‘Informal Insurance in Social Networks’

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I. Motivation.

- This paper studies networks of informal insurance.

- Networks are prevalent in rural areas of developing countries where:
  - Credit and insurance are scarce;
  - Income fluctuations are endemic.
I. Motivation.

• The existing notion of insurance as taking place within a group of several people may be misleading.

• A specification how and with whom people interact may be crucial. The concept of a network could be more appropriate.

• The paper recognizes the possibility that the lack of commitment may destabilize insurance arrangements.

• The paper combines the methods from the basic theory of repeated games with the more recent theories of networks.
II. Environment
A. Endowments and Preferences.

• Consider a community of individuals occupying different positions in a social network.

• Each agent receives a stochastic income \( y_i(\theta) \geq 0 \) of a perishable good.

• Individuals outputs are not perfectly correlated.

• Agent I is endowed with a smooth, increasing and strictly concave von Neumann-Morgenstern utility function over consumption and a discount factor \( 0 < \delta < 1 \).
II. Environment
B. Networks.

• Agents interact in a social network – a collection of pairs of agents – with the interpretation that the pair $ij$ belongs to a graph $g$ if they are directly linked.

• Two individuals are connected in a network if they are directly or indirectly linked.

• The components of a network are the largest subsets of connected individuals.

• $N(h)$ denotes the set of agents in component $h$. 
II. Environment

B. Networks.

- A link between individuals $i$ and $j$ means:
  - $i$ and $j$ can make transfers to each other;
  - It is a possible avenue for the transmission of information.
II. Environment
C. Bilateral Norms.

• A decentralized view of insurance.

• Any two individuals may insure each other. For every linked pair, third party transfers are verifiable ex post.

• State-contingent income vectors as well as third party transfers are observed and conditioned upon.

• Third party transfers are endogenous: their exact form is pinned down in a society wide equilibrium.
II. Environment
C. Bilateral Norms.

• A bilateral (insurance) norm is a specification of consumptions for every linked pair of individuals. 
\[(c_i, c_j) = b(i, j, y_i, y_j, z_i, z_j) \text{ s.t. } c_i + c_j = y_i + z_i + y_j + z_j.\]

• Some norms could be derived from bilateral welfare functions. If such a function is additive, the resulting bilateral norm is equal sharing.
\[
c_i = \alpha_j y_i + \sum_{k=i,j} (1- \alpha_k) y_k + z_k
\]
\[
c_j = \alpha_j y_j + \sum_{k=i,j} (1- \alpha_k) y_k + z_k
\]
When \(\alpha_j > 0\), we call these norms with private domain.
II. Environment
C. Bilateral Norms.

• A bilateral norm aggregates third-party obligations if the consumption of each individual depends on $z_i$ and $z_j$ through their sum $z_i + z_j$ alone and is continuously increasing in this variable.

• These bilateral norms can be still be asymmetric and they can also prescribe consumptions that are dependent on individual incomes in a variety of ways.

• Equal sharing norm and the norms with private domain aggregate third-party preferences.
II. Environment
C. Consistent Consumption Allocations

• A bilateral norm will yield a consumption allocation for everyone in the network, as a function of the realized state $\theta$.

• Proposition 1: If a bilateral norm aggregates third-party obligations, then there is at most one consumption allocation consistent with that norm.

• A unique consistent scheme entails ‘global’ equal sharing of total output in any component of the network.
II. Environment
C. Consistent Consumption Allocations

• The equal sharing norm has the feature that there is some ‘multilateral norm’ with which it is consistent: the **multilateral equal sharing**.

• For a given income realization, any individual $i$ in a component $d$ of size $n$ will consume:

$$c_i = \alpha_j y_i + \frac{1}{n} \left( \sum_{k \in d} (1-\alpha_k)y_k \right)$$

• A **consistent consumption allocation** may fail to exist. Under some technical conditions, existence is guaranteed.
II. Environment
D. Monotone Norms

• A bilateral norm is ‘monotone’ if whenever more individuals are brought into a connected network by being connected to any particular individual, that individual’s payoff increases.

• Intuitively, more individuals create better insurance possibilities.
III. Enforcement Constraints and Stability

• The norms in the previous section are largely ‘normative’ in that they take little or no account of self-enforcement constraints.

• An individual is constrained by the transfer norm in her dealings with j, provided she wants to maintain the dealings.

• But it may NOT be in her best interest to maintain them and could choose to renege on some (or all) transfers that she is required to make under a particular bilateral norm.
III. Enforcement Constraints and Stability
A. Punishment Schemes

• Network links limit physical transfers, but do they also limit the flow of information? Consider three possibilities:

• **Strong Punishment**: Following a deviation, every agent severs its direct link (if any) with the deviant, so that the deviant is left in autarky thereafter.

• **Weak Punishment**: Following deviation, only those agents who have been directly mistreated by the deviant sever their links with the deviant.
III. Enforcement Constraints and Stability
A. Punishment Schemes

- **Level-q punishment**: Following a deviation, all agents who are connected to a victim by a path not exceeding length q (but not via the deviant) sever direct links (if any with the deviant).

- Weak punishment can be thought of as a special case of level-q punishment where $q = 0$.

- Note: $q$ is an exogenous parameter.
III. Enforcement Constraints and Stability
B. Recursive Formulation

- Consider a network $g$ representing the links among our $n$ individuals.

- Suppose the set of stable subnetworks of $g$ has been defined, along with collections of stable payoff vectors for each stable subnetwork.
III. Enforcement Constraints and Stability
B. Recursive Formulation

• Expected payoffs:

• For an individual who abides with the norm:
  \[(1 - \delta) u(c_i(\theta)) + \delta v_i, \text{ where } \delta \text{ is the discount factor and } v_i \text{ is the value function for individual } i.\]

• For an individual who deviates from the norm:
  \[(1 - \delta) u(y_i(\theta) + \sum_{j \in S} x_{ij}(\theta)) + \delta v_i', \text{ where } x \text{ is a transfer scheme.}\]
III. Enforcement Constraints and Stability  
B. Recursive Formulation

• Need to address how $v_i'$ is determined.

• If $g'$ is stable, it is expected that $i$ will enjoy a payoff of $v_i'$.

• If $g'$ is not stable, the resulting payoff will be presumably drawn from some stable subnetwork ($g''$) of $g'$ itself.

• This formulation of the payoffs following a deviation implicitly assumes that an agent’s deviation does not reflect the ability of other agents to fulfill their commitments.
III. Enforcement Constraints and Stability
B. Recursive Formulation

• Next each individual compares the payoffs from abiding with the norm and deviating:
\[(1 - \delta) u(y_i(\theta) + \sum_{j \in S} x_{ij}(\theta)) + \delta v_i' \leq (1 - \delta) u(c_i(\theta)) + \delta v_i\]

• Alternatively, equation can be re-written as:
\[u(y_i(\theta) + \sum_{j \in S} x_{ij}(\theta)) - u(y_i(\theta) + \sum_{j \in S} x_{ij}(\theta)) \leq \delta(1 - \delta)^{-1} (v_i - v_i')\]

• This inequality requires that the short-term deviation from not making the transfers be smaller than the long-term gain from remaining in the original risk-sharing network.
IV. Stable Networks for High Discount Factors

- **Sparseness** is related to the length of minimal cycles connecting any three agents in a network.

- Proposition 3: Suppose a bilateral norm is monotonic and aggregates third-party obligations. Then a network is q-stable iff it is q-sparse.

- Lemma 1: Suppose a bilateral norm aggregates third-party obligations. Then, assuming that a consistent consumption allocation exists for $g$, it is also consistent for every subnetwork of $g$. 
IV. Stable Networks for High Discount Factors

- Stability implications for Strong and Weak Punishment:

- Corollary 1: Suppose the bilateral norm is monotonic and aggregates third party obligations.

  a) Then a network is stable under weak punishment for discount factors close to unity iff it has only trees as components.

  b) Under strong punishment, every network is stable for high discount factors.
IV. Stable Networks for High Discount Factors

• Some simulation results:

• The stronger the punishment, the larger the proportion of stable graphs. Networks of intermediate density tend to be unstable.

• The clustering coefficient measures the propensity for i’s neighbours to be linked to each other.

• For intermediate level of punishment, more clustered networks are better able to ostracize deviants and therefore are more likely to be stable.
V. Short-Term or Transit Effects
A. Bottleneck Agents

- To isolate the short-run effects from the instantaneous gain from reneging on the transfers and the architecture of the network, consider a specific model with equal sharing norm and strong punishment.

- Short-run gain from a deviation at state $\theta$ is given by:
  \[ u(y_i(\theta) + \sum_{j \mid x_{ij} > 0} x_{ij}(\theta)) - u(\sum_{j \in S} y_i(\theta)/m) \]

- To check for stability of a graph, we need to check, component by component, and for every income realization, the incentives for which the above equation results in a maximal gain.
V. Short-Term or Transit Effects

A. Bottleneck Agents

• The bottleneck agent is an agent who receives and redistributes transfers and has the highest incentive ‘to take the money and run’.

• The identification of bottleneck agents is a complex task, as it depends on the exact routing of transfers.

• The star and the line belong to a special class of decomposable networks for which the short-run incentives to deviate are extremely high.
V. Short-Term or Transit Effects
B. Decomposable Networks

• A connected network of size $m$ is decomposable if for any $\gamma \in [1, m-1]$, there exists a way to decompose the network into two subnetworks of size $\gamma$ and $m - \gamma - 1$ such that a single agent (a critical agent) controls all transfers from agents in one subnetwork to agents in the other subnetwork.

• It is easy to identify the bottleneck agent in a decomposable network.
V. Short-Term or Transit Effects
C. Mixing Long-Run and Short-Run Effects

• In general, the stability of networks depends on the interplay between long-run and short-run effects.

• For high (low) values of the discount factor, the short-term (long-term) effect dominates.

• For weak punishment and lower values of $\delta$, complete graphs emerge as stable network architectures.

• However, stable networks are not necessarily connected.
VI. Conclusion and Critique.

• The paper develops a decentralized model of risk-sharing in social networks.

• Transfers among individuals are endogenous with respect to history-dependence and the size of the network.

• The paper distinguishes two important factors that affect the stability of networks:
  - a transit effect;
  - an informational effect.
VI. Conclusion and Critique.

- The introduction of ‘bottleneck agents’ describes how incentive problems allow for the decomposition of the network into two parts.

- The decomposition of networks due to the presence of a ‘bottleneck agent’ creates a form of a transaction cost.