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Economics Department

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Consumption Smoothing in Island Economies: Can Public Insurance Reduce Welfare?

Orazio Attanasio

University College, London

José-Víctor Ríos-Rull

University of Pennsylvania, CEPR and NBER

ABSTRACT

In this paper we study the effects of certain types of public compulsory insurance arrangements for aggregate shocks on private allocations in environments with limited commitment. We show that this type of insurance can improve the wellbeing of private situations, but it can also deteriorate it. We also describe how different characteristics of the environment affect the role of public insurance. Using data on the Mexican PROGRESA program, we document the impact that some government programs have in crowding out private transfers.

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Correspondence to José-Víctor Ríos-Rull, Department of Economics, 3718 Locust Walk, University of Pennsylvania, Philadelphia, PA, 19104, USA. Phone 1-215-898-7767, Fax 1-215-573-4217, email vr0j@econ.upenn.edu.

1 Introduction

In a recent meeting between a World Bank official and a finance minister from a developing country in which the provision of an income support scheme or safety net was being discussed the minister opposed strongly such scheme. When questioned by the World Bank official about the reason for his opposition, the minister's reply indicated the worry that such schemes could jeopardize the existence of the support network provided by extended families. In this paper, we consider a model that justifies these worries. In particular, we consider the implications of the provision of aggregate insurance schemes in situations where agents cannot fully insure idiosyncratic risk because of the presence of enforceability constraints. We show that the minister's worry was justified in that it is likely that the provision of aggregate insurance can crowd out private insurance by more than the insurance that is publicly provided. Furthermore, we construct examples in which the crowding out of private insurance causes overall welfare to decrease.

Obviously the results we provide cannot be fully general, as they will depend on the particular institutional features that we discuss in our model. Our framework, however, stresses that to evaluate the desirability and the design of various insurance schemes, one has to pay attention to the way in which such schemes interact with existing private (and often informal) insurance mechanisms.

We focus on a situation in which individuals facing idiosyncratic risk can partly diversify it by entering a contractual agreement with another individual. The arrangement we study, however, cannot fully achieve the best possible allocation within the pair because of the absence of enforceability of contracts. Consumption can be smoothed between agents because the agents that give up consumption goods can expect to get some extra consumption in the future, especially when their shocks are bad. In other words, if agents do not comply with the arrangement when times are relatively good by giving up some consumption they will be left alone in the future (autarky) to deal with the shocks. It has been shown (Thomas and Worrall (1988), Ligon, Thomas, and Worrall (1997), and Kocherlakota (1996)), and we replicate those findings, that the amount of consumption smoothing that can be achieved depends, among other things on the degree of agents' risk aversion and on the variance and persistence of shocks. Moreover, we show how a reduction in the variance of agents' endowment due to shocks that are common to both agents may reduce welfare. We interpret the reduction of this variance component as the outcome of some actuarially fair insurance policy, or safety net, implemented by the government. We aggregate from pairs of individuals into islands and from islands into a whole economy to ensure that it is feasible for the government to provide such an insurance. The scheme we study could be interpreted as the government smoothing island level shocks. We assume that the shocks against which insurance is provided affect all the individuals in the island and are fully observable by the government and by the agents.

What we have in mind is the provision of insurance against natural disasters, price fluctuations of agricultural commodities and so on.[1] The phenomena linked to El Niño or Hurricane Mitch are obvious recent examples of large shocks against which the national government or international organization might want to provide insurance. However, other phenomena and other insurance schemes (such as support of agricultural prices) would also fall within the type of schemes we study in this paper. The important features we are considering is that the type of shocks the government is providing insurance against are aggregate and perfectly observable.

The intuition behind our results is quite simple: while a reduction of the variance of the endowment allows in principle more consumption smoothing, but it also reduces the cost of being in autarky. Sometimes the reduction of the enforcing power outweigh the reduction of the endowments' variance. The overall effect depends on the curvature of the utility function on the persistence of idiosyncratic and aggregate shocks and, once again, on the relative variance of aggregate and idiosyncratic risks.

From what we have said so far, it is clear that the empirical relevance of our results depends on a variety of characteristics that can potentially be measured. For this reason, in the last part of the paper, we document the highly disruptive role of certain government policies on the realm of private transfers. We take this as evidence of the important role played by informal private arrangements and of its sensitivity to changes in the environment. Henceforth, we think that the type of welfare reductions discussed goes well beyond a theoretical possibility.

While in our model, we consider a relatively specific insurance scheme (in that is targeted towards aggregate and observable shocks), the sort of mechanism that lead to crowding out of private insurance arrangements is operative in a variety of situations and may be relevant for many government programs. Therefore, the main lesson we learned from our exercise, is that government interventions do not occur in a vacuum. In addition to their direct effects there also are indirect effects as government programs can change the incentives to participate into private arrangements and, more generally, the way in which these private arrangements work. These indirect effects can be quite important as our example shows, inducing crowding out of private insurance schemes. In other words, government intervention can break down the fragile social fabric that maintains some form of social insurance among related individuals. Even if one does not think that the social fabric is valuable by itself, it can turn out that certain types of government intervention, namely an attempt to insure households, can have negative effects on the households overall insurance possibilities. The obvious policy implication of this is that one should assess carefully the impact of a proposed intervention to see whether it may destroy private arrangements and the social fabric that sustains it.[2]

A possible objection to our argument is that many 'safety nets', that is programs that provide relief in exceptional circumstances, such as natural disasters, are financed by international organizations it would not be necessary to consider the premium that an actuarially fair insurance would imply in good times. Obviously, it should be stressed that a simple transfer is very likely, especially if large in size, to increase the welfare of the agents who receive it. However, by focusing on an *actuarially fair* scheme, we want to consider not just the possible benefits of a proposed scheme, but also its costs. Moreover, by stressing the possible crowding out effects that an aggregate insurance scheme might have, allows us to focus on its inefficiencies and possible ways to improve it.[3] That is, regardless of whether a proposed insurance scheme increases or decreases welfare, the presence of crowding out effects stresses that such a scheme might be sub-optimal and, subject to some caveat, could be improved.

As a second possible objection, one might argue that the government could devise more complicated insurance schemes to avoid or minimize the interference that an aggregate scheme might have with the functioning of private insurance mechanisms. Our findings call for a more careful study of the details of how income support and other type of government policies are implemented. We think that a mechanism design approach is appropriate. Our future work is geared towards answering the question of whether the government can design a policy with that smoothes people's endowment, yet it does not reduce their ability to sustain private arrangements. We are optimistic in this respect and hope to come up with designs that will actually improve beyond what the agents were doing without the government provided insurance.

Whether the mechanisms we stress are important or not is ultimately an empirical issue. Very few papers have performed empirical exercises to study the type of models we study. In the last part of the paper we propose what we call 'suggestive empirical evidence' relating to a large welfare program in rural Mexico (PROGRESA) that suggests the presence of crowding out even if the program itself is not exactly a public insurance program.

In a related but independent paper Krueger and Perri (1999), explore the properties of progressive taxation. These taxes are not distortionary. However, they change the relevant individual endowment, and therefore, the value of autarky. They show that the perverse effect that we study in this paper may be very pervasive. Their model is different and they study partial insurance mechanisms that are private yet centralized since they involve all agents. Moreover, they do not consider the presence of aggregate shocks. As we discuss below, the presence of aggregate shocks can lead to particularly interesting dynamics.

The study of the substitution of private by public insurance is not new. Cutler and Gruber (1996) estimate the extent of crowd-out arising from the expansions of Medicaid to pregnant women and children over the 1987-1992 period and find that approximately 50 percent of the increase in Medicaid coverage was associated with a reduction in private insurance coverage. This type of crowding out is related to the one that we document using Mexican data, and it hints to the possible pervasiveness of the theoretical problems that this paper points to. Schoeni (1996) estimates whether income received from AFDC displaces private familial assistance in the form of cash and time help. Their findings (displacement is precisely estimated among blacks but not whites) suggest that annual familial cash received is reduced by 17 cents per dollar increase in AFDC benefits, and time help received is reduced by 75 hours per year per $1,000 increase in AFDC benefits. Using a household survey for Peru, Cox, Eser, and Jimenez (1998) find that capital market imperfections are likely to be an important cause of private transfers and that social security benefits 'crowd out' the incidence of private transfers. Cox, Jimenez, and Okrasa (1997) found large transfers among Polish families, partly targeted to those family members faring less well. They have also found a weakening of the family networks after its transition to a market economy, indicating perhaps how this transfers substitute for other mechanisms.

The rest of the paper is organized as follows. In section 2 we present the model. We consider a particular form of institution: what we have labeled as the 'extended family'. Effectively, our extended families are made of two individuals that enter a form of risk sharing subject to constraint that allow for the lack of perfect enforceability. In this section we also show how to build from a two agent economy to a multi-agent economy to be able to interpret a reduction in the variance of the endowments due to aggregate shocks as the result of government provided insurance. The model we present in Section 2 is not new: several contributions in the literature have constructed and used similar models. In Section 3, we describe by means of an example how the model works: we discuss the properties of the equilibrium allocation. In Section 4 we show an example where we compare two economies with different variance in the endowment due to aggregate shocks (the low variance has government provided insurance) and show how the utility of the implementable allocation is lower in the insurance economy even though the autarkic and the first best utilities are higher. We also discuss what are the characteristics of the economies that affect these different outcomes. In Section 5, we discuss some the empirical evidence that we have obtained from the PROGRESA data set that documents the crowding out of private transfers by public transfers. Finally, section 6 concludes the paper.

2 The Model

While we will eventually consider an endowment economy made of a large number of identical separate islands, we start considering two individual agents and a government that has access to actuarially fair insurance. Endowments are stochastic and there are no storage possibilities. We think of this pair of agents as 'an extended family'.

There are different kinds of shocks in this economy. Let z denote a shock with finite support in Z. Furthermore, the shock z is Markov with transition matrix $\Gamma_{z,z'} = \text{Prob}(z_{t+1} = z'|z_t = z)$, and stationary distribution γ^*_z.[4] We label shock z the aggregate or island shock. Let $s \in S$ denote another Markov shock to each household that may be multi-valued, so that it can incorporate both temporary and permanent elements. This shock also has finite support. We call shock s the idiosyncratic or individual shock. Accordingly, aggregate shock z is common to both agents, while this is not true for shock idiosyncratic s. Conditional on two consecutive realizations of the aggregate shock,[5] we write the stochastic process for s as having transition $\Gamma_{s,z,z',s'} = \text{Prob}(s_{t+1} = s'|z_{t+1} = z', z_t = z, s_t = s)$, and unconditional means $\bar{z}$ and $\bar{s}$. In each state $\{z, s\}$ agents get endowment $e(z, s)$. We write compactly $\epsilon \equiv \{z, s\}$ and its transition $\Gamma_{\epsilon,\epsilon,'}$. We use the compact notation $y = (z, s_1, s_2)$ and we refer to its components as $\{z(y), s_1(y), s_2(y)\}$, which are the aggregate shock, and the idiosyncratic shock of agents 1 and 2 respectively. We also write compactly the transition matrix of the pair as $\Gamma_{y,y'}$. We denote by $\gamma^*(y)$ the stationary distribution of the shocks.[6] Moreover, the history of shocks up to t, is denoted by $y^t = \{y_0, y_1, \cdots, y_t\}$. We use $\pi(y^t|y_{-1})$ to denote the probability of history y^t conditional on the initial state of the economy y_{-1}.

The government does not observe the idiosyncratic components of households shocks, but it does observe the aggregate shock z. The government can raise taxes and make transfers. We assume that the government has access to a fair insurance scheme so there is an ex-ante zero transfer condition. We denote these taxes (net of transfer) by $-\tau(z)$, or $-\tau(\epsilon)$ or $-\tau(y)$, depending on the context. However, it is understood that the tax only depends on the aggregate state.

We assume that the agents of our model maximize the expectations of a standard inter-temporally separable, strictly concave and differentiable utility function. Future expected utility is discounted at a rate $\beta < 1$.

$$E_0 \left\{ \sum_t \beta^t u(c_t) \right\}. \tag{1}$$

If an agent were to be alone, we assume that there are no trading opportunities except for those involved by the government transfer, and we refer to this as autarky. Therefore the consumption of an agent in autarky is $c(\epsilon) = e(\epsilon) + \tau(\epsilon)$. We write the value of the autarkic agent recursively as

$$\Omega(\epsilon) = u\left[e(\epsilon) + \tau\left(\epsilon\right)\right] + \sum_{\epsilon'} \ \Gamma_{\epsilon,\epsilon'} \ \Omega(\epsilon'). \tag{2}$$

If the two agents are not in autarky, they are affected by each other's idiosyncratic shock and their joint consumption is restricted by the pairwise feasibility constraint which now takes the form

$$c_1(y) + c_2(y) = e_1(y) + e_2(y) + 2\ \tau(y). \tag{3}$$

In the absence of enforceability problems, agents would equate their marginal utilities in all states of the world taking into account the transfers from the government.

$$\frac{u'\left[c_1(y)\right]}{u'[c_2(y)]} = \text{ a constant independent of } y. \tag{4}$$

While it is trivial to show[7] that any optimal allocation has to satisfy (4), theory is silent on how the surplus is split. Replication arguments and equality between the agents imply that a competitive equilibrium allocation within the pair would be symmetric. In any case, we denote with $W(y, 1)$ the value of the first best that treats both types symmetrically starting from each of the possible states y.

Notice that in such a situation an actuarially fair aggregate insurance scheme would substitute the random endowments $e(z, s)$ by an endowment given by $e(\bar{z}, s)$, with the same mean and lower variance. This insurance scheme is welfare improving both if the agents are able to share risk between them in the absence of enforceability problems and if the agents are in autarky.

We assume that contracts are not enforceable, and that the cost for any agent of breaking an agreed arrangement is zero. Obviously, in this event the future course of the agreement changes but the agent that broke it suffers no immediate cost as a result of his action.[8]

Since we are interested in the best allocations achievable, we further assume that if an individual breaks a contract, he will not be able to enter any similar contract in the future and will revert to autarky. We could think of this as the most severe subgame-perfect punishment (see Abreu (1988)).[9]

Agents upon breaking the contract get utility $\Omega[\epsilon(y)]$. This means, among other things, that we assume that the government cannot observe who broke a contract and who did not in order to select the transfer. If this were possible, the government could use the transfer to enhance the set of privately achievable allocations by reducing the value of autarky.

The agents can engage in a mutually advantage relationship that may allow them to smooth consumption even without commitment. To describe how this is done we draw from Kehoe and Perri (1997) who in turn follow the recursive approach of Marcet and Marimon (1992) and Marcet and Marimon (1995).[10]

Any allocation for the pair should satisfy enforcement constraints. That means that at each point in time and in every state of the world, y^t, the members of the pair prefer the allocation they receive to autarky. These enforcement constraints, therefore, take the form

$$\sum_{r=t}^{\infty} \sum_{y^r} \beta^{r-t} \; \pi(y^r | y^t) \; u[c_i(y^r)] \;\; \geq \;\; \Omega[\epsilon(y_t)]. \tag{5}$$

Let us consider the problem of maximizing a weighted sum of utilities subject to the resource constraints and the enforcement constraints, that is, the problem of choosing allocations $\{c_1(y^t), c_2(y^t)\}$ for all y^t to solve

$$\max_{\{c_i(y^t)\}} \; \lambda_1 \; \sum_{t=0}^{\infty} \sum_{y^t} \beta^t \; \pi(y^t) \; u[c_1(y^t)] \; + \; \lambda_2 \; \sum_{t=0}^{\infty} \sum_{y^t} \beta^t \; \pi(y^t) \; u[c_2(y^t)] \tag{6}$$

subject to (3) and (5) where λ_1 and λ_2 are non-negative initial weights. We can write the Lagrangian as

$$\sum_{t=0}^{\infty} \sum_{y^t} \beta^t \; \pi(y^t) \; \left\{ \sum_{i=1}^{2} \; \lambda_i \; u[c_i(y^t)] + \right.$$
$$\left. \sum_i \mu_i(y^t) \left[\sum_{r=t}^{\infty} \sum_{y^r} \beta^{r-t} \pi(y^r | y^t) u[c_i(y^r)] - \Omega_i[\epsilon(y_t)] \right] \right\} \tag{7}$$

plus the standard terms that relate to the resource constraints.

Noting that $\pi(y^r|y^t)$ can be rewritten as $\pi(y^r) = \pi(y^r|y^t)\pi(y^t)$ we can rewrite the Lagrangian as

$$\sum_{t=0}^{\infty} \sum_{y^t} \sum_{i} \beta^t \; \pi(y^t) \; \left\{ M_i(y^{t-1}) u[c_i(y^t)] + \mu_i(y^t) \left[u[c_i(y^t)] - \Omega_i[\epsilon(y_t)] \right] \right\} \tag{8}$$

plus again the terms that refer to the feasibility constraint. The newly introduced variable,

$M_i(y^{t-1})$ is defined recursively as $M_i(y_{-1}) = \lambda_i$ and

$$M_i(y^t) = M_i(y^{t-1}) + \mu_i(y^t) \tag{9}$$

Note that at time t , the $M_i(y^t)$'s are equal to the original weights plus the cumulative sum of the Lagrange multipliers on the enforcement constraint at all periods from 1 to t. The first order conditions that can be derived from this modified Lagrangian include

$$\frac{u'\left[c_1(y^t)\right]}{u'[c_2(y^t)]} = \frac{M_2(y^{t-1}) + \mu_2(y^t)}{M_1(y^{t-1}) + \mu_1(y^t)}, \tag{10}$$

in addition to the complementary slackness conditions. The next step consists in renormalizing the enforceability multipliers by defining

$$\varphi_i(y^t) = \frac{\mu_i(y^t)}{M_i(y^t)} \qquad \text{and} \qquad x(y^t) = \frac{M_2(y^t)}{M_1(y^t)} \tag{11}$$

The virtue of this normalization is that it allows us to keep track only of the relative weight x. Its transition law can be written as

$$x(y^t) = \frac{[1 - \varphi_1(y^t)]}{[1 - \varphi_2(y^t)]}\ x(y^{t-1}) \tag{12}$$

by noting that $[1 - \varphi_1(y^t)]\, M(y^t) = M(y^{t-1})$.

We are now in a position to write this problem recursively. To do so we define a mapping T from values into values, a fixed point of which are the value functions that characterize the solution to our problem. To solve our model numerically, as we do in the next section, we actually follow this procedure, that is, we iterate from a certain initial set of value functions. Successive approximation have yielded in every case the desired fixed point. The state variables are the current value of the shock y (recall that, due to the fact that the shocks are Markov, their current value is sufficient to evaluate conditional expectations) and the current value of the relative weights x. Let $\mathbf{V} = \{V_0(y, x), V_1(y, x), V_2(y, x)\}$ be three functions one for the planner and one for each of the agents, that satisfy the following property:

$$V_0(y, x) = V_1(y, x) + \ x\ \ V_2(y, x) \tag{13}$$

The mapping $\mathbf{T}$, whose fixed point we are looking for, updates these three functions, and, therefore, we write the updated functions as

$\mathbf{T}(\mathbf{V}) = \{T_0(\mathbf{V}), T_1(\mathbf{V}), T_2(\mathbf{V})\}$.

To define $\mathbf{T}$, we first solve the following auxiliary problem where no incentive constraints are taken into account

$$\Phi(y, x; \mathbf{V}) = \max_{c_1, c_2} \; u(c_1) + x \; u(c_2) + \beta \sum_{y'} \Gamma_{y,y'} \; V_0(y', x) \tag{14}$$

subject to the feasibility constraint (3), with solution $c_i^{\Phi,\mathbf{V}}$. Note that in this problem the relative weight x is constant. Next, we verify the enforceability of the solution to (14). This means verifying whether

$$u[c_i^{\Phi,\mathbf{V}}(y, x)] \; + \; \beta \sum_{y'} \Gamma_{y,y'} \; V_i(y', x) \geq \Omega[\epsilon(y)] \qquad \text{for} \qquad i = 1, 2 \tag{15}$$

If (15) is satisfied, then $T_0(\mathbf{V}) = \Phi(y, x; \mathbf{V})$, and $T_1(\mathbf{V})$ and $T_2(\mathbf{V})$ are given by its left hand side. It is easy to see that (15) cannot be violated for both agents at the same time (just note that autarky is a feasible allocation). The only remaining problem is to update the value functions when the constraint is binding for one of the agents, say agent 1. In this case, we solve the following system of equations in $\{c_1, c_2, x'\}$.

$$\Omega[\epsilon(y)] = u(c_1) \; + \; \beta \sum_{y'} \Gamma_{y,y'} \; V_1(y', x') \tag{16}$$

$$x' = \frac{u'(c_1)}{u'(c_2)} \tag{17}$$

$$c_1 + c_2 = e_1(y) + e_2(y) + 2\tau(y) \tag{18}$$

With solution $\{\bar{c}_1, \bar{c}_2, \bar{x}'\}$.[11] To update the value functions we let

$$T_1(\mathbf{V})(y, x) = u(\bar{c}_1) + \beta \sum_{y'} \Gamma_{y,y'} \; V_1(y', \bar{x}') \tag{19}$$

$$T_2(\mathbf{V})(y, x) = u(\bar{c}_2) + \beta \sum_{y'} \Gamma_{y,y'} \; V_2(y', \bar{x}') \tag{20}$$

$$T_0(\mathbf{V})(y, x) = T_1(\mathbf{V})(y, x) + \; x \; T_2(\mathbf{V})(y, x) \tag{21}$$

A fixed point of $\mathbf{T}$, *i.e.* a $\mathbf{V}^* = \mathbf{T}(\mathbf{V}^*)$, gives the value to the problem of maximizing a weighted sum of utilities (see Marcet and Marimon (1992) and Marcet and Marimon (1995), or Kehoe and Perri (1997) for an implementation of this approach to international business cycles). Moreover, it also gives us a way to completely characterize the properties of such a solution by numerical methods. This means that for any parameterization we can tell whether the enforceable allocation is autarky, the first best or anything in between. We can also study how the enforceable allocations are affected by changes in the environment.

Note how different this type of problem is from a standard optimization problem. Note that there is more than one relevant set of first order conditions: binding states are represented by alternative Euler equations characterized by the default constraints.

One question that remains is how is this allocation actually implemented. Like in the first best, the theory is silent about how to split the surplus initially. We assume a symmetric split. This means that the starting value for x is 1. From there a contract can be implemented by a state contingent transfer say $\theta(y, x)$ that specifies what agent 1 gives to agent 2 (it can be negative) when the state is given by the pair $\{y, x\}$. This transfer is just the difference between the endowment and the solution to the problem above. The law of motion for the state variable x is also given by the procedure described above.

This completes our description of the model and its solution. The steps between equation (13) and equation (19) reflect the steps of the simulation program we use below to characterize the quantitative properties of some examples. In the next subsection we describe how to aggregate the model so that a reduction of the variance of the aggregate shock can be interpreted as government insurance.

2.1 Aggregate Insurance across Islands

Let the economy consists of a large number (a continuum) of islands. Let each island itself be populated by a large number (a continuum) of agents, all of which are paired with one and only one other agent. Aggregate shocks are common for all agents within an islands but are independent across islands. Idiosyncratic shocks are independent across agents. In this economy a law of large numbers (Uhlig (1996)) can be applied twice so that for each island only the aggregate shock determines aggregate output and so that there is no aggregate uncertainty in the economy as a whole. Moreover, aggregate shocks are observable by the government.

In this economy, a small[12] tax/transfer scheme $\tau(z)$ can be levied from all the agents. If the transfer satisfies the following property

$$\sum_{z} \tau(z)\ \gamma_z^* = 0 \tag{22}$$

then the government can provide some actuarially fair aggregate insurance to all agents without access to third parties. Moreover, if the variance of the aggregate shocks is not too large relative to the endowment of agents in bad idiosyncratic states, the transfer can be made large enough so that individual endowments net of the transfer are no longer dependent on z and they have the same mean and lower variance than the endowments before the transfer. Formally,

$$\hat{e}(s) = e(z, s) + \tau(z). \tag{23}$$

3 The Model at Work

In this section we show, by means of an example and using numerical solutions and simulations, how the agents by themselves improve upon autarky. Next, we use a similar example to show how the type of insurance described in the previous section can actually decrease the welfare of the two agents. We discuss the features of the model that are more likely to cause the provision of aggregate insurance to interact and interfere with the working of private contracts.

Before delving into the details of the simulation it is worth discussing some features of the model that can be described even without the help of the numerical computations. First of all, it is clear that the amount of risk sharing that can be achieved in equilibrium depends on the difference between the value function within a given contract and that achieved under autarky. Therefore, whatever increases the value of autarky decreases the amount of risk sharing in our economy.

The most obvious example is the effect of changes in the discount factor. Increasing the rate at which agents discount the future decreases the value of the punishment imposed by autarky and therefore decreases the amount of risk sharing that can be achieved in equilibrium. Reducing the discount factor, instead, increases the amount of risk sharing achieved in equilibrium. For low enough levels of discounting one might be able to enforce first best allocations. Increasing the variance of shocks increases the amount of risk sharing as it makes 'autarky' more painful. With CRRA preferences, on the other hand, a shift in the mean of the shocks does not affect the amount of risk sharing as it is equivalent to a change in units.

An increase in the persistence of idiosyncratic shocks makes 'lucky' agents more reluctant to share positive shocks and therefore decreases the amount of risk sharing. In the limit, a random walk shock cannot be shared at all. On the other hand, the persistence of aggregate shocks does not have obvious implications. In the examples we study, with additive shocks, an increase in the persistence of aggregate shocks improves risk sharing.

We next choose a specific example to illustrate the workings of the model. This implies parameterizing the processes that generate the stochastic endowments of our model as well as individual preferences. We compute the solution of the model numerically. Welfare can be computed either directly from the solution or through the evaluation of the utility of long simulations. We describe the properties of this solution. Next, we will show in the context of another example how a reduction of the variance of the endowment, specifically, of the part that is common to both agents since it is due to the aggregate shocks, might reduce welfare. Finally, we discuss how specific is the example.

We work with a particularly simple version of the model where aggregate and individual shocks can take only two values. The processes for the idiosyncratic shocks are the same for the two members of the extended family, although the realizations of these shocks are uncorrelated. The example that we use has the endowment depend additively on the aggregate shock and the idiosyncratic shock, $e = z + s$. Since there are two agents, there are three shocks and therefore $2^3 = 8$ possible values of the state of the economy and in both cases, the Markov process that describes the joint process $\{z, s_i\}$ is the one described above.

Utility is of the CRRA class with risk aversion parameter $\sigma = 1.1$, and the discount factor is $\beta = 0.85$. Aggregate states are given by $z \in \{1, 0.1\}$ with persistence of good and bad aggregate states $\{0.9, 0.1\}$ (diagonal elements of $\Gamma_{z,z'}$). Idiosyncratic individual states are $s \in \{1, 0.1\}$, with persistence of good and bad individual states $\Gamma_{s,s'} = \{0.7, 0.7\}$ (independent of the aggregate states). This economy, therefore, is characterized by quite severe fluctuations both at the aggregate and at the individual level. Bad aggregate shocks are quite unlikely to occur and when they do occur are quite unlikely to persist. Bad idiosyncratic shocks, on the contrary, are much more likely to occur and are more persistent. While the level of risk aversion (just above one) is quite standard, there is a fair amount of discounting. Within this model, a lower degree of discounting would allow first best to be achieved.

HERE GOES Figure 1

In Figure 1, we plot, for each value of the state (recall that the state consists of the shocks and the relative weight that consumer 2 gets into the problem), the consumption function of agent 1 against (minus the log of) the state variable.[13] In each panel, we also plot the consumption of agent 1 generated by a model where no contracts are enforceable ('autarky') and by a model where full risk sharing among the two agents is achieved ('first best').

The consumption function under first best is obviously increasing in the negative of the state variable. It should be remembered that under first best such a variable is kept constant over time, at whatever level it happens to be. At the opposite extreme, under autarky, consumption of agent 1 coincides with her endowment and is therefore independent of the state variable.

The enforceable consumption function coincides over some intervals with the first best or with the autarky level and differs in others. When the shocks of the two agents are the same, the region over which the enforceable allocation coincides with first best is independent of the aggregate state. However, when the idiosyncratic shocks are different, that is when there is scope under first best for private transfers, the interval of values of the state variable where the enforceable allocation coincides are different depending on the aggregate state. If the aggregate state is bad, the enforceable and first best function coincide only for low values of the state variable, when it is good, they coincide for intermediate level. Finally, notice that it is possible to have situations where the relatively luckier agent consumes more than her autarkic level of consumption. This happens for sufficiently high levels of the state variable when the aggregate state is good. Sufficiently high level of the state variable means that the luckier agent has been relatively lucky (and with a binding enforceability constraint) in the past. If the aggregate state is good, the unlucky agent is 'repaying' some of her debts even though the realization of her idiosyncratic shock is a bad one. In such a situation not only is the allocation of resources different from first best, but the direction of transfers is the opposite of that predicted by first best. Notice that for this effect to happen it is necessary to have an aggregate shock, which has not received much attention in the literature.

HERE GOES Figure 2

On the same chord, Figure 2 shows the evolution of the negative of the log of the ratio of marginal utilities $\hat{x}$ for each of the eight states of the economy under first best and under the enforceable contract. Under first best the state variable does not change over time so that the graph coincides with the graph of the log. For the enforceable equilibrium, this graph describes the dynamic of the system. When neither of the two constraints is binding the value function is constant and the graphs coincides with that of the first best. However, over large regions of the state space, the behaviour of the enforceable equilibrium differs from the first best. Typically, when the aggregate state is good, the enforceability constraints are not binding only for intermediate levels of the state variable. When the aggregate state is bad, the enforceability constraint is not binding for sufficiently high levels of the state variable. The ratio of marginal utility under autarky varies the most and reflects the ratio of marginal utilities in the different endowment points. We would represent this by a horizontal line since it does not depend at all in the previous period ratio of marginal utilities.

The situation in which the relatively luckier agent consumes more than her endowment and of the other agent, that is a situation in which not only the size but the sign of the transfer differs from first best, corresponds to regions where the state variable is tilted towards one of the two agents. This represents the promises made in the past so that the favored agent would give up some of her consumption.

HERE GOES TABLE 1

The properties of the long run equilibrium of this example are summarized in Table 1. The averages of the relevant variables are obtained letting the economy run for 20,000 periods and averaging the resulting sample path. In the first row, we report the average output per capita in the economy. In rows 2 to 4 we report the average level of the value function under autarky, enforceable and first best equilibria. Obviously they are increasing. In row 5 we report the average absolute size of private transfers. This measures the extent of insurance provided in equilibrium. At about 0.1 they constitute more than 5% of per capita output.

Finally, in row 6, we report the ratio of the variance of individual consumption (net of aggregate consumption) and the variance of individual endowment (net of aggregate endowment). This ratio is equal to zero under perfect risk sharing (first best) and to 1 under autarky. In this example a number of 0.267 indicates that there is a substantial amount of risk sharing.

4 More Aggregate Insurance May Decrease Welfare

In this section we describe the effects of a simple aggregate insurance scheme, of the kind discussed above. The effect that simple aggregate insurance schemes might have on welfare and on the performance of the economy described by our model is complex and depends on a variety of factors. In particular, in addition to preferences, the effects depend crucially on the properties of the aggregate shocks and how they interact with individual shocks, on the amount of individual risk that can be diversified in equilibrium and on the relative importance of aggregate and idiosyncratic shocks. The effects of the introduction of a government sponsored insurance policy can only be computed with numerical situations. Moreover, mapping the features of the model into a pattern is not completely trivial as the various components of the model interact in a complex way.

Introducing insurance against aggregate shocks has two effects. On the one hand it reduces the variance of aggregate shocks and therefore increases welfare because utilities are concave. On the other hand it reduces the amount of idiosyncratic risk that can be diversified by enforceable contracts. The reason for this is that increasing all individual endowments in 'bad' states of the world makes 'autarky' less unappealing and therefore the enforceability constraints more likely to be binding.

The net effect depends on which of these two effects prevails. Obviously, if we start from a situation in which no risk sharing contract is enforceable ('autarky' equilibrium), the introduction of the aggregate insurance scheme cannot make things worse as it cannot crowd out any private insurance. On the other hand, if in the initial situation private arrangements are able to diversify part of idiosyncratic risk, there is potential for a substantial amount of crowding out that might lead to a welfare reduction.

This result is not entirely surprising. Ligon, Thomas, and Worrall (1998), for instance, show that in a model similar to that considered here, the introduction of storage possibilities can lead to a reduction in welfare. The reason for their result is the same as that considered here. Giving the individual households the possibility of self insure via storage, makes 'autarky' less unappealing and therefore, via the enforceability constraints, crowds out some of the private insurance. Also, Krueger and Perri (1999) find that the private sector's ability to partially ensure against shocks diminishes with certain class of government sponsored redistributive policies (in their case progressive taxation).

In the rest of this sub-section we show by means of an example how simple aggregate insurance reduces welfare. Furthermore, in addition to the effects on welfare, we try to quantify the amount of crowding out induced by the introduction of a simple aggregate insurance scheme. This is important to assess the amount of inefficiency implied by a certain scheme, regardless of its overall welfare effect.

In this section we consider two simulations that differ somewhat from that presented in Section 3. While we use the same discount factor, we decrease the coefficient of risk aversion to 0.8. The most dramatic change relative to the previous simulations, however, is in the processes that generate aggregate and idiosyncratic shocks. Aggregate states are now $z \in \{1, 0.05\}$ with persistence of good and bad aggregate states $\{0.95, 0.8\}$ (diagonal elements of $\Gamma_{z,z'}$), idiosyncratic individual $s \in \{1, 0.015\}$ with persistence of good and bad individual states $\Gamma_{s,s'} = \{0.95, 0.75\}$ (independent of the aggregate states). That is we consider a world in which bad shocks are much more extreme and much more persistent. The combination of a bad aggregate and a bad idiosyncratic shock implies a level of the endowment of 0.055 to be compared to a value of 2, relevant for good states.

HERE GOES Figure 3

HERE GOES Figure 4

Figures 3 and 4 are equivalent to Figures 1 and 2. Figure 3, for instance, plots the consumption function against the negative of the log of the state variable, the ratio of the weights in the surrogate social planner's problem, $\hat{x}$, in each of the eight states of the world.

As before, as first best is not enforceable, the equilibrium allocation of our model coincides with the first best only in certain regions of the relative weights. Outside those regions, the first best is no longer enforceable. Agents can, however, still do better than autarky in some of the states and get a small transfer bounding away their allocations from the autarkic ones.

HERE GOES TABLE 2

The first column of Table 2 summarizes the properties of this version of the model. Notice that the enforceable equilibrium there is relatively little risk sharing. The ratio of the variance of consumption to the variance of endowment is now 0.88, much closer to 1 than in Table 1. The average size of private transfers is also quite small: only about 1% of output per capita. The reason for this lies mainly in the persistence of the individual shocks. The fact that shocks are so extreme would, other things being equal, allow for more risk sharing than in the environment summarized by Table 1. However, the much higher persistence of the idiosyncratic component results in the impossibility of sharing this increased risk.

In the second column of Table 2, we introduce the mandatory insurance scheme discussed above. As the scheme is actuarially fair, average output per capita does not change. Average welfare under autarky and first best both increase as we decrease the variance of aggregate shocks. However, average welfare achieved in the enforceable equilibrium decreases relative to that in column 1. This is caused by the crowding out of the already small private sharing. Average private transfers go from 0.016 to 0.013. Furthermore, the ratio of the variance of consumption to the variance of endowment increases to almost 0.9: the model gets much closer to autarky.

HERE GOES Figure 5

HERE GOES Figure 6

If we provided some aggregate insurance to the economy in Table 1, we would obtain a larger amount of crowding out, but a welfare increase rather than a decrease. This might seem a little surprising: as in Table 1 private transfers is much larger and the equilibrium much 'closer' to first best, one would imagine there is much more scope for crowding out. To understand what is happening, it is useful to look at Figures 5 and 6 that plot sample paths for the consumption of agent 1 and for the ratio of marginal utilities for our second model, whose summary statistics are reported in Table 2. Notice that most of the times the enforceable equilibrium is very close to autarky and considerably different from the first best. However, there are situations in which there is a substantial amount of risk sharing. This happens, for example, when both the aggregate state and the idiosyncratic state of agent 1 are bad, while the idiosyncratic state of agent 2 is good. Such a situation is particularly evident in Figure 6, where, in such a situation, the marginal utility of consumption is considerably smaller than that that would obtain under autarky. Even a small amount of crowding out, such as that documented in Table 2, can be extremely detrimental in such a situation.

4.1 How Restrictive is the Example

The model we sketched in Section 2 can be extended in several directions. The first, obvious extension is to allow for the possibility of storage. As discussed in Ligon et al. (1997) and in Alvarez and Jermann (1998), the problem becomes numerically much more complex. However, the main result obtained in this paper, that simple aggregate insurance schemes are inefficient and can potentially decrease welfare should go through. The only caveat one has to bear in mind is that the presence of storage in a model with enforceability constraints might put severe limitations to the amount of idiosyncratic risk that is diversified. This is because the possibility of self insurance makes autarky much less unappealing than without storage.[14] When considering the introduction of aggregate insurance, therefore, we start from a situation in which there is potentially very little private insurance to crowd out. However, as we saw in Table 2, one can get a decrease in welfare in situations in which there is very little risk sharing to start with. The important point is that risk sharing might be happening at crucial moments.

So far we have considered symmetric idiosyncratic shocks. It might be interesting to consider situations in which individuals are characterized by very different processes. It would be interesting to establish both whether one gets more or less risk sharing and whether the introduction of aggregate insurance is more or less likely to result in welfare decreases in such a situation.

5 A suggestive empirical analysis

While there is now a considerable theoretical literature that uses models similar to the one above, very little empirical evidence on their ability to describe actual economies exists. Moreover, as far as we know, no evidence exists on the introduction of aggregate insurance schemes on the function of private informal arrangements. And yet the empirical relevance of the sort of mechanisms we have described is bound to be of crucial importance for the design and operation of a large variety of government programs.

In addition to the papers of Cox and co-authors, Cutler and Gruber (1996) and Schoeni (1996) that we mentioned in the introduction, there are three pieces of empirical evidence we are aware of that are relevant for the models we have used. Ligon et al. (1998) using a model similar to ours, try to fit the data from Indian villages in semi-arid tropics that have been used in a variety of studies of risk sharing, including Townsend (1994). Ligon et al. (1998) estimate the model by simulating numerically the solution of the enforceable contract. There are two problems with their approach. First, instead of considering a multi-agent framework they solve the problem of each household vs. the rest of the village. Second, they ignore completely storage. Both simplification were done to simplify the numerical computations. While the first might not be too important in practice, the second is much more serious. Nonetheless, Ligon et al. (1998) report that the version of the model they estimate fits the data better than a model that assumes first best allocations.

Foster and Rosenzweig (1999), instead, take an opposite approach and test some simple implications of models with imperfect enforceability. In particular, they test the hypothesis that, conditional on current shocks, current transfers are negatively related to the cumulate of past transfers. Furthermore, to take into account altruism, they also test the hypothesis that this negative correlation is stronger for transfers from non-relatives than from relatives. This approach constitutes a first important step in establishing the plausibility and empirical relevance of enforceability problems.

Finally, there exist a relatively large literature in anthropology that documents the existence of phenomena, sometimes defined as quasi-credit, that could be conceivably explained by model with limited risk sharing. A large part of this literature is summarized in some recent papers by Platteau (1997). Platteau himself has studied fishing communities in South India and Senegal (see Platteau and Abraham (1987)).

One of the reasons why the study of models with endogenously limited risk sharing is difficult is because of the stringent data requirements that both a structural and a descriptive approach imply. In particular, one would like to have information about the nature and importance of private insurance schemes, about the dynamic environment where the households live, about the degree of prevailing risk sharing and, possibly, about the importance of enforceability problems. Ideally, one would like to compare different small economies that differ, for instance, in the variance and persistence of aggregate and idiosyncratic shocks and compare the degree of risk sharing among these economies. The main problems to be faced when attempting to gather information on these issues are the fact that surveys are often not targeted towards a small village or island but are instead nationally representative surveys and the fact that they are typically lack a long longitudinal dimension. These considerations are even more important if one would like to evaluate specific government programs, in that one would want to have information on the different islands that differ in the access to this type of schemes.

However, more and more surveys in which the sampling is done at the village or island level are becoming available. Furthermore, such surveys are starting to include retrospective information and could therefore be used to measure not only the mean but possibly the amount of variability faced by individual households and by each island.

In this paper, we present some reduced form evidence from a recent social program introduced in Mexico. The PROGRESA program is a large welfare initiative targeted towards rural communities. The program aims at providing poor rural households with help in three dimensions: nutrition, education and health. Started at the end of 1997, it now covers about 8 million individuals in about fortyl thousands villages. The program is implemented by first targeting villages on the basis of a well specified statistical algorithm. Such an algorithm considers the so-called index and 'degree of marginalization' of each community as well as the availability of certain structures, such as schools, hospitals etc in the region. For a description of the targeting procedure and more generally of the program see Gómez de León (1998).

At the start of the program, the agency that runs it decided to start the collection of a panel data set to evaluate its effects and impact. For this purpose, the program's officials chose 506 villages that qualified for the program in which a very rich questionnaire was administered to about 25,000 households living in these villages. Interestingly, in 186 of the 506 villages chose for the data collection, the implementation of the program was delayed until November 1999. As far as we know, the 186 villages were chosen in a random fashion and the delay in the program implementation was done only with the aim of introducing an experimental feature in the evaluation of the program. Therefore, we can work with a set of 'treated' villages (in the sense that the program was implemented from the beginning) that can be compared to a set of otherwise 'identical' 'control' villages.

As mentioned above, the program has three components: nutrition, health and education. The first consists in the provision of some vouchers, delivered to the females in the household, that can be used to purchase food items. This aspect of the program is linked to the health component, in the sense that the participant households are entitled to the food subsidy only if they take their children to health centers and hospitals for some vaccinations and visits. Finally, the program offers scholarships, differentiated by age and gender, for kids to attend school. They are conditioned on school attendance.

As it is clear from this brief description, PROGRESA in not an aggregate insurance scheme of the type we discussed in the first part of the paper. However, the program is likely to have the effect of limiting the impact of bad shocks and, therefore, if the mechanisms we study are operative, crowd out private insurance for the same reasons our aggregate insurance scheme does. Moreover, what we want to stress is that government programs involving transfers to households may have an effect on the interactions among households. What we check below is whether the existence and size private transfers is affected by the introduction of the program.

Before going into the details of the empirical analysis, it is important to provide a few words of caution. Partly because the program at hand is very different from an 'aggregate insurance program', its welfare implications could be very different from those we considered in the theoretical model discussed above. This is particularly so because the main goals of the program are long run objective (human capital accumulation in particular) so that the program cannot be evaluated on the basis of the effect it might have on the prevalence and importance of private insurance. The exercise we perform is only indicative of the importance that the mechanism we study might have.

Given the nature of the data, and in particular because of the absence of a long panel of observations on individual households, we do not estimate a structural model. Instead, we provide some evidence on the interaction of the program itself with the existence and importance of private transfers. In particular, we use explicitly the 'control' and 'treatment' samples to test the hypothesis that private transfers are somehow crowded out by public programmes. In addition, we also perform the same exercise by looking at whether the village received some form of support from the outside.

The exercise we perform is reduced form in nature. In particular, we relate the existence and magnitude of private transfers received by individual households to a number of controls, including variables that measure the occurrence of various negative shocks that might have affected the household in the recent past. In addition to these variables, we also consider a dummy for the existence of the program. As the control villages in which the implementation of the program was delayed were chosen randomly, this variable is exogenous.

5.1 The data

The data available to us was collected in October 1998 by PROGRESA, the agency that runs the program, in collaboration with IFPRI. In total we have data from 506 villages. Of these, in 320 the program was started in July 1997, about one year before the interviews we use took place. In the other 186 'control' villages the program will be introduced in November 1999. Supposedly, these 186 villages were chosen at random. We present some evidence below that substantiates this claim.

Our sample includes a total of 23511 households, of which 14672 are living in 'treated' and 8839 in 'control' villages. The villages are from 7 states in Mexico: Guerrero, Hidalgo, Michoacán, Querétaro, Puebla, San Luis de Potosí and Veracruz. Some of these households are not used in the analysis that follows because of missing or inconsistent information on some of the key variables.

The data set include information both on recent shocks received by the households and the nature and prevalence of private transfers. Furthermore we have information on a variety of other family and village characteristics. In particular, we use information on the following variables.

5.1.1 Welfare indicators and shocks

The data set contains additional and more detailed information on expenditure share that we have not used. We use a comprehensive measure of consumption obtained from the question: 'How much money does your household allocate to expenditure'? We also know whether the household is above or below the poverty line.

In terms of shocks experienced recently by the household we know the number of days each household member was sick in the last month and the number of work days lost because of sickness by each earner in the last six months. Furthermore we know whether the household was affected by some large shocks. These include things like draughts, floods, hurricanes etc. A complete list is given in the Data Appendix.

5.1.2 Demographics

We have information on family size and composition, including the age of each household member. Furthermore we have information on occupation and labour supply behaviour of each member. The survey also contains information on household members that have left the family, usually for migration.

5.1.3 Transfers and loans

We know the nature of the transfers received by each individual household member in the last month. The transfers can be in money or in kind (food, clothes etc.). For the monetary transfers we also know the amount received by each household member for each transfer. Moreover, we know for how long these transfers have been received and by whom they were given. We also have information on all the loans received by each household member, including their amount, their sources and the reason for the loan.

There are relatively few households where more than one transfer is received. In what follows, however, we consider the total of all transfers, except for remittances received by immigrants. Furthermore, we also consider the sum of individual transfers and loans received by family or friends (that is not received by financial institutions or money lenders). The results were not greatly affected by the definition of loans we used.

5.1.4 Village information

We know whether the village has been affected by one of several large shocks. The shock typology used in the question is the same as that used in the questions asked to the individual households. The information is given by a village representative, not by the individual households. We also know whether the village received some external support to cope with the above mentioned shocks. Finally we know the village index of marginalization and degree of marginalization as well as the so-called 'deepness of poverty' in the village.

5.2 Results

In Table 3, we report the mean of some village-level variables in the control and treatment samples. All means are weighted by the sample size in each village. In the third column, we report the p-value of the test that the two means are equal in the treatment and control villages. In particular, we consider four variables from the village data set and a number of village averages computed from the household data set. The variables from the village data set include three indexes of poverty and marginalization that are computed by the PROGRESA officials on the basis of well defined algorithms (called the marginalization index, the degree of marginalization, the degree of poverty) and a dummy that indicates whether a village has been affected by one or more 'large shock'. Moreover, we report the percentage of households in a village under the poverty line, the means of the log of consumption expenditure, family size, age of the reference person, the number of days of sickness of all household members, the number of days of work lost because of sickness, the value of monetary private transfers (unconditional and conditional on a positive transfer) and the percentage of households in the village receiving some kind of private transfer (monetary or in kind). Finally, we report the average duration of the existing transfers.

HERE GOES TABLE 3

Most of the averages are almost identical in the treatment and control villages. In particular, we can never reject the hypothesis that these means are different in the control and treatment villages. Testing for the statistical significance of the means in the two sets of villages, we fail to reject the null for most of the variables in the table. When we try to use any of these (and a variety of other village averages) to 'predict' whether a village belongs to the treatment or control group, we failed to find any significant regressor. This is comforting about the random nature of the allocation of villages to the two groups.

The majority of these villages were affected by some sort of large negative shock: in particular, 83% and 82% of the treatment and control village representatives reported that the village had suffered because of one of these shocks. The most common of these shocks were draughts that affected about 70% of the villages considered.

Of the variables in Table 3, the only noticeable difference among treatment and control villages is in the average level of transfers (conditional on positive transfers). In the control villages, individual transfers seem to be larger, on average, than in the 'treatment' villages. This difference, although not significant at standard levels, attracts the smallest p-value and is suggestive of the results to come.

Not very many households receive private transfers (5.8% and 6.2% in the treatment and control villages respectively). However, these transfers, when positive, can be quite important in the household budget: for the households with a positive transfer and positive food expenditure, the median ratio of the (monthly) transfer to the monthly food budget is 0.7. The existing transfers seem to be the outcome of relatively long relationships: the average and median duration is around 5 years, both in the control and in the treatment villages.

As anticipated above, we consider both some Probit models (for the indicator that at least a household member receives a transfer -either monetary or in kind) and some Tobit models (for the monetary transfers). The results for the Probit models are reported in Table 4, while those for the Tobits are reported in Table 5. Similar results were obtained for slightly different definitions of transfers (for instance including a variable indicating loans received by relatives and friends, or considering the transfers of the reference person only).

HERE GOES TABLE 4

In both tables we start with the simplest specification that includes only the dummy for the control villages. In interpreting these coefficients, it should be remembered that the treatment villages include households that do not benefit directly from the program. This is the right way to proceed both because the program is targeted to households that are particularly needy, so that it is not surprising that they receive more transfers, and because we are interested in the crowding out effects at the village level.

Given the results in Table 3, it is not surprising that, while the sign of this variable is positive, it is not significantly different from zero. The size of the coefficient, however, especially for the monetary transfers, is economically significant. It is therefore worthwhile to check whether we can obtain more precise estimates by including in the specification variables that are likely to be important determinants of transfers and are exogenous for the individual households.

In the second column of Tables 4 and 5, we include a village level variable (the marginalization index) and several dummies to control for the shocks that a household receives. The coefficient on the marginalization index is consistently negative, both in the Probit and in the Tobit models. The shock dummies are strongly significant and their coefficient take, for the most part, the expected sign, in that a shock is usually associated with a larger transfer. In this specification, the significance of the coefficient on the control village's dummy increases in size both in the Probit and in the Tobit models. In the first case, the p-value associated to the hypothesis that this coefficient is zero is 0.21, while in the second is 0.075. As far as the amount of monetary transfers is concerned, therefore, once we control for differences across villages and for shocks experienced by the sample households, the coefficient is marginally significant, indicating the presence of some crowding out, at least in terms of the size of the transfers received by some households.

HERE GOES TABLE 5

In column (3) we add to our models the number of days of sickness experienced by the household members and the number of days of work lost because of sickness by the household earners. The coefficient on the day sick is positive, while that on the days of work lost is negative. In interpreting this coefficient it should be remembered that the net effect of a day of work lost because of sickness is the sum of the two coefficients, so that the net effect is close to zero. This result, that is that transfers received are affected only by the days of sickness of the non-earners, is somewhat surprising. The significance of the coefficient on the control villages dummy marginally increases again in both the Probit and Tobit models. The p-value on the hypothesis of no difference in the intercept between treatment and control villages is now 0.19 in the Probit and 0.064 for the Tobit model.

The introduction of these two variables could be questioned if one thinks that the program has an important health component. However, it is unlikely that the program, whose focus is on vaccinations and preventive medicine, could have an effect on these outcomes in the short period over which it was implemented. Furthermore, as we saw in Table 3, there is no indication that these variables were different in the control and treatment villages.

In column (4) of Tables 4 and 5, we add the (log) consumption expenditure, in an attempt to control for the size of transfers. This variable takes a consistently negative and significant coefficient. As the phrasing and timing of the question is not completely clear, the interpretation of this coefficient is not completely straightforward. It might be interpreted as indicating that households with a relatively low average level of consumption are targeted by relatives with higher transfers. Or it might be interpreted as indicating that households with a low level of recent consumption expenditure have been affected by some kind of shocks and therefore receive some transfers. Once again, and with more plausibility than for the days of sickness, it may be argued that such a variable is endogenous to the determination of transfers so that its introduction could introduce some important biases.

The coefficient in column (4) on the control villages dummy is now on the verge of being significant for the Probit (p-value of 0.061) and strongly significant for the Tobit (p-value of

0.025), indicating the presence of some crowding out induced by the program.

To summarize the evidence in Tables 4 and 5, we find some evidence of a negative effect of the program on the size of monetary transfers. To uncover such evidence, however, it is necessary to condition on various types of shocks received by the sample households. The evidence of the effect on the *existence* of any transfers (that is monetary or in kind) is much weaker, even though, when one conditions on log consumption, the coefficient on the control villages is marginally significant.

6 Conclusions

In this paper we have analyzed the effects that the introduction of aggregate insurance might have in a situation in which individuals in a small economy face both idiosyncratic and aggregate risk. While we allow risk sharing among members of what we call extended families, we are interested in situations in which idiosyncratic risk is less than fully insured because of the presence of enforceability problems. We show that in such a situation, the provision of simple insurance schemes against aggregate shocks is almost surely inefficient, in that it crowds out private insurance against idiosyncratic shocks. While the net effect of such a scheme is ambiguous, we have shown that it is possible to construct examples in which the crowding out effect leads to a welfare decrease.

We solve and simulate our model in the case in which individual households do not have access to storage technologies. We conjecture, however, that the zest of our results carries through to the case of economies with storage.

The important message of this paper is that government interventions do not occur in a vacuum. They occur in the context of, and interact with, private sector mechanism whose nature can, in all likelihood, be altered. Simplistic government interventions might have pernicious effects, resulting in a worsening of people's welfare. And even if this does not happen, our results indicate that in designing aggregate insurance, one should both be aware of its crowding out effect and possibly think of ways to avoid them.

Two important questions arise from our research. First, how relevant are these types of issues in reality? Second, if they are important, can one design aggregate insurance schemes, or more generally a wide variety of government programs, so to avoid the inefficiencies implied by our arguments?

The answer to the first question must be based on empirical evidence. The empirical study of these models is still at the beginning. However, some early findings, that we mentioned in Section 4, and our own evidence indicate that these types of models might be important.

The evidence we have presented in Section 4 is derived from the analysis of a new data set on a Mexican welfare program. While the program is not an aggregate insurance scheme of the kind discussed in the theoretical model, it shows that public programs targeted at a variety of goals in general interact with private arrangements among households. The evaluation of such programs, along with their direct effects, should also take into account these indirect effects.

As far as the second question is concerned, in this paper we have only considered simplistic insurance mechanisms. However, one can think of implementing alternative schemes that, by inducing the right type of interactions between the members of the extended family, avoid the crowding out of private arrangements that we described in Section 3. We have left the study of these mechanisms for future research.

Table 1: Computed statistics from the Model Economy

Average output per capita $\sum_y \ \gamma^*(y)\ [e_1(y) + e_2(y)]$	1.46000
Average enforceable value function $\sum_y \ \gamma^*(y)\ V_i(y, 1)$	-10.705
Average symmetric value function (first best) $\sum_y \ \gamma^*(y)\ W(y, 1)$	-10.698
Average value function under autarky $\sum_y \ \gamma^*(y)\ \{\Omega[\epsilon_1(y)] + \Omega[\epsilon_2(y)]\}$	-10.739
Sample average private transfers $\sum_y \ \gamma^*(y)\ \lvert e_1(y) + \tau(y) - c_1(y, .)\rvert$	0.1024
Ratio of the variance of individual consumption (net of aggregate) and the variance of individual endowment (also net of aggregate) $\frac{\sum_y \ \gamma^*(y)\ \left[c_1(y,.) - \sum_y \gamma^*(y) c_1(y,.)\right]^2}{\sum_y \ \gamma^*(y)\ \left\{e_1(y) + \tau(y) - \sum_y \gamma^*(y)[e_1(y) + \tau(y)]\right\}^2}$	0.2674

Notes: $\sigma = 1.1$, $\beta = .85$, $z \in \{1.0, 0.1\}$, $\Gamma_{z_1,z_1} = .9$, $\Gamma_{z_2,z_2} = .1$, $\Gamma_{z_2,z_2} = .1$ $s \in \{1.0, 0.1\}$, $\Gamma_{s_1,s_1} = .7$, $\Gamma_{s_2,s_2} = .7$.

Table 2: Computed statistics from the Model Economies

	No insurance $\tau(1)=0$	0.001 insurance $\tau(1)=.001$
Average output per capita $\sum_y \gamma^*(y)\ [e_1(y)+e_2(y)]$	1.64583	1.64583
Average enforceable value function $\sum_y \gamma^*(y)\ V_i(y,1)$	4.44575	4.44558
Average sym. value function (first best) $\sum_y \gamma^*(y)\ W(y,1)$	4.47292	4.47350
Average value function under autarky $\sum_y \gamma^*(y)\ \{\Omega[\epsilon_1(y)]+\Omega[\epsilon_2(y)]\}$	4.43563	4.43692
Sample average private transfers $\sum_y \gamma^*(y)\ [e_1(y)+\tau(y)-c_1(y,1)]$	0.01626	0.013780
Ratio of the variance of individual consumption (net of aggregate) and the variance of individual endowment (also net of aggregate) $\frac{\sum_y \gamma^*(y)\ \left[c_1(y,1)-\sum_y \gamma^*(y)c_1(y,1)\right]^2}{\sum_y \gamma^*(y)\ \left\{e_1(y,1)+\tau(y)-\sum_y \gamma^*(y)[e_1(y,1)+\tau(y)]\right\}^2}$	0.88376	0.89550

Notes: $\sigma=.8$, $\beta=.85$, $z\in\{1,.05\}$, $\Gamma_{z_1,z_1}=.9$, $\Gamma_{z_2,z_2}=.8$, $s\in\{1.,.015\}$, $\Gamma_{s_1,s_1}=.95$, $\Gamma_{s_1,s_1}=.75$,

Table 3: Descriptive statistics in control and treatment villages

	treatment villages	control villages	p-value of difference
degree of poverty	2.550	2.474	0.345
marginalization index	0.405	0.447	0.536
degree of marginalization	4.643	4.638	0.917
% of poor households	0.535	0.511	0.224
average log consumption	4.834	4.848	0.613
family size	5.496	5.554	0.350
days of sickness	3.856	3.850	0.979
days of work lost	0.959	1.057	0.293
frequency of village shocks	0.835	0.845	0.762
age of reference person	47.19	47.59	0.989
value of monetary private transfers	27.32	36.18	0.167
value of monetary private transfers (condit. on pos.)	636.40	772.67	0.277
percentage of h.h. receiving a transfer (monet. or in kind)	0.058	0.062	0.592
time since transfer started (in months)	58.44	54.95	0.707
Number of villages	320	186	-

Table 4: Probit models for individual monetary and in-kind transfers

	(1)	(2)	(3)	(4)
constant	-1.567	-1.611	-1.665	-0.152
	(0.017)	(0.072)	(0.073)	(0.123)
control villages	0.025	0.034	0.036	0.052
	(0.027)	(0.027)	(0.027)	(0.028)
marg. index	-	-0.249	-0.234	-0.300
	-	(0.021)	(0.021)	(0.022)
days sick	-	-	0.013	0.013
	-		(0.001)	(0.001)
days of work lost	-	-	-0.009	-0.009
	-	-	(0.003)	(0.003)
log(consumption)	-	-	-	-0.319
	-	-	-	(0.021)
shocks dummies	no	yes	yes	yes

Standard errors in parentheses.
Number of observations: 23306

Table 5: Tobit models for individual monetary transfers

	(1)	(2)	(3)	(4)
constant	-4487.6 (125.8)	-4604.7 (241.9)	-4716.6 (243.4)	-2193.7 (356.5)
control villages	119.0 (75.54)	135.0 (75.88)	141.0 (75.98)	167.5 76.6
marg. index	-	-556.4 (59.13)	-522.2 (59.11)	-628.3 (61.75)
days sick	-	-	29.84 (3.66)	29.51 (3.69)
days of work lost	-	-	-29.81 (8.81)	-28.33 (8.72)
log(consumption)	-	-	-	-528.78 (61.03)
shocks dummies	no	yes	yes	yes

Standard errors in parentheses.
Number of observations: 23306
of which 1038 uncensored

References

Abreu, D. 1988. On the Theory of Infinite Repeated Games with Discounting. *Econometrica*, *56*, 383–96.

Alvarez, F. and Jermann, U. 1998. Asset Pricing when Risk Sharing is Limited by Default. Unpublished Manuscript, University of Pennsylvania.

Castañeda, A., Díaz-Giménez, J., and Ríos-Rull, J.-V. 1998. Exploring the Income Distribution Business Cycle Dynamics. *Journal of Monetary Economics*, *42*(1).

Cox, D., Eser, Z., and Jimenez, E. 1998. Motives for Private Transfers Over the Life Cycle: An Analytical Framework and Evidence for Peru. *Journal of Development Economics*, *55*(1), 57–80.

Cox, D., Jimenez, E., and Okrasa, W. 1997. Family Safety Nets and Economic Transition: A Study of Worker Households in Poland.. *Review of Income and Wealth*, *43*(2), 121–209.

Cutler, D. M. and Gruber, J. 1996. Does Public Insurance Crowd Out Private Insurance?. *Quarterly Journal of Economics*, *111*(2), 391–430.

Foster, A. and Rosenzweig, M. 1999. Imperfect Commitment, Altruism, and the Family; Evidence from Transfer Behavior in Low-Income Rural Areas. Mimeo, University of Pennsylvania.

Gómez de León, J. 1998. Applying Discriminant Analysis for the Selection of Beneficiaries: the Case of Progresa in Mexico. Mimeo. Paper presented at the First Annual Meeting of the LACEA/IDB/WorldBank Network on Inequality and Poverty, Buenos Aires.

Kehoe, P. and Perri, F. 1997. International Business Cycles with Endogenous Incomplete Marjets. Working Paper, Federal Reserve bank of Minnepolis.

Kocherlakota, N. R. 1996. Implications of Efficient Risk Sharing without Commitment. *Review of Economic Studies*, *63*(4), 595–609.

Krueger, D. and Perri, F. 1999. Risk Sharing: Private Insurance Markets or Redistributive Taxes?. Working Paper, Federal Reserve bank of Minnepolis.

Ligon, E., Thomas, J. P., and Worrall, T. 1997. Informal Insurance Arrangements in Village Economies. Mimeo.

Ligon, E., Thomas, J. P., and Worrall, T. 1998. Mutual Insurance, Individual Savings and Limited Commitment. Mimeo.

Marcet, A. and Marimon, R. 1992. Communication, Commitment and Growth. *Journal of Economic Theory*, *58*(2), 219–49.

Marcet, A. and Marimon, R. 1995. Recursive Contracts. Unpublished manuscript, Universitat Pompeu Fabra.

Platteau, J. P. 1997. Mutual Insurance as an Elusive Concept in Traditional Rural Communities. *Journal of Development Studies*, *33*, 764–96.

Platteau, J. P. and Abraham, A. 1987. An Inquiry into Quasi-Credit Contracts: The Role of Reciprocal Credit and Interlinked Deals in Small-scale Fishing Communities. *Journal of Development Studies*, *23*, 461–90.

Schoeni, R. F. 1996. Does Aid to Families with Dependent Children Displace Familial Assistance?. Rand Working Paper, DRU-1453-RC.

Thomas, J. and Worrall, T. 1988. Self-Enforcing Wage Contracts. *Review of Economic Studies*, *55*, 541–54.

Townsend, R. M. 1994. Risk and Insurance in Village India. *Econometrica*, *62*(3), 539–91.

Uhlig, H. 1996. A Law of Large Numbers for Large Economies. *Economic Theory*, *8*(1), 41–50.

Notes

[1] In the Mexican data set that we study, about 82% of the 506 villages included in the sample are affected, according to the village authorities, by some sort of aggregate shocks, such as draught (the most common), fires, hurricanes etc., in the year preceding the survey.

[2]More drastically interpreted, our example could suggest, as a referee kindly pointed out, that creating intrinsic aggregate uncertainty could be welfare improving.

[3]Furthermore, a naive and careless insurance scheme in some circumstances might bring about a reduction in welfare by simply *over–insuring* the agents in the economy.

[4]There are simple conditions that we assume and that guarantee that the stationary distribution exists, is unique and is the limit for any initial condition.

[5]See Castañeda, Díaz-Giménez, and Ríos-Rull (1998) for details about the modelization of joint aggregate and idiosyncratic shocks.

[6]We make sufficient assumptions on the $\Gamma' s$ to ensure that there is a unique stationary distribution and no cyclically moving subsets.

[7]It just follows from strict concavity and the possibility of transferring resources across dates and states.

[8]Alternatively, we could characterize the degree of enforceability of contracts between the two agents by a function $P(y)$. This function denotes the cost for an individual of breaking the agreed arrangement. When $P(y) = \infty$ we are in the standard perfect enforcement case. When $P(y) = 0$ we have the case studied here. This function could be used to study special institutions such as the family where certain social activities can be used to increase the costs of breaking the agreement. This specification is particularly well suited for empirical work.

[9]Note that the allocations attained through the enforcement induced by the fear of the reversion to autarky (trigger strategies) are not renegotiation proof.

[10]The characterization of the optimal contracts in a model with imperfect enforceability is stated in different terms in Ligon et al. (1997), Ligon et al. (1998) and Alvarez and Jermann (1998). We find the approach that keeps track of the current ratio of utility weights is both more transparent and computationally easier.

[11]There will typically be only one solution given the monotonicity of all the functions involved.

[12]The requirement of smallness is required so that all agents have to be able to pay it regardless of their unobservable idiosyncratic shock.

[13] Negative so that it is increasing, log so that it is symmetric around zero. There is no loss of generality in this.

[14]As mentioned above, Ligon et al. (1997) show that the presence of storage might decrease welfare through the same mechanism. This possibility arises in our model with the introduction of aggregate insurance.

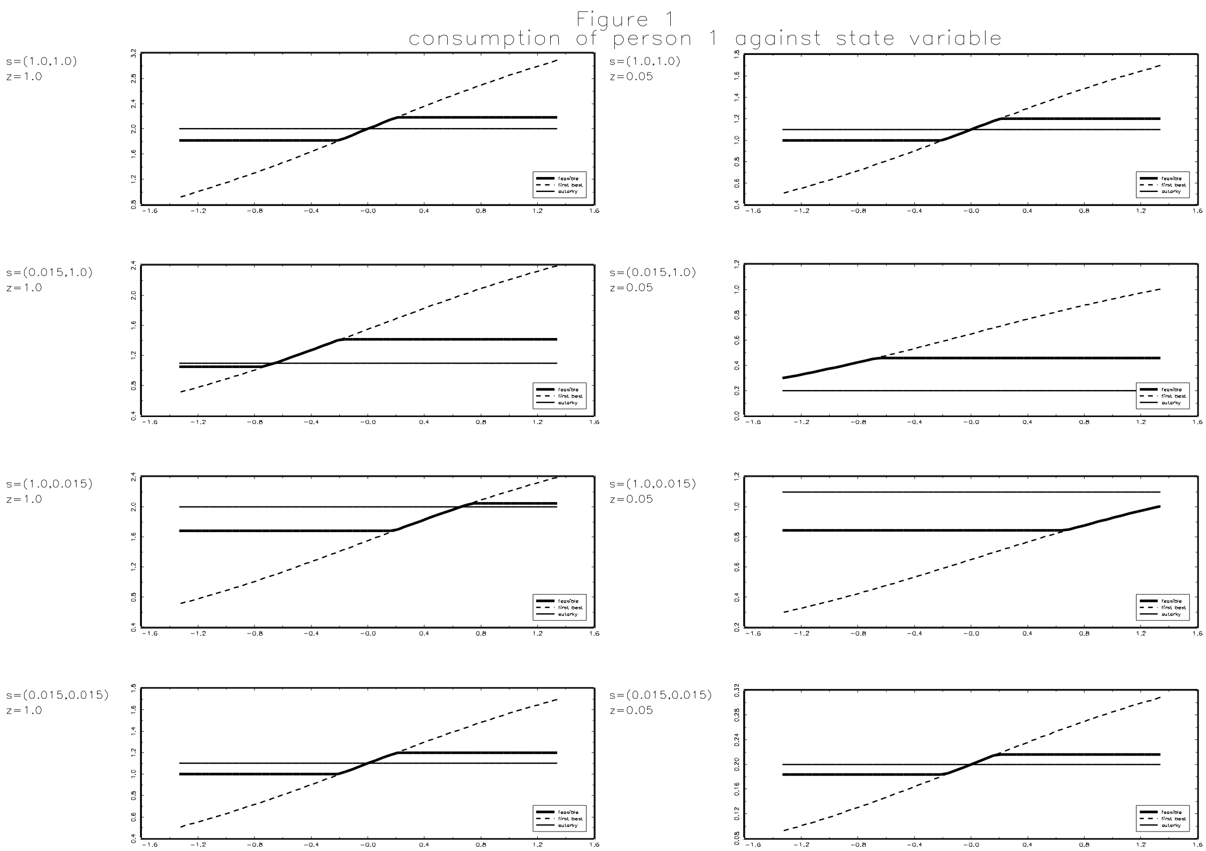
Figure 1
consumption of person 1 against state variable
s=(1.0,1.0)
z=1.0
s=(1.0,1.0)
z=0.05
s=(0.015,1.0)
z=1.0
s=(0.015,1.0)
z=0.05
s=(1.0,0.015)
z=1.0
s=(1.0,0.015)
z=0.05
s=(0.015,0.015)
z=1.0
s=(0.015,0.015)
z=0.05

Figure 1:

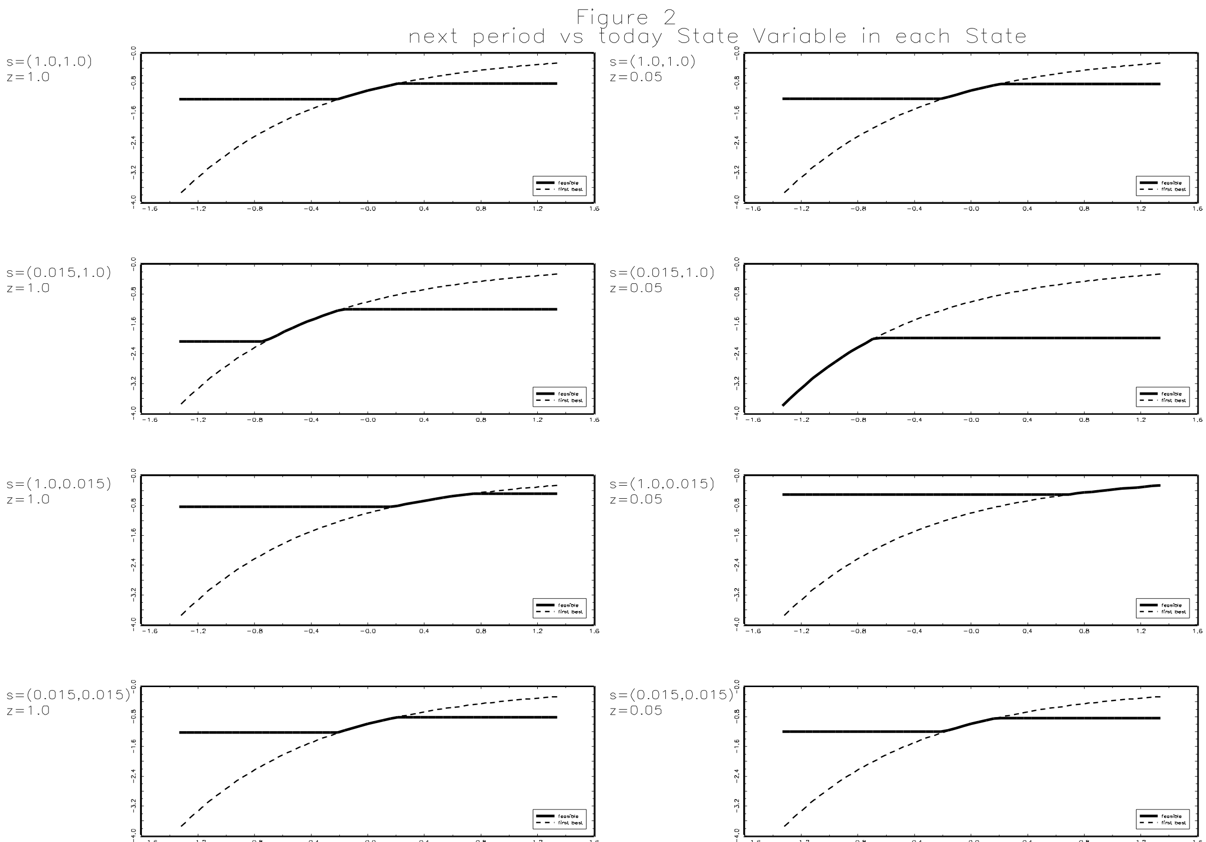
Figure 2
next period vs today State Variable in each State
s=(1.0,1.0)
z=1.0
s=(1.0,1.0)
z=0.05
s=(0.015,1.0)
z=1.0
s=(0.015,1.0)
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s=(1.0,0.015)
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s=(0.015,0.015)
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s=(0.015,0.015)
z=0.05

Figure 2:

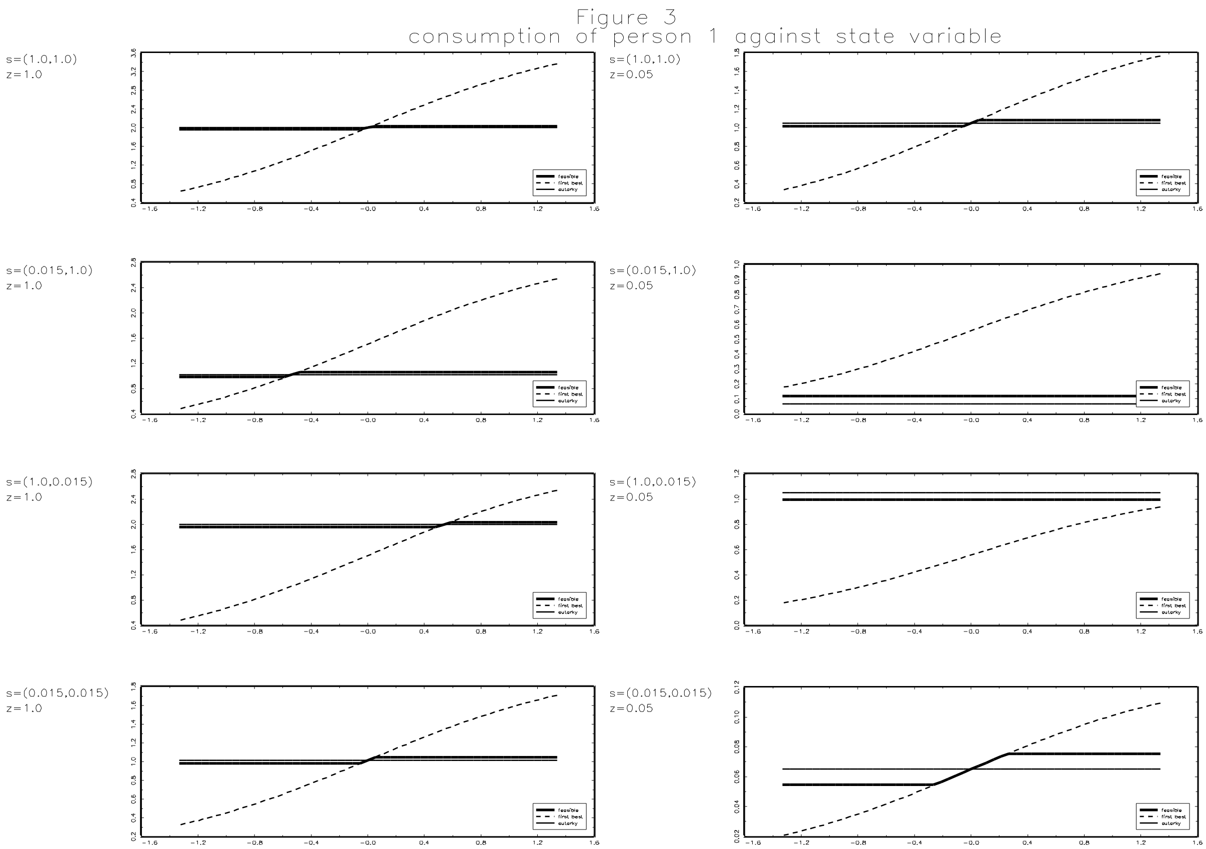
Figure 3
consumption of person 1 against state variable
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z=1.0
s=(1.0,1.0)
z=0.05
s=(0.015,1.0)
z=1.0
s=(0.015,1.0)
z=0.05
s=(1.0,0.015)
z=1.0
s=(1.0,0.015)
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s=(0.015,0.015)
z=0.05

Figure 3:

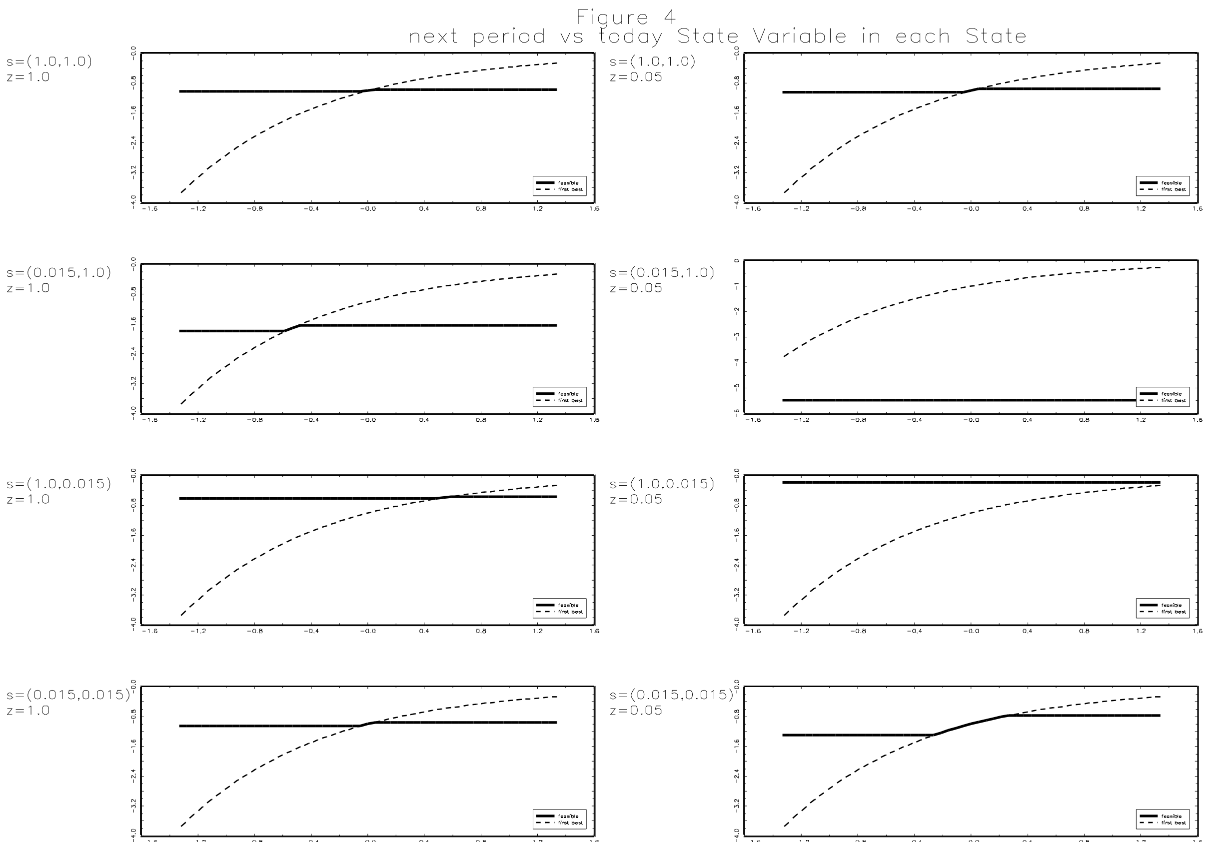
Figure 4
next period vs today State Variable in each State
s=(1.0,1.0)
z=1.0
s=(1.0,1.0)
z=0.05
s=(0.015,1.0)
z=1.0
s=(0.015,1.0)
z=0.05
s=(1.0,0.015)
z=1.0
s=(1.0,0.015)
z=0.05
s=(0.015,0.015)
z=1.0
s=(0.015,0.015)
z=0.05

Figure 4:

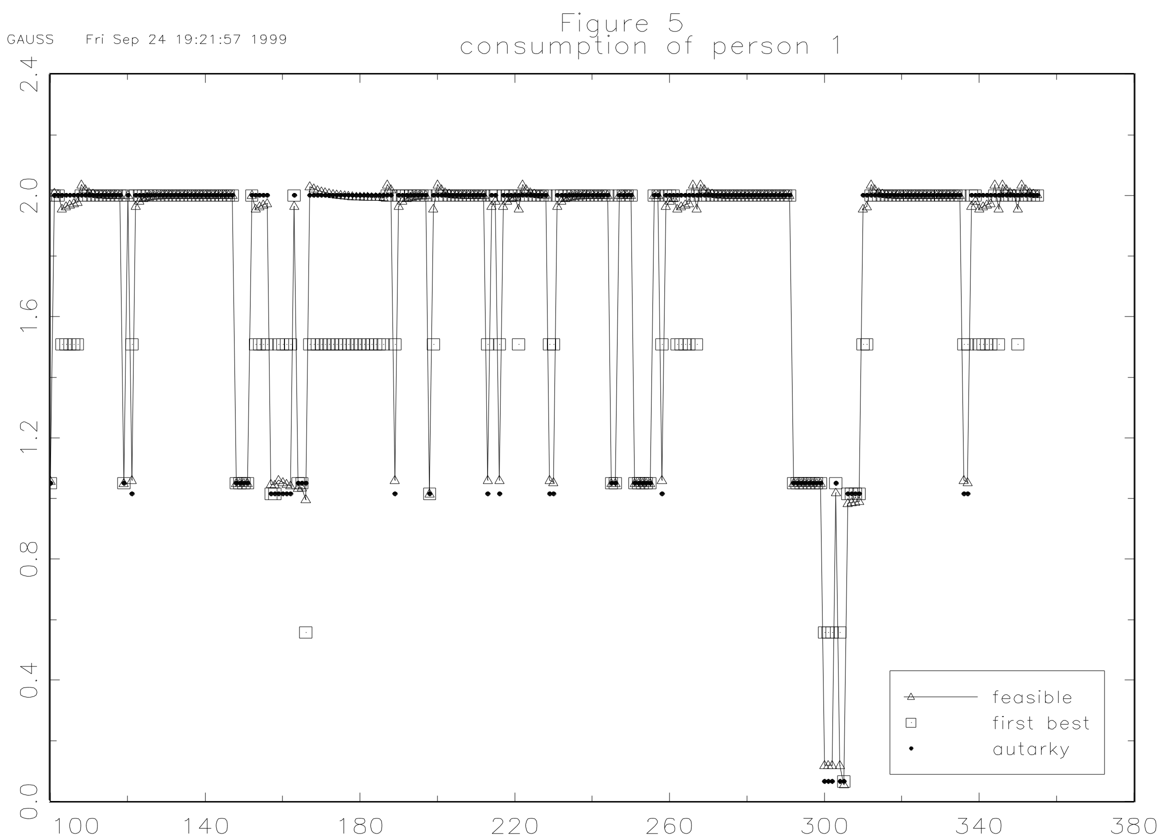
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Figure 5
consumption of person 1
2.4
2.0
1.6
1.2
0.8
0.4
0.0
100
140
180
220
260
300
340
380
feasible
first best
autarky

Figure 5:

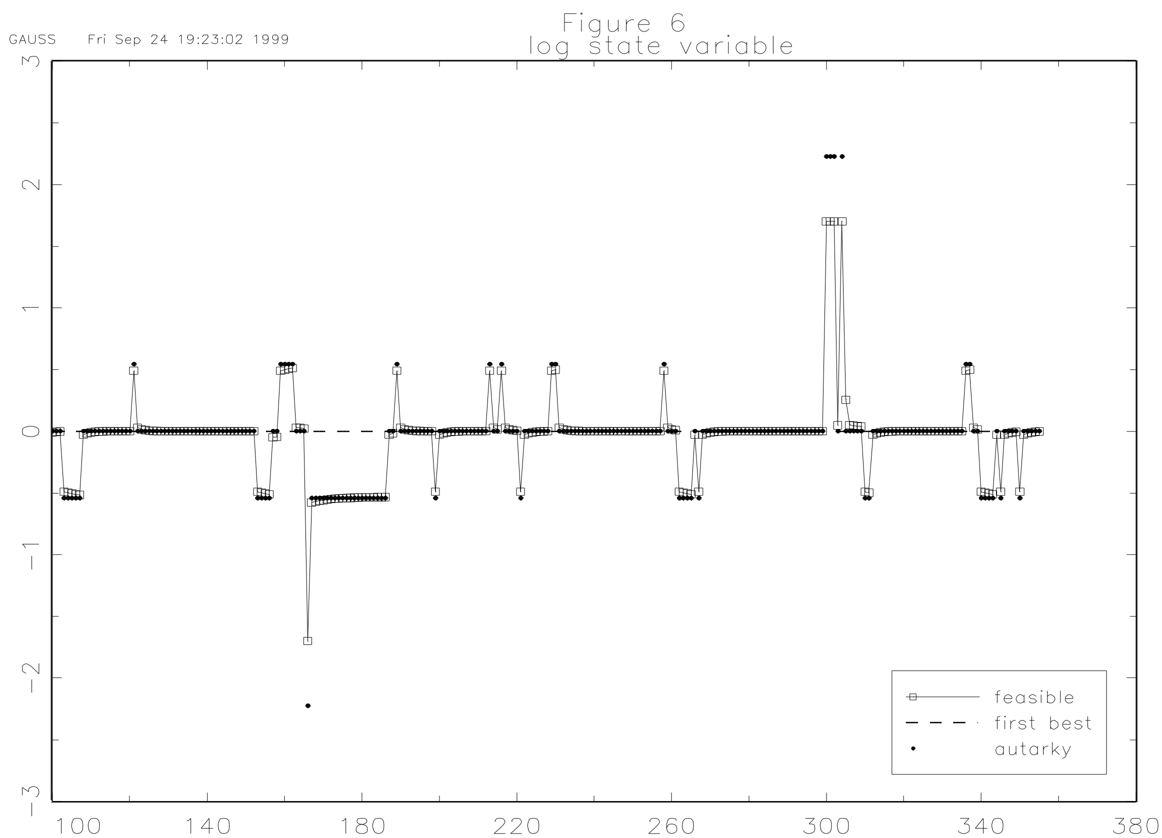
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Figure 6
log state variable
3
2
1
0
−1
−2
−3
100
140
180
220
260
300
340
380
feasible
first best
autarky

Figure 6: