



Is dishonesty the best policy? Supplier behaviour in a multi-tier supply chain



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ABSTRACT

In this paper, we examine suppliers' dishonest behaviour in a multi-tiered supply chain. In particular, we consider a buyer purchasing a product consisting of two components from a tier-one supplier. The tier-one supplier produces one component in-house and purchases the other component from a tier-two supplier. The suppliers decide their investment in production technology, but the production technologies are imperfect, so the components may be defective. In the unfortunate situation where a defective component is produced, the seller can choose to rework the component to an acceptable standard (honesty) or may ship it without reworking (dishonesty). In turn, the buyer has the option of accepting the product "as is" or may conduct an inspection to identify defective components before accepting the delivery. Our results show that the buyer can benefit from either a *high* rework cost or when the suppliers' negative consequences from cheating are *low*. We also identify strategy shift-points where the changes in the players' tactics lead to rapidly changing outcomes. Finally, we examine the supply chain inefficiencies introduced by the dishonest behaviour of the suppliers.

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1. Introduction

Subcontracting part of their workload is a common practice among suppliers in many industries. In the aerospace industry, up to 70% of components are outsourced, and it is fairly common for first-tier suppliers to subcontract a portion of their work to lower-tier suppliers (Masten, 1984; Williams et al., 2002, Bales et al., 2004). Similarly, in the computer industry, manufacturing is often outsourced to suppliers, who in turn, may subcontract some components to specialized lower-tier suppliers. To illustrate, Compal Electronics, the second largest notebook manufacturer in the world (Foster et al., 2006) takes responsibility for the production of products for clients like Dell and Toshiba but subcontracts many components to a wide network of suppliers such as Lishin, one of its main sources for power supplies. The automobile industry is another example where many suppliers subcontract part of their work to lower-tier suppliers.

Of course, subcontracting does not come without drawbacks. One of the main issues faced by firms which make extensive use of subcontractors is the loss of control. Suppliers can be guided, but ultimately subcontractors make their own decisions and may

possess knowledge and information that the customer cannot access. In these situations, a principal-agent problem can arise, where subcontractors may act in their own best interest rather than that of their customer. As recent history has shown, the actions of suppliers can seriously impact the quality of the end product. This has been the case with a variety of products such as toys (Story and Barboza, 2007), toothpaste (Bogdanich and Hooker, 2007), and pet treats (Sacks, 2012). In each case, a supplier's willingness to "cut corners", combined with customer's failure to detect this activity, led to dramatic and damaging results. This reveals a darker side of supply chains – suppliers may be tempted to act dishonestly at times. Unfortunately, many examples of corporate dishonesty regarding quality issues exist. For example, Mitsubishi Motors admitted (Magnier and O'Dell, 2000) that they purposely hid records of consumer complaints to avoid product recalls. Moreover, recent accusations (Basu, 2014) that General Motors failed to rectify a defective ignition switch even though it had been aware of the problem for years suggest that quality problems can go unreported even in highly-visible industries.

To manage supplier quality, firms can choose from collaborative relationships (vendor certification), more adversarial relationships (appraisal), or a combination of the two. Collaborative relationships support cooperative quality improvement activities and allow the formation of long-term bonds between supplier and buyer (Deming, 1986). Appraisal of products often takes the form of acceptance sampling (Von Collani, 1988) and allows the buyer to

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manage the quality of items which are not routinely purchased from the same source. We examine the latter situation to determine how effectively an appraisal system can manage incoming product quality and, from the supplier point-of-view, when and where incentives for dishonesty may exist.

Although collaborative relationships seem to be the logical choice for most firms, past research has shown that in many cases buyers also consider more immediate concerns such as cost (Verma and Pullman, 1998). Subsequently, Krause et al. (2001) showed the emergence of additional factors such as quality, delivery, and flexibility in the purchasing decision, but cost still remained a key factor, both individually and through its correlations with other factors in their study. Similarly, Cheraghi et al. (2004) found that although the importance of price (as a stand-alone factor) has decreased over the years, it remains one of the three most important factors in the supplier selection process. It may not always be possible for buyers to find suppliers who are willing to participate in collaborative relationships and, even when it is possible, collaboration is no guarantee of quality. Fynes et al. (2005) collected data from 200 electronics suppliers and found that the strength of supply chain relationships is not positively correlated with conformance quality. Finally, collaborative relationships generally rely on penalties (often in the form of shared warranty costs) assigned to suppliers when quality issues arise. Unfortunately, these penalties, which are often quite high, may not be enforceable under the Uniform Commercial Code's (UCC) restriction on penalties that are "excessive" in nature. The applicability of the UCC to commercial buyers has been affirmed (in *Spring Motor Distributors, Inc. vs. Ford Motor Company, Clark Equipment Company, and Turnpike Ford Sales, Inc.*, 1985) and firms have experienced difficulty enforcing contractual penalties due to this interpretation of the UCC. For example, in *I. Lan Systems, Inc. vs. Netscout Service Level Corp.* (2002), the United States District Court for the District of Massachusetts found that the supplier (Netscout Service Level Corp.) was not liable for any penalties beyond the purchase price, in part because of the nature of the product. Similarly, the New York State Court of appeals (in *Fertico Belgium S. A., Appellant, v. Phosphate Chemicals Export Association, Inc.*, 1987) found that the supplier's liability for defective products was limited to actual damages, but not an additional charge. Although limited penalties may seem harmful to buyers, our study identifies conditions where a lower penalty may actually increase the buyer's profits.

In this paper, we consider a stylized model, where a buyer purchases a product that consists of two components from a tier-one supplier. The top-tier supplier produces one component in-house and purchases the other component from a lower-tier supplier. Each supplier decides its own level of investment in production technology, and a larger investment increases the likelihood of producing a functioning component. The product is functioning if and only if both components are not defective. If a defective component is produced, the seller can choose to rework the component to an acceptable standard (being honest) or to ship it without any reworking (being dishonest). In the latter case, the seller gambles that the problem will not be identified by the buyer upon receipt and, due to a general lack of traceability, knows that the buyer will not be able to hold the supplier responsible for future quality problems. In turn, the buyer has the option to inspect the delivered product before accepting it. If the buyer inspects the product upon receipt and finds it defective, the seller pays a penalty to the buyer and replaces the defective product with a functioning product. If the recipient chooses not to inspect, liability for future costs lies solely with the buyer. This situation can arise when traceability is lost during the assembly process or if the buyer is making use of foreign suppliers, where the enforcement of future penalties is difficult. The latter problem is being

discussed in the United States Congress (H.R. 1910 – Foreign Manufacturers Legal Accountability Act of 2013, [Government Printing Office, 2013](#)) and has been highlighted in [Babich and Tang \(2012\)](#).

Unfortunately, when dealing with foreign suppliers, supplier's product liability is rarely enforceable due to different legal systems and inconsistent law enforcement practices in different countries. In some cases, the manufacturer may not even be able to trace the true identity of the fraudulent supplier.

There are several anecdotal examples of situations where a lack of traceability (or, equivalently, an inability to assign responsibility) made it impossible for a buyer to show *ex post facto* that a particular supplier was responsible for a quality defect. In late 2005, Diamond Pet Food was recalled due to high levels of aflatoxin, which sickened numerous pets ([U.S. Food and Drug Administration, 2005](#)). Aflatoxin-producing molds thrive when weather conditions are dry or when grains are stored under poor conditions. When conditions are favourable for aflatoxin development, local and federal agriculture departments encourage farmers to provide information concerning contamination to buyers ([University of Missouri, 2010](#)), but unless a buyer actually tests incoming shipments it is possible for contaminated grain to enter the supply chain. Since aflatoxin levels are closely related to growing and harvesting conditions, farmers who are aware of contamination do not necessarily report this when selling their grain. In the Diamond Pet Food case, no specific source of the aflatoxin contamination was ever identified. In another example of a firm's struggles to assign responsibility for sub-standard quality, Metro Ready Mix, Inc. accused Essroc Cement Corporation of providing substandard cement ([Metro Ready Mix, Inc. vs. Essroc Cement Corporation, 2007](#)), allegedly leading to concrete failures in major projects at locations such as Dulles International Airport and Johns Hopkins University. However, Judge Cathernie C. Blake dismissed Metro's allegation of fraud, citing a lack of proof. Furthermore, Judge Blake refused to consider punitive damages against Essroc, explaining that no "actual malice" was evident. One additional aspect of the case that Judge Blake cited in her opinion was the fact that Metro acknowledged that Essroc had, on at least two occasions, provided acceptable concrete, further undermining Metro's claims of fraud and highlighting the importance of maintaining either traceability or timely testing of materials. Ultimately, failure of concrete produced by Metro led to the closing of the firm.

As a motivating example, we ground our discussion in the chemical processing industry. The tier-two supplier uses a chemical reaction to produce a precursor material, which is then sold to a tier one supplier for further processing. Finally, the product is sold to the end user. A simple example is the production of polyurethane precursor materials. From benzene (a raw material commonly obtained from petroleum or as a by-product of steel production) a tier-two supplier can produce aniline through the chemical process of nitration–hydrogenation (effectively adding an amine group). The aniline is then sold to a tier one processor, who uses it to produce methylene diphenyl diisocyanate (MDI). The MDI can then be sold to customers, where it is used in the production of polyurethane, which in turn is a raw material in diverse products such as foams, adhesives, coatings, and myriad other applications. While the suppliers' choice of production processes (through investment in equipment) can improve the likelihood of producing high-quality materials, variations in production process can lead to the production of sub-standard materials. While the supplier can observe process conditions (temperature, pressure, etc.) as effective indicators of product quality, the buyer must either rely on the supplier's honesty or conduct their own

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