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The Structural Estimation of Princip al-Agent Models by Least Squares:

Evidence from Land Rental Markets in Madagascar

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Research questions:

1.) How do exogenous sources of utility figure into the formulation of a 2nd best optimal risk sharing contract?

2.) How can this structure be used in reduced form empirical work?

Motivation

- Are contracts optimal (Chiappori and Salanié 2002)?
- What are some restrictions on the optimal contract in terms of the primitives?
- No one has systematically analyzed how principal *and* agent "wealth" affect an optimal contract.

Wealth effects and contracts, precedents

- Guo and Yang (2004, JET)
- Vera-Hernandez (2003, RAND)
- Laffont, Matoussi (1995, RES)
- Others…

Ackerberg and Botticini (2002, JPE)

$$\text{contract} = \beta_p(\text{principal traits}) + \beta_a(\text{agent traits}) + \varepsilon$$

Instrument:

$$\text{principal and agent traits} = \gamma(\text{regional heterogeneity}) + \omega$$

Theoretical Model

Principal's objective

$$\max_{w(\cdot),e} \int_{\underline{q}}^{\overline{q}} V\big(z_p + q - w(q)\big) f(q,e)\,dq$$

Agent rationality

$$\int_{\underline{q}}^{\overline{q}} U(z_a + w(q)) f(q,e)\,dq - \Psi(e) \geq U(z_a + c)$$

Agent incentive compatibility

$$e = \arg\max_{\tilde{e}} \int_{\underline{q}}^{\overline{q}} U(z_a + w(q)) f(q, \tilde{e}) dq - \Psi(\tilde{e})$$

Using first-order approach (Rogerson 1985),

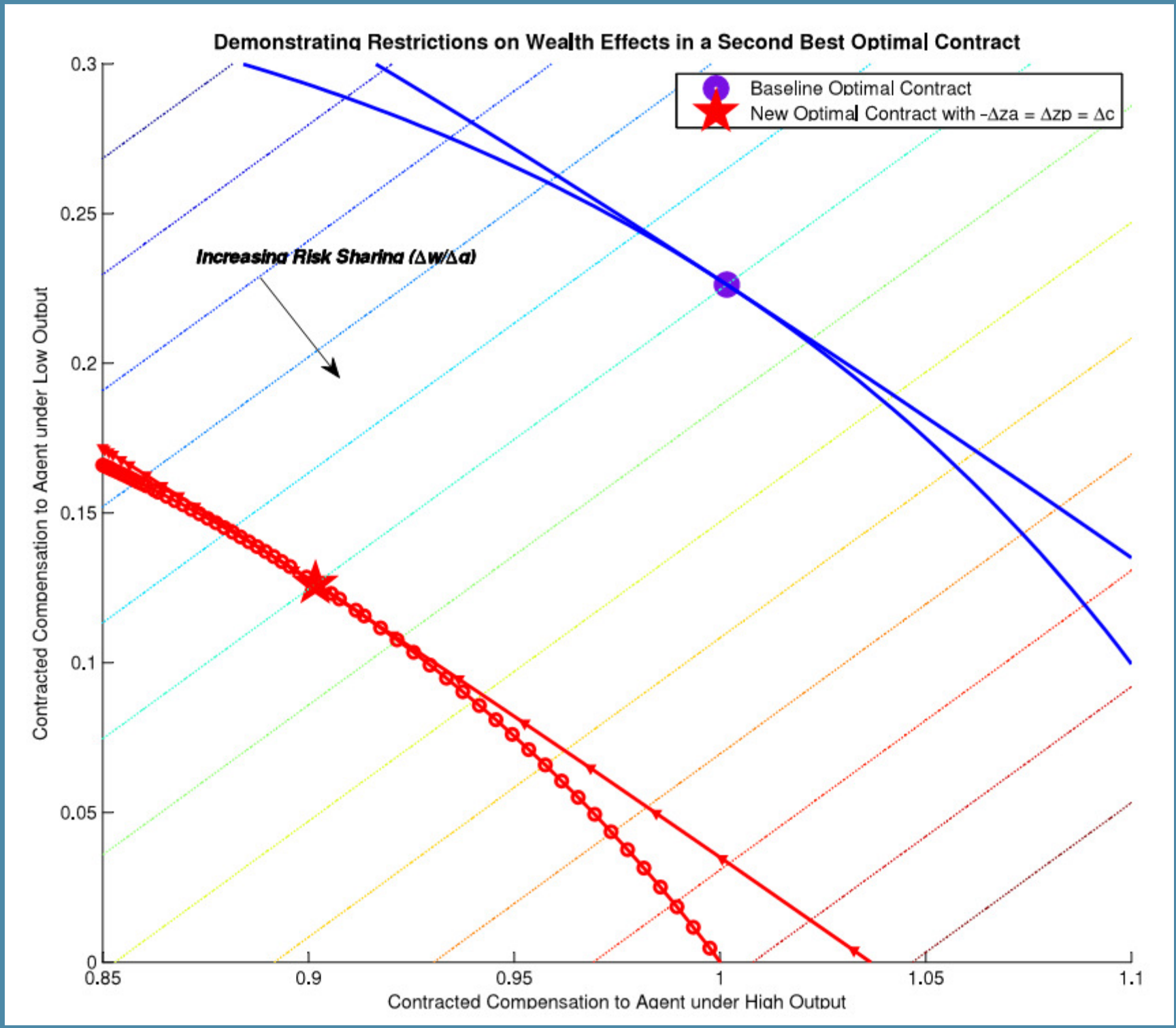
$$\int_{\underline{q}}^{\overline{q}} U(z_a + w(q)) f(q, e) dq - \Psi'(e) = 0$$

Theoretical Implications

$$\frac{dw^*}{dz_p} = \frac{dw^*}{dz_a} - \frac{dw^*}{dc} + 1$$

$$w^* = \Phi\left(q, z_p + z_a, c + z_a\right) - z_a = \Omega\left(q, z_p + z_a, c + z_a\right) - z_p$$

$$\mathrm{E}_q\left\{V\left(z_p + q - w^*(q)\right)|e^*\right\} = \nu\left(q, z_p + z_a, c + z_a\right)$$


Demonstrating Restrictions on Wealth Effects in a Second Best Optimal Contract
Baseline Optimal Contract
New Optimal Contract with -Δza = Δzp = Δc
Increasing Risk Sharing (Δw/Δα)
Contracted Compensation to Agent under Low Output
Contracted Compensation to Agent under High Output
0.3
0.25
0.2
0.15
0.1
0.05
0
0.85
0.9
0.95
1
1.05
1.1

Empirical framework

$$w = \beta_0 + \beta_z z_p + (\beta_z + \beta_c - 1) z_a + \beta_c c + \beta_q q + \eta$$

$$\eta = \beta_{qq} q^2 + \beta_{zz} z_p^2 + \beta_{cc} c^2 + (\beta_{zz} + 2\beta_{zc} + \beta_{cc}) z_a^2 + \beta_{zc} z_p c + \beta_{qc} q c + \beta_{qz} q z_p$$
$$+ \left(\beta_{qz} + \beta_{qc}\right) q z_a + (\beta_{zz} + \beta_{zc}) z_p z_a + (\beta_{zc} + \beta_{cc}) c z_a + r$$

An N^{th} order Taylor approximation gives us

N(3N-1)/2 restrictions on the coefficients.

And all of this buys us … ?

Estimation

- Survey data from Lac Alaotra, Madagascar. Collected to analyze reverse share tenancy; see Bellemare (2008, working paper)
- Around 387 observations.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	*N*
Sharecropping Dummy	0.687	(0.464)	387
z_p (1,000,000 Ariary)	0.273	(0.652)	380
z_a (1,000,000 Ariary)	0.171	(0.275)	384
c (1,000 Ariary)	0.294	(0.178)	383
q (1,000,000 Ariary)	1.361	(0.890)	387
Family-Owned Plot Dummy	0.199	(0.400)	387
Plot Size (Ares)	109.809	(84.164)	387
Titled Plot Dummy	0.384	(0.488)	125
Tanety Dummy	0.070	(0.255)	387
Bas-Fonds Dummy	0.075	(0.264)	387
Irrigated Plot Dummy	0.755	(0.431)	387
Distance from House (Walking Minutes)	33.013	(36.266)	387
P Household Size (Individuals)	5.475	(2.807)	387
P Household Dependency Ratio	0.450	(0.252)	387
P Household Head Age (Years)	53.359	(16.391)	387
P Household Head Female Dummy	0.196	(0.398)	387
P Household Head Education (Years)	5.413	(3.882)	387
P Household Income Per Capita (100,000 Ariary)	1.162	(2.349)	386
Relationship Length (Years)	5.373	(7.433)	386
Kin Contract Dummy	0.638	(0.481)	387
A Household Size (Individuals)	5.753	(2.566)	384
A Household Dependency Ratio	0.412	(0.216)	384
A Household Head Age (Years)	39.036	(11.098)	384
A Household Head Income (100,000 Ariary)	0.931	(1.484)	384
A Household Head Education (Years)	5.927	(3.427)	384
Slope of Asset Risk Function (r_a)	-0.258	(3.960)	387

Table 2: Estimation Results

	(1)		(2)		(3)		(4)		(5)	
	Coefficient	(Std. Err.)	Coefficient	(Robust Std. Err.)	Coefficient	(Robust Std. Err.)	Coefficient	(Robust Std. Err.)	Coefficient	(Robust Std. Err.)
z_p	-0.02	(0.09)	0.33	(0.34)	0.25	(0.34)	0.35	(0.36)	0.38	(0.36)
z_s	0.04	(0.12)	-0.03	(0.65)	0.00	(0.70)	0.35	(0.71)	0.30	(0.69)
c	0.00	(0.19)	0.19	(0.80)	0.43	(0.81)	0.21	(0.83)	0.10	(0.82)
q	0.03	(0.04)	0.01	(0.14)	-0.01	(0.20)	-0.16	(0.21)	-0.11	(0.20)
z_p^2			-0.03	(0.06)	-0.02	(0.06)	-0.02	(0.07)	-0.02	(0.07)
z_s^2			-0.14	(0.27)	-0.13	(0.28)	-0.25	(0.28)	-0.20	(0.26)
c^2			-0.21	(0.76)	-0.29	(0.72)	-0.17	(0.76)	-0.11	(0.78)
q^2			-0.01	(0.04)	-0.04	(0.05)	-0.01	(0.05)	-0.01	(0.05)
$z_p * q$			-0.06	(0.11)	-0.04	(0.10)	-0.05	(0.11)	-0.08	(0.11)
$z_s * q$			0.13	(0.19)	0.08	(0.20)	0.05	(0.21)	0.02	(0.20)
$c * q$			0.13	(0.26)	0.06	(0.27)	0.19	(0.28)	0.18	(0.28)
$z_p * c$			-0.85	(0.70)	-0.86	(0.68)	-1.03	(0.71)	-1.03	(0.72)
$z_s * c$			0.29	(1.86)	0.27	(2.01)	0.29	(2.01)	0.30	(1.93)
$z_p * z_s$			0.20	(0.55)	0.19	(0.54)	-0.03	(0.55)	0.02	(0.52)
Family-Owned Plot					-0.11	(0.08)	0.18	(0.16)	-0.12*	(0.07)
Plot Size					0.00*	(0.00)	0.21**	(0.13)	0.00*	(0.00)
Titled Plot					0.15	(0.27)	-0.34	(0.16)	0.24	(0.27)
Tanety					0.01	(0.17)	0.04	(0.17)	-0.01	(0.17)
Bas-Fonds					-0.04	(0.17)	0.06	(0.17)	-0.04	(0.16)
Irrigated Plot					-0.09	(0.10)	-0.24	(0.15)	-0.11	(0.10)
Distance from House					0.00	(0.00)	-0.12	(0.29)	0.00	(0.00)
P Household Size							0.05	(0.15)	0.01	(0.01)
P Household Dependency Ratio							0.05	(0.14)	0.00	(0.13)
P Household Head Age							-0.39*	(0.17)	0.00*	(0.00)
P Household Head Female							-0.48	(0.19)	-0.02	(0.07)
P Household Head Education							-0.12	(0.08)	-0.01	(0.01)
P Household Income Per Capita							0.00	(0.00)	0.01	(0.01)
Relationship Length							0.29	(0.28)	0.02	(0.01)
Kin Contract							0.00	(0.18)	0.01	(0.07)
A Household Size							-0.06	(0.17)	-0.02	(0.02)
A Household Dependency Ratio							-0.10*	(0.10)	0.26*	(0.15)
A Household Head Age							0.00	(0.00)	0.00	(0.00)
A Household Head Income							0.01*	(0.01)	-0.05*	(0.02)
A Household Head Education							0.00	(0.13)	-0.01	(0.01)
Slope of Asset Risk Function (r_s)									0.03***	(0.01)
Intercept	0.77***	(0.12)	0.73***	(0.23)	0.69**	(0.31)	1.06***	(0.39)	1.20***	(0.38)
N	376		376		376		376		376	
Village Dummies	Yes		Yes		Yes		Yes		Yes	
Bootstrap Replications	1000		1000		1000		1000		1000	
R^2	0.19		0.21		0.23		0.30		0.33	
p-value (All Coefficients)	0.00		0.00		0.00		0.00		0.00	
p-value (Structural Coefficients)	0.94		0.99		0.99		0.94		0.97	

- Caveats:
  a. Data
  b. Standard econometric issues

- Future work
  a. More general theoretical model (e.g. incorporation of disutility of effort).
  b. Dynamic stochastic control framework (Schattler 1993, JET)