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PRECAUTIONARY SAVING AND ALTRUISM*

by

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ABSTRACT

The potential importance of the precautionary motive for saving has been noted in many studies during the last decades. This paper examines the determination of precautionary saving when people have access to intra-family risk sharing. I show that, with uncertain future income, altruism *per se* can induce time consistent, however, not necessarily *ex ante* efficient, risk sharing between risk averse spouses. The more altruistic the couple is, the closer is the solution to the efficient one. Also welfare and savings effects from social insurance turn out to be sensitive to assumptions about family structure. For risk sharing couples, the introduction of a compulsory insurance scheme may have substantially smaller effects on welfare and precautionary savings.

Keywords: Precautionary saving, Altruism, Risk sharing, Marriage, Intra-family insurance.

JEL-codes: D64, D81, J12

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1 Introduction

Since Leland (1968) and Sandmo (1970) many economists have paid attention to the precautionary savings motive. People save not only to smooth consumption, but also because they are uncertain about the future in one way or the other. The uncertainty could, among other things, concern length of life, future earnings, medical expenses or cost of housing. There are several empirical studies indicating that precautionary savings actually constitutes an important fraction of total wealth accumulation.[1] If the insurance market is incomplete, a substitute may be intra-family insurance, and it has also been concluded that the family often permits some kind of insurance among its' members.[2] A problem in many existing models of family decision making is, however, that the resulting risk sharing may well be time inconsistent when binding contracts are impossible to create and there are no self enforcing constraints. As shown in this paper, that problem may be solved by taking altruism into account. Altruism *per se* can make married couples share risk in a time consistent way.

When risk is shared with the spouse, uncertainty about future income may be less important than if the individual is single. The probability that both spouses e.g. become unemployed is likely to be much lower than the corresponding individual probability. (Of course, there may be macro level risk that is impossible to reduce, even within the family) How much lower the risk is for an individual that lives in a family depends, among other things, on how family decisions are reached.

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[1] See e.g. Skinner (1988), Carroll (1994), Merrigan & Normandin (1996).

[2] See e.g. Kotlikoff & Spivak (1981) and Becker (1991, chaps. 8 and 11), for theoretical reasoning and Merrigan & Normandin (1996) and Gruber & Berry Cullen (1996) for empirical evidence. Also the extended family may give rise to risk sharing, but e.g. Hayashi et al. (1996) reject full risk sharing between parent households and their split-offs.

There are various possible modes of family decision making. Often it is simply assumed that the family maximises one common utility function and it is of no importance who earns the money in the family. For this model to yield a time consistent solution, it requires full altruism from at least one party[3] and/or that all consumption goods are public within the family where everyone has the same preferences. Another way of decision making is a non-cooperative solution. Both spouses maximise their utility unilaterally, taking the other's actions as given. The resulting Cournot-Nash solution is self-enforcing, but likely to be inefficient, and may be reached with, as well as without altruism.[4]

Spouses may also act co-operatively, and set up a contract that via e.g. a bargaining process maximises some *ex ante* utility function[5]. This process is efficient *ex ante*, and does not require altruism. It may, however, lead to time inconsistency, a problem which is often neglected. Kotlikoff & Spivak (1981) concludes e.g. that selfish individuals may gain from risk sharing within marriage when there is uncertainty about length of life. The two spouses agree on a joint consumption path while both are alive, and the one who dies first bequeaths his or her assets to the spouse. This arrangement maximises *ex ante* utility for both spouses, but with lack of altruism, there is possibly a problem with time inconsistency, which is illustrated by an example: If the husband does not care about his wife, it might be optimal for him to act *as if* she will be the only beneficiary in his will, but in fact he gives the assets to someone else, a

[3] An example where not all family members have to be altruistic to maximise a joint utility function is the Rotten Kid Theorem, see e.g. Becker (1974 and 1991, chap. 8).

[4] See e.g. Lindbeck & Weibull (1988), Kooreman & Kapteyn (1990) and Browning (1996).

[5] See e.g. Kotlikoff & Spivak (1981) and Konrad & Lommerud (1996).

fact that will not be discovered until he is dead, and hence the wife cannot punish him for deviating from the contract.

In this paper, I specifically explore the relationship between precautionary saving and altruism. In a world with uncertain future income I show that altruism can enforce risk sharing within the family, and thereby reduce the need for precautionary saving. The spouses share risk to a larger extent the more they love each other. The presence of altruism and the assumption that savings decisions in the family are made in a non-cooperative way, taking the other's actions as given, guarantee that the solution is *ex post* efficient and time consistent, although it is not necessarily efficient *ex ante*.[6]

The possibility of insurance within the family has obvious implications also for the effectiveness of social insurance. Engen & Gruber (1995) empirically find large crowding-out effects on precautionary saving from unemployment insurance, and also notice that the effects are stronger for singles. This is very much in line with the theoretical results in this paper, where I show that the magnitude of the crowding-out effects very much depends on family structure. If people already are insured within the family, the introduction of social insurance may primarily crowd out this existing insurance, and hence have smaller welfare effects than expected. I show that the effects on savings behaviour and welfare from the introduction of compulsory insurance turn out to be stronger if people are single than if they are altruistically risk sharing couples.

[6] The *ex ante* inefficiency is of the same kind as that studied by Lindbeck & Weibull (1988).

The remainder of the paper is organised as follows. In section 2 I study precautionary saving for a single individual. The individual lives for two periods, one in which income is certain, and one in which there may be either employment with high income or unemployment with low income. Section 3 considers a married mutually altruistic couple, who make savings decisions in a non-cooperative way. Precautionary savings turn out to be smaller for a married than for a single person, and less sensitive to increased risk. Sections 4 and 5 contain two extensions. In section 4 one of the spouses has a higher probability of becoming unemployed, and section 5 studies the effects from compulsory insurance. I show that the effects on savings, as well as on welfare, from the introduction of social insurance are larger if people are single, rather than married, completely risk sharing couples. Section 6 concludes the paper.

2 One single individual

Assume that there is an individual who lives for two periods. In the first he receives a certain income, and in the second an uncertain one. He gets utility from consumption in the two periods according to a utility function with constant absolute risk aversion[7]:

$$u = -\frac{1}{q}e^{-qc_1} - \frac{1}{q}e^{-qc_2}\ , \tag{1}$$

where c_t indicates consumption in period t and q is the coefficient of absolute risk aversion. With the exponential utility function, q is also the coefficient of absolute prudence. Kimball (1990) defines the measure of absolute prudence as representing the intensity of the precautionary saving motive. The interest and discount rates are, for simplicity, equal to zero, but according to Caballero (1991) such an assumption does not alter the result appreciably. In the

[7] This is not the most realistic utility function generating precautionary saving, i.e. $u'''(c_t) > 0$, but unfortunately more realistic utility functions make it impossible to get a closed-form solution to the present problem.

first period there is a non-random income y_1. Period-two income consists of two parts; one non-random part $\bar{y}$ and one random $\tilde{y}$, that may be high or low indicating, for example, employment or unemployment, an interpretation adopted throughout the paper:

$y_2 = \bar{y} + \tilde{y}$,

where

$\tilde{y} = ke_1$ with probability p,

and

$\tilde{y} = ke_2$ with probability (1-p).

k is a shift parameter, and $pe_1+(1-p)e_2=0$, so that the expected value of y_2 is $\bar{y}$. We think of $e_1<0$ as representing unemployment and $e_2>0$ as representing employment. The part of y_1 saved to period two is denoted s (with a perfect capital market s may well be negative), so that the individual's problem can be expressed as:

$$\max_s \; Eu = -\frac{e^{-q(y_1-s)}}{q} - \frac{pe^{-q(s+\bar{y}+ke_1)}}{q} - \frac{(1-p)e^{-q(s+\bar{y}+ke_2)}}{q} \;, \tag{2}$$

where E is the expectations operator.

The resulting Euler condition can be reformulated as an expression for saving:

$$s = \frac{y_1 - \bar{y}}{2} + \frac{\ln\left[pe^{-qke_1} + (1-p)e^{-qke_2}\right]}{2q} \tag{3}$$

The first term reflects ordinary consumption smoothing, while the second term is positive[8] and expresses precautionary saving.

Because of the precautionary savings motive, savings increase when there is a mean preserving increase in risk (an increase in k):

[8] This follows since $pe^{-qke_1} + (1-p)e^{-qke_2} > e^{-qk(pe_1+(1-p)e_2)} = e^0 = 1$.

$$\frac{\partial s}{\partial k} = \frac{pe_1\left(e^{-qke_2} - e^{-qke_1}\right)}{2\left(pe^{-qke_1} + (1-p)e^{-qke_2}\right)} > 0 \qquad (4)$$

where I have used the fact that $pe_1+(1-p)\, e_2=0$.

It is also trivially true that:

Proposition 1: *Utility is lower under uncertainty than under certainty*.

Proof: The discrepancy between utility under certainty and the expected utility under uncertainty is measured in terms of the Equivalent Precautionary Premium (*EPP*)[9]. *EPP* is the reduction in nonrandom period-two income that makes the individual optimally choose the same amount of savings as in the uncertain case. Higher precautionary savings rates thereby corresponds to higher values of *EPP*. The measure is derived and further discussed in Appendix A. If *EPP* is positive this indicates that income risk decreases utility. *EPP* derived from the optimisation (2) is

$$EPP = \frac{\ln\left[pe^{-qke_1} + (1-p)e^{-qke_2}\right]}{q} > 0$$

Hence utility under uncertainty is lower than under certainty. ∎

3 Altruism

Now consider a married, mutually altruistic couple, *A* and *B*, both with earnings and utility functions as described in section 2. The spouses have identical incomes y_1 in period one and identical, but independent income structures $\bar{y} + \tilde{y}$ in period two. Furthermore they have the same altruistic concern for each other, a concern represented by the parameter $0 \leq \gamma \leq 1$ in their respective utility function:

$$EU_i = Eu_i + \gamma Eu_j \tag{5}$$

where u_i is utility from own consumption, henceforth called private utility, defined in (1) for $i=A, B, j \neq i$[10]

Besides own private utility, the utility function hence includes the private utility of the spouse, weighted by the altruism parameter γ. The one extreme is that one does not care at all about the spouse ($\gamma=0$), and the other is that both have the same weight in the expected utility function ($\gamma=1$).[11] *A* and *B* unilaterally maximise their own utility according to (5), but because of altruism they both consider the other's utility while doing so. They also take the other's actions as given. In period two, when the states of employment or unemployment are known, it is possible for spouses to give non-negative transfers to each other in order to smooth incomes and thereby increase utility (a transfer from *A* to *B* is labelled T_A and a transfer from *B* to *A* is labelled T_B). Negative transfers are ruled out, because one cannot take money from the spouse. The whole sequence can be seen as a two-stage game with a resulting Cournot-Nash equilibrium. In the first period both spouses unilaterally decides how much of their income they are going to save, and in the second period they may either remain employed or become unemployed, and then decide whether or not to transfer some amount to the spouse. To achieve the

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[9] This measure was first introduced by Kimball (1990). In Appendix A it is further discussed.

[10] It is really a philosophic issue whether this is the correct utility form, or if it should be $EU_i=Eu_i+\gamma EU_j$, but for $\gamma=1$, a transfer between the spouses would lead to infinite utility for both with the latter form. If $\gamma<1$, the two formulations are behaviourally equivalent . Lindbeck & Weibull (1988) discuss this matter.

[11] I exclude the cases $\gamma<0$, which would imply disutility from the spouse's utility, and $\gamma>1$, where one loves the spouse more than one loves oneself.

subgame perfect equilibrium, the game is solved by backwards induction. In period two there are four possible outcomes:

I With probability p^2 both *A* and *B* become unemployed and receive income $\bar{y}+ke_1$.

II With probability *p*(1-*p*) *A* becomes unemployed, receiving $\bar{y}+ke_1$, while *B* stays employed with income $\bar{y}+ke_2$.

III With probability *p*(1-*p*) *A* stays employed and receives $\bar{y}+ke_2$, while *B* becomes unemployed with income $\bar{y}+ke_1$.

IV With probability $(1-p)^2$ both *A* and *B* remain employed and receive income $\bar{y}+ke_2$.

In each case both spouses have to decide if a transfer should be made to the other, and how large such a transfer should be. In cases **I** and **IV**, where the outcome is the same for both spouses no transfers are made.[12]

In case **II**, where *A* receives $\bar{y}+ke_1$, while *B* gets $\bar{y}+ke_2$ the problem for *A* is, in utility terms:

$$\max_{T_A} U_A^2 = -\frac{e^{-q(s_A+\bar{y}+ke_1-T_A+T_B)}}{q} - g\frac{e^{-q(s_B+\bar{y}+ke_2-T_B+T_A)}}{q}, \tag{6}$$

[12] If *A* (and equivalently *B*) maximises period two utility with respect to the transfer T_A possibly given to *B*, the resulting Kuhn-Tucker conditions make it obvious that if $g<1$ both spouses want to make a smaller transfer than the other, and hence $T_A=T_B=0$ is the only possible solution. If $g=1$ both spouses always want to make identical transfers, so all $T_A=T_B$ are solutions to the problem, but the net effect is equivalent to $T_A=T_B=0$

where U_A^2 is the period-two utility for A, s_i is i's savings from period one and T_i is the transfer given from i to j for $i=A, B, j \neq i$.

Because spouses are identical, their savings from period one are equal and denoted by s_m where subscript m indicates a married person, i.e. $s_A=s_B=s_m$. The savings decisions are made in period one, so in period two s_m is treated as a state variable. The first-order conditions from this Kuhn-Tucker maximisation are:

$$\frac{\partial U_A^2}{\partial T_A} = -e^{-q(s_m+\bar{y}+ke_1-T_A+T_B)} + g e^{-q(s_m+\bar{y}+ke_2-T_B+T_A)} \leq 0 \tag{7a}$$

$$T_A \geq 0 \tag{7b}$$

$$T_A \frac{\partial U_A^2}{\partial T_A} = 0 \tag{7c}$$

Analogously B maximises utility, and these first-order conditions are:

$$\frac{\partial U_B^2}{\partial T_B} = -e^{-q(s_m+\bar{y}+ke_2-T_B+T_A)} + g e^{-q(s_m+\bar{y}+ke_1-T_A+T_B)} \leq 0 \tag{8a}$$

$$T_B \geq 0 \tag{8b}$$

$$T_B \frac{\partial U_B^2}{\partial T_B} = 0 \tag{8c}$$

Assume T_B=0. Then (7a) gives $T_A \geq \frac{\ln g}{2q} - \frac{k(e_2-e_1)}{2}$. If T_A>0 this expression must hold with equality, which immediately gives a contradiction, since $\frac{\ln g}{2q} - \frac{k(e_2-e_1)}{2} < 0$. Hence T_A=0 is the only possibility if T_B=0. From (8a) we see that T_B =T_A =0 requires that altruism is so weak that $g \leq e^{-qk(e_2-e_1)}$.

If instead $g > e^{-qk(e_2-e_1)}$ and T_B>0, (8a) implies:

$$T_B = T_A + \frac{\ln g}{2q} + \frac{k(e_2 - e_1)}{2} \tag{9}$$

Furthermore assume T_A>0. (7a) then implies $T_A = T_B + \frac{\ln g}{2q} - \frac{k(e_2 - e_1)}{2}$. Inserting (9) into this expression gives $\frac{\ln g}{q} = 0$, which is false for $g<1$. Hence the solution must be T_A=0 also when T_B>0 for $g<1$. If $g=1$ there is an infinity of solutions. All combinations of T_A and T_B satisfying (9) are solutions, but the net effect is equivalent to T_A=0 and $T_B = \frac{\ln g}{2q} + \frac{k(e_2 - e_1)}{2}$ for all values of $g > e^{-qk(e_2-e_1)}$, why this is assumed to be the solution, also when $g=1$.

Case **III** is entirely symmetric to case **II**, and the derivation of optimal transfers proceeds in exactly the same way as above.

The transfers can hence be summarised as follows: If both spouses receive the same income in period two no transfers are made. If *B* is employed and *A* becomes unemployed, *A* does not pay any transfer to *B*. If $g \leq e^{-qk(e_2-e_1)}$ altruism is so weak, that *B* does not make any transfer to *A* either. If $g > e^{-qk(e_2-e_1)}$ there is, however, a strictly positive transfer from *B* to *A*:

$$T_B = \frac{\ln g}{2q} + \frac{k(e_2 - e_1)}{2} \tag{10}$$

Because of symmetry, the transfer is the same if roles are reversed, so $T_A=T_B=T$. Henceforth it is implicitly assumed the spouses are effectively altruistic, i.e. $g \geq e^{-qk(e_2-e_1)}$, so that altruism is strong enough to generate positive transfers according to (10) if one spouse is employed and the other is unemployed. It is the presence of altruism that makes the couple willing to share risk. The transfer is larger the stronger the altruism ($\frac{\P T}{\P g} > 0$), and according to (10) the two spouses split total earnings into halves if $g=1$, irrespective of who earns the money.

In period one, A (and B) maximises own expected utility EU_A (EU_B) and thereby decides how much to save. T only depends on known parameters, and is therefore common knowledge already in period one:

$$\begin{aligned}\max_{s_A} \; EU_A = &-\frac{e^{-q(y_1-s_A)}}{q} - g\frac{e^{-q(y_1-s_B)}}{q} - p^2\left[\frac{e^{-q(s_A+\bar{y}+ke_1)}}{q} + g\frac{e^{-q(s_B+\bar{y}+ke_1)}}{q}\right] - \\ &- p(1-p)\left[\frac{e^{-q(s_A+\bar{y}+ke_1+T)}}{q} + g\frac{e^{-q(s_B+\bar{y}+ke_2-T)}}{q} + \frac{e^{-q(s_A+\bar{y}+ke_2-T)}}{q} + g\frac{e^{-q(s_B+\bar{y}+ke_1+T)}}{q}\right] - \\ &- (1-p)^2\left[\frac{e^{-q(s_A+\bar{y}+ke_2)}}{q} + g\frac{e^{-q(s_B+\bar{y}+ke_2)}}{q}\right]\end{aligned} \quad (11)$$

The optimisation results in the following expression for savings:

$$s_A = \frac{y_1-\bar{y}}{2} + \frac{\ln\left[p^2e^{-qke_1} + p(1-p)\left(e^{-q(ke_2-T)} + e^{-q(ke_1+T)}\right) + (1-p)^2e^{-qke_2}\right]}{2q} \quad (12)$$

The savings decision thus depends on the expected transfers and, due to symmetry, the solution is identical for both spouses, i.e. $s_A=s_B=s_m$. Together (10) and (12) then give the following expression for s_m :

$$s_m = \frac{y_1-\bar{y}}{2} + \frac{\ln\left[p^2e^{-qke_1} + p(1-p)\left(g^{1/2} + g^{-1/2}\right)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2e^{-qke_2}\right]}{2q} \quad (13)$$

As was the case for the single individual, the first term represents consumption smoothing, and the second precautionary saving. That this second term is positive follows from the fact that:

$$\frac{\partial s_m}{\partial \gamma} = \frac{p(1-p)\left(\gamma^{-1/2} - \gamma^{-3/2}\right)e^{\frac{-qk(e_1+e_2)}{2}}}{4q\left[p^2 e^{-qke_1} + p(1-p)\left(\gamma^{1/2} + \gamma^{-1/2}\right)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e^{-qke_2}\right]} \leq 0 \qquad \forall\ \gamma \leq 1 \tag{14}$$

so the smallest amount saved by a married person occurs when $\gamma=1$. For precautionary saving to be positive when altruism is present, it is hence sufficient that the expression within brackets in (13) exceeds unity for $\gamma=1$. That $p^2 e^{-qke_1} + 2p(1-p)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e^{-qke_2} > 1$ follows immediately from Jensen's inequality:

$$p^2 e^{-qke_1} + 2p(1-p)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e^{-qke_2} > e^{-qk\left(p^2 e_1 + p(1-p)(e_1+e_2) + (1-p)^2 e_2\right)} =$$

$$= e^{-qk\left(pe_1 + (1-p)e_2\right)} = 1$$

The precautionary part of savings is hence positive also for a married individual. Empirical findings by Merrigan & Normandin (1996) suggest that households with two income earners are less prudent than households with only one income earner. This can also be shown theoretically:

Proposition 2: *Precautionary savings are smaller for a married, risk sharing person than for a single one.*

Proof: Because $\frac{\partial s_m}{\partial \gamma} < 0$ (as shown in (14)) the largest amount saved by a married person arises for the smallest γ allowed, i.e. $\gamma = e^{-qk(e_2-e_1)}$. Inserting this value in (10) makes T=0, and (13) then implies a savings rate identical to that chosen by the single individual in (3). For higher values of γ T>0 and precautionary saving by the married person is lower. ∎

Precautionary saving, and hence utility, is influenced by the degree of altruism via the expected transfers. The private part of the expected utility function (as well as total utility) for both spouses would, however, be maximised if they agreed on always splitting total income into halves, independent of the degree of altruism. This is shown by minimising the *EPP* with respect to *T*:

$$EPP = \frac{\ln\left[p^2 e^{-\theta k e_1} + p(1-p)\left(e^{-\theta(ke_2 - T)} + e^{-\theta(ke_1 + T)}\right) + (1-p)^2 e^{-\theta k e_2}\right]}{\theta}, \tag{15}$$

where *EPP* is calculated in the same way as in Section 2. The first order condition becomes

$$\frac{\partial EPP}{\partial T} = \frac{p(1-p)\left(e^{-\theta(ke_2 - T)} - e^{-\theta(ke_1 + T)}\right)}{p^2 e^{-\theta k e_1} + p(1-p)\left(e^{-\theta(ke_2 - T)} + e^{-\theta(ke_1 + T)}\right) + (1-p)^2 e^{-\theta k e_2}} = 0 \tag{16}$$

This implies that expected utility is maximised for the transfer

$$T = \frac{k\left(e_2 - e_1\right)}{2}, \tag{17}$$

implying that both spouses have the same ”after-transfer” income. This is also the time consistent transfer according to (10) when $\gamma = 1$, and it may be labelled the *first-best marriage solution*, because it yields the highest possible expected utility within marriage.

Proposition 3: *When* $\gamma < 1$ *the non- cooperative solution is inefficient compared with the first-best marriage solution. However, the non-cooperative solution is always time consistent.*

Proof: As shown above, the first-best solution *ex ante* occurs when both spouses agree on splitting their total income into halves (*T* determined in (17)), regardless of the value of γ This gives the smallest possible precautionary saving and maximises expected utility through a minimised *EPP*.[13] However, this solution is not time consistent when $\gamma \neq 1$. If, in period two, one spouse is employed and the other is unemployed, the employed individual has an incentive to deviate from such an agreement, and instead transfer the optimal amount determined in (10). Because there are only two periods, there is no effective punishment in case of deviation, and the time consistent transfer is always the one determined in (10). The more altruistic the spouses are, the more are they willing to share risk ($\frac{\partial T}{\partial \gamma} > 0$). When $\gamma = 1$ the spouses always split total income into halves, and the time consistent solution coincides with the first-best solution. ÿ

Furthermore I observe that:

Proposition 4: *The savings response to a mean preserving increase in risk (the parameter k) is weaker for a risk sharing married person, than for a single one.*

Proof: For a married person the response to a shift in *k* is:

$$\frac{\partial s_m}{\partial k} = -\frac{p^2 e_1 e^{-qke_1} + p(1-p)\frac{(e_1+e_2)}{2}(\gamma^{1/2}+\gamma^{-1/2})e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e_2 e^{-qke_2}}{2C} > 0 \qquad (18)$$

where $C = p^2 e^{-qke_1} + p(1-p)\left(\gamma^{1/2}+\gamma^{-1/2}\right)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e^{-qke_2}$

[13] *EPP* determined in (15) combined with (17) gives the minimum *EPP*. Inserting time consistent transfers determined in (10) gives higher values of *EPP* and hence lower utility whenever $\gamma \neq 1$.

That $\frac{\partial s_m}{\partial k} > 0$ follows immediately from the definition of precautionary saving, but may also be shown analytically.[14]

Compare the derivative $\frac{\partial s_m}{\partial k}$ with the corresponding one for the single individual:

$$\frac{\partial s}{\partial k} = -\frac{pe_1 e^{-qke_1} + (1-p)e_2 e^{-qke_2}}{2D} > 0 \tag{19}$$

where $D = pe^{-qke_1} + (1-p)e^{-qke_2}$

Note that (19) is only a reformulation of (4).

$\frac{\partial s}{\partial k} - \frac{\partial s_m}{\partial k}$ is hence the difference between (19) and (18). After some manipulation we see that

$$\frac{\partial s}{\partial k} - \frac{\partial s_m}{\partial k} = F\left[(1-2p)e^{\frac{-qk(e_1+e_2)}{2}} + \frac{\left(g^{1/2} + g^{-1/2}\right)}{2}\left(pe^{-qke_1} - (1-p)e^{-qke_2}\right)\right] =$$

$$= F\left[p\left(\frac{\left(g^{1/2} + g^{-1/2}\right)}{2}e^{-qke_1} - e^{\frac{-qk(e_1+e_2)}{2}}\right) + (1-p)\left(e^{\frac{-qk(e_1+e_2)}{2}} - \frac{\left(g^{1/2} + g^{-1/2}\right)}{2}e^{-qke_2}\right)\right] \tag{20}$$

where $F = \frac{p(1-p)(e_2 - e_1)e^{\frac{-qk(e_1+e_2)}{2}}}{2CD}$

(20) is positive if and only if the expression within brackets is positive. The first parenthesis is always positive, since $\left(g^{1/2} + g^{-1/2}\right) \geq 2$, $e_1<0$ and $e_2>0$. The second parenthesis takes on its

[14] Because $pe_1 + (1-p)e_2 = 0$ the numerator in (18) may be rewritten as $-pe_1\left[p\left(e^{-qke_1} - \frac{\left(g^{1/2} + g^{-1/2}\right)}{2}e^{\frac{-qk(e_1+e_2)}{2}}\right) + (1-p)\left(\frac{\left(g^{1/2} + g^{-1/2}\right)}{2}e^{\frac{-qk(e_1+e_2)}{2}} - e^{-qke_2}\right)\right]$ The second part of the expression within brackets is always positive because $g^{1/2} + g^{-1/2} \geq 2$, $e_1 < 0$ and $e_2 > 0$. The first part takes on its lowest value for the smallest g allowed, i.e. $g = e^{-qk(e_2-e_1)}$. Inserting this makes the first part within brackets $p\frac{e^{-qke_1} - e^{-qke_2}}{2} > 0$. Thereby the whole numerator, as well as the complete expression (18) is positive.

smallest value for the smallest allowed value of g i.e. $g = e^{-qk(e_2 - e_1)}$. Inserting this value makes the second parenthesis

$$e^{\frac{-qk(e_1+e_2)}{2}} - \frac{\left(e^{\frac{-qk(e_2-e_1)}{2}} + e^{\frac{-qk(e_1-e_2)}{2}}\right)}{2} e^{-qke_2} =$$

$$= \frac{e^{\frac{-qk(e_1+e_2)}{2}} - e^{\frac{-qk(3e_2-e_1)}{2}}}{2} \qquad (21)$$

Keep in mind that $e_1<0$ and $e_2>0$. Then it is obvious that (21) is positive, and hence

$$\frac{\partial S}{\partial k} - \frac{\partial S_m}{\partial k} > 0 \,. \text{ÿ}$$

4 Different risks

There are gains from marriage in a situation as the one described above. When expected income is equal for the spouses, both achieve higher expected private utility by sharing the risk. But what happens if one party has a higher probability of experiencing bad luck, i.e. if one of the spouses is a relatively bad risk? It is easy to show that altruistic risk sharing might still make private utility for both of them higher within marriage than outside.

Assume the two spouses *A* and *B* still to be identical in terms of y_1 and $\bar{y}$, but that they now have different probabilities *p* of meeting the outcome e_1 in period two. Assume $p_A>p_B$, and that expected income in period two is still $\bar{y}$ for *B*, i.e. $p_B k e_1+(1-p_B) k e_2=0$. Hence A has a somewhat lower expected income in the second period. Consider the special case where husband and wife maximise a joint utility function, i.e. they both have $g=1$ in their utility function

(5).[15] Because they love each other as much as they love themselves, the two always split total income into halves. It is hence total expected income within the family that is of importance when they make their savings decisions in period one. Together with the assumption of equal period-one income this makes both spouses save the same amount in spite of the difference in individual expected income:

$$s_m = \frac{y_1 - \bar{y}}{2} + \frac{\ln\left[p_A p_B e^{-qke_1} + (p_A + p_B - 2p_A p_B) e^{\frac{-qk(e_1+e_2)}{2}} + (1-p_A)(1-p_B) e^{-qke_2} \right]}{2q} \qquad (22)$$

Note, however, that because $p_A e_1 + (1-p_A) e_2 < 0$, $\bar{y}$ is no longer the joint expected income in period two. Because *B* is risk averse, it may still be advantageous (in terms of private utility) for him to share the risk with *A*, although such risk sharing decreases his expected income. Denote the *EPP* that *B* would face as a single as EPP_B. *EPP* within marriage, denoted EPP_m is the same for both spouses because $\gamma = 1$. The condition for the private part of expected utility for *B* to be higher within than outside marriage is that

$$EPP_B - EPP_m > 0 \qquad (23)$$

where $EPP_B = \frac{\ln\left[p_B e^{-qke_1} + (1-p_B) e^{-qke_2} \right]}{q}$

and $EPP_m = \frac{\ln\left[p_A p_B e^{-qke_1} + (p_A + p_B - 2p_A p_B) e^{\frac{-qk(e_1+e_2)}{2}} + (1-p_A)(1-p_B) e^{-qke_2} \right]}{q}$

Condition (23) is equivalent to:

$$\frac{p_B e^{-qke_1} + (1-p_B) e^{-qke_2}}{p_A p_B e^{-qke_1} + (p_A + p_B - 2p_A p_B) e^{\frac{-qk(e_1+e_2)}{2}} + (1-p_A)(1-p_B) e^{-qke_2}} > 1 \qquad (24)$$

[15] If $\gamma < 1$ there is no closed-form solution to the problem.

If p_A is not too high compared with p_B, B's expected private utility is hence higher when sharing risk with A, than alone.[16] From (24) the condition is:

$$p_A < \frac{p_B\left(e^{-qke_1} - e^{\frac{-qk(e_1+e_2)}{2}}\right)}{(1-2p_B)e^{\frac{-qk(e_1+e_2)}{2}} + p_B e^{-qke_1} - (1-p_B)e^{-qke_2}} \tag{25}$$

If the discrepancy between the probabilities p_A and p_B is not too large the risk-sharing effect hence outweighs the decrease in expected income for *B*. For *A* private utility is always higher within marriage than outside. Besides the risk-sharing effect, *A*'s expected income is also increased because $p_A > p_B$. Because *A* has higher marginal utility from expected income than has *B*, the redistribution from *B* to *A* that risk sharing implies, always makes total private utility (for *A*+*B*) higher when *A* and *B* are married to each other than when they both are single, regardless of the values of p_A and p_B.

5 Social insurance

In most western countries public pensions and well developed insurance systems (whether optional or compulsory) reduce the loss in case of unemployment, disability etc. This may decrease the importance of precautionary saving. For instance, Engen & Gruber (1995) find for the US, that unemployment insurance substantially crowds out precautionary savings. There has, however, always been the case that many people have had the possibility of insuring within the family, so that the introduction of social insurance may not have the expected

[16] A parallel in the trade-union literature is Agell & Lommerud (1992), who conclude that risk averse workers who have a relatively high probability of becoming skilled, prefer some wage compression between skilled and unskilled workers, if the dispersion in skill probabilities is not too large.

large effects. The crowding-out effects on precautionary savings from compulsory insurance turn out to be smaller for risk sharing families than for singles.

Once again assume that agents are homogeneous, i.e. everyone faces the same probability *p* of becoming unemployed in period two. Assume that the government provides a compulsory insurance, with the compensation $kq = k\,d(e_2 - e_1)$, in case of period-two unemployment, where the replacement ratio, $d<1$ makes uncertainty diminish, but not vanish, even with the compulsory insurance.[17] Note that the compensation, like the possible loss is inflated by the shift parameter *k*. Moreover, everyone has to pay a fair premium that makes the insurance break even. This means that the premium paid by every individual in period one is *pkq*. For a single person savings are now:

$$s_I = \frac{y_1 - \bar{y}}{2} - \frac{pkq}{2} + \frac{\ln\left[pe^{-qk(e_1+q)} + (1-p)e^{-qke_2}\right]}{2q}, \qquad (26)$$

where subscript *I* denotes insurance. Savings are obviously smaller than without the insurance determined in (3), but the precautionary part of savings is still positive[18]

[17] In many western countries there really is a replacement ratio less than unity in case of unemployment, so this assumption does not seem to be too farfetched.

[18] Savings, when the individual with certainty receives *pkq* in period two, after having paid *pkq* in period one, is $s = \frac{y_1 - \bar{y}}{2} - pkq$, because consumption in both periods is $\frac{y_1 + \bar{y}}{2}$. Precautionary saving, i.e. the difference between savings under uncertainty and certainty is hence $\frac{pkq}{2} + \frac{\ln\left[pe^{-qk(e_1+q)} + (1-p)e^{-qke_2}\right]}{2q}$. Whether this expression is positive is equivalent to the question if $pe^{-qk(e_1+q)} + (1-p)e^{-qke_2} > e^{-qpkq}$. Since $pe^{-qk(e_1+q)} + (1-p)e^{-qke_2} > e^{-qk\left[p(e_1+q)+(1-p)e_2\right]} = e^{-qpkq}$ precautionary saving is positive also in presence of the compulsory insurance.

Now consider a married couple, where the spouses love one another as much as they love themselves, i.e. $g=1$. Savings by a married person in presence of the compulsory insurance are:

$$s_{mI} = \frac{y_1 - \bar{y}}{2} - \frac{pkq}{2} + \frac{\ln\left[p^2 e^{-qk(e_1+q)} + 2p(1-p)e^{\frac{-qk(e_1+e_2+q)}{2}} + (1-p)^2 e^{-qke_2}\right]}{2q} \tag{27}$$

By comparing this with savings in absence of insurance determined in equation (28) (which really is equation (13) where $g=1$), one can see that also savings by a married individual decline when the insurance is introduced:

$$s_m = \frac{y_1 - \bar{y}}{2} + \frac{\ln\left[p^2 e^{-qke_1} + 2p(1-p)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e^{-qke_2}\right]}{2q} \tag{28}$$

Proposition 5: *The effects on savings and welfare from a compulsory insurance are larger if people are single, than if they are completely risk sharing couples.*

Proof: Because *EPP* can be used to rank different uncertain states in terms of savings, the welfare gain from the compulsory insurance can be expressed as $EPP\text{-}EPP_I$, where *EPP* corresponds to the situation without, and EPP_I to the situation with insurance. Subscript *m* implies a married person, so the comparison between the welfare gains for a single and for a married person can be expressed as the ratio $(EPP\text{-}EPP_I)/(EPP_m\text{-}EPP_{mI})$. If this ratio exceeds unity the welfare gain from the compulsory insurance is larger for a single person, than for a married one.[19]

[19] The discussion about savings effects is equivalent to that about welfare gains. The precautionary part of savings equals 2**EPP*, so the ratios between differences in savings rates and between differences in *EPP* are identical.

$$(EPP - EPP_I)/(EPP_m - EPP_{mI}) = \frac{\ln K - \ln L - qpkq}{\ln M - \ln N - qpkq}, \qquad (29)$$

where

$$K = pe^{-qke_1} + (1-p)e^{-qke_2},$$

$$L = pe^{-qk(e_1+q)} + (1-p)e^{-qke_2},$$

$$M = p^2 e^{-qke_1} + 2p(1-p)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e^{-qke_2}$$

and

$$N = p^2 e^{-qk(e_1+q)} + 2p(1-p)e^{\frac{-qk(e_1+e_2+q)}{2}} + (1-p)^2 e^{-qke_2}.$$

Showing that this ratio exceeds unity is equivalent to showing that *KN*-*LM*>0. This proof is performed in Appendix B.

If the aim of introducing the compulsory insurance is to increase social welfare by reducing precautionary savings, the result hence differs whether one regards single people or couples. The magnitude of the difference of course depends on parameter values, and a numerical example, using (29), provides some intuition.

Assume the probability of becoming unemployed, p=0.1, the replacement ratio in the unemployment insurance, d=0.75 and, for simplicity k=1. The model assumes the constant coefficient of absolute prudence, q to coincide with the coefficient of absolute risk aversion, following the definition of absolute prudence given by Kimball (1990). When absolute risk aversion is constant, the relative risk aversion, cq will vary over consumption levels c. The parameter q is chosen so as to provide some reasonable values of relative risk aversion evaluated at the average consumption level $\bar{c}$.[20, 21] The welfare gain from introducing the insurance is measured in terms of *EPP*, in the way discussed above. The ratio $(EPP\text{-}EPP_I)/(EPP_m\text{-}EPP_{mI})$ is presented in table 1 for some different values of average relative risk aversion $\bar{c}q$, and losses in case of unemployment e_1.

Table 1: Comparing welfare gains from social insurance

$\bar{c}q$	e_1	$(EPP - EPP_I)/(EPP_m - EPP_{mI})$
3	$-\bar{y}/2$	2.5
6	$-\bar{y}/2$	2.6
6	$-\bar{y}/4$	2.5
9	$-\bar{y}/2$	2.2

If the average coefficient of relative risk aversion is 6, and the loss in case of unemployment is half the expected income, the estimated gain from the compulsory insurance is more than two and a half times as large if people are assumed to be single, compared with the gain when they completely share the risk with a spouse. Although this numerical experiment is extremely simplified, it indicates the importance of carefully studying the family structure, before drawing any conclusions about the effects from, for instance, social insurance. A severe risk in evaluating a project like this on individual basis, is that the gains may be overstated if intra-family insurance is neglected.

[20] I base the choice of q on the average relative risk aversion because we generally have a better idea of what numerical value this coefficient should have than the coefficient of absolute prudence, although e.g. Merrigan & Normandin (1996) have estimated this measure.

[21] Assume $y_1 = \bar{y}$. This makes average consumption, $\bar{c}$ equal in both periods.

6 Conclusion

This paper has shown that, besides the trivial fact that a single individual has smaller precautionary saving than an individual who has access to intra-family insurance, altruism may actually enforce time consistent solutions regarding family risk sharing. In my model, binding contracts are impossible to create, because there are no credible threats in case of deviation. Instead it is altruism *per se* that makes the married couple willing to share risk. Because the degree of altruism determines the extent of risk sharing, the solution is not necessarily *ex ante* efficient. The highest expected utility occurs when spouses always split total income into halves. This solution is, however, only time consistent when there is full altruism between the two. If they love each other somewhat less than they love themselves, they instead share risk to a somewhat smaller extent, thereby gaining somewhat lower expected utility.

A high degree of risk sharing within families also reduces the importance of social insurance, which has also been concluded empirically by e.g. Engen & Gruber (1995). If people are single the welfare gain and the reduction in precautionary saving from the introduction of social insurance are larger than if people have an intra-family insurance. A numerical example shows that the difference may be substantial. This indicates the importance of studying what the family structure in the economy looks like, before drawing any conclusions about e.g. welfare gains. How large a fraction are single, and how large a fraction lives in families? It is also desirable to find out to what extent risk really is shared within families, although this may be a difficult empirical task.

The theoretical model of how altruism may influence precautionary saving presented in this paper of course has its limitations. Therefore some theoretical extensions naturally come to mind. The exponential utility function, that is used throughout the paper, is itself quite restrictive, in that it assumes constant absolute risk aversion. More general functional forms would therefore be desirable, but then analytical solutions are no longer available. Instead simulations become necessary, which also means loss of generality. Besides more general functional forms, another extension of the model could be to involve more than one generation in the family, with altruism also between parents and children. It would also be interesting to find out what happens in presence of endogenous labour supply, where the individual is allowed to accommodate labour supply when it becomes clear whether or not the spouse becomes unemployed. There is hence a lot that can be done theoretically to better understand precautionary saving and how it is influenced by the family.

Appendix A: *The Equivalent Precautionary Premium (EPP)*

Welfare effects are, throughout the paper, measured in terms of the Equivalent Precautionary Premium (*EPP*), a measure first developed by Kimball (1990). It is defined as the certain reduction from the non-random income $\bar{y}$ in period two that has the same effect on the optimal savings decision as the addition of the random $\tilde{y}$. A positive *EPP* indicates that the income risk is equivalent to a reduced certain income. Hence it implies that utility is lower in the uncertain case than in the certain with the same expected income. For the same reason, the higher is *EPP*, the lower is utility. The mathematical definition of *EPP* is:

$$E\left[\frac{\partial u\left(y_1, \bar{y}+\tilde{y}, s\right)}{\partial s}\right]=\frac{\partial u\left(y_1, \bar{y}-EPP, s\right)}{\partial s} \quad , \tag{A1}$$

where E is the expectations operator, u is the utility function, s is period-one saving, and $\tilde{y}=ke_1$ with probability p, and $\tilde{y}=ke_2$ with probability (1-p).

From the first-order condition of utility maximisation we know that the left-hand side equals zero, so that optimal saving under uncertainty is:

$$s=\frac{y_1-\bar{y}}{2}+\frac{\ln\left[pe^{-qke_1}+(1-p)e^{-qke_2}\right]}{2q} \tag{3}$$

for a single person when there is no insurance. The right-hand side of (A1) is calculated as follows:

$$u=-\frac{e^{-q(y_1-s)}}{q}-\frac{e^{-q(\bar{y}-EPP+s)}}{q} \tag{A2}$$

$$\frac{\partial u}{\partial s}=-e^{-q(y_1-s)}+e^{-q(\bar{y}-EPP+s)}=0\,, \tag{A3}$$

because left-hand side of (A1) equals zero. This gives the following expression for *EPP*:

$$EPP=2s+\bar{y}-y_1 \tag{A4}$$

Because optimal saving with certain income $\bar{y}-EPP$ is identical to optimal saving with uncertain income $\bar{y}+\tilde{y}$, (3) is inserted into (A4) to give an expression for *EPP*:

$$EPP=\frac{\ln\left[pe^{-qke_1}+(1-p)e^{-qke_2}\right]}{q} \tag{A5}$$

EPP is derived analogously throughout the paper, and it is always the case that *EPP* equals the precautionary part of savings times two. For a married, altruistic individual, *EPP* is smaller than for the single one, indicating that uncertainty does not affect utility for the married as much as it does for the single one. Note, that when calculating *EPP* in presence of social insurance, the uncertain state is compared with the certain where the insurance premium *pkq* (*kq* is the compensation paid to the individual in case of period-two unemployment, which occurs with probability *p*) is paid in period one and the expected amount *pkq* is paid back with certainty to the individual in period two.

The *EPP* measure can also be used to rank various uncertain states. A smaller *EPP* always corresponds to smaller precautionary saving, and to a higher level of utility.

Appendix B: *Proving Proposition 5*

$$(EPP - EPP_I)/(EPP_m - EPP_{mI}) = \frac{\ln K - \ln L - qpkq}{\ln M - \ln N - qpkq}, \tag{29}$$

where

$K = pe^{-qke_1} + (1-p)e^{-qke_2}$,

$L = pe^{-qk(e_1+q)} + (1-p)e^{-qke_2}$,

$$M = p^2 e^{-qke_1} + 2p(1-p)e^{\frac{-qk(e_1+e_2)}{2}} + (1-p)^2 e^{-qke_2},$$

$$N = p^2 e^{-qk(e_1+q)} + 2p(1-p)e^{\frac{-qk(e_1+e_2+q)}{2}} + (1-p)^2 e^{-qke_2}$$

and

$q = d(e_2 - e_1)$.

Below I show that KN-LM>0. After some manipulation of (29), we see that

$$KN - LM =$$

$$= p(1-p)e^{\frac{-qk(e_1+e_2)}{2}} \left\{ 2\left(1-e^{\frac{-qkq}{2}}\right)\left(pe^{-qk\left(e_1+\frac{q}{2}\right)} - (1-p)e^{-qke_2}\right) + (1-2p)(1-e^{-qkq})e^{\frac{-qk(e_1+e_2)}{2}} \right\} \quad \text{(B1)}$$

In demonstrating the proof I rely on the fact that

$$pe^{-qk(e_1+q)} - (1-p)e^{-qke_2} + (1-2p)e^{\frac{-qk(e_1+q+e_2)}{2}} =$$

$$= p\left(e^{-qk(e_1+q)} - e^{\frac{-qk(e_1+q+e_2)}{2}}\right) + (1-p)\left(e^{\frac{-qk(e_1+q+e_2)}{2}} - e^{-qke_2}\right) =$$

$$= p\left(e^{-qk((1-d)e_1+de_2)} - e^{\frac{-qk((1-d)e_1+(1+d)e_2)}{2}}\right) + (1-p)\left(e^{\frac{-qk((1-d)e_1+(1+d)e_2)}{2}} - e^{-qke_2}\right) > 0 \quad \text{(B2)}$$

That the inequality (B2) holds is obvious when we consider the assumptions that e_1<0, e_2>0 and d<1. (B2) hence implies

$$-(1-p)e^{-qke_2} > -pe^{-qk(e_1+q)} - (1-2p)e^{\frac{-qk(e_1+q+e_2)}{2}},$$

which, together with (B1), allows the following inequality:

$$KN - LM > p(1-p)e^{\frac{-qk(e_1+e_2)}{2}} \left\{ 2\left(1-e^{\frac{-qkq}{2}}\right)\left(pe^{-qk\left(e_1+\frac{q}{2}\right)} - pe^{-qk(e_1+q)} - (1-2p)e^{\frac{-qk(e_1+q+e_2)}{2}}\right) + \right.$$

$$\left. + (1-2p)\left(1-e^{-qkq}\right)e^{\frac{-qk(e_1+e_2)}{2}} \right\} =$$

$$= p(1-p)e^{\frac{-qk(e_1+e_2)}{2}}\left\{2\left(1-e^{\frac{-qkq}{2}}\right)pe^{-qk\left(e_1+\frac{q}{2}\right)}\left(1-e^{\frac{-qkq}{2}}\right)+(1-2p)e^{\frac{-qk(e_1+e_2)}{2}}\left(1+e^{-qkq}-2e^{\frac{-qkq}{2}}\right)\right\}=$$

$$= p(1-p)e^{\frac{-qk(e_1+e_2)}{2}}\left(1-e^{\frac{-qkq}{2}}\right)^2\left\{2pe^{-qk\left(e_1+\frac{q}{2}\right)}+(1-2p)e^{\frac{-qk(e_1+e_2)}{2}}\right\}=$$

$$= p(1-p)e^{\frac{-qk(e_1+e_2)}{2}}\left(1-e^{\frac{-qkq}{2}}\right)^2\left\{2pe^{-qk\left(e_1+\frac{d(e_2-e_1)}{2}\right)}+(1-2p)e^{\frac{-qk(e_1+e_2)}{2}}\right\}=$$

$$= p(1-p)e^{\frac{-qk(e_1+e_2)}{2}}\left(1-e^{\frac{-qkq}{2}}\right)^2\left\{e^{\frac{-qk(e_1+e_2)}{2}}+2p\left(e^{\frac{-qk((2-d)e_1+de_2)}{2}}-e^{\frac{-qk(e_1+e_2)}{2}}\right)\right\}>0 \qquad ÿ$$

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