Strategic Uncertainty and Counter-Party Risk

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In this presentation, I will discuss strategic uncertainty and why it is the key to understanding counter-party risk which is prevalent in ag contracting.

I will break the presentation into three parts:

1. Motivation and basic concepts.
2. Some recent research on strategic uncertainty in the experimental economics literature.
3. How we can apply the concepts to agricultural contracts that include informal elements.

- Standard models of risk and uncertainty are largely based on expected utility to conceptualize how a decision maker responds to some exogenous risk (e.g. weather, pests, price shocks, etc)
- But what about situations involving more than one decision maker and joint decisions affect everyone's payoffs?
  - e.g. contracting relationships, common resource management problems, or other situations requiring mutual cooperation.
- There ought to be a way to capture the endogenous risk (or uncertainty) that other parties will not hold up their end of an agreement (i.e. counterparty risk).

Turns out, **strategic uncertainty** is a common problem in game theory and studying the impact of strategic uncertainty on outcomes is one of the most active areas of empirical game theory right now.

Definition 1

Strategic uncertainty is the uncertainty concerning the purposeful behavior of players in an interactive decision situation (Brandenburger 1996).

- Strategic uncertainty can also be used to model counter-party risk.
  - Counter-party risk is real and pervasive in the real world (Narduzzo 2010)
  - Managing counter-party risk largely ignored in the incomplete contracts literature.
- It can also potentially explain some "behavioral anomalies."

Examples of counter-party risk

- Section 7 of the Producer Protection Act: “One of the greatest risks for a producer in production contracting is the risk of not getting paid.”
- Processors often worry that producers will not supply the quality appropriate for producing specialized end products.
- Many ag contracts are relational and rely on tacit understandings and handshake agreements. This increases counterparty risk because parties can deviate from agreement without suffering legal penalties.

A Conceptual Example of strategic uncertainty

Table: A Simple Coordination Game

	C	D
C	10,10	0,7
D	7,0	5,5

- There are two pure-strategy Nash equilibria in this game (C,C) and (D,D) plus a mixed strategy equilibrium.
- Both parties would like to coordinate on (C,C) because it is the **Pareto dominant** equilibrium.
- But parties face strategic uncertainty in the following way:
  Suppose row player tries to coordinate on the PD equilibrium. He runs the risk that column player will choose D leaving him with the payoff 0; i.e. the "sucker's payoff."
- If D is low enough, it's risky to try to coordinate. Hence, the players may settle for (D,D), the **risk dominant** equilibrium.

- Strategic uncertainty creates counter-party risk, which affects behavior.
- In particular, parties may choose **Risk Dominant** strategies rather than efficient strategies (Harsanyi and Selten 1988)

Definition 2

The equilibrium (D,D) risk dominates (C,C) iff $(\pi_{1D.2D}-\pi_{1C.2D})(\pi_{2D.1D}-\pi_{2C.1D}) \geq (\pi_{1C.2C}-\pi_{1D.2C})(\pi_{2C.1C}-\pi_{2D.1C})$

In words: (D,D) is risk dominant if the product of the absolute gains from avoiding the sucker's payoff by playing it safe (choose D) is at least as great as the product of the absolute gains from cooperating (choose C).

Let's revisit our example

Table: A Simple Coordination Game

	C	D
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$(\pi_{1D.2D}\text{-}\pi_{1C.2D})(\pi_{2D.1D}\text{-}\pi_{2C.1D}) \geq (\pi_{1C.2C}\text{-}\pi_{1D.2C})(\pi_{2C.1C}\text{-}\pi_{2D.1C})$

$\implies$ Avoided sucker's losses $\geq$ Gains from cooperating

$\implies$ (5-0)(5-0) $\geq$ (10-7)(10-7)

$\implies$ $25 \geq 9$ True!

$\therefore$ Players choose (D,D) because it is risk dominant

Note: if the sucker's payoff is greater than 2, then the parties would choose (C,C), the efficient equilibrium.

Lesson 1

Strategic uncertainty can explain seemingly "irrationally" behavior in economic experiments.

One advantage to strategic uncertainty is that it is typically much simpler than behavioral theories and more robust across different contexts.

PRISONER'S DILEMMA GAMES (HEALY, 2016)

Table: Subjects Played Prisoner's Dilemma Game

	C(35%)	D(65%)
C(26%)	10,10	1,15
D(74%)	15,1	5,5

- Approximately 30% of people choose "C" even though it is a dominated strategy. This is irrational.
- Healy also elicited preferences based on behavioral theories and found that it can only explain 53% of playing C.
- Healy's follow up experiments removes strategic uncertainty for player 2 by allowing player 2 to observe 1's move before choosing her move.
    - **Irrationality largely disappears for the second mover.**

Lesson 2

In long-term relationships, people are not likely to cooperate unless the sucker's payoff is raised to the point that the cooperative equilibria becomes the risk dominant equilibria.

	C	D
C	90,90	30,130
D	130,30	70,70

	C	D
C	90,90	0,100
D	100,0	80,80

- Both prisoner's dilemma games have a unique equilibrium (D,D).
- But standard theory predicts that if the game is repeated and the discount factor is sufficiently high, then (C,C) is possible.
- E.g. in the left game: $\frac{90}{1-\delta} \geq 130 + \frac{\delta 70}{1-\delta} \longleftrightarrow \delta \geq 0.667$ then (C,C) possible.
- For the right game, we need $\delta \geq 0.5$ (less demanding than left game)
- Yet, a significantly larger fraction of subjects cooperated under the left game vs the right game. What happened?

It turns out if you calculated risk dominated adjusted discount factors, then we have $\delta^d \geq 0.80$ **(left), and** $\delta^d \geq 0.90$ **(right)!**

This is primarily driven by the larger sucker's payoff of 30 (vs 0) in the left game making it less risky to cooperate.

Lesson 3

Risk dominance is a better predictor of cooperation than the standard criteria that (C,C) is a long-run equilibrium.

Table: Probit estimates

	Supergame 1	Supergame 15
(C,C) long-run equilibrium	0.0584	0.108
	(0.134)	(0.308)
(C,C) is Risk Dominant	0.440***	1.193***
	(0.119)	(0.00733)
Constant	-0.413***	-0.967***
	(0.0629)	(0.286)
N	1896	614

Lesson 4

Strategic uncertainty is even more prevalent than theory predicts.

In repeated Prisoner's dilemma games, Brietmoser finds that:

- Even when cooperation is established, (C,C), the probability of cooperation in the next period is only 90%, on average.
- When only one party has deviated and played "D", the probability of mutual cooperation (C,C) in the following period is 30% on average.
- When both parties defect (D,D), there is still a 10% chance of cooperation the following period, in contrast to Grim.

Key point: People play mixed strategies often and "all-or-nothing" pure strategies are rarely observed.

Now lets talk about contracts

- A contract is simply an agreement in which a buyer (principal) and an seller/supplier (agent) each make promises and have obligations, and these promises and obligations are meant to be enforced.
- The seller/supplier's obligation is to deliver some quality and/or quantity which I will generically denote Q. I will label q to be the *actual* quality/quantity delivered.
- The buyer's obligation is to make the payment, which typically consists of a **base price** P, and an **incentive bonus**, B.
    - In the case of informal or relational contracting, B, is promised but not externally enforced so that actual bonus b need not equal B.

Counter-party risk arises from the fact that q can deviate from Q and b can deviate from B.

Other first order features of agricultural contracts

- Contracts typically are incomplete in that they don't cover everything.
  - Precise about quality, imprecise about quantity.
  - Conditions for renewal are not specified.
  - Sometimes quality/quantity arent't third-party measured.
- Incomplete contracts require informal incentives to govern some aspects of the transaction. Informality creates more counter-party risk.
- Repeat contracing - can be used to enforce informal promises and obligations. Common for integrators to trade with same growers across seasons.

Agricultural contracting has a similar structure as a sequential prisoner's dilemma game!

The structure of a contracting game

A typical contracting sequence:

1. Principal offers a contracts.
2. Agent accepts or rejects.
3. If accepted, the agent chooses actual q which can differ from promised Q.
4. Output is realized and then Principal chooses actual b which can differ from promised B.

The above is similar to a sequential Prisoner's dilemma game in that if parties choose $q \geq Q$ and $b \geq B$, it is similar to (C,C) rather than (D,D)

Hence, we have counter-party risk at steps (3) and (4).

Another important feature of ag contracts is repeat tradeing (e.g. many ag contracts involve repeat trading over years, flocks, seasons, etc.).

Thus, the stage-game

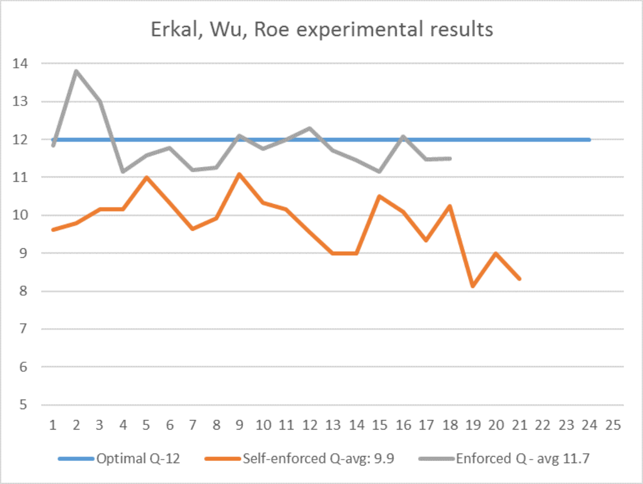
1. Principal offers a contracts: (P, B, Q)
2. Agent accepts or rejects.
3. If accepted, the agent chooses actual q which can differ from promised Q.
4. Output is realized and then Principal chooses actual b which can differ from promised B.

is repeated an indefinitely number of times; i.e the structure is similar to a repeated game.

This now creates counter-party risk at (1),(2),(3), and (4).

Strategic uncertainty affects contractual outcomes

Erkal, Wu, and Roe experiments showed that strategic uncertainty can substantially impact the level of Q that parties are willing to contract on:



Nearly 20% higher efficiency when strategic uncertainty removed by guaranteed enforcement of contract.

- Strategic uncertainty is a type of risk that ag economists have rarely considered even though it is pervasive in many agricultural transactions.
- Recent experimental evidence suggests that strategic uncertainty has a substantial impact on behavior.
- In particular, it is hard to get people to cooperate or honor agreements if the underlying game does not have an risk dominant cooperative equilibrium.
- Risk dominance is also simple and parsimonious because it does not require strong assumptions on risk preferences. Yet it predicts well.