will be verified below.

The self-enforceability constraints are thus forward-looking and can be formulated as follows: $\alpha \in A_i$ if and only if $\alpha \in A$ and, for all $m > k$ such that $\alpha_{mk} > 0$,[4]

$$u\left(y^m - \alpha_{mk}\left(y^m - y^k\right)\right) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} V(\theta_j) \geq u(y^m) + \delta V(s). \tag{3}$$

[3] The literature on risk-sharing usually assumes that there is a reversion to the static no-transfer equilibrium. This captures the idea of broken trust. Note, however, that generally we would expect there to be a severe renegotiation problem. The same renegotiation problem occurs in the current model; if the couple knows that they are well-matched they would be better off forgetting the deviation.

[4] It is implicitly assumed that the deviating spouse loses the match-quality in the deviating period; this assumption is not crucial.

The left hand side is the utility associated with making the prescribed transfer while the right hand side is the utility of deviating. Since the set of sustainable risk-sharing agreements $A_i$ depends on the current match-quality $\theta_i$, so will in general the chosen $\alpha$; hence the notation $\alpha(\theta)$ can be used to denote the risk-sharing agreement adopted when the match-quality is $\theta$. Equation (2) together with (3) defines $V(\cdot)$ as the solution to a functional equation. Next it is demonstrated that, under a sufficient condition, the functional equation has a unique solution and that $V(\cdot)$ has some expected properties.

### Risk-Sharing and Divorce

Since match-quality has a consumption value it is a natural conjecture that the couple is better off the higher is the current match-quality. A low enough match-quality can also be expected to trigger divorce. However, if low match-quality triggers divorce – and a high current match-quality has a degree of persistence (Assumption 1) – then a high current match-quality is also associated with a low future divorce risk. This in turn facilitates more risk-sharing since risk-sharing is based on expected reciprocity. Thus it seems natural to conjecture that a high current match-quality is associated with a high current level of risk-sharing. This should then further contribute to making the couple better off when the current match-quality is high.

Note however that since the scope for risk-sharing increases when the divorce risk decreases, staying together almost becomes self-motivating. To ensure uniqueness a condition is imposed. It should be stressed that the condition, which imposes an upper bound on the value of risk-sharing, is only sufficient and, in most cases, probably far from necessary.[5] Thus assume:

Assumption 2. *(A bound on the value of risk-sharing). The following inequality holds:*

$$\sum_{m=2}^{M}\sum_{k=1}^{m-1} g_m g_k \left(\frac{u'\left(y^k\right)}{u'\left(y^m\right)} - 1\right) < \frac{1-\delta}{\delta}.$$

Consider e.g. the case where there are only two income levels, $y^1, y^2$. The left hand side increases in the income difference $\left|y^2 - y^1\right|$ and in risk-aversion; moreover $g_1 g_2$ is maximized when the income variance is maximized. The inequality then places an upper bound on the weight placed on future utility, $\delta$. Suppose e.g. $u'\left(y^1\right) = 2u'\left(y^2\right)$ and $g_1 = g_2 = 1/2$; the condition then requires that $\delta < 0.8$ while for other $g_1$ and $g_2$ the critical $\delta$ is closer to unity.

[5] Indeed, it is a sufficient condition for (2) to identify a mapping which satisfies Blackwell's sufficient condition for a contraction mapping, which in turn is sufficient the functional equation to have a unique solution (see the Appendix for details.)

The first conjecture can now be verified: the higher is the current match-quality, the better off is the couple.

Claim 1. *The value function $V(\cdot)$ is unique and weakly increasing in $\theta$.*

**Proof.** See the Appendix.

Knowing that $V(\cdot)$ is increasing is sufficient to establish a cut-off rule for the divorce decision. Suppose that the variability in $\theta$ is large enough that there will be some match-qualities where the couple stays together and some where they break up; then by defining $\widehat{\theta} \equiv \max\{\theta \in \Theta | V(\theta) = V(s)\}$ it follows that the couple stays together only as long as $\theta > \widehat{\theta}$. Combining the observation that divorce occurs at low match-qualities with the monotonicity of $V(\cdot)$, and invoking the assumption that a high current match-quality is associated with high future match-qualities (Assumption 1) it can also be verified that risk-sharing is an increasing function of the current match-quality.

Claim 2. *Given that the couple have not separated at time $t$, the level of risk-sharing in that period is increasing in the current match-quality: $\theta' > \theta$ implies $\alpha(\theta') \geq \alpha(\theta)$.*[6]

**Proof.** See the Appendix.

Indeed, what drives this result is that the set of self-enforceable risk-sharing agreements, $A_i$, is smaller the worse is the current match-quality $\theta_i$. The main results from this section is thus that the match-quality drives both the divorce decision and the risk-sharing decision. The better is the current match-quality, the more risk will be shared by the partners, and, due to the persistence of the match-quality the lower is the risk of future divorce. Generally match-quality will unobserved, but suppose we had access to panel data on risk-sharing and divorce behavior; then the model makes the very natural prediction that more current cooperation is negatively associated with future divorce risk. A similar phenomenon was reported by Johnson and Skinner (1986) who found that women tend to increase their labour supply a couple of years prior to divorce.

# IV A Partial Equilibrium Effect of Formal Insurance

This section provides, by ignoring the possibility of re-marriage, a partial equilibrium analysis of the impact of public insurance on divorce behavior and risk-sharing. Publicly provided

[6] $\alpha(\theta') \geq \alpha(\theta)$ if every element in $\alpha(\theta')$ is at least as large as the corresponding element in $\alpha(\theta)$.

insurance is shown to make the couple more prone to divorce in the sense that it expands the set of match-qualities where they divorce.

Two forces are at work: first – since formal insurance is more valuable to an individual who has no other insurance available – there is direct positive effect of formal insurance on the probability of divorce: intuitively formal insurance implies that an individual can afford to leave a relationship that has gone sour even if that means forgoing future access to informal risk-sharing. However, by making divorce more attractive the direct effect then also reduces cooperation in the states where the couple actually stays together which further increases the relative attractiveness of divorce and so on.

To demonstrate these effects formally it is convenient to focus on the case where there are only two possible income levels $y^1$ and $y^2$; this simplifies the analysis and avoids making assumptions about the form of the publicly provided insurance: as long as formal insurance based only on *current individual* income it reduces to a net transfer from individuals with high income, $y^2$, to individuals with low income, $y^1$. Thus let $\tau$ denote the tax imposed on individuals with a current high income. By budget balance, the transfer to low-income individuals must equal $(g_2/g_1)\,\tau$. Hence, given $\tau$, the net incomes are

$$\widetilde{y}^2 = y^2 - \tau, \qquad \text{and} \qquad \widetilde{y}^1 = y^1 + \frac{g_2}{g_1}\tau. \tag{4}$$

Consider then a marginal expansion of formal insurance from a situation with less than full insurance (i.e. initially $\widetilde{y}^2 > \widetilde{y}^1$). Note that, with formal insurance included, and using $M = 2$, the definition of $\upsilon(\cdot)$ in (1) becomes:

$$\begin{aligned} \upsilon(\alpha) \quad = \quad & g_2^2 u\left(\widetilde{y}^2\right) + g_2 g_1 u\left(\widetilde{y}^2 - \alpha\left(\widetilde{y}^2 - \widetilde{y}^1\right)\right) \\ & + g_1 g_2 u\left(\widetilde{y}^1 + \alpha\left(\widetilde{y}^2 - \widetilde{y}^1\right)\right) + g_1^2 u\left(\widetilde{y}^1\right). \end{aligned} \tag{5}$$

The subscript on $\alpha$ is dropped since with just two income levels $\alpha$ reduces to a scalar.

To emphasize the impact of $\tau$, write $\widehat{\theta}(\tau)$ for the critical match-quality. The main result is that $\widehat{\theta}(\tau)$ is monotonic in $\tau$:

Claim 3. *Suppose that $M = 2$ and that no remarriage is possible. Then $\widehat{\theta}(\tau)$ is non-decreasing in $\tau$.*

**Proof.** See the Appendix.

Publicly provided insurance is often suspected of crowding out private insurance coverage. But formal insurance can also crowd out less formal forms of insurance that occur within families. This was noted e.g. by Berry-Cullen and Gruber (2000) who argue that a reason why the literature on the so-called added-worker effect typically finds relatively small effects is the existence of unemployment insurance. The current model focuses on direct transfers between partners as opposed to compensating income streams; yet the analysis suggests that crowding out can be pervasive. No formal analysis will be provided here, but the main arguments are straightforward: consider a marginal expansion of formal insurance, and suppose that private transfers were reduced on a one-for-one basis. This would increase the relative attractiveness of divorce since the expansion of formal insurance would make singlehood more attractive. This would make the couple more prone to divorce, which in turn would further reduce the sustainable levels of voluntary risk-sharing; thus, in the end, crowding out may be more than one-for-one.[7]

# V Family Formation

The analysis in the previous section was only of a partial equilibrium nature in that family formation was ignored. To get a more complete picture a marriage market is now introduced.

### The Marriage Market

Assume that the economy consists of a continuum of unit measure of infinitely lived individuals. Each individual is either married or single; let $S \in [0,1]$ denote the number of single individuals. Single persons search for new partners. Let $\phi(S)$ denote the probability of finding a potential partner during a period of search (for simplicity I assume that a searching individual meets at most one potential partner during a period of search). The probability of finding a partner depends non-negatively on the number of searching individuals: $\phi(0) = 0$ and $\phi'(\cdot) \geq 0$ ("agglomeration"). Search has no cost but a searching individual does not have anyone to share income with; hence the expected utility during a period of search is $\upsilon(0)$.

Potential partners meet at the end of a period of search; at the beginning of the next period they learn their initial match-quality. Based on the initial match-quality two newly matched

[7] To formalize the above arguments one would need to assume that the partners' incomes are, somehow, perfectly negatively correlated; without this assumption formal insurance and informal risk-sharing would not be directly comparable. Di Tella and MacCullogh (1999) and Attanasio and Rios-Rull (2000) have recently considered the crowding out effect of formal insurance on voluntary risk-sharing and the above argument essentially follows Di Tella and MacCullogh (1999) with the addition of a breakup risk (see their Proposition 3).

individuals decide whether to form the partnership or to continue to search. Since the Markov process for the match-qualities is regular it has a limiting distribution $F$ defined on $\Theta$. The density of $F$, which is strictly positive on $\Theta$, is uniquely defined through the following equations:

$$f(\theta_i) = \sum_{k=0}^{N} \pi_{ki} f(\theta_k), \quad \text{and} \quad \sum_{i=0}^{N} f(\theta_i) = 1. \tag{6}$$

The distribution $F$ is a natural candidate for the distribution of initial match-qualities. Since I assume that there are no specific marriage- or divorce costs, two newly matched individuals are in exactly the same position as a couple that have been married for any arbitrary number of periods with the same match-quality and will hence adopt the same cut-off rule.

### The Choice of Critical Match-Quality

When remarriage is possible, the value of starting a period as single, $V(s)$, is endogenous. Formally, there is, in addition to (2) and (3) which characterize $V(\theta)$, an equation for $V(s)$. This equation has the following form:

$$V(s) = v(0) + \delta \left\{ \phi \sum_{j=0}^{N} f(\theta_j) V(\theta_j) + (1-\phi) V(s) \right\}, \tag{7}$$

where $v(0)$ is the within-period expected utility and the bracketed term is the value of the continuation; $\phi f(\theta)$ is the probability that the individual will find a new partner with initial match-quality $\theta$ and with probability $1-\phi$ no new potential partner is located during the period. The matching probability $\phi$ is taken as given by a searching individual even though it is determined by the aggregate behavior of the individuals in the economy.

Since $V(s)$ is now endogenous, the cut-off rule can now best be viewed as a function of the matching probability $\phi$. Thus introduce the notation $\widehat{\theta}(\phi)$ to highlight that the cut-off rule adopted by the individuals depends on the matching-probability $\phi$. Clearly, the larger is $\phi$ the easier it is to find new potential partners. This implies that singlehood becomes more attractive: why stay with a partner when the relationship has turned sour if it is easy to find a new partner? Equally, it makes sense to be "picky" when meeting a new potential partner. Thus, as $\phi$ increases, $\widehat{\theta}(\phi)$, should, if anything, increase. Indeed, the next claim verifies that this so. But a higher cut-off level also must be associated with reduced cooperation since it increases the divorce risk; thus $\alpha$ depends negatively on $\phi$:

**Claim 4.** *The critical match-quality $\widehat{\theta}(\phi)$ increases in $\phi$ and, moreover, risk-sharing $\alpha(\theta)$ decreases in $\phi$ for all $\theta > \widehat{\theta}$.*

**Proof.** See the Appendix.

Since $\phi$ increases in $S$ Claim 4 indicates the strategic complementarity of joining the pool of singletons: the more people join the pool, the more attractive it is for each individual to do the same.

### Flow Equilibrium

The steady state pool of singletons, $S$, is characterized by equal in- and outflows. Moreover, $S$ depends positively on $\widehat{\theta}$. To see this, let $\mu\left(\theta|\widehat{\theta}\right) > 0$ denote the expected duration of a new marriage with initial quality $\theta$ given the cut-off quality $\widehat{\theta}$. The expected time that a single individual is away from the pool of singletons upon meeting a potential partner is then $\sum_{\theta>\widehat{\theta}} f(\theta)\,\mu\left(\theta|\widehat{\theta}\right)$ which naturally decreases in $\widehat{\theta}$, both since fewer meetings will result marriages, and since the expected duration of every new marriage will be shorter ($\mu$ decreases in $\widehat{\theta}$ for every $\theta$). An equation relating $S$ to $\widehat{\theta}$ can be obtained by noting that $S$ has the alternative interpretation as the fraction of total time that an individual spends as single if the process is allowed to go on forever; hence flow-equilibrium implies:

$$S = \frac{1/\phi(S)}{1/\phi(S) + \sum_{\theta>\widehat{\theta}} f(\theta)\,\mu\left(\theta|\widehat{\theta}\right)}, \tag{8}$$

where I used that $1/\phi$ is the expected time until a potential partner is located. Equation (8) implicitly and uniquely defines $S$ as an increasing function of $\widehat{\theta}$, henceforth denoted $S\left(\widehat{\theta}\right)$.

Lemma 5. *The steady state fraction of single individuals in the economy, $S$, is increasing in the critical match-quality, $\widehat{\theta}$.*

### Steady States

A steady state equilibrium is characterized by two conditions: flow equilibrium, $S = S\left(\widehat{\theta}\right)$, and individual rationality of $\widehat{\theta}$ conditional on $\phi$ where $\phi = \phi\left(S\left(\widehat{\theta}\right)\right)$. An equilibrium in thus a fixed-point for the composite mapping $S\left(\widehat{\theta}(\phi(\cdot))\right)$ which maps the unit interval into itself. Noting that $S(\cdot)$ increases in $\widehat{\theta}$ (Lemma 5), $\widehat{\theta}(\cdot)$ increases in $\phi$ (Claim 4), and finally that $\phi'(\cdot) \geq 0$, it follows that the composite mapping is non-decreasing. Then, by Tarski's fixed-point theorem, an equilibrium exists.

Furthermore, any equilibrium will under the natural assumption that there is sufficient spread in $\theta$ be "interior". To see this note that if consumption value of the best match-quality is positive, i.e. $\theta^N > 0$, such matches will rationally never be rejected, ruling out a steady state equilibrium with $S = 1$. On the other hand if the lowest match-quality, $\theta^0$, is so abysmal that an individual will opt for divorce even if that means that he/she will never have the opportunity to marry again there cannot be an equilibrium with $S = 0$ either.

# VI Equilibrium Features

This section first looks at how the provision of formal insurance affects family-formation and cooperation in the general equilibrium setting. After that qualitative differences of multiple equilibria are investigated. Finally, the welfare properties of decentralized steady state equilibria are considered.

### General Equilibrium Effects of Formal Insurance

The possibility of multiple equilibria offers a potential explanation for why countries with similar levels of social expenditures have quite different divorce rates; moreover it allows this observation to be consistent with the claim that publicly provided insurance affects family formation decisions as well as the role of the family in providing financial security in a monotonic fashion.

To demonstrate this, publicly provided insurance is now introduced into the general equilibrium model. Consider again the case with only two income levels, $y^1$ and $y^2$ where $y^2 > y^1$; net incomes given by (4) and $\tau$ represents the generosity of public insurance. As usual with multiple equilibria, it is of interest to look at the "extremal equilibria". Thus let $S_L$ and $S_H$ denote the lowest- and the highest steady state fraction of single individuals; to emphasize the impact of formal insurance let $\tau$ be an argument for the bounds, i.e. $S_i(\tau)$, $i = L, H$.

In Section IV is was noted that $\widehat{\theta}$ was increasing in $\tau$ when no remarriage was possible; the reason was that formal insurance is more valuable to single individuals, and that formal insurance tends to crowd out private risk-sharing. The same effects are at work in the general equilibrium context implying that $\widehat{\theta}$ still tends to be increasing in $\tau$; although a general proof is not available, simple sufficient conditions can be obtained. Consider e.g. the following "memoryless stochastic process" which allows the match-quality to be a continuous variable, $\Theta = [\underline{\theta}, \overline{\theta}]$. Given any current $\theta$ the probability that a shock occurs which changes next period's match-quality is $\lambda \in (0, 1)$ (conversely, with probability $1 - \lambda$ the match-quality remains $\theta$). If a shock occurs the new match-quality is drawn from some distribution $F$, the density of which is strictly positive on $\Theta$. Since $F$ is also the long-run distribution associated with the stochastic process all initial match-qualities are assumed to be drawn from $F$. For this process, which will be used more extensively below, it can be shown that a sufficient, but not necessary, condition for $\widehat{\theta}$ to be increasing in $\tau$ is that $\lambda \geq \phi$.[8]

Returning to the main model, suppose then that $\widehat{\theta}$ increases in $\tau$, i.e. that the direct effect is to make singlehood more attractive. Due to the strategic complementarity in joining the pool of singletons, the direct effect carries over to the general equilibrium setting. The set of equilibria thus moves monotonically "upwards". Stated in precise terms:

**Claim 6.** *Suppose that $M = 2$ and that $\widehat{\theta}$ increases in $\tau$; then $S_L(\tau)$ and $S_H(\tau)$ both increase in $\tau$.*

**Proof.** See the Appendix.

The model thus predicts that there is an underlying monotonic impact of an expansion of formal insurance of family formation and breakup behavior in the sense that the set of equilibria moves towards people spending more time as single.

Letting $\sigma$ denote the rate at which single individuals marry, $\sigma = \phi(S)\left(1 - F\left(\widehat{\theta}\right)\right)$, and using $\zeta$ to denote the average rate at which married individuals divorce, flow equilibrium implies $S = \zeta / (\sigma + \zeta)$. Hence an expansion of formal insurance will increase the *relative* divorce rate $\zeta/\sigma$ in both the lowest- and the highest equilibrium. Since risk-sharing in steady state is monotonically related to $S$ (through $\phi$ – see Claim 4) the model also predicts that an expansion of formal insurance will lead to a reduction in cooperation between partners in the sense of decreasing $\alpha(\theta)$ – i.e. the model exhibits crowding out also in the general equilibrium setting.

More can be said about the *absolute* divorce rate if more specific stochastic processes are assumed. Consider e.g. the "memoryless" stochastic process introduced above. For this process the probability that any given married couple will divorce in a period is $\lambda F\left(\widehat{\theta}\right)$ which is independent of their current match-quality; hence for this process $\zeta = \lambda F\left(\widehat{\theta}\right)$ whereby the absolute average divorce rate $\zeta$ increases with $\tau$ as long as $\widehat{\theta}$ does so (e.g. as long as $\lambda \geq \phi$).

[8] For this specific process, $\Delta(\theta) \equiv V(\theta) - V(s)$ satisfies

$$\Delta(\theta) = \max\left\{0, v(\alpha(\theta)) - v(0) + \theta + \delta(\lambda - \phi)\int_{\underline{\theta}}^{\overline{\theta}} \Delta(\theta')\, dF + \delta(1-\lambda)\Delta(\theta)\right\}.$$

Using this a proof can be constructed along the lines of that of Claim 3.

## Qualitative Differences of Multiple Equilibria

The logic of the comparative static exercise carries over to a comparison of multiple equilibria. Thus consider an economy with at least two steady state equilibria; to avoid new notation consider the extremal equilibria, $L$ and $H$, where $S_L < S_H$. Since $S_i = \zeta_i / (\zeta_i + \sigma_i)$ in each equilibrium it follows that the *relative* aggregate divorce rate is higher in equilibrium $H$ than in equilibrium $L$, i.e. $\zeta_H/\sigma_H > \zeta_L/\sigma_L$. Moreover, for the "memoryless" stochastic process the *absolute* divorce rate is higher in equilibrium $H$ than in equilibrium $L$. This follows since $S$ is monotonically related to $\widehat{\theta}$ (Lemma 5), and, for this specific process, $\zeta = \lambda F\left(\widehat{\theta}\right)$. Hence $S_L < S_H$ implies $\zeta_L < \zeta_H$.

Since, people spend more time looking for a partner (and generally marriages have shorter expected duration and divorce rates are higher) in equilibrium $H$ than in equilibrium $L$ it is natural to think of the former as a "high turnover" equilibrium and the latter as "low turnover" equilibrium; from Claim 4, using that $S_L < S_H$ and that $\phi(\cdot)$ is increasing, it then also follows that there is less risk-sharing in the high-turnover equilibrium than in the low-turnover equilibrium: for any given match-quality a married couple will share less risk in equilibrium $H$ than in equilibrium $L$, $\alpha_L(\theta) \geq \alpha_H(\theta)$ for all $\theta$.

The model thus captures the idea that two fundamentally identical economies can sustain different equilibria where the people in one economy appear to be more "committed" to marriages and enjoy more risk-sharing than the people in the other economy. More generally, the attitudes towards marriage and financial cooperation may differ systematically. In other words, the role of social norms may be to act as a coordination device under multiple equilibria.

## Welfare Aspects

A matched couple views their match as having an option value; this value determines the breakup rule adopted in a decentralized steady state equilibrium. A decentralized equilibrium will, however, generally fail to be efficient, and moreover, the direction of the distortion is ambiguous. The ambiguity arises since there are two conflicting forces. First, there is a standard "agglomeration" externality that arises when $\phi' > 0$ (see e.g. Diamond, 1982). If cooperation had been contractible, the trivial conclusion would have been that any steady state equilibrium would have (locally) too few single individuals. However, the effect of an additional individual joining the pool of singletons is also to make the threat of divorce more credible for those who remain married, which, when cooperation is sustained by reciprocity, reduces risk-sharing.

To see how the individuals look at the option value of a match, consider the memoryless stochastic process outlined above; for this process, the value of beginning a period with a partner in state $\theta \geq \widehat{\theta}$, is

$$V(\theta) = \upsilon(\alpha(\theta)) + \theta + \delta \left[ \lambda \int_{\widehat{\theta}}^{\overline{\theta}} V(\theta')\, dF + \lambda F\left(\widehat{\theta}\right) V(s) + (1-\lambda) V(\theta) \right].$$

The value of starting a period as single is,

$$V(s) = \upsilon(0) + \delta \left[ \phi \int_{\widehat{\theta}}^{\overline{\theta}} V(\theta')\, dF + \left(1 - \phi + \phi F\left(\widehat{\theta}\right)\right) V(s) \right].$$

The risk-sharing agreement $\alpha(\theta)$ must satisfy

$$u\left(y^m - \alpha_{mk}\left(y^m - y^k\right)\right) + \theta$$
$$+\delta \left[ \lambda \int_{\widehat{\theta}}^{\overline{\theta}} V(\theta')\, dF + \lambda F\left(\widehat{\theta}\right) V(s) + (1-\lambda) V(\theta) \right] \geq u(y^m) + \delta V(s)$$

for every $m > k$ and $\alpha_{mk}(\theta)$ satisfies the constraint with strict equality whenever the $mk$'th constraint is binding.

Each individual treats $\phi$ as parametrically given. A couple then stays together as long as the value of doing so exceeds the value of breaking up; hence $\widehat{\theta}$ is implicitly defined through $V\left(\widehat{\theta}\right) = V(s)$. Let $r = (1-\delta)/\delta$ be the implicit "interest rate" that corresponds to the discount rate $\delta$. Standard manipulations of the rule $V\left(\widehat{\theta}\right) = V(s)$ gives the following characterization of $\widehat{\theta}$ in a decentralized steady state,

$$\upsilon\left(\alpha\left(\widehat{\theta}\right)\right) + \widehat{\theta} - \upsilon(0) = (\phi - \lambda) \int_{\widehat{\theta}}^{\overline{\theta}} \frac{\upsilon(\alpha(\theta)) + \theta - \upsilon\left(\alpha\left(\widehat{\theta}\right)\right) - \widehat{\theta}}{r + \lambda} dF. \tag{10}$$

The option value arises since, even if the current match-quality is less than perfect, it may improve. However, a better match-quality can also be obtained by joining the marriage market. Suppose e.g. that $\phi > \lambda$; then a couple would only accept a current utility within marriage that is strictly larger than the current utility of singlehood – i.e. the left-hand side of (10) is positive – since singlehood is a "faster" way to obtaining a new match-quality than being married.

If risk-sharing had been contractible, each married couple would have agreed on complete risk-sharing in each period of marriage, $\alpha^{mk}(\theta) \equiv 1/2$ at all $\theta \geq \widehat{\theta}$. In that case the characterization of the socially efficient cut-off quality would be identical to Equation (10), except with $\left(\phi + S\phi' - \lambda\right)$ replacing $(\phi - \lambda)$, implying a higher cut-off match-quality $\widehat{\theta}$; the extra term indicates the benefit to the searching individuals of expanding the pool of singletons.[9]

However, when risk-sharing is not contractible, the effect of an additional individual joining the pool of singletons would be to directly reduce the utility of those who remain married by reducing the scope for cooperation.[10] Hence a decentralized steady state equilibrium may have locally too few married individuals. Equally, if there are multiple equilibria these cannot be unambiguously welfare-ranked: whether a "high turnover" equilibrium (with a high average match-quality among married individuals and low levels of risk-sharing) or a "low turnover" equilibrium (with a lower average match-quality but higher levels of risk-sharing) is better cannot be determined on an a priori basis.

A second welfare implication of reciprocity-based cooperation concerns the variability of match-quality. A high match-quality not only has a consumption value, it also enables more risk-sharing. However, the second marginal benefit eventually decreases due to diminishing marginal utility of consumption and, since at high-enough match-qualities, full risk-sharing is sustainable. As a consequence, with reciprocity-based cooperation, the value function $V(\theta)$ generally possesses an inflection point where it switches from being convex to being concave if there is sufficient spread in $\theta$. The initial convexity arises since an individual has the option of leaving a low-quality partnership. Indeed, if full risk-sharing were contractible $V(\theta)$ would be globally convex. E.g. for the memoryless stochastic process, if $\alpha^{mk}(\theta) = 1/2$ for all $\theta \geq \widehat{\theta}$, then $V(\theta)$ increases linearly in $\theta$ at all $\theta \geq \widehat{\theta}$; since $V(\theta) = V(s)$ for $\theta < \widehat{\theta}$, $V(\theta)$ is then globally convex. An increase in the variability of $\theta$ (in the sense of a mean-preserving spread of $F$) would then positively affect welfare. In contrast, if risk-sharing is reciprocity-based, it may be better that people are more "homogenous" since this promotes valuable risk-sharing.

[9] The characterization can be obtained along the lines of Pissarides' (2000) analysis of efficiency of decentralized endogenous job-creation and destruction.

[10] Note that even in the case where risk-sharing is contractible, a married couple would become more prone to divorce when an additional individual joins the pool of singletons: this is simply to the strategic complementarity and would not constitute an externality. The difference here is that the utility of a married couple is negatively affected *while remaining married.*

## VII Extensions to the Theory

**Relation-Specific Investments** The most important omission from the model is all forms of relation-specific investments. Empirical evidence suggests that children and joint property stabilize marriages, causing the individual divorce hazard to drop over time (see Weiss and Willis, 1997). The reason for omitting relation-specific investments from the current model is two-fold. First investments by partners have recently been treated by other authors; most notable is Drewianka (2000). Second, although including relation-specific investments would be an interesting extension, the current model may not be ideal for the purpose. Suppose e.g. that a married couple can make some investment that will increase the divorce costs (e.g. having a child, jointly buying a house, building a network of joint friends etc.) It is then conceivable that a couple would be willing to make investments in order to facilitate future cooperation. However, one must then consider the degree of irreversibility of such investments: in the current model where match-qualities follow a Markov process a couple is well-aware of the fact that love does not last forever and that, consequently, they will eventually divorce. This is however an artifact of the model which implies that it may not be suitable for studying partly irreversible investments; indeed a model with "learning" may provide a more realistic setting.

**Learning** An alternative to assuming that match-quality evolves stochastically would be to assume that the underlying match-quality is fixed, but is only revealed over time (in the spirit of Jovanovic (1979)). This formulation would more naturally lead to duration dependent divorce hazards (as observed e.g. by Weiss and Willis (1997)). A couple that has been observed to stay together for a long time has then presumably found out that their match-quality is very likely to be high; their perceived divorce risk would then also be low, enabling substantial risk-sharing. In such a generalization, current risk-sharing would be positively related to the couples current beliefs that the match is good.

**Persistent Income Shocks** Allowing persistent income shocks could potentially lead to a number of interesting new insights. When risk-sharing relies on expected reciprocity an individual's willingness to make transfers to his/her partner hinges on him/her expecting the favour to be reciprocated. However, if there is a high degree of income shock persistence, then the time until the "tables are turned" will be longer which will reduce the scope for sustaining voluntary risk-sharing. Persistency of income shocks would also introduce new elements in the marriage market analysis since each single individual would then be characterized by an individual-specific expected stream of future incomes. Thus it would be necessary to consider bargaining between newly matched individuals. Finally, allowing persistent income shocks could potentially also shed light on the observed phenomenon that new information causing revised expectations about future incomes can trigger divorces.

# VIII An Empirical Investigation

The above theory accommodates the observation that there is no tight connection between aggregate divorce rates and levels of social transfers in a cross-country comparison. However, it also implies that both high levels of social expenditures and a high aggregate divorce rate should negatively affect the probability that any given individual has a partner as well as risk-sharing by existing partners. In this section I present some evidence to support these predictions.

The current analysis is related to the growing empirical literature investigating the effect of welfare payments on marriage and divorce (see e.g. Moffitt, 1990). It is also related to the literature on intra-household allocations (see Browning and Chiappori (1996) and the references therein) where a common finding is that the "income pooling" hypothesis (i.e. that the source of income does not matter for the allocation) is rejected. The current analysis however requires international data which rules out using actual consumption data. Instead I use data from the International Social Survey Programme (ISSP) 1994 survey on "Family and Changing Gender Roles" which includes self-reported information on how couples organize their incomes.

I use two binary dependent variables: first whether the respondent has a "partner", and second, if so, whether "incomes are pooled". Both decisions depend on unobserved stochastic factors, e.g. match-quality, which can be expected to be correlated. Hence I use a bivariate probit model with sample selection: let $z^* = \boldsymbol{\beta}'\mathsf{x} + \varepsilon$ be a latent variable. The respondent "has a partner" ($z = 1$) if $z^* > 0$ and is "single" ($z = 0$) otherwise. For those individuals that have partners, let $q^* = \boldsymbol{\gamma}'\mathsf{w} + \eta$ be a second latent variable such that income pooling with the partner is "complete" ($q = 1$) if $q^* > 0$ and otherwise is "incomplete" ($q = 0$) (see below). $(\varepsilon, \eta)$ has a bivariate normal distribution with zero means, unit variances and correlation $\rho$. The two sets of regressors, $\mathsf{x}$ and $\mathsf{w}$, may overlap but need not be identical.

### The Data

The ISSP 1994 survey was conducted in 22 countries. Some countries, however, had to be eliminated due to data omissions.[11] The sample was restricted to individuals aged 20-65 who are either employed (full- or part-time) or unemployed, and who are either single or have partners (who are employed or unemployed). The final sample consists of 11 125 individuals from 16 current OECD countries: Australia, Austria, Canada, Czech Republic, Germany, Hungary, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Sweden, UK, and the US.

I include a number of country-level variables. To capture the effect of welfare state arrangements, I use social transfers as per cent of GDP.[12] There are obvious pros and cons to using such an aggregate measure, but the hope is that it will serve as an index for the extent to which citizens are protected against earnings-losses. I also include each country's aggregate divorce rate (divorces per 1000 population). To capture "cultural effects" a range of variables are used. Since earnings-risk is related to the structure of the labour market I include (i) the female labour force participation rate, and (ii) an employment protection legislation index which can range (continuously) from 0 to 6 with higher values representing stricter regulation. Individual employment status is represented by dummies for "part-time employed" and "unemployed" (where the effects are allowed to differ by gender). Dummies were included for "regular attendance to religious services" and self-employment.

Age, age squared, gender (dummy for "male") were included in both sets of regressors. For education, categories were used; the base category is "primary education or less" and dummies were included for "some secondary education" and "some university education". In the income-pooling equation I use information on household earnings (log of net annual earnings in 1994 US Dollars). To pick up the effect of children I control, in the same equation, for household

[11] Israel, the Philippines, Russia, Bulgaria and Slovenia were eliminated due to lack of reliable income data. Spain was eliminated because of a lack of information on education.

[12] The following sources were used in addition to the ISSP survey. Social transfers, which are taken to include old-age cash transfers, disability cash benefits, occupational injury and disease, sickness benefits, family cash benefits, unemployment, compensation, early retirement, and housing-benefits, were obtained from the OECD Social Expenditure Database 1980-1997 (supplemented with information from the IMF Government Finance Statistics Yearbooks). Female participation rates were obtained from ILO Yearbooks of Labour Statistics and refers to females aged 15 and above. Divorce rates were obtained from the UN 1997 Demographics Yearbook. The index of employment protection legislation is from OECD Employment Outlook June 1999 Table 2.5 (Overall strictness, version 1).

size: the base case is a two-person household; dummies were then included for households with 3-4 members and for households with 5 or more members. Finally I include dummies for prior divorce by the respondent and the respondent's current partner.

The first dependent variable is a dummy which is unity if the respondent has a "partner" (spouse or steady life-partner). For those individuals with partners there is a second dependent variable constructed from the following question:

> How do you and your spouse/partner organize the income that one or both of you receive?

The available answers were (i) "I manage all the money and give my partner his/her share", (ii) "My partner manages all the money and gives me my share", (iii) "We pool all the money and each take what we need", (iv) "We pool some of the money and keep the rest separate", (v) "We each keep our own money separate". Less than 15 percent of the answers fell in category (i) and (ii), and, moreover, men were somewhat more inclined than women to respond that they give all the money to their partners. Since this suggested that (i) and (ii) does not signal any strong "asymmetry" between partners I classify (i) through (iii) as "full income pooling" ($y = 1$) whereas (iv) and (v) is interpreted as "incomplete income pooling" ($y = 0$).

### Results

As a preliminary step I estimated the model using only the explanatory variables measured at the individual level and using country-dummies to pick up "cultural effects".[13] Doing this revealed that there are significant country-specific effects. Using the US as the reference country, two patterns emerged: US citizens were considerably less likely to have partners then almost everyone else (Ireland was an exception); moreover, people in e.g. the Nordic countries were significantly less likely to pool their incomes conditional on having a partner. Both these results seem plausible given that the US has the highest aggregate divorce rate and the Nordic countries have large welfare states. I then proceeded by replacing the country-dummies with the aforementioned country-level variables. This allows me to check whether these variables come out with the expected sign and if they can account for the cultural effects. As shown below, the variables came out with the expected sign and quite strongly. Moreover, there were no qualitative effects on the coefficients for the individually measured variables.

[13] The results are available on request from the author.

In interpreting the result one must however keep in mind the limitations; since the variables are only measured at the country-level the "effective number of observations" is obviously low. Also, if the individuals in the same country are affected by some common component not accounted for their error terms will be correlated; the effects of the country-level variables may then be measured less precisely than their $t$-ratios suggest.

Column 2 of Table 1 shows the result for the "partner-equation". The "marginal effects" in this case are calculated as traditional probit marginal effects:

$$\frac{\partial \Pr(z=1|\mathsf{x})}{\partial \mathsf{x}} = \phi(\boldsymbol{\beta}'\mathsf{x})\,\boldsymbol{\beta},$$

where $\phi(\cdot)$ is the pdf for the standard univariate normal distribution.

The probablity of having a partner naturally increases with age. Education beyond secondary level has a negative effect, particularly so for women; the results is consistent with two findings in the literature: that divorce rates and education are negatively correlated (see e.g. Becker et al. (1977)) and that highly educated individuals tend to marry late. That the effects of higher education differ by gender is consistent with the "good catch" hypothesis for men and the "self-reliance" hypothesis for women (Aassve et al, 2001). Part-time employment is positively associated with having a partner for women, consistent with specialization by married couples, but negatively so for men. Unemployment has an unambiguously negative effect. A prior divorce naturally negatively affects the probability of currently having a partner. Flexible labour markets (low employment protection and a high female participation rate) negatively effects the probability of having a partner; flexible markets may make it easier to manage after a break-up and may also affect the structure of the stochastic earnings so as to make it easier for an individual to smooth consumption through individual savings.[14]

Turning to the main variables of interest both the aggregate divorce rate in the economy and the level of social transfers affect the probability of an individual having a partner negatively. The negative effect of social transfers thus confirms the findings in the literature while the negative of the aggregate divorce rate suggest the presence of a "social multiplier" (Becker and Murphy, 2000) in the decision to enter and remain in partnerships.

Inspecting the predictions from the partnership-equation, there were no clearly discernible geographical patterns of over- and under-predictions; the percent correctly predicted responses

[14] Blau, Kahn and Waldfogel (2000) found that favorable labor markets for women negatively affected the probability of marriage.

| | Income Pooling | | Partner | |
|---|---|---|---|---|
| | Coeff. | Marg. Eff | Coeff. | Marg. Eff |
| *Gender* | 0.116 (0.048) | 0.037 | −0.022 (0.034) | −0.008 |
| *Age* | 0.086 (.105) | 0.027 | 0.273 (0.009) | 0.100 |
| *Age Squared* | −0.0009 (0.0011) | −0.0003 | −0.003 (0.0001) | −0.001 |
| *Secondary Education* | −0.073 (0.068) | −0.023 | 0.107 (0.037) | 0.039 |
| *University* (male) | −0.211 (0.083) | −0.067 | 0.083 (0.049) | 0.030 |
| *University* (female) | −0.306 (0.078) | −0.097 | −0.184 (0.051) | −0.067 |
| *Part-time* (male) | −0.182 (0.203) | −0.058 | −0.408 (0.085) | −0.149 |
| *Part-time* (female) | 0.264 (0.122) | 0.084 | 0.380 (0.045) | 0.139 |
| *Unemployed* (male) | −0.086 (0.331) | −0.027 | −0.695 (0.068) | −0.253 |
| *Unemployed* (female) | 0.257 (0.159) | 0.082 | −0.216 (0.067) | −0.079 |
| *Self-employed* | 0.030 (0.052) | 0.010 | 0.044 (0.040) | 0.016 |
| *Log Household-Earnings* | −0.114 (0.032) | −0.036 | – | – |
| *Household Size 3-4* | 0.333 (0.049) | 0.105 | – | – |
| *Household Size >4* | 0.497 (0.068) | 0.158 | – | – |
| *Divorced* | −0.446 (0.344) | −0.142 | −0.933 (0.037) | −0.340 |
| *Partner Divorced* | −0.212 (0.062) | −0.067 | – | – |
| *Religious Services* | 0.054 (0.038) | 0.017 | 0.055 (0.027) | 0.020 |
| *Social Transfers % of GDP* | −0.018 (0.008) | −0.006 | −0.012 (0.005) | −0.004 |
| *Aggregate Divorce Rate* | −0.042 (0.051) | −0.013 | −0.121 (0.022) | −0.044 |
| *Female Partication Rate* | −0.010 (0.007) | −0.003 | 0.016 (0.002) | 0.006 |
| *Employment Protection* | 0.050 (0.026) | 0.016 | 0.029 (0.020) | 0.011 |
| *Constant* | 0.1055 (2.27) | | −5.772 (0.192) | |
| *Censored obs: 4011* | | | | |
| *Uncensored obs: 7114* | *Log L = -9645.544* | | | |

Table 1: Effects on the probability of having a partner and the probability of pooling income given a partner. Estimation by bivariate probit with sample selection. Robust standard error in paranthesis.

was somewhat lower in the US and the UK which is natural since these countries also had the most even distributions of individuals with and without partners.[15]

Perhaps more interesting is the income-pooling equation, the results for which are presented in column 1 of Table 1. The marginal effects reported in this case is the *direct effect* of the regressors in $\mathsf{w}$ on the conditional probability of pooling income given marriage,

$$\frac{\partial \Pr(q=1|z=1;\mathsf{x},\mathsf{w})}{\partial \mathsf{w}} = \frac{\Phi_2(\boldsymbol{\beta}'\mathsf{x},\boldsymbol{\gamma}'\mathsf{w},\rho)}{\Phi(\boldsymbol{\beta}'\mathsf{x})}\boldsymbol{\gamma}, \tag{11}$$

where $\Phi(\cdot,\cdot,\cdot)$ and $\Phi(\cdot)$ are the cdfs for the bivariate and univariate standard normal distribution, respectively.

Age appears to affect the probability of income pooling positively; this is natural if there is learning about an underlying match-quality since "age" presumably picks up the effect of duration. Education negatively affects income-pooling. Education may act to stabilize the income streams reducing the need for risk-sharing; it may also be due to the fact that highly educated individuals tend to marry late, implying shorter duration. Income negatively affects income pooling.[16] Part-time employment has a strong positive effect on income sharing for women, consistent with specialization with women working part-time in the household. The effects of unemployment are mixed; on the one hand it is positive for women which is consistent with income-pooling arising in response to earnings-losses. On the other hand, for men the sign is negative (but not significant); this may, however, be partly due to an increased divorce risk since a consistent finding in the literature is that unemployment increases the risk of divorce, particularly for men.

The larger the number of people in the household the more likely is it that income is pooled. This is consistent with the hypothesis that kids stabilize a relationship and/or appear once the partners feel confident that their match-quality is good. Prior divorce, both for the respondent as well as the respondent's partners, strongly reduces the probability of income pooling. Two explanations are conceivable. Controlling for age, a prior divorce may mean that the current relationship is relatively "new". Alternatively, prior divorce may act as a signal of low commitment.

A high aggregate female participation rate negatively affects income-sharing; this may be due to specialization within the household being less the norm, and with that, that there is

[15] The countries that were difficult to predict were the Czech Republic, Hungary and Japan.

[16] See Coate and Ravallion (1993) for comparative statics on reciprocity-based income-sharing.

more a culture of financial independence. On the other hand employment protection appears to encourage risk-sharing. One possible explanation for this is that low employment protection is associated with a high turnover rate in the labour market, which in turn makes it easier for each partner to smooth his or her own consumption through savings.

Social transfers has, ceteris paribus, a negative effect on income pooling suggesting that public insurance indeed crowd out informal income-sharing. The aggregate divorce rate also appears to have a negative effect on income pooling (although the effect is not statistically significant): a couple living in an economy where breakups are more frequent would thus appear to be less likely to cooperate financially than an otherwise identical couple. Finally the estimated $\rho$ has a positive sign which is consistent with the story where the partnership decision and the income-sharing decision are driven in part by an underlying unobserved match-quality.

In conclusion the results seem consistent with the theory – social transfers as well as a high aggregate divorce rate appears to affect both the probability of marriage and the probability of income sharing negatively. With respect to the impact of the divorce rate, one must however keep in mind that agglomeration in search is not the only reason why an individual may be less inclined to be married when the divorce rate is high. As noted above Burdett et al (1999) have recently shown that if people continue to search while matched, this can lead to multiple equilibria which differ in the degree of "faithfulness" or "attachment". An even more simple explanation is of course that, generically, there may be stigma attached to deviating from the average behavior. However, it is still interesting that a high aggregate divorce rate appears to reduce the financial cooperation between partners.

## IX Conclusions

It is sometimes argued that welfare state arrangements break up families and prevent family formation, partly because they take on some of the functions otherwise performed by the family. This paper constructs a stylized model of marriage and divorce in which partners have the option of engaging in voluntary sharing of earnings-risk. Risk-sharing between partners is supported by expected reciprocity: as such it contributes to the benefit of marriage, but it is also restricted by the risk of divorce. Consequently, any policy change that increases the relative attractiveness of divorce will not only directly increase the individuals' proneness to choose singlehood, but will also reduce the level of cooperation between partners which in turn further reduces the relative attractiveness of marriage and so on.

The model predicts that partners change their behavior in response to new information about their match-quality. In particular, the better is the current match-quality, the more risk will the shared between the partners. On the other hand, the worse is the current match-quality the less the partners will cooperate. Since a low current match-quality is also correlated with a high divorce risk, the model predicts that the level of financial cooperation between partners should be negatively correlated with future divorce risk. The model further reconciles the observation that there is a low correlation in a simple cross-country comparison of welfare spending and divorce rates with the claim that publicly provided insurance monotonically affects family formation decision. The mechanism underlying this result is a standard assumption of increasing returns in the matching technology characterizing the marriage market. As a consequence the same economy can sustain multiple steady state equilibria differing in the rate of turnover in the marriage market and the role of the family in providing financial security.

The model also highlights how reciprocity-based financial cooperation can have important implications for policy-design. Despite equilibrium multiplicity it is shown that publicly provided earnings-insurance affects family formation in a monotone fashion: the more insurance is provided publicly, the more time people will spend in singlehood. Publicly provided insurance is also argued to potentially severely crowd out private informal insurance partly by making singlehood relatively more attractive and thus making it more difficult for partners to sustain cooperation. It is also shown that, when cooperation between partners is based on expected reciprocity, a decentralized steady state equilibrium fails to be locally inefficient, but that it may be that the direction of inefficiency is ambiguous: it may be that an equilibrium has too few married individuals.

An empirical analysis based on international survey data was then presented. The findings were consistent with the theory: more generous welfare spending and higher aggregate divorce rates seemed to reduce the probability than an individual has a steady partner, and also the income-pooling by those individuals that do have partners.

# Appendix

**Proof of Claim 1**. Let $B(\Theta)$ denote the space of bounded real-valued functions on $\Theta$, and endow this space with the sup norm. Blackwell (1965) provides the following sufficient condition for $T : B(\Theta) \rightarrow B(\Theta)$ to be a *contraction mapping* (with modulus $\beta$):

1. (monotonicity) $f, g \in B(\Theta)$ and $f(\theta) \geq g(\theta)$ for all $\theta \in \Theta$ implies $(T_f)(\theta) \geq (T_g)(\theta)$ for all $\theta \in \Theta$, and

2. (discounting) there exists some $\beta \in (0,1)$ such that $(T_{f+a})(\theta) \leq (T_f)(\theta) + \beta a$ for all $f \in B(\Theta)$, $\theta \in \Theta$ and $a \geq 0$.

Define a mapping $T : B(\Theta) \to B(\Theta)$ in the following way: for each $f \in B(\Theta)$ let

$$(T_f)(\theta_i) = \max \left\{ V(s), \max_{\alpha \in A_i^f} \upsilon(\alpha) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} f(\theta_j) \right\}, \tag{A1}$$

where $\alpha \in A_i^f$ if and only if $\alpha \in A$ and, for all $m > k$ such that $\alpha_{mk} > 0$,

$$u\left(y^m - \alpha_{mk}\left(y^m - y^k\right)\right) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} f(\theta_j) \geq u(y^m) + \delta V(s). \tag{A2}$$

Lemma A.1. *$T$ is a contraction mapping.*

**Proof.** The proof uses Blackwell's sufficiency conditions. Consider first "monotonicity". From Equation (A2) it follows that $f(\theta) \geq g(\theta)$ for all $\theta \in \Theta$ implies $A_i^g \subseteq A_i^f$ for all $i$; "monotonicity" then follows immediately follows from Equation (A1).

Consider then "discounting". Let $\Gamma_i(a) \equiv \max_{\alpha \in A_i^{f+a}} \upsilon(\alpha) + \delta a$ and note that $(T_{f+a})(\theta_i) = \max\{V(s), \Gamma_i(a) + K_i\}$ where $K_i$ does not depend on $a$. If $\Gamma_i(a)$ then always grows at a rate less than unity, "discounting" holds. Totally differentiating (1) and substituting for $d\alpha_{mk}/da$ using (A2) yields

$$\Gamma_i'(a) = \delta \sum_{m=2}^{M} \sum_{k=1}^{m-1} \iota_{mk} g_m g_k \left[ \frac{u'\left(y^k + \alpha_{mk}\left(y^m - y^k\right)\right)}{u'\left(y^m - \alpha_{mk}\left(y^m - y^k\right)\right)} - 1 \right] + \delta,$$

where $\iota_{mk} = 1$ if the $mk$'th incentive constraint is relaxed by the increase in $a$ and else is zero. Thus, since $\alpha_{mk} \in [0, 1/2]$ and $y^m > y^k$,

$$\Gamma_i'(a) < \delta \sum_{m=2}^{M} \sum_{k=1}^{m-1} g_m g_k \left[ \frac{u'\left(y^k\right)}{u'\left(y^m\right)} - 1 \right] + \delta < (1-\delta) + \delta = 1,$$

where the second inequality follows from Assumption 2. #

Since $T$ is a contraction mapping it has a unique fixed point $f^* \in B(\Theta)$ and furthermore, $T_h^n \to f^*$ as $n \to \infty$ for any $h \in B(\Theta)$ ("the method of successive approximations"). From (2) and (3) $T_V = V$; thus $V$ exists and is unique. Then apply the method of successive approximations: define $V_0(\theta) = \theta$ for all $\theta \in \Theta$. For $n \geq 1$, $V_n$ is recursively defined: $V_n = T_{V_{n-1}}$ (implying that $V_n = T^n_{V_0}$). Since $\Theta$ is ordered increasingly $V_0(\theta_j)$ increases in $j$. Assume then that $V_{n-1}(\theta_j)$ also increases in $j$. Using stochastic dominance (Assumption 1), $\sum_{j=0}^{N} \pi_{ij} V_{n-1}(\theta_j)$ then increases in $i$, whereby $i > j$ implies $A_j^{V_{n-1}} \subseteq A_i^{V_{n-1}}$. Consequently

$$V_n(\theta_i) = \max \left\{ V(s), \max_{\alpha \in A_i^{V_{n-1}}} \upsilon(\alpha) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} V_{n-1}(\theta_j) \right\}$$

increases in $i$. By induction on $n$, $V_n(\theta_i)$ increases in $i$ for all $n$, whereby $V(\theta_i) = \lim_{n\to\infty} V_n(\theta_i)$ also increases in $i$. Since $\Theta$ is ordered increasingly, this is equivalent to $V(\cdot)$ being increasing in $\theta$. ■

**Proof of Claim 2**. Since the incentive constraints are independent of each other (see Equation (3)) $A_i$ can be expressed as follows: $A_i = \times_{m>k} [0, \overline{\alpha}_{i\cdot mk}]$ where each $\overline{\alpha}_{i\cdot mk}$ is an upper bound in the range $[0, 1/2]$. Furthermore, trivially $\alpha(\theta_i) = \overline{\alpha}_i \equiv (\overline{\alpha}_{i\cdot mk})_{m>k}$. Using Claim 1 and stochastic dominance (Assumption 1), $i > j$ implies $A_j \subseteq A_i$ whereby $\overline{\alpha}_j \leq \overline{\alpha}_i$. ■

**Proof of Claim 3.** The Claim follows if $\Delta(\theta) \equiv V(\theta) - V(s)$ decreases in $\tau$ for all $\theta \in \Theta$. The argument is by induction. Consider an $n$-period approximation to original problem: Suppose the couple must divorce after $n$ periods, but can divorce at any time before that. (The reader might argue that no risk-sharing can be sustained if the horizon is known to be finite. However, that relies on a subgame perfection argument that does not invalidate the approximation.) Let $V_n(\theta)$ denote the value of being in state $\theta$ with a maximum of $n$ periods remaining; then as the horizon $n$ goes to infinity it's impact will vanish. Since no remarriage is possible $V(s) = \upsilon(0)/(1-\delta)$.

When $n = 0$, $V_0(\theta) = V(s)$ for all $\theta \in \Theta$, and $\Delta_0(\theta) = V_0(\theta) - V(s)$ trivially (weakly) decreases in $\tau$ for all $\theta \in \Theta$. Assume then that $\Delta_{n-1}(\theta)$ decreases in $\tau$ for all $\theta \in \Theta$. For $n \geq 1$, $V_n(\cdot)$ satisfies the following recursive definition:

$$V_n(\theta_i) = \max \left\{ V(s), \max_{\alpha \in A_i^{V_{n-1}}} \upsilon(\alpha) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} V_{n-1}(\theta_j) \right\}, \tag{A3}$$

where $\alpha \in A_i^{V_{n-1}}$ if and only if $\alpha \in A$ and, for all $m > k$ such that $\alpha_{mk} > 0$,

$$u\left(\widetilde{y}^2 - \alpha\left(\widetilde{y}^2 - \widetilde{y}^1\right)\right) - u\left(\widetilde{y}^2\right) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} \Delta_{n-1}(\theta_j) \geq 0. \tag{A4}$$

Using that $(1-\delta) V(s) = \upsilon(0)$, it follows that

$$\Delta_n(\theta_i) = \max \left\{ 0, \upsilon_n^*(\theta_i) - \upsilon(0) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} \Delta_{n-1}(\theta_j) \right\}, \tag{A5}$$

where $v_n^*(\theta_i) \equiv \max_{\alpha \in A_i^{V_{n-1}}} v(\alpha)$. Thus if $v_n^*(\theta_i) - v(0)$ decreases in $\tau$, $\Delta_n(\theta_i)$ will also decrease in $\tau$. If complete risk-sharing is sustainable, $v_n^*(\theta_i) = v(1/2)$; but $v(1/2) - v(0)$ naturally decreases in $\tau$ since the additional formal insurance is more valuable when no risk-sharing is available. Suppose then that risk-sharing is incentive constrained implying that (A4) holds with equality. An increase in $\tau$ decreases $\widetilde{y}^2$ as well as $\Delta_{n-1}(\theta_j)$ for every $j$; from (A4) (using $u'' < 0$) the self-enforceability constraint is therefore tightened, forcing a reduction in the absolute transfer $\alpha\left(\widetilde{y}^2 - \widetilde{y}^1\right)$. $v_n^*(\theta_i) - v(0)$ then decreases in $\tau$ also due to the crowding out effect on private risk-sharing.

By induction on $n$, $\Delta_n(\theta)$ then decreases in $\tau$ for every $\theta \in \Theta$ and $n$. Letting $n$ go to infinity $\Delta(\theta) = \lim_{n\to\infty} \Delta_n(\theta)$ also decreases in $\tau$ for each $\theta \in \Theta$. ■

**Proof of Claim 4**. The proof uses that $\phi$ affects $V(\theta)$ only through $V(s)$. Thus start by treating $V(s)$ as parametrically given and note that:

Lemma A.2. *$\Delta(\theta) \equiv V(\theta) - V(s)$ and $\alpha(\theta)$ decreases in $V(s)$ for all $\theta \in \Theta$.*

**Proof.** The proof uses the same $n$-period approximation as used in the proof of Claim 3. For $n = 0$, $V_0(\theta) = V(s)$ for all $\theta \in \Theta$ while for $n \geq 0$, $V_n(\theta)$ is defined recursively as in (A3), where now $\alpha \in A_i^{V_{n-1}}$ if and only if $\alpha \in A$ and, for all $m > k$ such that $\alpha_{mk} > 0$,

$$u\left(y^m - \alpha_{mk}\left(y^m - y^k\right)\right) + \theta_i - u(y^m) + \delta \sum_{j=0}^{N} \pi_{ij} \Delta_{n-1}(\theta_j) \geq 0. \tag{A6}$$

$\Delta_0(\theta) = V_0(\theta) - V(s)$ trivially (weakly) decreases in $V(s)$ for all $\theta$. Assume then that $\Delta_{n-1}(\theta)$ decreases in $V(s)$ for all $\theta$. From (A6) the set $A_i^{V_{n-1}}$ then decreases in $V(s)$. Note that

$$\Delta_n(\theta_i) = \max\left\{0, \max_{\alpha \in A_i^{V_{n-1}}} v(\alpha) + \theta_i + \delta \sum_{j=0}^{N} \pi_{ij} \Delta_{n-1}(\theta_j) - (1-\delta) V(s)\right\} \tag{A7}$$

Hence $\Delta_n(\theta_i)$ decreases in $V(s)$. Moreover, as noted in the proof of Claim 2, $A_i^{V_{n-1}}$ can be expressed as the cross-product of $M(M-1)/2$ intervals where the set of upper bounds is the optimal risk-sharing agreement. Then since $A_i^{V_{n-1}}$ decreases in $V(s)$ for all $i$ it follows that $\alpha_n(\theta)$ decreases (component by component) in $V(s)$ for all $\theta$. By induction on $n$ it follows that $\Delta_n(\theta)$ as well as $\alpha_n(\theta)$ decreases in $V(s)$ for all $n$ and $\theta$. Letting $n \to \infty$ the result follows. #

Lemma A.3. *$V(s)$ increases in $\phi$.*

**Proof.** Subtracting $V(s)$ from both sides of (7) shows that:

$$\frac{(1-\delta)V(s)-v(0)}{\delta\sum_{j=0}^{N}f(\theta_j)\Delta(\theta_j)}=\phi \tag{A8}$$

holds identically. Noting that l.h.s. increases in $V(s)$ (by Lemma A.2) the result follows. #

Combining Lemma A.3 and Lemma A.2 and noting that divorce is optimal whenever $\Delta(\theta) = 0$, monotonicity of $\widehat{\theta}$ and $\alpha(\theta)$ in $\phi$ follows. ■

**Proof of Claim 6**. Since $\Theta$ is discrete and each component of the composite mapping $S\left(\widehat{\theta}(\phi(\cdot))\right)$ are increasing, the composite mapping is an increasing step-function and is hence "continuous but for upward jumps". Furthermore, since $\widehat{\theta}$ increases in $\tau$ the composite mapping increases in $\tau$; then from Milgrom and Roberts (1994, Corollary 1) it follows that the lowest and the highest fixed point, $S_L(\tau)$ and $S_H(\tau)$, both increase in $\tau$. ■

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