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For Better or For Worse? State-Level Marital Formation and Risk Sharing

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For Better or For Worse? State-Level Marital Formation and Risk Sharing

Ralph Chami and Gregory D. Hess

Why do some U.S. states have higher levels of marital formation than others? This paper introduces an economic model wherein a state's representative individual may choose to marry in order to diversify his or her idiosyncratic income risk. The paper demonstrates that such a diversification motive is enhanced for some utility functions when a state's level of undiversifiable risk becomes larger, and when a state's initial income and growth rate is lower. A test of the model's predictions, using cross - sectional data for the 50 U.S. states, suggests that there is broad support for a risk sharing motive for marriage as well as for a precautionary attitude towards risk.

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1 Introduction

In the face of fluctuating incomes, individuals can turn to a number of alternatives to improve their expected economic welfare. One alternative is for an individual to hold assets to smooth their consumption streams as in the Life-Cycle / Permanent Income Hypothesis. In contrast to consuming purely out of individual permanent income, individuals may wish to diversify risk to their individual labor incomes by pooling across other individual permanent income risks – see, for instance, Cochrane (1991) and Mace (1991). This complete markets, aggregate risk sharing utopia may be hard to obtain in a society, although some institutions and markets do exist to facilitate it.

Alternatively, families themselves are a non-market institution that can also provide income insurance through the pooling of resources. For instance, Kotlikoff and Spivak (1981) analyze the gains through marriage from risk sharing when expected lifetimes are uncertain. Rosenzweig and Stark (1989) explore the marriage market from the perspective of how families in different Indian villages arranged marriages in order to offset weather-related risk. Recently, Ogaki and Zhang (2001) find further evidence that women migrate to distant villages to marry as a means of family risk-sharing.[1]

In Section 2 we provide a model that demonstrates the potential economic welfare benefits from marriage *vis a vis* the diversification of risk when asset markets are incomplete. In particular, we analyze the case where a state's representative individual can chose to marry to help to diversify his/her idiosyncratic labor income risk. These agents also face some undiversifiable state income risk, which marrying an individual of the same state certainly won't help them diversify.[2] However, we point out that for certain utility functions,

[1]In contrast, using the PSID and CEX data sets, Dynarski and Gruber (1997) find that a wife's labor income does not appreciably affect the smoothness of the head's labor income. However, as long as the correlation between the head's and wife's incomes is less than one, marriage will still provide a consumption-insurance benefit - see Hess (1997). Also see Bergstrom (1996) and Weiss (1997) for a broader survey of the literature on the economics of the family.

[2]See Clark and Shin (2000) and Hess and Shin (1999,2000) for aggregate and household level evidence, respectively, that intranational geographic related risk is both economically and statistically significant. See

an increase in a state's level of undiversifiable risk will lead individuals to marry more often in order to ameleorate the risk that they can diversify – namely, idiosyncratic risk.[3] As well, such a diversification motive is enhanced when a state's initial income and growth rate is lower.

Section 3 provides cross-sectional evidence that marital formation across the 50 U.S. states is in part determined by the risk sharing motive identified by the theory. Moreover, this evidence supports the view that a precautionary motive towards risk is an important consideration. We conclude in section 4.

2 The Model

The decision to get married involves both economic and non-economic factors. Consider first the economic factors in this two period model. Individuals receive income in periods 1 and 2, and must choose to finance their path of optimal consumption over periods 1 and 2. We assume that income is known in period 1, though it is uncertain in period 2. In period 1, income for the i^{th} individual who lives in region R is certain and identical for all individuals in the region. We denote this first period income level as $y_{1i}^R = y_1^R$, where the subscripts refer to the individual and time period. In period 2, an individual who lives in region R has stochastic income equal to $y_{2i}^R = \gamma^R + y_{1i}^R + \epsilon_i^R$ where ϵ_i^R is distributed $N(0, \sigma^2_{\epsilon_i^R})$. One can consider γ^R to reflect an increase or decrease in expected future income depending on its sign, that is common to all individuals within the region. Together, these constraints place the following structure on the problem we consider: first, within a region, everyone has the same individual expected income levels, income growth and income uncertainty in both periods.[4] Second, across regions, these key economic characteristics can differ.

further discussion and references below.

[3]See Kimball (1990, 1993) and Elmendorf and Kimball (2000) for a more general discussion of the properties of risk aversion in intertemporal models similar to the one used in this paper.

[4]It is a straightforward extension to allow individuals to have differing levels of expected mean income or income volatility. We simply abstract from such heterogeneity as our empirical work below does not focus

With regards to preferences, to facilitate the presentation of the findings, we assume that the individual has constant absolute risk averse preferences (CARA). This functional form has the benefit that it allows for an explicit solution that features a precautionary motive towards uncertainty. This latter effect, will turn out to be quite important for our findings.[5] Moreover, to focus on our contribution, we simplify by assuming that the rate of discounting future utility is equal to the return on savings, which are both set to zero. Hence, an individual i that lives in autarky solves the following problem.

$$\max_{\{c_{1i}^R, c_{2i}^R\}} E_1 \sum_{t=1,2} -\alpha^{-1} \cdot e^{-\alpha c_{ti}^R} \tag{1}$$

subject to:

$$c_{1i}^R + s_i^R = y_{1i}^R \qquad \text{and} \qquad c_{2i}^R = y_{2i}^R + s_i^R \tag{2}$$

where c and s refer to consumption and savings, respectively. E denotes the expectations operator, and $a > 0$ is a parameter of the utility function.

The optimality condition for intertemporal consumption is:

$$e^{-\alpha c_{1i}^R} = E_1 \left\{ e^{-\alpha c_{2i}^R} \right\} \tag{3}$$

Using the properties of log-normality, the optimality condition simplifies to:

$$c_{1i}^R + (\alpha/2)\sigma_{\epsilon_i^R}^2 = E_1 c_{2i}^R \tag{4}$$

Expression (4) reflects, in a parsimonious way, the analytics of the impact of precautionary behavior toward risk on intertemporal consumption. Everything else equal, a rise in the volatility of expected future income decreases current consumption relative to expected

on this aspect of within household bargaining and the probability of marriage – see Hess (2001).

[5] CARA, however, has a few well-documented shortcomings. Therefore, below we demonstrate the generality of our predictions to other utility functions.

future consumption. To solve for the level of consumption, combine the optimality condition, expression (4), with the constraint, expression (2):

$$c_{1i}^R = (\gamma^R/2) + y_1^R - (\alpha/4)\sigma^2_{\epsilon_i^R} \qquad c_{2i}^R = (\gamma^R/2) + y_1^R + (\alpha/4)\sigma^2_{\epsilon_i^R} + \epsilon_i^R \tag{5}$$

The consequence of such precautionary behavior it to introduce non-certainty equivalence into the consumption decisions and welfare evaluations of individuals. Again, using the properties of log-normality, the expected welfare for individual i, EW_i^{*R}, is:

$$EW_i^{*R} = -2\alpha^{-1} e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)\sigma^2_{\epsilon_i^R}\right\}} \tag{6}$$

2.1 Marriage

So far, the problem has not involved the institution of marriage and the relationship between diversifiable and non-diversifiable risk. To get at this, suppose that the income shock that each individual faces is made up of two components: one that is idiosyncratic, e_i, and one that is common to the state or region where someone lives, u^R, namely:

$$\epsilon_i^R = e_i + u^R. \tag{7}$$

For simplicity, these shocks are assumed to be independent, Normal random variables with mean zero and variances σ_e^2 and $\sigma^2_{u^R}$, respectively, so that $\sigma^2_{\epsilon_i^R} = \sigma_e^2 + \sigma^2_{u^R}$.[6] Note that our identification of shocks has two important implications. First, the idiosyncratic part of an individual's income shock is the same, regardless of where an individual lives.

Second, depending upon the region in which an individual lives in, they may have a

[6] Assuming independence actually makes generating this phenomenon harder rather than easier. For instance, if anything, one is likely to argue that the variances are positively related: namely, individuals who live in regions where regional shocks are harder to diversify are also likely to live in regions where un-diversifiable idiosyncratic risk is also harder to diversify. If this were the case, then our predictions would hold even with quadratic utility.

differing degree of region specific risk. Indeed, region specific risk may stem from the state's exposure to industry related risk, or it may be due to differences in state laws, culture, levels of financial development, or differences in geography that can magnify industrial shocks through spillover effects and network externalities.[7] Of course, with perfect aggregate risk sharing this latter term should be diversified away as would all idiosyncratic risk. If, however, markets are incomplete so that full across regional risk sharing is impossible, then regional undiversified risk may differ across regions.

We now think of marriage as the case where two individuals i and j meet at the beginning of period 1 and must decide whether to get married or not. The marriage lasts for two periods, and two individuals must live in the same region so that one cannot diversify the region specific risk just by having each partner live in a different region. Of course, they can decide not to marry. For the case of someone who does not get married, while they can use savings to smooth their intertermporal consumption path, they cannot diversify or share their idiosyncratic risk, and they can do nothing about diversifying their regional risk. The expected welfare for the k^{th} individual from not marrying (NM) is:

$$EW_k^{*NM} = -2\alpha^{-1} \cdot e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)(\sigma_e^2+\sigma^2_{u^R})\right\}} \qquad k = i, j \tag{8}$$

Notice that both types of income uncertainty lower expected welfare, and that they do so in a symmetric fashion.

What about individuals that decide to marry? The important factor we focus on is the extent to which these individuals can help share each other's idiosyncratic risks in addition

[7] For more background on the extent to which U.S. shocks are decomposable into industry specific, region specific and aggregate, see Clark and Shin (2000). They find that using a quarterly aggregate VAR/factor model of US employment growth estimated from 1948-1997, the steady state share of variance due to region-specific shocks is 55 percent, while that for industry specific shocks is 35 percent. Moreover, Crucini and Hess (2000), using regional level data, find broad evidence of incomplete risk sharing (i.e. undiversified regional risk) across U.S. states, as do Hess and Shin (1999,2000) using household data. Also see van Wincoop (1995), Asdrubali, Sorensen and Yosha (1996), Hess and Shin (1998), Crucini (1999) Athanasoulis and van Wincoop (2001), Del Negro (2001).

to the consumption smoothing role that they already have at their disposal via their savings decision. The key to marriage, therefore, is to share "for better or worse". We assume that if i and j marry that they each share a fraction of their resources with one another and that each continues to maximize their individual utility. More specifically, individual i solves:[8]

$$\max_{\{c_{1i}^R, c_{2i}^R\}} \quad E\left\{\sum_{t=1,2} -\alpha^{-1} \cdot e^{-\alpha c_{ti}^R}\right\} \; + \; \delta \tag{9}$$

subject to the joint resource constraint:

$$c_{1i}^R + c_{2i}^R = (1-\lambda)(y_{1i} + y_{2i}) + \lambda(y_{1j} + y_{2j}) = 2 \cdot y_1^R + \gamma^R + (1-\lambda)e_i + \lambda e_j + u^R \tag{10}$$

To parsimoniously capture the expected non-pecuniary net-benefits to marriage, we allow δ in equation (9) to be common to both individuals. While these net expected benefits are stochastic, the level of δ is shared across both individuals i and j. Obviously, as δ rises, the expected benefit to marriage rises, for both partners. Of course, δ could be negative if two individuals simply find each other disagreeable.[9] Moreover, for simplicity we assume that their idiosyncratic risk, e_i and e_j, are uncorrelated. λ is an income sharing term to be discussed below.

We assume that agents cannot obtain complete insurance for their income risk, and so must be concerned about bad states of nature that they cannot (fully) contract on. The justification for this assumption is two-fold. First, agents can face moral hazard problems

[8] Due to the problem's assumed symmetry, individual j also solves a similar problem to (9) and (10). See Hess (2001) for a presentation where such symmetry is not imposed.

[9] Evidence in Hess (2001) implies that such non-pecuniary marital benefits that are gross substitutes for the utility from economic consumption are very temporary. We abstract from such considerations in this paper, while merely acknowledging that the decision to marry involves more than just economic factors, and that these factors can be random. Note that given the model's simplistic set-up, without the term δ, which can be negative, all couples would marry in order to enjoy the income hedging benefits from marriage. Such hedging benefits exist in a marriage as long as the individual's income shocks do not have a correlation coefficient of one.

which would preclude the complete insurance of idiosyncratic risk – see Chami and Fischer (1996). The second is that the source of risk may be partly systemic, which is not diversifiable through risk pooling. Marriage may be a vehicle, however, for diversifying part of this remaining risk. Suppose for instance that as part of a marriage proposal, for better or for worse, i and j agree to transfer resources to one another in the case that one of them realizes a bad state of nature but not the other. We denote $1-\lambda$ to be the amount of each individual's resources that they retain and hence λ is the amount of their resources that they share with their spouse. We restrict λ to be $0 < \lambda \leq 1/2$ so that individuals incorporate at least pooling of resources.[10] The problem is, of course, symmetric for individual j, so that total consumption across both individuals and time sum to joint resources.

The consequences of sharing resources are that married individuals can gain in expectation if their idiosyncratic shocks have a correlation coefficient of less than one. Denote the correlation between individuals' idiosyncratic shocks to be ρ. Then, following the steps above, expected welfare from Marriage (M), EW_k^{*M}, is:

$$EW_k^{*M} = \delta - 2\alpha^{-1} \cdot e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)(\sigma_e^2(1-\omega)+\sigma^2_{u^R})\right\}} \qquad k = i, j \tag{11}$$

where $\omega = 2\lambda(1-\lambda)(1-\rho)$ and $0 \leq \omega < 1$ given the restrictions on λ and ρ. Note that if $\rho = -1$ and $\lambda = 1/2$, then $\omega = 1$ and the individuals can perfectly hedge each others income risks. That mutual income pooling is welfare enhancing can be shown by noting that:

$$\frac{d\ EW_k^{*M}}{d\ \lambda} = \alpha \cdot \sigma_e^2(1-2\cdot\lambda)(1-\rho)e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)(\sigma_e^2(1-\omega)+\sigma^2_{u^R})\right\}} > 0 \quad k = i, j$$

where, again, λ is the fraction of each individual's risk that he / she shares with a partner,

[10] Of course, in the absence of moral hazard and adverse selection, $\lambda = 1/2$ might be the likely outcome, though our results below do not depend on fully maximizing joint utility. See Chami and Fischer (1996) for an endogenous determination of λ.

and $0 \geq \lambda < 1/2$, $\rho < 1$. Obviously, non-market transfers are utility enhancing in the presence of income risk that cannot be diversified in the market.

The decision to marry, therefore, will depend on whether both individuals get more utility from marriage as compared to staying single. Due to the symmetry of the problem, each individual will decide to marry if $EW_k^{*M} \geq EW_k^{*NM}$. This will depend on:

$$EW_k^{*M} - EW_k^{*NM} = \delta + 2\alpha^{-1}\left(e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)(\sigma_e^2+\sigma_{u^R}^2)\right\}}\right)\left(1 - e^{-\alpha^2\omega\sigma_e^2}\right) \quad k = i, j \tag{12}$$

Notice that due to the assumption that income levels and uncertainty are symmetric across individuals within a region, both i and j will both mutually agree to marry or not in an identical fashion.[11]

We now have the paper's major theoretical predictions.

Proposition 1 *Regions with a greater amount of non-diversified regional income risk will have higher rates of marital formation.*

Proof: Consider the case where the value of δ is such that two individuals are just indifferent to marriage. Hence, an increase in shared, though non-diversifiable risk $\sigma_{u^R}^2$, will lead to welfare for an individual to fall regardless of whether they are married or not. However, from expression (12), for $\omega > 0$:

$$\frac{d(EW_k^{*M} - EW_k^{*NM})}{d\sigma_{u^R}^2} = (\alpha/2)\left\{e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)(\sigma_e^2+\sigma_{u^R}^2)\right\}}\right\}\left\{1 - e^{-\alpha^2\omega\sigma_e^2}\right\} \geq 0 \;\; k = i, j.$$

The intuition is based on the fact that expected welfare is concave in risk. To see this more clearly, let σ^2 denote an individual's total income risk, while noting that σ^2 will higher for those that are not married compared to those that are: $\sigma^{2NM} = \sigma_e^2 + \sigma_{u^R}^2 > \sigma^{2M} = \sigma_e^2(1-\omega) + \sigma_{u^R}^2$. It is straightforward to show concavity by noting that $\frac{dEW_k^*}{d\sigma^2} < 0$ and $\frac{d^2EW_k^*}{d\sigma^{2\,2}} < 0$. Hence, an increase in risk will make the expected welfare from marriage fall less than that for the non-marriage, which will increase the likelihood of marriage.

[11] Again, see Hess (2001) for the case where they do not.

While Proposition 1 depends on the concavity of expected welfare with respect to income uncertainty, the following two propositions depend on the cross partial of expected welfare with respect to income uncertainty and income.

Proposition 2 *Regions with faster growth will have lower rates of marital formation.*

Proof: Again, consider the case where the value of δ is such that two individuals are just indifferent to marriage. Hence, an increase in income γ^R will lead to welfare for an individual to rise regardless of whether they are married or not. From expression (12), for $\omega > 0$:

$$\frac{d(EW_k^{*M} - EW_k^{*NM})}{d\gamma^R} = -(\alpha^2/4)\left\{e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)(\sigma_e^2+\sigma_{u^R}^2)\right\}}\right\}\left\{1-e^{-\alpha^2\omega\sigma_e^2}\right\} \leq 0 \;\; k = i, j.$$

The intuition is that as future expected income rises, the unexpected part of income falls in proportion. This reduces the need for marriage to hedge risks. More formally, the effect of uncertainty is lessened when expected growth rises. Namely, the cross partial of expected welfare with respect to income uncertainty and income growth is positive: $\frac{d^2EW_k^*}{d\sigma^2 d\gamma^R} > 0$. Hence, the rise in expected resources lessens marriage's relative benefit for hedging idiosyncratic income risk. Not only does expected future regional income growth demonstrate this property, but so does the initial amount of regional income as the following proposition demonstrates.

Proposition 3 *Regions with higher initial income levels will have lower rates of marital formation.*

Proof: Again, consider the case where the value of δ is such that two individuals are just indifferent to marriage. Hence, an increase in income y_{1i}^R will lead to welfare for an individual to rise regardless of whether they are married or not. From expression (12), for $\omega > 0$:

$$\frac{d(EW_k^{*M} - EW_k^{*NM})}{dy_1^R} = -(\alpha^2/2)\left\{e^{-\alpha\left\{(\gamma^R/2)+y_1^R-(\alpha/4)(\sigma_e^2+\sigma_{u^R}^2)\right\}}\right\}\left\{1-e^{-\alpha^2\omega\sigma_e^2}\right\} \leq 0 \quad k = i, j.$$

Identical to the intuition for expected growth, as current (and future) resources rise, the unexpected part of income falls in proportion. This reduces the need for marriage to hedge risks. Namely, the cross partial of expected welfare with respect to income uncertainty and initial income is positive: $\frac{d^2 EW_k^*}{d\sigma^2 dy_1^R} > 0$.

While Propositions $1-3$ detail the extent to which risk sharing is important for thinking about state level marital formation, there is one sense in which these propositions may seem quite unintuitive. The reason is that while marriage can only help diversify idiosyncratic risk, other facts that are the same for the two individuals who are considering marriage $--$ namely regional un-diversified risk, initial income levels and growth rates $--$ magnify the benefits to diversification. This aspect of the model, as one might guess, does not hold for all specifications of the utility function. For example, under quadratic utility, the resulting certainty equivalent nature of the individual's consumption decision rules and welfare benefits, dramatically alters the earlier propositions. This finding is summarized in the following proposition.

Proposition 4 *Under quadratic utility, neither non-diversified regional income risk, regional growth rates or regional income levels affect the rate of marital formation.*

Proof: Let $U(c) = c - (\phi/2) \cdot c^2$, where $\phi > 0$ and is such that the marginal utility of consumption is always positive, $1 - \phi \cdot c > 0$. The the expected welfare from marrying is:

$$EW_k^{*M} = \delta + 2 \cdot \left[(\gamma^R/2) + y_1^R - (\phi/2) \left((\gamma^R/2) + y_1^R \right)^2 \right] - \phi \cdot (\sigma_e^2 (1-\omega) + \sigma_{u^R}^2)$$

While the expected welfare from not marrying is:

$$EW_k^{*NM} = 2 \cdot \left[(\gamma^R/2) + y_1^R - (\phi/2) \left((\gamma^R/2) + y_1^R \right)^2 \right] - \phi \cdot (\sigma_e^2 + \sigma_{u^R}^2)$$

Hence expression (12) which represents the difference in welfare between marriage and no marriage now becomes $EW_k^{*M} - EW_k^{*NM} = \delta + \phi\omega\sigma_e^2$. Indeed, neither γ^R, y_1^R nor $\sigma_{u^R}^2$ appears in this expression.

The difference in the utility functions considered is clear. Unlike the case of CARA utility, when utility is quadratic the expected welfare function is now linear in income uncertainty and no longer concave, $\frac{dEW_k^*}{d\sigma^2} < 0$ and $\frac{d^2 EW_k^*}{d\sigma^{2\ 2}} = 0$. Hence, an increase in uncertainty lowers expected welfare in marriage and non-marriage the same, thereby not affecting the willingness to marry. Moreover, the cross partial of expected welfare with respect to income uncertainty and income, $\frac{d^2 EW_k^*}{d\sigma^2 d\gamma^R}$, is now zero, rather than positive as before. Again, expected resources will not effect the relative hedging benefits of marriage vis-a-vis non-marriage.

To demonstrate that a positive third derivative is needed to obtain the results in Propositions $1-3$, we have the following proposition.

Proposition 5 *With a precautionary attitude towards risk motive, i.e. the third derivative of the utility function is positive, Propositions* $1-3$ *hold more generally.*

Proof: Define the Welfare function as:

$$EW = u(c_1) + 1/2u(x+v-c_1) + 1/2u(x-v-c_1),$$

where the utility function has the usual properties, with $u' > 0$, and $u'' < 0$, x is the permanent resources $2 \times y_1^R + \gamma^R$. The model is simplified so that there is a $\frac{1}{2}$ chance of a shock $+v$ and a $\frac{1}{2}$ chance of a shock $-v$, so that the mean shock is still zero and the variance is v^2. Let $u_H \equiv u(x+v-c_1)$, and $u_L \equiv u(x-v-c_1)$. Optimal first periond consumption is given by the first order condition

$$u'(c_1) - 1/2[u'_H + u'_L] = 0. \tag{13}$$

Thus $c^*(x,v)$. The impact of the initial income on optimal consumption is

$$\frac{\partial c_1^*}{\partial x} = -\frac{-1/2[u''_H + u''_L]}{\Phi} > 0 \qquad 1/2 \geq \frac{\partial c_1^*}{\partial x} > 0. \tag{14}$$

where the second order condition is denoted Φ, $\Phi = u''(c_1) + 1/2[u''_H + u''_L] < 0$. The impact of the shock on optimal consumption is

$$\frac{\partial c_1^*}{\partial v} = -\frac{1/2[u''_L - u''_H]}{\Phi} < 0. \tag{15}$$

Note that while the second order condition (Φ) is unambigously negative, the sign of the numerator in (15) depends on the sign of the third derivative $u'''(c_2)$. Thus, as long as $u''' > 0$, then $u''_L - u''_H < 0$. As a result, with the assumption that $u'''(c_2) > 0$, then $\frac{\partial c_1^*}{\partial v} < 0$. Moreover, note that $|\frac{\partial c_1^*}{\partial v}| < 1$. Substituting the optimal consumption level c_1^* into the welfare function we have,

$$EW^* = u(c_1^*) + 1/2[u(x+v-c_1^*) + u(x-v-c_1^*)].$$

Taking the derivative of the welfare function with respect to the shock

$$\frac{dEW^*}{dv} = \underbrace{[u'(c_1^*) - 1/2(u'_H + u'_L)]}_{FOC=0} \frac{\partial c_1^*}{\partial v} + 1/2[u'_H - u'_L] < 0, \tag{16}$$

if and only if $u'' < 0$. Note that with a quadratic utility function, $\frac{\partial c_1^*}{\partial v} = 0$ and the second term is a constant. Hence with a quadratic utility function, expected welfare is linearly decreasing in the variance of the shock, and is not concave.

Continuing on for the case of non-quadratic utility, we can then take the second derivative of the welfare function with respect to v

$$\begin{aligned} \frac{d^2EW^*}{dv^2} &= \Phi[\frac{\partial c_1^*}{\partial v}]^2 + FOC[\frac{\partial^2 c_1^*}{\partial v^2}] + 1/2[u''_L - u''_H]\frac{\partial c_1^*}{\partial v} + 1/2u''_H[1 - \frac{\partial c_1^*}{\partial v}] + 1/2[1 + \frac{\partial c_1^*}{\partial v}] \\ &= \Phi[\frac{\partial c_1^*}{\partial v}]^2 + \frac{\partial c_1^*}{\partial v}[u''_L - u''_H] + 1/2[u''_H + u''_L]. \end{aligned} \tag{17}$$

Rearranging terms

$$\frac{d^2EW^*}{dv^2} = \frac{\partial c_1^*}{\partial v}[\Phi\frac{\partial c_1^*}{\partial v} + [u''_L - u''_H]] + 1/2[u''_H + u''_L] \tag{18}$$

Substituting condition (15) in the above equation, noting that $|\frac{dc_1^*}{dv}| < 1$, and rearranging terms gives

$$\frac{d^2EW^*}{dv^2} = 1/2(\frac{dc_1^*}{dv}[u''_L - u''_H] + [u''_H + u''_L]) < 0, \tag{19}$$

where the ineqaulity holds as long as $u''' > 0$. The impact of the cross partial derivative of the expected welfare function with respect to income shock and income level can be seen from

$$\frac{d^2EW^*}{dvdx} = 1/2[-u''_H - u''_L]\frac{\partial c_1^*}{\partial v} + 1/2[u''_H - u''_L] + 1/2[u''_L - u''_H]\frac{\partial c_1^*}{\partial x} + \Phi\frac{\partial c_1^*}{\partial v}\frac{\partial c_1^*}{\partial x}$$

Rearraning terms and making use of conditions (14) and (15)

$$\begin{aligned} \frac{d^2EW^*}{dvdx} &= 1/2[-u''_H - u''_L]\frac{\partial c_1^*}{\partial v} + 1/2[u''_H - u''_L] + \frac{\partial c_1^*}{\partial x}[1/2(-u''_H + u''_L) + \Phi\frac{\partial c_1^*}{\partial v}] \\ &= 1/2[-u''_H - u''_L]\frac{\partial c_1^*}{\partial v} + 1/2[u''_H - u''_L] + \frac{\partial c_1^*}{\partial x}[1/2(-u''_H + u''_L) + 1/2(u''_H - u''_L)] \\ &= 1/2[-u''_H - u''_L]\frac{\partial c_1^*}{\partial v} + 1/2[u''_H - u''_L] > 0, \end{aligned} \tag{20}$$

where the last inequality follows from the fact that from condition (15) $|\frac{\partial c_1^*}{\partial v}| < 1$ and $u''' > 0$.

3 Empirical Test

In this section we test the broad implications of the theory as set out in Propositions 1, 2 and 3. Of course, as pointed out in Propositions 4 and 5, evidence in favor of the first three propositions does suggest that both a risk diversification motive for marriage is present as well as a precautionary motive toward risk.

3.1 The Data

The theory is tested using a variety of data for the 50 United States obtained from sources detailed in the statistical appendix.[12] The baseline specification that we consider is:

$$MARSTOCK^R = \beta_0 + \beta_1 \cdot \sigma_{\Delta c^R} + \beta_2 \cdot y_0^R + \beta_3 \cdot \Delta y^R + \beta_4 \cdot D^R + u^R \qquad (21)$$

According to the theory, the stock of marriages (MARSTOCK) will be higher the more incomplete is a state's ability to diversify its state specific consumption risk ($\sigma_{\Delta c^R}$), the lower is its initial level of income (y_0^R) and the slower is its average growth rate (Δy^R). Hence theory predicts that the signs of the coefficients should be $\beta_1 > 0$, $\beta_2 < 0$ and $\beta_3 < 0$. Moreover, we also include in the specification a list of other control variables, D, which will account for other state level factors which can affect the stock of marriages.

The dependent variable, $MARSTOCK_i$, is statewide data on the fraction of households where a married couple is present in 1990. The important economic variables which theory suggests should affect the rate of marital formation were also obtained as follows. First, for the initial level of income, y_0^R, we use per-capita real GSP Data from the Department of Commerce for 1963. Second, we construct state level average economic growth, Δy^R, using per-capita real GSP for the time period 1964-1989.

[12]Not all data are available for the District of Columbia, so they are dropped from the sample. In particular, given the size of the District, its proximity to other states, and the nature of the consumption measure (retail sales), it is likely that this variable contains tremendous measurement error.

Finally, we consider two measures of incomplete across region risk sharing, $\sigma_{\Delta c^R}$. Both measures are based on using the region specific variability of a state's consumption to measure a state's inability to share region specific risk. Recall that if a state can completely diversify its region specific risk, then the variability of its regional specific consumption should be zero. Moreover, the poorer the state is at diversifying region specific risk, the larger will be the measure of region specific consumption volatility. Hence, our first measure is the standard deviation of the region specific component of consumption as calculated in Del Negro (2001). In this paper, Del Negro constructs and estimates a factor model of U.S. consumption growth data using a panel of U.S. state from 1964-1995, allowing for asymmetry in the response to positive and negative shocks.[13] From this he identifies a state specific factor in consumption, for which he calculates the volatility of this factor by states. We label this measure of incomplete across region risk sharing for each state R as $\sigma^F_{\Delta c^R}$, where the superscript F denotes that the state measure was derived from a factor model. In addition to this factor based measure for incomplete risk sharing, we also construct a simpler one in order to demonstrate the robustness of our findings. This simpler measure is calculated as follows. Using the same underlying data from Del Negro, we calculate each states standard deviation of its consumption growth less the average consumption growth in the U.S. from 1963-1989. We denote this simpler measure of incomplete risk sharing as $\sigma^S_{\Delta c^R}$ This can be thought of as a simpler identification of region specific consumption growth volatility, and does not require the estimation of an asymmetric factor model as in Del Negro (2001).

In addition to these economic factors predicted by the theory, both legal and cultural factors can also affect a state's fraction of households that contain a married couple. These control variables, denoted D in equation (21).[14] To parsimoniously capture these factors,

[13]The data for state level consumption is retail sales of non-durable goods. This is widely used to measure consumption across U.S. states. See , Asdrubali, Sorensen and Yosha (1996), Hess and Shin (1998), Crucini (1999) Athanasoulis and van Wincoop (2001) and Del Negro (2001).

[14]A number of other explanatory variables were included (not shown) , such as average age, percentage of

we consider two important variables. First, we include the average fraction of a state's vote that went to the Republican candidate for President in 1988 in 1992, denoted $REPUB$. Given that during this time period the Republican party emphasized its role in identifying with 'family values', this political variable may be a good proxy for a broad set cultural and demographic factors that will be associated with an increased rate of marital formation. Moreover, with only 50 cross sectional observations, this variable is likely to parsimoniously captures these "pro-family" characteristics. Finally, to capture any legal differences in marital laws across states, we also consider a dummy variable from Friedberg (1998), $UNILAT$, that takes the value of one if the state has unilateral divorce laws, and is zero otherwise.[15] The issue we want to control for is whether the presence of unilateral divorce laws lowers the expected benefits from marital formation by increasing the probability of divorce and perhaps discouraging marital formation altogether – see Friedberg (1998) and Gruber (2000).

Moreover, while the purpose of this paper is to explain cross-sectional patterns in marriage formation across states, a concern is that our measures for the relevant economic variables and our other control variables may demonstrate reverse causality. Of course, such endogeneity, would make our estimation results less persuasive. To this end, we consider a number of instruments for our explanatory variables. While instrumental variables are not targeted to specific explanatory variables, our thinking was as follows. First, while the initial level of income is temporally prior, and is therefore an admissible, we include education variables to instrument for future growth. These variables are the state's illiteracy rate in 1960 as well as the medium number of years of formal schooling for the over-14 population in 1960. Both data series are available from the Census Bureau. Second, we use each state's fraction of the population in 1970 who designate themselves adherents / members

the population that is white, etc..., in the specification. These variables were not found to be statistically significant and are thus omitted.

[15]Specifically, we use the data from column (1) of Table 1 from Friedman (1998).

of an organized Christian denomination, $ADHER$, to instrument for the Republican vote share for president, REPUB. This data is reported in the Statistical Abstract published by the Census Bureau. Due to confidentiality issues, the Census did not report this prior to 1970, during the post-war period. Furthermore, since most states that did adopt unilateral divorce laws in the sample did so in the 1970's or earlier, we also include $UNILAT$ as an instrument.[16] Finally, to instrument for a state's ability to share risk, we use a corresponding measure of the volatility of their state specific shocks to GSP growth, $\sigma^F_{\Delta y^R}$ and $\sigma^S_{\Delta y^R}$. Moreover, since the ability to share risk may be related to a state's financial development, we use each states' 1977 fraction of GSP in the Finance, Real Estate and Insurance as an instrument. Such state/industry data in GSP is not available prior to 1977.

Taken together, these instruments are generally quite a bit prior and exogenous to the dependent variable, the fraction of households where there is a married couple, and are likely to be correlated to the explanatory variables. While the dates of these instruments do not perfectly coincide, they are generally the earliest available for each series.

3.2 Data Description

Table 1 presents some basic statistics of the data. On average, about 56 percent of households have a married couple, with the range varying between just under 50 percent to around 65 percent. State specific consumption and output volatility demonstrates quite a range, from a standard deviation of around 2 percent to over 10 percent. Notice that, on average, the standard deviation of consumption is higher than that for output. As argued by Hess and Shin (1998) and Del Negro (2001), this is likely due to the large independent measurement error in the consumption data for states used in this study.[17] Average state per-capita real GSP was just under ten thousand dollars in 1963 (based on 1994 prices), and

[16] Of the 31 states coded as having unilateral divorce laws, the most recent state to adopt such laws was South Dakota in 1985. The next most recent was Wyoming in 1977. Again, see Table 1 of Friedberg (1998).

[17] Some long footnote here about the relative measurement errors.

average growth until 1990 was just under two percent. The Finance, Insurance and Real Estate sector was about 13 percent of GSP in 1977, though the range is from just under 10 percent to over 20 percent of GSP.

For the demographic variables, illiteracy rates in the U.S. in 1960 varied from under 1 percent to over 6 percent, averaging 2.3 percent, while the median years of formal schooling was over 10 years on average at this time. The average state vote for Republican presidents in 1988 and 1992 was just over, with the entire range almost entirely within the range of 40 to 60 percent. On average, about 50 percent of a state's population declared themselves to be Christian adherents in 1970, with a range of a low of almost 30 percent to a high of over 80 percent. Finally, 31 of the 50 U.S. states had unilateral divorce laws during this time period.

Table 2 provides some basic correlations of the underlying data. Consistent with the theoretical propositions outlined above, states with larger fractions of married households have more volatile state specific consumption, lower growth and lower initial incomes. They were also more Republican and religious, and had smaller financial sectors. A few other points are also worth mentioning. First, the two consumption volatilities are correlated at almost .9, while the two output volatilities are correlated at .98, suggesting that our findings are unlikely to depend on the measure of incomplete regional risk sharing. Moreover, consumption and output volatility are positively correlated using both sets of measures. Second, states with larger financial sectors have lower measures of incomplete risk sharing, more schooling and higher initial GSP. Finally, the level of initial GSP and subsequent GSP growth are negatively correlated as one would predict given evidence of convergence across states. Hence, while ADHER is negatively related to both the initial level of GSP and its subsequent growth rate, the education variables more illiteracy and less schooling are related to lower initial income levels, they are also related to higher subsequent growth.

3.3 Empirical Results

While sub-section 3.2 presented the stylized facts of the data, in this sub-section we provide estimates of expression (21) in order to gauge whether incomplete regional risk sharing can help explain cross sectional patterns in state level marital formation. Table 3 reports the estimation results of this equation using the two measures of incomplete across region risk sharing. Those specifications using $\sigma^F_{\Delta c^R}$ are reported in columns (I) - (III), and those using $\sigma^S_{\Delta c^R}$ are reported in columns (IV) - (VI). To control for possible endogeneity of the explanatory variables, columns (III) and (VI), report estimates of equation (21) using instrumental variables (described above).

In general, the estimation results presented in Table 3 strongly support the theory: namely, there is broad evidence that marital formation is higher when incomplete risk sharing is higher ($\beta_1 > 0$), and when the initial level of output ($\beta_2 < 0$) and subsequent growth ($\beta_3 < 0$) are lower. Consider the results in columns (I)-(III) where we use the incomplete consumption risk sharing measure from Del Negro (2001), $\sigma^F_{\Delta c^R}$. In column (I), we include only the economic terms in the specification. The results demonstrate that incomplete risk sharing is positively related to a states' marital formation and statistically significant at the .05 level. Also, initial GSP is negatively related to a states' marital formation and statistically significant at the .01 level. However, while the coefficient on growth, β_3, has the correct sign, it is not significant at conventional levels (its p-value is .19). The R-squared demonstrates that these economic variables explain over 20 percent of the cross state variation in marital formation.

The results in column (II) introduce our additional control variables $REPUB$ and $UNILAT$ into our empirical specification.[18] Recall that the former is likely to be helpful as a proxy for a state's pro-family bias while the latter may reflect legal differences in

[18]We tried numerous other variables in this baseline specification, such as median age in the state, percentage of the state that is white, etc... The inclusion of these variables does not affect our findings.

the relative costs and benefits of marriage. The results in column (II) strengthen when introducing these variables into the specification in a number of ways. First, the coefficient on growth, β_3 is now statistically different from zero at below the .10 level (p-value of .066). Indeed, the estimated signs of the coefficients on the theory's three key economic variables, cannot be rejected at conventional significance levels. Second, the coefficient on the Republican variable is positive and statistically different from zero at below the .01 level, suggesting the positive association between Republican voting and marital formation. Third, while the coefficient on unilateral is not significantly different from zero, the equation's R-squared almost doubles.

Finally, to demonstrate the robustness of these findings, column (III) repeats the specification in column (II) except that we now use instrumental variables to estimate the specification.[19] Importantly, the results in column (III) indicate continued support for the theory. In fact, the effect of unilateral divorce laws is also now statistically different from zero at the .05 level and negative. It is unlikely, therefore, that our findings are driven by reverse causality or endogeneity of the explanatory variables. To further check this point, the bottom row of Table reports the p-value from a Hausman [1978] specification test that the ordinary least squares estimates in column (II) and the instrumental variables estimates in column (III) are equal. The p-value, well above conventional levels, suggests that endogeneity of the right hand side variables is not an important statistical concern.

The estimation results in columns (IV) - (VI) demonstrate broadly similar findings when we use the simpler measure of incomplete across region risk sharing, $\sigma^S_{\Delta c^R}$. In particular, the results in column (IV) closely mirror those in column (I). Also, in columns (IV) and (V), the estimated coefficients on incomplete risk sharing, initial real per-capita GSP and real per-capita GSP growth are significantly different from zero at below the .1 level and

[19]Again, for the results in column (III), the instruments include a constant, illiteracy and school year measures for 1960, the percentage of the population that are Christian adherents, the fraction of the states 1977 GSP that is in the Finance, Insurance and Real Estate sectors, initial GSP in 1963, $\sigma^F_{\Delta y^R}$ and $UNILAT$.

have the predicted signs. Finally, the results suggest that $REPUB$ is still positively and significantly related to marital formation, although $UNILAT$ remains negatively though insignificantly related to marital formation. Taken together, the results in Table 3 provide broad support for the view that regional aspects of risk sharing are important for explaining cross-state differences in marital formation.

4 Conclusion

In this paper, we have provided a model that examines the risk sharing determinants of state-level marital formation. The theory identifies two important economic factors. First, the greater is a state's level of undiversifiable state income risk, the greater will be the formation of marriages in a state. The reason is that individuals will be driven to diversify more of their idiosyncratic risk under such circumstances. Second, an increase in current or expected future resources in a state will decrease a state's rate of marital formation. In this case, holding fixed the amount of uncertainty, a rise in expected resources diminishes the relative importance of an individual's uncertain income stream. These factors are demonstrated to depend on the nature of the utility function. Namely, the presence of these economic factors in explaining state level marital formation is shown to depend on a precautionary motive towards risk, i.e. a utility function with a positive third derivative.

Cross sectional evidence in support of these economic / risk sharing factors in marriage is also provided. As discussed, these findings also provide indirect evidence of a precautionary motive towards risk. Indeed, the finding that the risk sharing aspects of marriage are important in the U.S., suggests that non-market institutions continue to be important factor even in advanced market economies.

As well, a more general point can be made that one does not need altruism to explain the mutual welfare enhancing role of risk sharing vows and commitments in marriage. In fact, the model points to an economic reason for why marriages become more frequent during periods of chaos and war – a time series prediction of marital fluctuations rather than the cross-sectional one explored in the empirical work. As the model points to, when the variance of systemic shocks rise, individuals with a precautionary motive towards risk will have further incentive to marry in order to diversify their idiosyncratic shock, despite the fact that marriage does not help them diversify a systemic shocks. Hence marriages will rise during periods of uncertainty such as war. Indeed, such rises have been experienced during the recent Civil War in Lebanon and during World War II in America. An examination of this time series prediction will be conducted in future research.

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Table 1: Simple Statistics

Series	*Mean*	*StdError*	*Minimum*	*Maximum*
MARSTOCK	56.53	2.68	49.90	64.80
$\sigma^F_{\Delta c^R}$	4.89	1.45	2.50	10.31
$\sigma^S_{\Delta c^R}$	4.05	1.50	1.69	10.61
$\sigma^F_{\Delta y^R}$	3.01	2.28	1.31	15.33
$\sigma^S_{\Delta y^R}$	3.05	1.95	1.36	13.52
y^R_0	9.92	1.82	6.17	14.14
Δy^R	1.94	0.54	0.75	3.79
REPUB	51.37	5.49	41.04	64.92
ILLIT	2.32	1.42	0.70	6.30
SCHOOL	10.63	0.87	8.90	12.10
ADHER	51.55	11.23	32.53	83.58
FIRE77	13.14	2.50	9.29	20.69
UNILAT	0.62	0.49	0	1

Notes: There are 50 observations, one for each U.S. state, for each series. MARSTOCK is the percent of households that has a married couple in 1990. $\sigma^F_{\Delta c^R}$ and $\sigma^F_{\Delta y^R}$ are the standard deviations of the state specific factors for real consumption and GSP growth rates, respectively, from Del Negro (2001). $\sigma^S_{\Delta c^R}$ and $\sigma^S_{\Delta y^R}$ are the standard deviations of state specific real consumption and GSP growth rates as measured as deviations from U.S. growth, respectively. y^R_0 is the level of per-capita real GSP in 1963, while Δy^R is the average growth rate of per-capita real GSP from 1963-1989. $REPUB$ is the average fraction of a state's vote that went to the Republican candidate for President in 1988 in 1992. ILLIT is the percent of the population that was illiterate in 1960, while SCHOOL is the median number of years of formal schooling for the over 14 population. ADHER is the percent of the 1970 population that considers itself adherent / members of a Christian denomination, UNILAT is a dummy variable that takes the value of one if the state has unilateral divorce laws, and FIRE is the percent of 1977's GSP that was accounted for by the Fire, insurance and real estate sector.

Table 2: Data Correlations for the U.S. States

	MARSTOCK	$\sigma^F_{\Delta c^R}$	$\sigma^S_{\Delta c^R}$	$\sigma^F_{\Delta y^R}$	$\sigma^S_{\Delta c^R}$	y^R_0	Δy^R	REP	ILLT60	SCHL60	ADH71	FIRE77
$\sigma^F_{\Delta c^R}$	.22											
$\sigma^S_{\Delta c^R}$	.18	.89										
$\sigma^F_{\Delta y^R}$	.17	.36	.44									
$\sigma^S_{\Delta y^R}$	.18	.31	.40	.98								
y^R_0	−.34	.20	.20	.19	.16							
Δy^R	−.11	−.01	.01	.32	.32	−.21						
REPUB	.48	.09	.13	.27	.30	−.24	.11					
ILLT60	−.22	−.26	−.16	.01	−.01	−.37	.44	.08				
SCHL60	−.03	.35	.33	.24	.17	.66	−.19	.00	−.64			
ADHER	.35	−.12	−.14	−.02	.04	−.23	.15	.11	−.10	−.14		
FIRE77	−.45	−.08	−.14	−.28	−.32	.35	.08	−.39	−.18	.44	−.09	
UNILAT	.05	.42	.41	.30	.26	.13	−.07	.07	−.26	.44	−.05	.10

Notes: See Table 1 for data details.

Table 3: State Level Marital Stock and Risk Sharing Regressions

Dependent Variable	$\sigma^F_{c^R}$			σ_{c^R}		
	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	62.078***	51.053***	47.970***	62.812***	51.837***	51.664***
	(2.060)	(3.817)	(7.743)	(2.801)	(4.052)	(7.334)
$\sigma^F_{\Delta c^R}$	.568**	.515***	1.385***			
	(.225)	(0.187)	(0.468)			
$\sigma^S_{\Delta c^R}$				0.472**	0.365*	1.028**
				(0.231)	(0.199)	(0.508)
y_0^R	− 0.651***	−0.496**	− 0.633***	− 0.636***	−0.477**	− 0.618**
	(0.191)	(0.192)	(0.246)	(0.194)	(0.198)	(0.247)
Δy^R	−0.969	−1.100*	−2.495*	−0.976	−1.090*	−2.683*
	(0.744)	(0.600)	(1.479)	(0.719)	(0.585)	(1.399)
REP		0.199***	0.270**		0.198***	0.247**
		(0.075)	(0.107)		(0.075)	(0.113)
UNIL		−0.373	−1.557**		−0.197	−1.122
		(0.679)	(0.743)		(0.668)	(0.765)
R^2	.236	.390	.122	.212	.361	.151
Hausman			.292			.522

Notes: See Table 1 for data details. There are 50 observations in each regression. Standard errors, robust to heteroskedasticity of unknown form, are reported in parentheses. ***, ** and * denote that the estimated coefficient is statistically different from zero at below the .01, .05 and .10 levels of significance, respectively. The results in columns (I)-(III) identifies the state specific volatility of consumption using Del Negro's asymmetric factor model, while the results in columns (IV)-(VI) uses the simple standard deviation of the each state's regional consumption growth as measured as a deviation from average U.S. consumption growth. The estimates in columns (I), (II), (IV) and (V) were obtained using OLS. The estimates in columns (III) and (VI) were obtained using instrumental variables, where the instruments used were a constant, the percent of each state's population that was illiterate in 1960, the median number of school years attended by those over 14 years of age in 1960, initial income, the fraction of a state's GSP that was concentrated in the Finance, Insurance and Real Estate Sector and a dummy variable for unilateral divorce laws. Hausman refers to the p-value from a specification test that the coeffficients are not significantly different between the OLS and IV estimates, (II) and (III), and (V) and (VI).