The Organization of Contracting in Supply Chains in the Presence of Relational Collusion

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Economic Problem

- How are effort and investment choices affected by delegation/centralization format in presence of Monitor-Grower (*M-G*) collusion sustained through repeated interaction?
- Principal (*P*) employs commodity expert *M* + group of identical growers
  - First, *P* makes investment that increases G_i effort cost & product value
  - Then G_is decide whether to work hard and supply input to *M*
  - *M* has private information about individual efforts to base her decision on whether to accept or reject a G_i's input. *M* takes or rejects, aggregates bought inputs and sends to *P*
  - *P* output stochastically depends on G_i aggregate effort but *P* has no direct information about individual effort
  - G_is have alternative input use, value being greater if that G_i works hard
  - G_is and *M* wealth constrained (can't save/borrow), leading to info. rents

Relevance in Food Supply Chains

- Many factors enter delegation choice (Aghion et al. 2013)
- There are some empirical regularities in commodity contracts (Briones 2015; Michelson et al. 2016)
  - Tend to be centralized: tobacco, cotton, sugar cane, bananas, coffee, tea, cocoa, rubber
  - Tend to be decentralized: fresh fruit, vegetables, poultry, livestock
- Recent efforts in U.S. and elsewhere to alter distribution & perhaps size of surplus by legislation (banning some asset ownerships, loan terms, etc.) that favors bargaining power of some party (Cordero-Salas 2016)
- Bribes and contract non-performance are animal health or food safety issues (Pei et al. 2011 food policy melamine)

Literature Review

- Excellent, dated, review in Mookerjee (2006)
- Revelation Principle (RP): when some mechanism designer seeks to implement a social choice function absent i) communic./info. & processing costs, ii) *P* commit. problems, iii) agent collusion, then can confine attention to mechanisms in which agents are willing to reveal their pte information (i.e., incent. compat. mechanisms). If no direct & truthful mechanism can implement it then no mechanism can
- In such cases, delegation can do no better than centralized control
- Decentralization cost is clear: it allows *M* to act on own self interests rather than interests of *P*

Literature Review, Cont'd

- So merits of decentralization should come down to where RP assumptions fail, be it i), ii) or iii). We focus on iii), collusion with *M*
- Related topics addressed in Tirole (1986) Baliga & Sjostrom (1998), Grimaud, Laffont & Martimort (2003), where cheating is not internalized or *M* also produces
- Martimort (1999) first to consider *M*- agent collusion reinforced through a relational contract (repeated interactions). That paper takes delegation as given and seeks to understand how to regulate it. Another literature considers optimality of delegation absent collusion in terms of effort, project selection, etc.
- We consider optimality of delegation in presence of collusion

Troya-Martinez & Wren-Lewis

- Have exogenous surplus split between *P* and *M*. This is important because *P* is essentially passive thereafter and does not condition payouts to *M* and G_is (under centralization) on observed behavior
- Information about agent performance and contracting is public whereas in our model *M* has private information about individual performances and contracts of the agents
- *Growers' outside options are fixed whereas in our case they depend on agent efforts*. This is realistic + critical: if G_is value of outside option rises with effort then G_i taking effort under D can bargain better than shirker G_i. Things might fall apart under D otherwise. *M* can always pay same price to G_i so G_i might always choose to shirk

Relational Contracting

- Idea here is that M and G_is may enter into an informal (secret/complicit) self-enforcing contract to accept and not take effort but to deviate from what M reports to P
- It is a infinite horizon trigger strategy starting from cooperation and where deviation is punished harshly
- Making this assumption is wlog because P will want to make formal contracts collusion-proof and to do so will require that collusion is as strongly enforced as possible

Choice Notation

$e_i \in \{1,0\}$ agent i effort for agent continuum $i \in [0,1]$

$b_i^G \in \{1,0\}$ grower i offers (or not) input

$b_i^M \in \{1,0\}$ monitor accepts offered (or not) input

$b_i = b_i^G b_i^M \in \{1,0\}$ input offered and accepted

$\delta =$ intertemporal discount factor, $t \in \{0,1, .. , \tau, .. ,\}$

$\alpha \in [0,1]$ agent productivity choice by P at game outset where agent cost is $c(\alpha)e_i$, $c(\alpha)$ increasing, convex, $c(0) = 0$, $c'(0) = 0$, $\lim_{\alpha \to \infty} c(\alpha) = \infty$;

Stochastic Principal Output Notation

$\theta \in \{0, v\}$ Bernouilli draw on output to sell

$A = \{i \in [0,1] : b_i = 1\}$: agent subset, inputs accepted by M

$A_1 = \{i \in [0,1] : (b_i, e_i) = (1,1)\}$: among those, effort takers

$s = |A|, \quad s_1 = |A_1|$, agent set share measures

$s\theta \in \{0, sv\}$ = output accruing to P

$\Pr(\theta = v \mid s, s_1) = \alpha s_1 / s$ probability of sv output

Expected output $\alpha s_1 sv / s = \alpha s_1 v$

Payoff Notation

Agents $i \notin A$ keeping input can use it to obtain $u \alpha e_i$

$\overline{f}$: signup fee from P to M

$f(s_\tau, \theta_\tau)$: contingent transfer from P to M

$w(b_{i,\tau}, s_\tau, \theta_\tau)$: contingent transfer from either

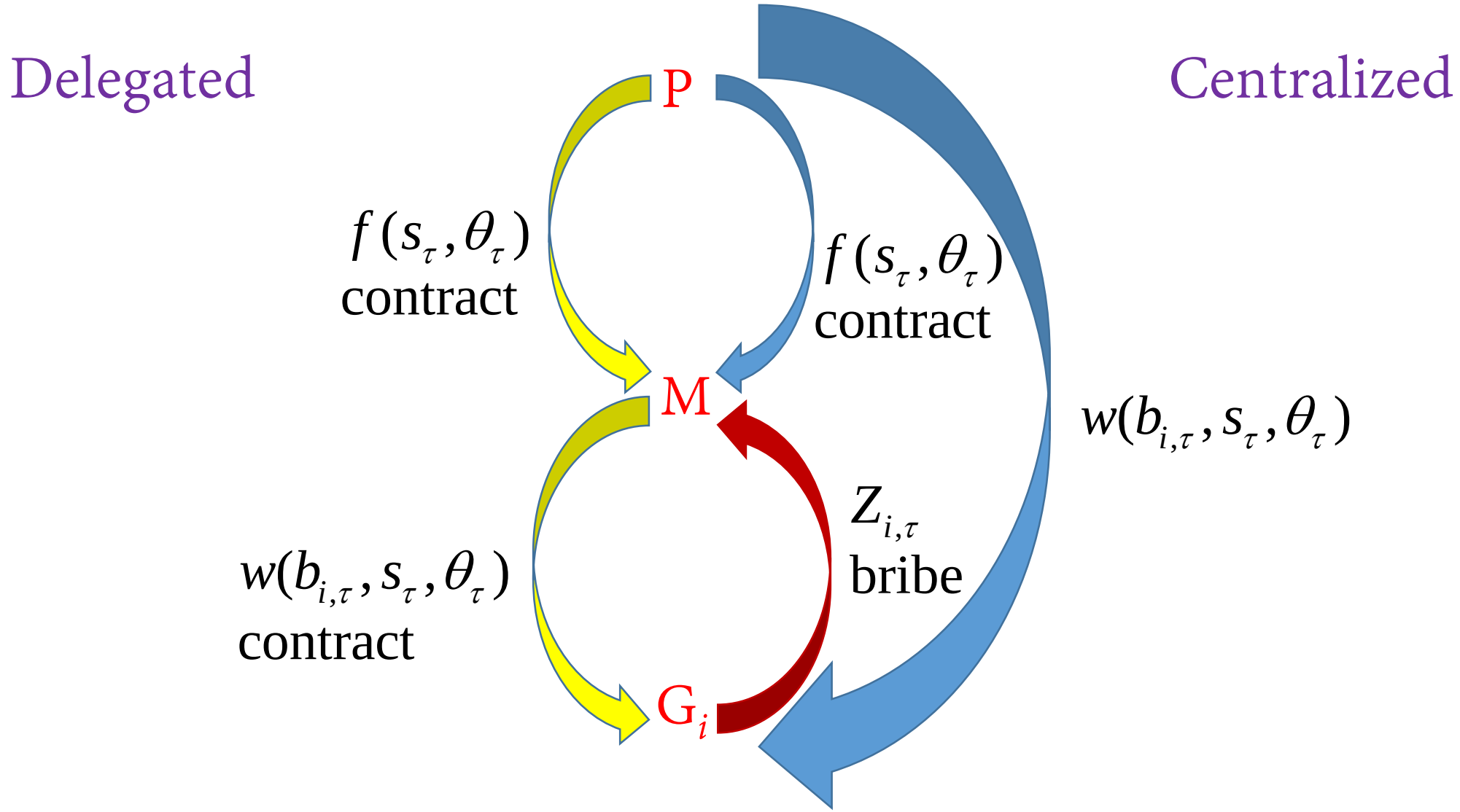
P to G_i (centralized) or M to G_i (delegated)

$z_{i,\tau}$: possible G_i bribe to M (centralized)

Infinite horizon discounted expected PV of returns starting t

$$Centralized: \{\pi_{i,t}^{\text{cent}}, \pi_{M,t}^{\text{cent}}, \pi_{P,t}^{\text{cent}}\} \quad Delegated: \{\pi_{i,t}^{\text{del}}, \pi_{M,t}^{\text{del}}, \pi_{P,t}^{\text{del}}\}$$

Payment Flow Diagram, date τ



Timing

0. α chosen by P
1. Two alternatives. P either offers a C or a D contract
2. M accepts or rejects offered contract
3. Each G_i privately chooses effort level e_i
4. If a D contract then M privately offers contract to each G_i
5. Each G_i either offers input to M or keeps it to obtain outside option
6. For any offered input, M observes effort and either accepts or rejects
7. P and non-participating G_is go to market
8. Contract payments are made
9. Each G_i does or does not pay bribe to M

Optimization

- Under Centralization *P* will
  - maximize private surplus less transfers over α and transfer amounts conditional on all growers taking effort s.t.

  i) grower incent. compat. & particip. constraints,

  ii) *M* truth-telling constraint, and

  iii) coalition-proofness or bribe avoidance constraint

- Under Delegation *P* will
  - maximize as above (except now no G_i payments) s.t.

  i) same grower incent. compat. & particip. constraints,

  ii) constraints to avoid *M* from holding up harder worker G_is

  iii) a *M* participation constraint because *M* has limited liability

Why Decentralization Matters

- Under Centralization, bribe happens last and after wages paid to G_is. This gives a G_i power to punish M if G_i shirks and M doesn't let it slide. So the G_is are well-positioned to bargain for info. rents regarding bribe transfers
- Under Delegation, 'bribe' is embedded in the wage contract between M and G_is. The transfer puts M in driver's seat for extracting info. rents. Were a G_i to shirk on effort then the outside option value is 0 and M can drive a very hard bargain when extracting rents that P leaves on the table to ensure no shirking
- As with Coase's ownership irrelev. thm and Modigliani-Miller debt irrelev. results, delegation choice is relevant when there are info. issues

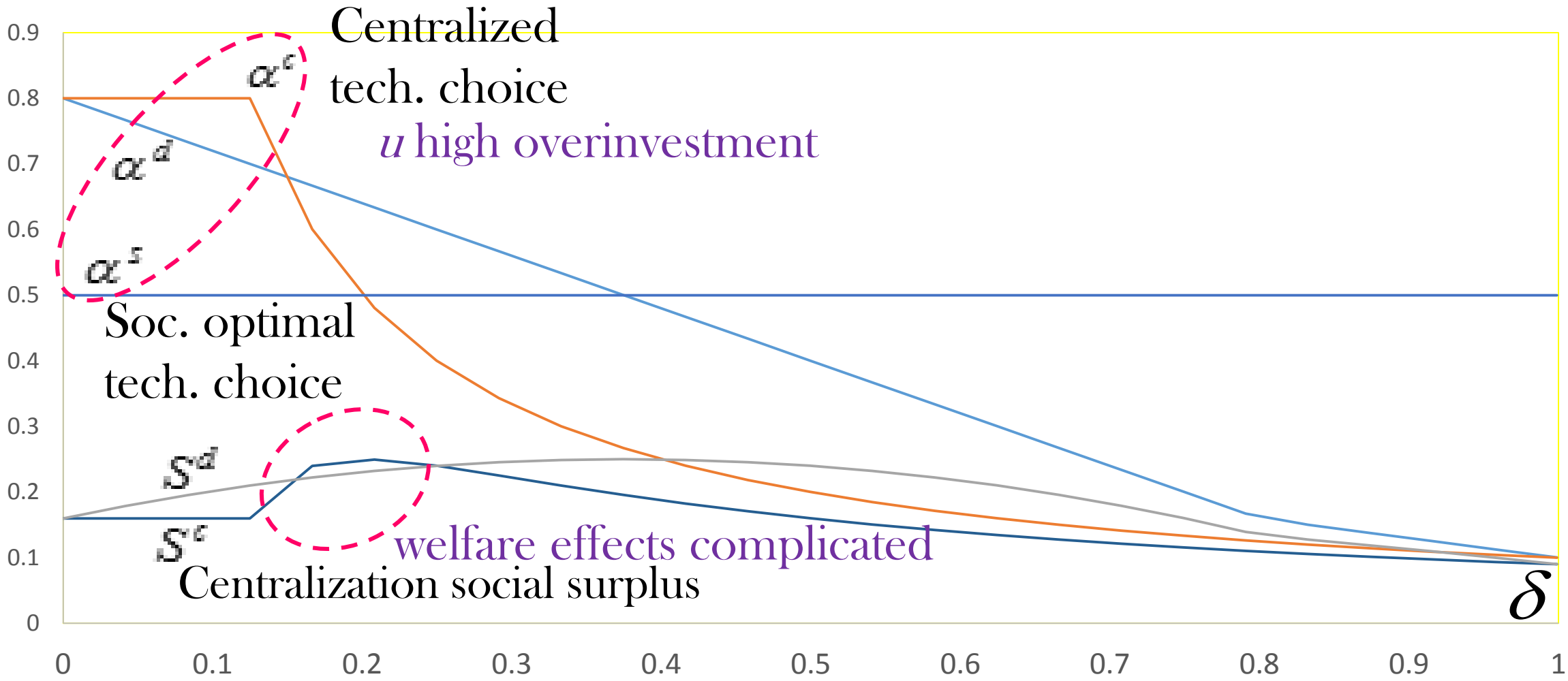
Outside Option

- PROPOSITION A: Delegation is preferred by *P* whenever

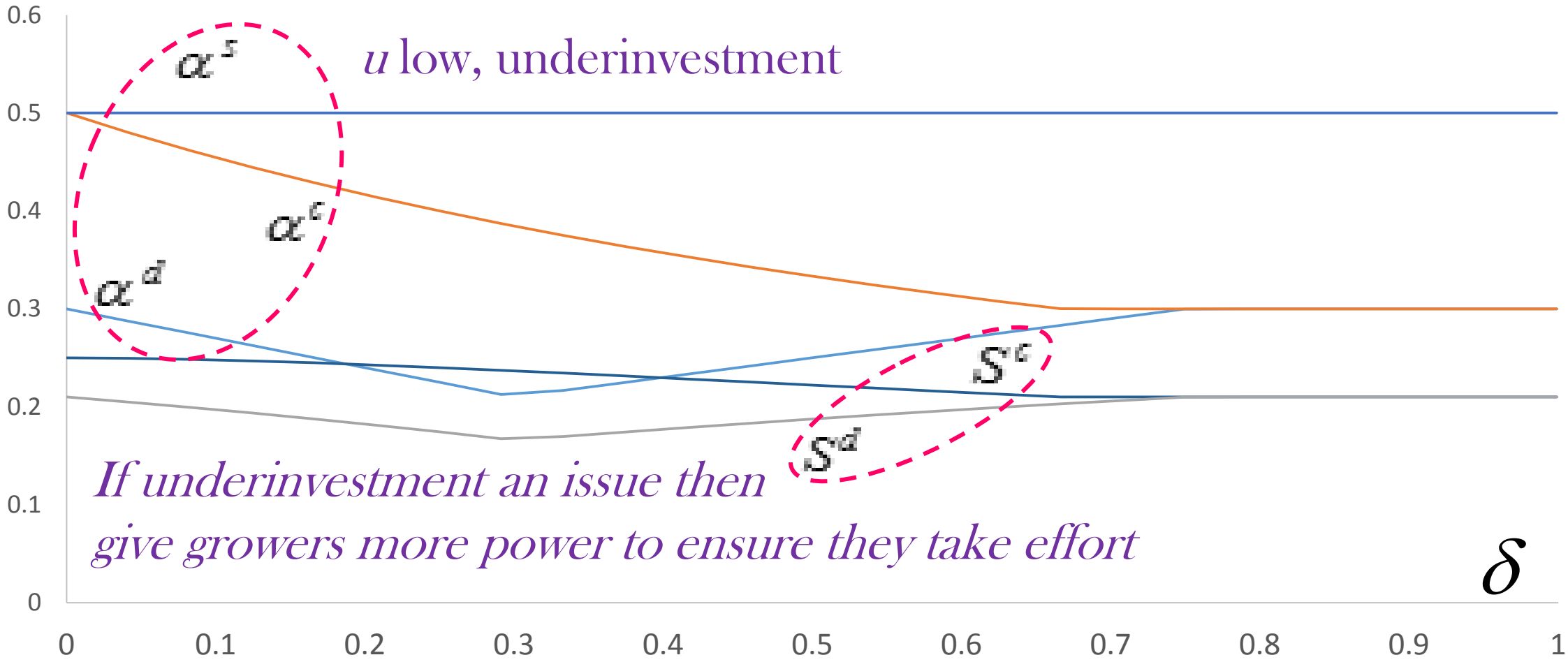
$$\frac{u}{1+\delta} \geq \frac{c\left[c_{\alpha}^{-1}\left(v/(1+\delta)\right)\right]}{c_{\alpha}^{-1}\left(v/(1+\delta)\right)}.$$

- This sufficiency condition seems reasonable as D gives *M* opportunity to stiff the G_is so that G_is will be keen to take effort, especially when outside option parameter *u* is sufficiently high. Form C would only offer opportunity for G_is to take *P* payment, take no effort and renege on bribe

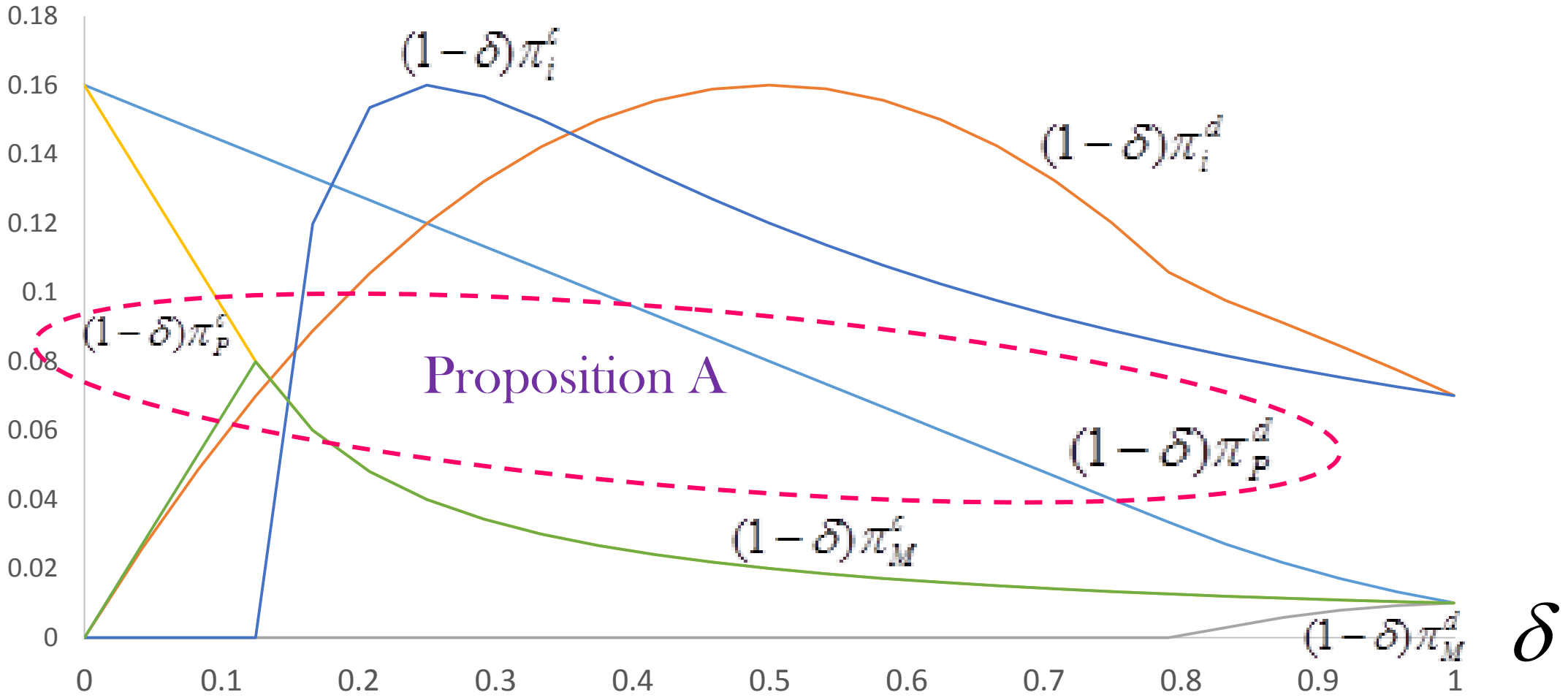
Equilibrium Technology Choice and Welfare for $c(\alpha)=\alpha^2$, v=1, u=0.8



Equilibrium Technology Choice and Welfare for $c(\alpha)=\alpha^2$, v=1, u=0.3



Equilibrium Payoff for $c(\alpha)=\alpha^2$, v=1, u=0.8



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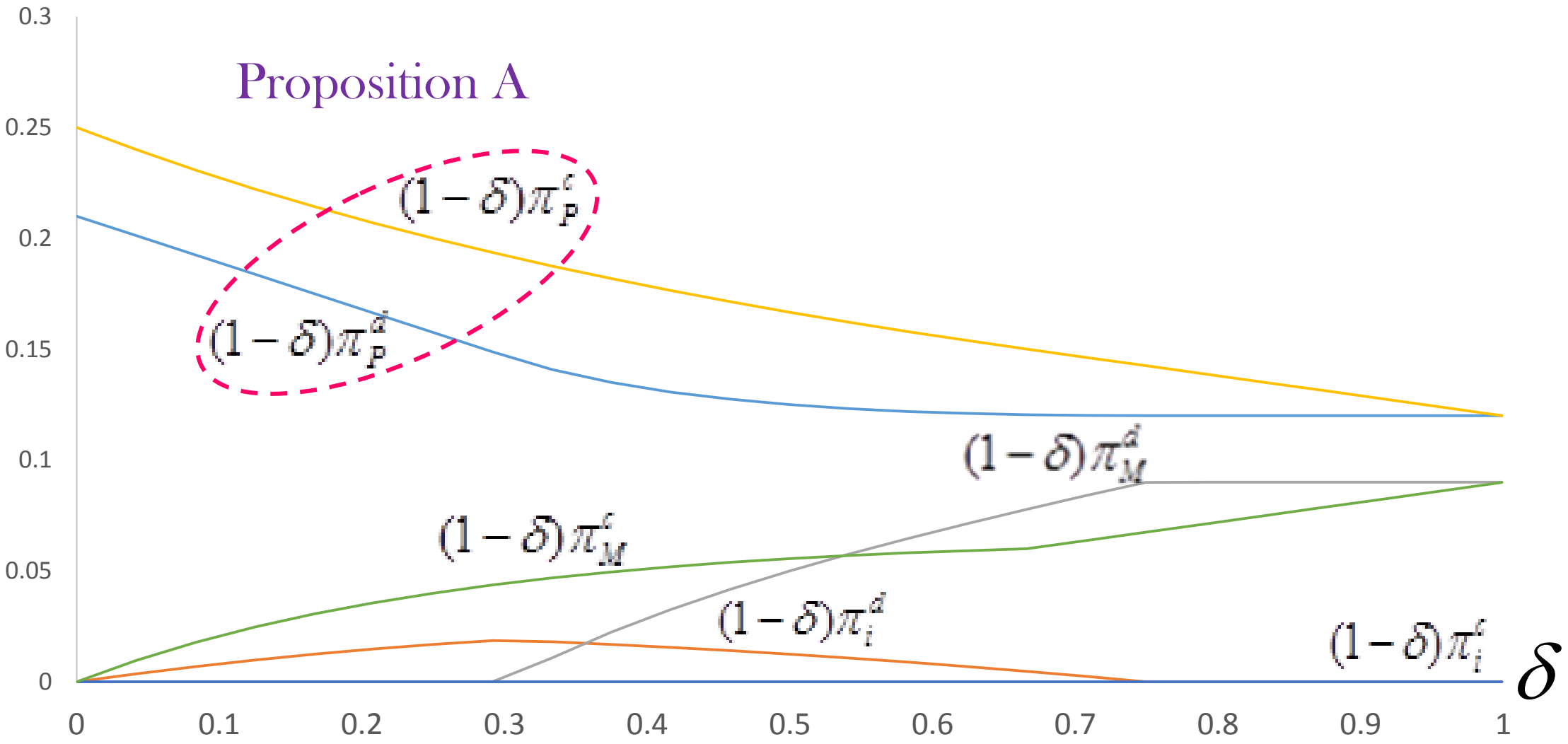

Questions?

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