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Relational incentive contracts with productivity shocks

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ABSTRACT

This paper extends Levin's (2003) relational contract model by having not only the agent's cost of effort (agent's type), but also the value of that effort to the principal (principal's type) subject to i.i.d. shocks. When optimal effort is fully pooled across agent types for multiple principal types, it is also pooled across those principal types. When optimal effort separates some agent types for multiple principal types, efforts of those agent types may be separated across principal types. But then, somewhat perversely, some agent type's effort is decreasing in the principal's value of effort. When agent type is uniformly distributed, that applies to agent types with lower effort cost, so reducing the difference in effort between low and high effort cost types. This result extends to the principal's type being observed only by the principal if the marginal cost of effort to the agent is sufficiently convex.

1. Introduction

Relational incentive contracts have proved a fruitful way to study on-going economic relationships. See Malcomson (1999) for applications to employment, Malcomson (2013) for applications to supply relationships. Levin (2003) provides an elegant analysis of the implications of adding short-term shocks in an agent's cost of supplying effort to the basic relational incentive contract model in MacLeod and Malcomson (1989). But his analysis does not incorporate short-term shocks in the value of the agent's effort to the principal. This omission is important for practical applications because employers and downstream firms typically face fluctuations in the demand for their products. This paper aims to fill that gap.

In the basic relational incentive contract model, a principal employs an agent who provides effort to produce output. Neither effort nor output is verifiable by third parties, so there can be no legally enforceable performance-related pay. Incentives are instead provided by the (potentially infinite) repetition of the relationship — the gains from future continuation provide incentives for performance today. Levin (2003) calls this *dynamic enforcement*.

The hidden information model in Levin (2003) adds to this basic model i.i.d. shocks each period in the agent's cost of supplying effort (the agent's type) that are unobserved by the principal. Levin (2003) shows that, under specific assumptions discussed later, an optimal effort schedule takes one of three forms:

1. *first best:* effort for all agent cost types is first best;
2. *pooling:* effort is the same for all agent cost types;
3. *partial pooling:* there is a single interval of agent cost types (always including the lowest cost type) for which effort is the same; for other agent cost types, effort is strictly decreasing in cost; for all types, effort is below the first-best level.

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The essential rationale is that, because there are only limited future gains from continuing the relationship with which to provide dynamic enforcement, the spread of rewards to the agent is limited. If the future gains are large enough, dynamic enforcement may permit first-best effort to be sustained for all agent types. But if the future gains are too small to permit that, it is optimal to pool some agent types. Under the assumptions in Levin (2003), the gain from separation is greatest for higher cost agent types, so pooling is of lower cost types.

The present paper adds to this model i.i.d. shocks each period in the value of the agent's effort to the principal (the principal's type). The implications are significant even when shocks to the principal are observed by the agent. When optimal effort for all agent types is pooled (case 2 above) for a set of principal types, it is also pooled across those principal types. Short-term shocks to the value of effort within that set have no effect on the agent's output even though it is efficient that they should. For agent types that are separated but not with first-best effort (case 3 above) for a set of principal types, those principal types are in general separated for some agent types. But, contrary to what one might expect, effort is *lower* for some principal type than for another principal type for which effort is *less* valuable. Thus separation of principal types is at the cost of less efficient effort for some types than if they were all pooled. For a uniform distribution of agent cost types, it is those with lower cost of effort who deliver less effort when effort is more valuable to the principal. Those with higher cost of effort deliver more effort.

These results have implications for employment and supply relationships. Employers and downstream firms typically face short-term shocks to demand. These shocks correspond to different principal types. If there is just one agent type, a demand shock has no effect on optimal agent effort as long as first-best effort remains unattainable — unless, that is, it is a negative shock sufficiently severe that first-best effort falls below the highest sustainable level. With first-best effort unattainable, a principal may respond to a positive shock by hiring more agents, or by increasing agent input along some verifiable dimension (such as overtime hours) but not by increasing agent input along an unverifiable dimension. Employment and/or overtime will then fluctuate more than they would if performance-related pay were legally enforceable.

With multiple agent types, any response to a positive shock results in *reduced* effort for some agent types, although increased effort for others. With uniformly distributed agent types, the reduction in effort is for lower cost agent types. But these have higher effort than higher cost agent types, so the difference in effort between the lowest and the highest cost agent types is reduced. Thus the interaction of multiple agent with multiple principal types results in practical implications that are significantly different than if no account is taken of short-term shocks faced by the principal.

The next section of the paper sets out the model. Section 3 analyses the limitations imposed by dynamic enforcement. Section 4 gives results on optimal relational contracts. Section 5 considers extensions of the basic model to the principal being privately informed about shocks to the value of the agent's effort and to those shocks not being i.i.d. Section 6 concludes. Proofs of propositions are in Appendix A.

2. The model

The model is the same as the hidden information model in Levin (2003), with the addition of principal types that are i.i.d. draws each period.

The agent's type a_t in period t is an i.i.d. random draw from the distribution $F(a_t)$ with support $[\underline{a}, \bar{a}]$ and everywhere strictly increasing. It is privately observed by the agent. If in a relationship with the principal, the agent's payoff in period t is $W_t - c(e_t, a_t)$, where W_t is the payment to the agent in period t, $e_t \in [0, \bar{e}]$ is the agent's (non-verifiable) effort in period t and $c(e_t, a_t)$ is the cost to agent type $a_t \in [\underline{a}, \bar{a}]$ of providing that effort. If not in a relationship with the principal, the agent's payoff in period t is $\underline{u}$. The agent discounts the future with discount factor $\delta \in [0, 1)$.

The principal's type p_t in period t is an i.i.d. random draw from the set $P \subseteq \left[\underline{p}, \bar{p}\right]$ with distribution $G(p_t)$. This type is observed by both principal and agent. (Implications of it being observed only by the principal are discussed in Section 5.) If in a relationship with the agent, the principal's (unverifiable) payoff in period t is $y(e_t, p_t) - W_t$. If not in a relationship with the agent, the principal's payoff in period t is $\underline{\pi}$. The principal has the same discount factor δ as the agent.

Assumption 1. *For all $p \in P$ and $e \in [0, \bar{e}]$, $y(e, p)$ is: (1) strictly increasing in p for $e > 0$ with $y(0, p) = 0$, and (2) twice differentiable in e, with $y_1(e, p) > 0$ and strictly increasing with p, and $y_{11}(e, p) \leq 0$.*

For all $a \in [\underline{a}, \bar{a}]$, $c(0, a) = 0$ and, for all $e \in [0, \bar{e}]$, $c(e, a)$ is twice differentiable, with $c_2(e, a) > 0$ for $e > 0$, $c_1(e, a) > 0$, $c_{11}(e, a) \geq 0$, and $c_{12}(e, a) > 0$.

$y(e, p) - c(e, a)$ is strictly increasing in e for $e = 0$, strictly decreasing in e for $e = \bar{e}$, and strictly concave in e for all (p, a).

$\underline{s} \equiv \underline{\pi} + \underline{u} > 0$.

Assumption 1 is maintained throughout. The condition that $c_{12}(e, a) > 0$ ensures that the Spence–Mirrlees single crossing property holds. The other conditions ensure that first-best effort is strictly interior to $[0, \bar{e}]$ for all (p, a). That $\underline{s} > 0$ ensures that the relationship is not mutually beneficial if no output is produced.

The timing of events within each period is set out in Fig. 1. Payments are as in Levin (2003). In each period t, there is a fixed payment w_t conditional only on the relationship being continued for period t by both parties at stage 3 of period $t - 1$ and on p_t. (For simplicity, the parties are assumed to be committed to paying w_t conditional on the p_t that occurs if the relationship is continued at stage 3 of period $t - 1$. This could be replaced without affecting the results in Sections 3