(Problem Description.) Although motor vehicles are produced under a brand name, virtually all automotive manufacturers rely on parts and component groups manufactured by external suppliers. Auto suppliers purchase commodities such as steel, aluminum, and plastic, to name a few, and process them for other companies such as car and equipment makers. For these suppliers, raw material costs frequently represent a substantial portion of the total production costs, and the market prices of these commodities can fluctuate substantially over time. Intuitively, mild cost fluctuations merely affect a supplier's profitability. Prolonged spells of significant cost variations, however, can have a paralyzing effect on the supplier's cash flows and, eventually, on its ability to operate.

By extension, raw material prices concern auto manufacturers. In the automotive industry, carmakers require suppliers to disclose significant raw material quantities in supplied components; downstream manufacturers know the exact compositions of the parts they purchase. The German automaker BMW deals with fluctuating prices of commodities between itself and its suppliers by writing smart supply contracts. Firms bid in an auction to win supply contracts from BMW. Such auctions typically take place two years before BMW launches a new vehicle model. After the auction, BMW finalizes the contract, which stipulates the tariff terms and quantities. The contract duration is five to six years, which is a lifecycle of particular vehicle design. At BMW, contracts fall under two general categories: pass-through (which allow suppliers to push price risk downstream) and wholesale (which forces suppliers to bear price risk). These contracts are written at the level of the raw materials, and so BMW often tracks multiple agreements per component.
By nature of being further downstream, carmakers are often disadvantaged in estimating "true" commodity prices; this is especially true for illiquid and opaque raw materials markets. As manufacturers only imperfectly see their suppliers' costs, suppliers are better-positioned to act opportunistically and capitalize on the downstream player's lack of knowledge. Such asymmetric information can lead to problems of moral hazard and a suboptimal allocation of risks.

The issues of contracting with stochastic costs under informational asymmetries has yet to receive attention in the academic literature. Thus, the current practice of assigning contract at BMW is based on guidelines obtained from managerial experience and data.

This paper can be seen as a first step towards developing a formal model of the contracting process from which managers could draw guidance in writing future supply contracts. We then check the plausibility of the guidelines that we develop in this paper against past contracting data. BMW centrally keeps electronic records of its raw materials contracts with its suppliers. The terms of these contracts have been made available to us and are used to test the hypotheses generated from the model. Each observation is highly-detailed and captures the contract terms of a raw material for a supplier delivering a given component to a specific manufacturing plant.

(Methodology.) Our paper consists of two parts. In the first part, we model a multi-stage game in which suppliers first engage in an auction to become preferred suppliers to BMW. Following the auction, BMW chooses the contract type and announces order quantities. The sequence of the game strictly follows the current practices at BMW. By solving the game, we obtain equilibrium contract type and equilibrium contract terms. In the second part of the paper, we check our theoretical conclusions against a unique dataset consisting of over 200,000 contract observations from more than 1,000 suppliers between 2013 to 2015.
(Results.) In transparent commodity markets (where downstream manufacturers have perfect information regarding suppliers' true costs and raw material prices), we find that pass-through is BMW's best contract type choice. Moreover, the higher the volatility of the underlying commodity, the more BMW benefits by choosing the pass-through contract. (Aluminum and copper are examples of commodities that are traded in a transparent, highly liquid markets.)

In contrast, in opaque markets (where manufacturers have imperfect information regarding suppliers' costs and price movements), we find that upstream suppliers have an incentive to distort their raw material costs. Surprisingly, the suppliers do not always distort prices "upwards." The bigger the supplier, the higher the true expected value of the underlying commodity and the smaller demand forecast for BMW cars, the less likely suppliers are to exaggerate their raw material costs.

In opaque markets, pass-through continues to be BMW's best option either when the supplier is unlikely to exaggerate its costs or when BMW perceives that the underlying commodity price will highly fluctuate in the near future. In all other cases, BMW is better off by choosing the wholesale contract. (Steel and plastic are examples of commodities that are traded in opaque markets.)

Past contracting data appears to support these predictions. Moreover, although the model and empirical evidence are predicated on the supply chain contracting strategy of one large automotive manufacturer, the sequence of events in the game are similar throughout the industry. The results are thus generalizable to the wider automotive context.