

**Quality Enforcement in the Supply Chains
with Imperfect Monitoring and Challenging
Legal Enforcement of Penalties**

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International corporations have many challenges enforcing compliance with environmental standards in their supply chains. First, environmental compliance failures detected in consumer products can result in significant direct remediation and indirect reputation costs. Second, in a complex supply chain, it is difficult to enforce compliance, because failures may originate in the higher levels of the supply chain. Third, oversight of suppliers is costly and incomplete. Fourth, buyers know that when sourcing to developing nations it may be hard to make suppliers pay penalties for poor quality. Fifth, the threat of termination is incomplete because a supplier can often find another buyer and resume its operations. In this paper we show how dynamic relational contracts can be used by a brand to mitigate these challenges.

We model the interaction of a single buyer with a single supplier within a market in a developing country with homogeneous local suppliers and homogeneous buyers from developed nations. The buyer sources a product in fixed batches from a supplier and then inspects and sells it on the market subject to quality standards such as regulations about chemical content. The buyer chooses an effort level for inspection and the terms of the contract with the supplier. The supplier chooses an effort level for ensuring compliance. We assume that a supplier's effort cannot guarantee the compliance of a batch as upstream suppliers can secretly deliver bad inputs. Compliance failures detected by the buyer can be remediated internally at some cost while failures that escape detection reach the market and generate external costs to the buyer (brand) that are greater than if detected internally. We assume that both guaranteeing compliance by the supplier and perfect inspection by the buyer are prohibitively expensive, i.e., they have infinite cost. Buyers are assumed to comply with contracts because they are based in countries with

strong legal systems, care about reputation and fear antagonizing local governments within the developing countries. We assume that legal enforcement of the supplier's contractual obligations is not possible. We model the interaction between the buyer and supplier as a repeated game in which the partnership can be terminated by the buyer if the supplier refuses to pay penalties for quality violation. After termination, the buyer and supplier start searching for a new business partner.

We propose the use of relational contracts with both court-enforced and informal provisions to manage the interaction between the buyer and supplier. The buyer's actions are enforced by law and the supplier's actions are motivated by the value of ongoing relationship. We show that optimal relational contracts have dynamic form in this setting because the value of the outside option available to the parties, if the relationship is terminated, is determined by the contract terms. We find that the optimal dynamic equilibria have the following features. First, the penalty for quality failures is non-decreasing: it is strictly increasing until the penalty of the first-best case is achieved (in period T) and constant after that. Second, the supplier's expected stage profit is non-decreasing. Before T , it is zero, later it increases and starting period $T+1$ remains constant. Third, the defect and inspection rates are non-increasing. Until T , they are strictly decreasing. Later they remain at the levels of those in the first-best case. Fourth, the buyer's expected stage profit grows until T . In period T , it may stay at the same level, increase or decrease. Later it remains constant at the level lower than that in period T . These dynamics are explained by the buyer's control over the compensation scheme and the buyer's ability to hold up the supplier for the initial investment and costly search. Our results extend the literature on relational contracts.

Intuitively, buyers use non-decreasing compensations and penalties to discipline the suppliers through the artificial increase of the supplies' termination costs. The observed dynamics provide the following managerial insight. If, starting a relationship, the buyer offers generous compensation and charges large fines, then the supplier is motivated to shirk and renege. That is why initial payments should be small. In turn, it results in low fines and frequent quality violation. It is possible that, in the beginning, the buyer experiences losses which are compensated by the future profit. As time passes, the supplier enjoys larger profit margins. Paying in full before the production occurs is possible as the supplier's shirking and reneging not only will result in costly search, but will make the supplier receive lower profits in the beginning of a new relationship.

In numerical experiments, we show that there are three key forces at work in this setting. First, because of the moral hazard only a portion of the payment that goes to the supplier is spent on quality. Second, the buyer has a mechanism for ensuring quality (inspections) that allows him to take quality control out of the hands of the supplier. However if internal failures are expensive this option is less useful. Third, the cost of relationship termination to the supplier drives his effort. How these three forces interact will determine how hard it is to maintain compliance in the supply chain. We also see that dynamic relational contracts can greatly outperform stationary contracts.