Hedging Policies, Incentives and Market Power[1]

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Comments Welcome.

ABSTRACT

This paper studies potential adverse incentive effects of hedging policies in non-competitive product markets. We develop an illustrative model which shows that for firms with market power, output hedging creates detrimental incentives, which are not present in competitive markets. This adds to the cost of hedging. Thus we expect firms in non-competitive markets to be less inclined to hedge outputs. We test this prediction on a sample of S&P500 firms from 2001 to 2005. Consistent with our model, we find that firms with market power tend not to hedge output commodity risk, while they tend to hedge input commodity risk. These results are robust to various econometric specifications and also robust when considering currency hedging. We also find support for some "traditional" variables which predict the tendency to hedge.

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Introduction and Literature Review

In general, investors should not want firms to hedge risks, which shareholders can hedge more easily and cheaply by their own portfolio choices and in various derivative markets.[2] The literature proposes several motives, related to various market frictions, which can make hedging an optimal policy for an individual business entity. Other work suggests that agency issues related to managerial risk aversion may be at the root of firm hedging policies. This paper, on the other hand, focuses on adverse incentives that are created by hedging behavior. In other words, whereas most of the literature focuses on the benefit side of hedging, we focus on the moral hazard costs that may be involved. We develop a simple model which shows that input and output hedging (for whatever reason) may create different incentives for firms depending on market structure. In particular, we show that in an oligopolistic setting, output hedging may destroy rents and lead to lower profits. We conclude that the cost of output hedging will be higher for firms with market power and thus such firms will tend to hedge their output less often.

We test our model on a sample of S&P500 firms from 2001 to 2005. Most of the analysis discusses companies that hedge commodity risk. Commodity risk is an ideal candidate for our study since firms that have large positions in the product market may be able to influence the price. Industry classifications from the input/output tables of the BEA allow us to consider input versus output hedging. We observe that in "output" industries,

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[2] This can be easily understood by the following extreme example. Suppose that two firms produce the same product, and their revenue can be either $50 or $150 with equal probabilities. Suppose further that the revenue streams are perfectly negatively correlated. Each firm can pay an insurance company to guarantee $100 in all states by paying the $50 in the good state to cover the $50 shortfall in the bad state. Suppose the insurance company charges $3. Then investors are guaranteed $97. However, it should be obvious that just by buying the two stocks investors can guarantee $100 x 2 in all states on their own, without paying the $3. Or, of course, they can just buy treasuries. Thus, in a world without significant frictions, as long as investors can create portfolios relatively cheaply, firms should not hedge.

64% of the firms with low market power hedge commodity risk as opposed to 18% of the firms with high market power. On the other hand, in input industries, 34% of the firms with low market power hedge commodity risk while 50% of the firms with high market power do so. The regression analysis is consistent with the model. We find that firms with high market power are more likely to hedge commodities if they use them as inputs rather than if they produce them as outputs. The economic significance of our results is strong. For instance, for a firm in an output industry, if its market share increases by 10%, then the odds of hedging commodity risk decreases by 50%; while in an input industry these odds do not change significantly.

We employ various econometric specifications to test our model. We first run a subsample analysis. We classify firms by type of industry and study the relation between the choice of commodity hedging and a firm's market power. We find that firms in input industries (who are therefore likely to hedge inputs if they hedge) exhibit a positive and significant relation between the predicted probability of hedging commodity risk and firm's market share. On the other hand, firms in "output" industries (who are likely to hedge output if they hedge) exhibit a negative and significant relation between the predicted probability of hedging commodity risk and the firm's market share. We then show that the interaction effects, which represent the change in the predicted probability of hedging commodity price risk for a change in both the firm's market power and type of industry (input vs. output), are significantly negative, as predicted.

Our results are also robust to the inclusion of currency hedging. We note that when we consider currency hedging in isolation, we find less significant results reflecting the different nature of this type of hedging (firms generally cannot influence exchange rates).

However, our results hold for firms that hedge both currency and commodity risk.

In addition to the cost side, which is the focus of our work, we include in our analysis control variables identified in the literature as predictors of hedging benefits. The findings regarding these variables generally agree with previous work.

Literature Review

Much of the literature on hedging focuses on frictions which may justify hedging. A well-known paper by Froot et al. (1993) justifies hedging as a way of avoiding costly external financing. Thus, hedging enables the firm to take advantage of profitable investment opportunities. Smith and Stulz (1985) identify and model three frictions, namely, taxes, bankruptcy costs, and managerial risk aversion. Much of the theoretical and empirical literature focuses on possibly sub-optimal managerial hedging motives. Managers may want to hedge when they have too much of their wealth invested in their own companies. Amihud and Lev (1981) suggest that managers diversify their own risky position via conglomerate mergers. DeMarzo and Duffie (1995) focus on another possible set-up, which can lead managers to take too little risk, namely, the presence of asymmetric information coupled with career concerns. If a manager knows that he will be judged on performance alone, and his efforts will remain unobservable, he may be tempted to over hedge. DeMarzo and Duffie (1995) show that when managers cannot hedge effectively, they may choose inferior projects, which are less risky (propositions 10, 11).[3] In general, managers can lower the risk stemming from production uncertainty in two ways. One is by using hedging instruments (such as derivatives) and the other is by the sub-optimal choice of projects. The latter is much more difficult to detect and monitor (who can tell which

[3] John and John (1993) describe seemingly reasonable managerial objective functions, which can lead to sub – optimal behavior on the part of managers (along the lines described here) if the firm carries some leverage.

projects the manager might have taken but did not). Ravid and Basuroy (2004) consider this perspective empirically. They show that movie industry executives choose sub-optimal, low risk projects. In particular, they find that studios produce very violent films which are less risky by several measures even though they do not provide the highest expected return. Most empirical work, however, focuses on overall firm behavior, but quite a few papers conclude that managerial motives drive hedging decisions. A study by Tufano (1996) of the gold-mining industry seems to confirm that corporate officers do engage in hedging their own production. He finds that almost all firms in the gold mining industry employ some form of hedging in gold-derivative markets. He detects no correlation between hedging and measures of bankruptcy costs. However, he finds a significant relationship between hedging measures and proxies for risk exposure of executives. Tufano (1996) also tests several other theories. He cannot find support for the theory in Froot et al. (1993). However, Houshalter (2000), who studies the hedging behavior of oil and gas producers, finds a correlation between leverage related variables and the fraction of production hedged, which he interprets as supporting the financial contracting cost hypothesis. There is little support in his study for tax proxies and mixed support for managerial risk aversion proxies, mainly the structure of compensation. The gold mining industry remains a fertile testing ground- several recent papers run firms' hedging decisions proxied by the use of derivatives on an extensive set of independent variables, and try to disentangle hedging from speculation. These papers include Brown et al. (2006), Adam et al. (2006) and Adam et al. (2010).

There are relevant studies in other industries as well. Chevalier and Ellison (1997) discover seemingly sub-optimal risk management in response to incentives in the mutual fund industry. These incentives are correlated with timing and age of the fund (see also Jin, 2002, where performance is tied, theoretically and empirically, to different types of risks faced by managers). De Angelis and Garcia (2008) use a data set similar to ours to come up with a new measure of firm's willingness to hedge. They find that managerial shareholdings, liquidity, growth opportunities, dividend policy, and tax credits are important in determining firms' hedging positions.

Finally, in a paper close to our framework, Adam, Dasgupta and Titman (2007) consider firms which can hedge future cash flows. These cash flows are later used for investment purposes. Hedging reduces the firm's expected production cost, but the volatility of production costs provides a real option value to firms which do not hedge. The latter benefit depends on the number of firms that choose to hedge. Adam et al. (2007) show that, in a Nash equilibrium (refined with sub-game perfection) identical firms may choose to hedge or not to hedge. Thus, industry structure and other variables may determine the proportion of firms that hedge. Our structure focuses on incentives created by hedging outputs (which for example, is common in the gold mining industry). The two papers, however, share the empirical view that industry structure is an important determinant of hedging behavior.

A final piece of empirical support for our way of thinking can be found in Raman and Fernando (2010). Their sample consists of gold mining firms which in our terminology are "output firms". They find that gold prices are affected by announcements of hedging changes, but not by central bank announcements. Importantly, an event study analysis shows that the market "likes" hedging decreases and "dislikes" hedging increases. While the paper is pitched as an information paper, it also provides very good evidence in support of our view. The announcement effect on gold prices (and other information) suggests that the gold market is not competitive. Our prediction would be that hedging by such "output firms" will be shunned by the market, and hedging decreases will increase stock prices. This is exactly what happens.

The paper continues as follows. Section II provides a simple illustrative market power model studying the impact of input and output hedging on corporate policies and firm value. Section III describes the hedging database and the econometric methodology we employ. We analyze the empirical results in Section IV. Section V concludes. Section VI is an appendix that includes a Cournot example of our simple model.

II. An illustrative Model

The purpose of the model is to show that hedging in non-competitive markets may create costly adverse incentives, and thus, the impact of hedging on profitability and corporate policies depends on market structure. We implicitly assume that hedging may be driven by other frictions which have previously been modeled such as taxes and bankruptcy costs, and we will consider these frictions as well as managerial incentives in the empirical analysis. This model does not address the question of why firms hedge (this has been discussed extensively in prior work) but it analyzes what happens when firms choose to hedge. In our model, we assume that firms buy inputs in competitive markets, and that issues of market power may arise in output markets. This conforms to the data as well. The model starts with a stark set-up where firms are allowed to hedge any quantity they like, and then we show that the same incentives exist for less extreme cases as well.

The firm: Specifically, we assume that a firm faces a random single input price, $\tilde{r}$, and an output price, $\tilde{p}$. q and k represent the output and input quantities respectively[4]. *F(k)* is the production function.

Each firm thus faces the following maximization problem:

$$\max_{\{q,k\}\in\mathbb{R}_+^2} \; E[q \cdot \tilde{p} - k \cdot \tilde{r}]$$

$$s.t.\; q \leq F(k)$$

Obviously at the optimal level:

$$q = F(k)$$

which implies that:

$$k = F^{-1}(q)$$

This simple textbook model can be specialized a bit to allow us to offer numerical examples: $F(k) = \sqrt{k}$

We can thus re-write the firm optimization problem:

$$\max_{\{q\}\in\mathbb{R}_+} \; E[\tilde{p} \cdot q - \tilde{r} \cdot q^2]$$

We assume risk neutrality throughout. This will simplify matters, but we note in our results how (managerial) risk aversion can affect our findings. It should be clear that in the absence of frictions, and if hedging is costless, hedging should be a matter of indifference for a risk neutral competitive firm. The purpose of the analysis below, however, is to show how hedging in non-competitive environments may lead to very detrimental incentives.

[4] There may be several inputs and if they are part of a fixed cost the model does not change. There may be several variable inputs of course. We only model one input for simplicity because the focus is on output hedging.

A. Competitive Markets

We start with a short discussion of this benchmark case. Assume competitive markets, that the firm is a price taker and has so has no impact on either the input or output prices. The FOC of the problem in the previous section will characterize the optimal solution:

$$q = \frac{E[\tilde{p}]}{2 \cdot E[\tilde{r}]}$$

If a firm is risk neutral, then hedging the price at the expected level will make no difference for the firm production decision, since firms cannot affect prices. We can trivially prove this[5].

B. Output Market Power

The interesting part of this illustration comes if we assume that the firm has output market power, for instance, as a monopoly or an oligopoly or a leading firm in a Stackelberg type situation. Naturally most firms of interest in the real world operate in oligopolistic markets - monopolies are rarely observed in reality and the outcome is less interesting once we analyze the more complicated cases of oligopolies.

In oligopolistic markets, p is still stochastic due to a stochastic element in the demand function. The firm, however, now has some impact on the expected price, i.e., if it supplies more, the equilibrium price decreases. For example, in a Cournot market: $\tilde{p} = \tilde{\theta} - (q_i + q_j)$ where θ is a random variable.

[5] Of course, it can be nice to hedge outputs at a high price and inputs at a low price, but in the presence of a rational insurer (hedging markets) and symmetric information, the firm will not be able to afford this. In other words, since there are no rents, the firm cannot subscribe to losing propositions.

We will now prove a proposition regarding the consequences of hedging. We will also provide a numerical illustration to make the analysis more concrete. In order to simplify our oligopolistic environment we will propose a few assumptions and definitions:

Definition 1: $E[\tilde{\theta}] = \bar{\theta}$ *and* $E[\tilde{r}] = \bar{r}$

Assumption 1: *MC=0*

Assumption 2: *In order to break ties, we will assume that firms produce at a positive price and exit the market if profits drop to zero*

Assumption 1 is standard in simple illustrations of oligopolistic models (see Rasmussen, 2001) and it will serve us well here, in bringing out the intuition of the model.

Assumption 2 is designed to make sure that if the hedging firm can supply the entire market demand, the non-hedging firm will not produce anything. Our very simple structure does not explicitly include fixed costs or frictions, and this assumption substitutes for some of these costs. The proposition below contains the crux of our story. We will use the terms insurance and hedging interchangeably. In this model, they serve the same purpose.

PROPOSITION 1

a) Assume any oligopolistic market, i.e. a situation in which two firms compete in a market and split some rents. Assume further a rational insurer (a counter-party for hedging). If one of the firms hedges output prices at any price greater than its marginal cost (by our assumption, MC=0), then the hedging firm will produce up to the point where the price reaches MC (here zero); the competing firm will be shut out of the market; no firm will make *any rents, the insurer breaks even and consumers will be better off. The outcome is similar in the case where both firms hedge, except that then both firms will be producing and earning zero profits.*

b) If a firm hedges specific quantities, then in the presence of uncertain demand, the firm will still over-produce in bad states of the world and lose rents relative to a non-hedged position. The insurer still breaks even.

Proof:

Assume two firms, a and b. Depending on our assumed market structure, they split the rents in different ways (Cournot, Stackelberg are the most common cases and will be discussed below). If one of the firms is guaranteed a fixed price P for its output, P>MC=0, then it will produce until demand is exhausted. We will call this quantity, at which the demand curve intersects the horizontal axis, Q*. At that point, the market price of the good is zero.

Assume now that firm 2 chooses to stay in the market. It can offer to sell at some price φ, φ > 0. The quantity it can sell at that price is at most less than Q*. However, firm 1 will sell at any price, and thus this price φ cannot be an equilibrium price. Therefore, the equilibrium price will have to drop to zero and firm b will have to exit the market (see assumption 2).

The insurer is assumed to be rational, and thus will anticipate the behavior of the hedging firm. It will charge PxQ* for the insurance and essentially pay it back to the firm after production has been completed[6]

Thus, the two firms will have lost all previous rents and the insurer will break even. Consumers are better off because under any oligopoly model they would have been offered a quantity < Q* at a price higher than zero, whereas now they are offered Q* at a price of zero.

This outcome cannot be prevented in equilibrium because of time inconsistency. Once hedging is done, the hedging firm will find it optimal to produce as much as possible.

If two firms hedge, then we are into a Bertrand type competition at a price of zero. Bertrand equilibrium generally assumes that firms split the market evenly and we will assume this here as well; however, as is the case in a general Bertrand equilibrium with fixed and equal marginal costs, any split of the market between the two firms will result in a similar outcome. Regardless of the split, both firms earn zero profits, as the insurer prices insurance rationally. The insurer breaks even again, and consumers gain as in the previous case.

To simplify the proof of part b) assume two equally likely states of the world (different levels of demand). The firm hedges the average quantity at the average price. In the high state, the equilibrium price is P_h and the optimal quantity for the hedging firm is Q_h*. In the low state, the equilibrium price is P_l and the optimal quantity is Q_l*. If MC is 0, then the expected profit is $(P_h Q_h* + P_l Q*_l)/2$. However, if the good state is realized, since

[6] There is a literature which suggests that managers hedge based upon market view - see Adam and Fernando, 2006, Geczy et al., 2007, and even Bodnar et al., 1998. Here we only assume that hedging is fairly priced, without taking a position as to why firms hedge. Of course, the analysis is very schematic - papers such as Adam and Fernando (2006) take a much more detailed look at hedging contracts and activity.

the firm hedged a lower price, it will not use the insurance. However, in the bad state of the world, the firm will use the hedge, and overproduce, lowering the price below the optimal level. More formally, denote the average price by P^. If P_l is realized, then the company will use the hedge, and instead of producing Q_l* will produce a higher quantity, Q^*. This will create a price drop to a new low level, $P_{tl\ (too\ low)}$. Since the insurance company breaks even, then the new profit will be (P_h Q_h*+ Q^*. $P_{tl\ (too\ low)}$)/2. The profit at the high state stays the same, but at the low state the hedging company is producing more at a lower price, which by definition lowers profits relative to the un-hedged position (if this were optimal, the firm would have produced at that level even with no hedging). Thus expected profit declines. The extreme case, where any quantity is eligible for the hedged price, was discussed in part a).

Corollary 1:

Assume two identical oligopolistic markets. In one market, firms hedge output. In another they do not. Firms that hedge outputs are weakly less profitable than firms that do not hedge.

The proof is obvious from the discussion above. If both firms do not hedge, then they are both profitable. If one firm hedges, the other one will be driven out of the market, and the firm we observe will be making zero profits. If both firms hedge, then both are driven to zero profits.

We will now illustrate the proposition with a Stackelberg game example.

An Example: A Stackelberg Game

We use numerical values for clarity of exposition, but the results generalize easily.

In every Stackelberg game, there are two players, a leader and a follower. Without loss of generality, a is the leader, b is the follower.

We assume a simple linear demand function, $P(Q) = 120+e -q_a- q_b$. e is the only uncertain element $E(e) = 0$, and it makes demand stochastic. However, as the firms are assumed to be risk neutral, it will not play much of a role here.

As per assumption 2, MC =0.

In a Stackelberg game, the leader chooses a quantity and the follower maximizes profit given the leader's quantity. Thus, if the leader produces q_a, then player b will produce:

$$q_b = 60- q_a /2 \qquad (4)$$

We now substitute this quantity into the expected profit function of player a to obtain:

$$\prod a = 120\, q_a - q_a^{\,2}- q_a\, (60- q_a /2).$$

Player a (the leader) will maximize $\prod a$ with respect to q_a.

In our simple numerical example we obtain that $q_a = 60$ and then $q_b =30$. The equilibrium price is P= 30. The leader earns 1800 and the follower 900.

We now assume that the leader can hedge prices at the expected level, 30. This will simplify the example, but obviously hedging at any positive price will do.

The leader's optimal policy becomes to sell as many units as he can, thus it will essentially flood the market with 120 units[7]. The price will drop to 0, and at that price the follower (per assumption 3) will drop out of the market and lose all rents. Given a marginal cost of 0, the leader will then sell 120 units and at the guaranteed price and will make 3600. b will be shut out.[8]

Consider now the cost of insurance (hedging). Since the price drops to 0, the insurer will have to refund the entire 3600 to the leader, a. A rational insurer will demand 3600 upfront and the leader will end up with no profit. The insurer breaks even. There is no better solution, since the problem is time inconsistent. Once insurance is purchased, the leading firm will flood the market with its product.

The only benefit accrues to consumers, who can now purchase 120 units at a price of 0 vs. 90 units at a price of 30 without hedging.

We should note that Stackelberg equilibrium in general does not explain why one agent is a leader and another is a follower. It is assumed. Therefore, if a follower hedges we essentially have to speculate how the equilibrium will evolve. One possibility is discussed below. Suppose b hedges at 30 as well. In this case, the situation reverts to a Bertrand type competition. As noted, in a Bertrand equilibrium the parties are usually assumed to split the market. In that case, each competitor makes 30x60 = 1800 and the insurance payment will be split as well, but the final outcome will be exactly the same- no producer makes money, the insurer breaks even and the consumers benefit. It is important to understand

[7] Since demand is stochastic, then actual demand will be 120 +e. The leader will observe this and produce 120+e. However, since everybody is risk neutral, we can continue with the example at the expected value.

[8] With somewhat less extreme assumptions regarding the cost of production, we will still see that qa increases production, and qb still maximizes (4), given the quantity produced by the hedger. If indeed qa will be larger, then qb will decrease accordingly.

that the result generalizes to an increasing marginal cost case, except that then the outcome is less extreme.

In the appendix we discuss an example of a Cournot equilibrium, with similar outcomes.

Continuing the example for part b), suppose that the leader is able to insure the exact (expected) optimal quantity at the exact price. Recall the demand function: P(Q) = $120+e - q_a - q_b$. Assume that e is equally likely to be +20 and -20.

Note that the only hedge the leader can buy without losing money is at the expected quantity, $q_a = 60$ and at the price P= 30.

If demand is low, namely $100 - q_a - q_b$, then $q_a = 50$ $q_b = 25$ P=25. However, given the insurance, the leader will have an incentive to produce up to 60 units at a price of 30 rather than 50 units at 25. If player a produces 60 units, player b will produce 30 units; with a total of 90 the market price will drop to 100-90=10 and the insurance will have to pay the difference, 1800-600= 1200. Again, a rational insurer will demand this in advance.

If demand ends up higher, at $140 - q_a - q_b$ then the leader will not use the hedge. He will produce 70, the follower will produce 35 and the price will be 35. Again, assuming a rational insurer, since the leader is committed to sub-optimal activities, then he will pay for it ex-ante. Under no insurance, the expected profit of the leader is 50x25 (= 1250) half of the time, and 70 x 35 (= 2450) half of the time. With insurance, he will make 70 x 35 (= 2450) half of the time and 60 x 30 (= 1800) half of the time, but the insurance will cost 1200 netting him only 925. Clearly, it is better to insure a specific quantity, however, it is even better not to insure at all.

We have shown so far that with rational players, hedging output prices will cut profits in a market where the players have market power because of the adverse production incentives created. Note also that in a Stackelberg situation the leader produces more and profits more than the followers. Thus hedging will create worse incentives for the firm with the larger market share.

Hedging prices is most common. However, some work assumes that firms can hedge output directly, that is, receive a fixed amount of money regardless of what is actually produced. However, hedging contracts represent a specific amount of underlying assets, thus to be more precise, total output hedging means hedging at a certain price for a specific quantity. We discuss this in proposition 2.

PROPOSITION 2

Assume any oligopolistic market. If a firm hedges total output (as opposed to hedging output prices) it will lose all rents in the presence of a rational insurer. The insurer again will break even (by assumption). If the second firm hedges too, all production will cease. If the second firm does not hedge it will become a monopoly. Either way consumers lose.

Proof: Assume that one firm in an oligopoly hedges its output. That is, it will receive a fixed amount F regardless of the price or quantity produced. Once insurance is purchased, a rational firm will produce 0 and the insurance company will make up the difference to F.

Again, assuming rational insurers, the insurance will require F upfront and the producing company will end up breaking even, as it pays F and receives F. The insurance company will break even too, as it takes the opposite position. Again, this is a time inconsistent problem, and this is the only sub-game perfect equilibrium. If we start with an oligopoly situation, then the second competitor finds itself alone in the market, producing essentially a monopoly output. If the second competitor hedges as well there will be no production. Thus consumers will have lost, either with lower production and higher prices than in the case of non-hedging oligopoly or with no production.

QED.

In a less extreme situation, the company can guarantee that it will produce at least Q. Then if Qx(realized)P<F the insurance company will make up the difference.

In that case, the hedging company will produce exactly Q and the analysis can proceed as in a Stackelberg case, where a follower assumes an output Q by the leader. Clearly the implications are less extreme.

In the setting discussed so far, hedging of (exogenously determined) input prices is a very different matter and risk neutral investors should be indifferent to such decisions since they cannot affect prices. Finally, we have assumed so far that there are no transaction costs. Obviously, costs will make hedging even less attractive (more costly).

To summarize, we conclude that risk neutral competitive firms should be indifferent to hedging input or output prices in competitive markets. In an oligopolistic setting, hedging output prices will be detrimental to the companies involved, but helpful to consumers. Hedging total output (which is not found in our empirical data) will be detrimental to hedging firms but also detrimental to consumers. The clear empirical implication is that output hedging in non-competitive markets creates adverse incentives and that everything else equal, firms that do that, will have lower profitability. In other words, the cost of output hedging for firms in non-competitive markets is higher and it increases with market shares.

Our main hypothesis is then:

Main Hypothesis

Firms in non-competitive industries should find output hedging costly, and losses should increase with market shares. In the same setting, however, they should be indifferent to input hedging.

Our model applies rather directly to commodity hedging. Many firms use commodities as inputs, other produce commodities. It will be much more difficult to apply this logic to other types of hedging, i.e. currency hedging or interest-rate hedging. While there are obviously input and output markets for firms that use currency hedging, no firm is actually producing currencies or using them as an input and also the firms in our sample have no market power in currency markets. Currency fluctuations may affect the prices of inputs and outputs, however, so we will try to explore the empirical implications and test them below.

When now proceed to the empirical analysis. We will of course include all control variables that were found to be significant by other research and generally represent frictions that can make hedging more desirable.

III. Data and Methodology

A. Data

Our database consists of hand-collected data from EDGAR and accounting data extracted from Compustat. We select firms from the S&P500 for the fiscal years 2001 to 2005. In 2001, the Financial Accounting Standards Board (FASB) implemented a new regulation regarding the disclosure of derivative instruments used for corporate hedging. The Statement of Financial Accounting Standards No.133 (SFAS133), "Accounting for Derivative Instruments and Hedging Activities," requires that all derivatives be recognized as assets and liabilities and measured at fair value. For corporate hedging data, foreign sales and managerial ownership, we use the same database as De Angelis and Garcia (2008). They obtain derivative ownership information from 10-k forms (annual reports) available at EDGAR Database provided by the U.S. Securities and Exchange Commission. Disclosures of financial instruments used are included in Item 7a, "Quantitative and Qualitative Disclosure about Market Risk," and in "Notes to Consolidated Financial Statements" in Item 8, "Financial Statements and Supplementary Data." These notes contain detailed descriptions of the types of instruments used in hedging and their purposes. We can thus find out whether the firm hedges against commodity risk or/and currency risk.

We also collect information on managerial ownership and foreign sales from EDGAR Database. Information pertaining to the holdings of the top five executives at each firm is found in the "Notice of Annual Meeting of Stockholders" (the proxy statement) on form DEF 14A. In this proxy statement, under the section of "Executive Compensation," companies disclose the market value of unexercised (exercisable and un-exercisable) options at fiscal year-end for the CEO and for their five most highly compensated executive officers. In the section "Information about Beneficial Ownership of Principal Stockholders and Management" in the proxy statement, firms report the amount and the type of ownership of different stockholders. Similar to other studies of executive compensation, we collect the total number of shares of stock that the top five named executive managers held and multiply it by the fiscal year-end stock price to get the managerial stock ownership. This data is often used in analysis of corporate governance and managerial compensation.

Since much of the work on hedging concludes that managerial motives are behind the hedging decisions of firms (see for example, Tufano, 1996, Ravid and Basuroy, 2004, Adam et al. 2009) we include these variables here.

Foreign sales represent the sum of the sales from countries other than the United States.

The other variables are obtained from Compustat. They are in general used as control variables to account for hedging motives mentioned in previous work: the book value of assets (Data6); the dividend yield, which is calculated as the annual dividend distributed per share (Data26) divided by the fiscal end year stock price stock price (Data199); the book value of equity which is calculated as the book value of assets minus intangible assets (Data33) minus total liabilities (Data181); the market value of equity which is calculated as the number of common shares outstanding (Data25) multiplied by the fiscal year-end stock price (Data199); research and development expenses (Data46), long term debt (Data9); current assets (Data4); inventories (Data3); current liabilities (Data5); total sales (Data12); and the net operating loss carry-forward (NOL) (Data52).[9]

We follow papers such as Graham and Rogers (2002), Adam and Fernando (2006) and Raman and Fernando (2010) and use debt equity ratio as a measure of possible distress costs (it is labeled "distress" in the latter paper). We use the quick ratio as an additional identifier of distress (See Raman and Fernando, 2010). Similarly, we follow Graham and Rogers (2002) and others in using NOLs as a tax variable, and we use book to market, R&D expenses and dividend ratio as other control variables.

We exclude the financial industry (SIC code 6000 to 6999) since firms in this industry are providers and users of derivatives, and since their quick ratios and foreign sales are estimated differently.

We now proceed to explain how we obtain our main hedging variables. As noted earlier, we analyze two common types of risk, namely, commodity risk and foreign exchange risk.

B. Identifying Input and Output Hedging for Commodity Price Risk

A key element of the analysis is identifying which firms hedge inputs and which ones hedge outputs. There is no direct reporting of the purpose of hedging and often no

[9] The research and development expenses and the net operating loss carry-forward variables have many missing values; these two variables are set equal to zero if the value was missing in the Compustat database. When research and development expenses and net operating loss carry-forward are material, firms are required to report them in their income statement. Therefore, these variables might not be reported when immaterial, and thus would be missing in the Compustat database (see, for instance, Loughran and Ritter, 1997).

clear distinction of the type that will help our analysis. However, we can proxy for input Commodity Hedgers by selecting industries that are extensive commodity users (Input Industries) whereas output commodity hedgers should be firms that are heavy commodity sellers (Output Industries). This is not a comprehensive classification- some firms may buy and sell commodities or may do neither. However, empirically, this distinction seems useful. We identify the industries using input output tables produced by the U.S. Bureau of Economic Analysis (BEA).[10] We construct the ratio of output produced by an industry to the total of commodities used in that industry as a measure of an “output” vs. an “input” industry. An industry which has a high ratio is identified as an output industry (a light user of commodities- potentially a seller of commodities) whereas an industry with a low ratio is identified as an input industry (a heavy buyer of commodities). For example, the electric power generation, transmission, and distribution industry has a ratio of 3.09 (electricity is a commodity they sell) whereas the automobile manufacturing industry, which is a heavy user of commodities, has a ratio of 1.33. We then examine hedging practices of the companies in our sample, and match them to the industry in question- if a firm in an “output” industry hedges commodities it be classified as an “output hedger”, whereas a firm in an “input industry” which hedges will be classified as “input hedger”. For example, we find that it is common practice for firms in the electric power generation industry to hedge against electricity price risk (i.e. the output price risk) while firms in the automobile industry hedge against steel price risk (i.e. the input price risk).

Naturally, this is a rather rough proxy; therefore, we use the extreme quartiles in most of our analysis.

[10] Studies in Finance and Economics have recently started using these tables, see for example, Acemoglu et al (2009) and Fan and Goyal (2006).

C. Identifying Input and Output Hedging for Currency Rate Risk

Hedging currencies does not amount to a full hedge of either input or output prices. In order to fully hedge output prices, a firm which sells or buys abroad needs to hedge both the currency risk and the price of the output in the domestic currency. For example, if a firm sells 50% of its production abroad, and it fully hedges its foreign exposure, the situation is equivalent to selling in local currency. However, this does not hedge the local sale price. Similarly, input price currency hedging is only equivalent to fixing the price in terms of local currency. Therefore, we expect the effect (if any) of pure currency hedging to be much weaker than the effect of commodity hedging. On the other hand, firms which sell or buy overseas and hedge both commodity and currencies are expected to behave as we predict.

We identify Input and Output Currency Hedging by selecting firms that have a large proportion of foreign assets (input) or a large proportion of foreign sales (output). Currency hedgers with a large proportion of foreign assets are more likely to hedge their inputs; while those with a large proportion of foreign sales are more likely to hedge their output. We define input hedgers (output hedgers) as firms in the upper quartile of our sample sorted by the ratio of foreign assets to total assets (by the ratio of foreign sales to total sales) which use derivatives to hedge against currency risk.

IV. Empirical Analysis and Results

A. Summary Statistics & Univariate Analysis

Table I contains summary statistics. It shows that 28% of the firms in our sample hedge commodity exposure and 59% hedge currency exposure. Many of these firms have market power- in fact; the average market share is 12% (the median is 19%, meaning that some firms have a large position in their respective markets). The value added ratio (output/input) varies widely; in other words, firms face very different incentives for hedging output versus input. Finally, firms have very different foreign exposure. This data set is thus very suitable to test our work and is one of the few datasets that spans different industries (see Tufano, 1996, Haushalter, 2000, Brown et al. 2006, Adam et al, 2006 and Adam et al. 2009 and Raman and Fernando, 2010, for work on a single industry, mostly gold mining).

[Insert Table I here]

Table II panel A classifies firms which hedge commodities by market power and by input/output ratios. Our model says that optimally, hedging firms are likely to be in competitive environments and are likely to hedge inputs. Firms in non-competitive environments with significant value added, are likely to hedge less. This preliminary analysis suggests that this is indeed the case. High market power firms tend to hedge inputs, whereas low market power firms behave very differently. Since our effect is obviously confounded by many other considerations, we look at the extreme quartiles in any classification. In output industries, 64% of the firms with low market power hedge commodity risk while only 18% of the firms with high market power choose to hedge. On the other hand, in input industries, 34% of the firms with low market power hedge commodity risk while 50% of the firms with high market power hedge commodity risk.

[Insert Table II here]

Table II panel B repeats the analysis for firms that hedge foreign currency and commodities. In general, foreign currency hedging may be different for reasons mentioned earlier. However, if our idea is correct, then firms which sell overseas, are apt to hedge both risks less if they have significant market power. We implicitly assume in this discussion that firms that have significant market power in the U.S. will also have significant market position abroad. Panel B provides this analysis. We consider firms that hedge currency risk among the firms that have non-zero foreign sales, i.e. where there is output exposure to foreign currency risk. The results are similar to the previous panel: Heavy commodity users with high market power are much more likely to hedge both currency and commodity risks than firms in output industries with foreign exposure.

Panel C considers foreign currency exposure in general. Firms with more foreign sales and more foreign assets are more likely to hedge, however, this seems to be true for all degrees of market power, less so for output than for input industries. This supports our view- in general, foreign currency hedging in itself may not fit in our model, and involves a mix of firms which hedge for reasons modeled in this paper and firms that hedge for a variety of other reasons in competitive markets.

B. Commodity Hedging

1. Subsample Analysis

We now test our hypothesis in a regression analysis. In order to test our main hypothesis, i.e. that "output" firms with greater market power are less likely to hedge, we estimate the following equation:

$$\Pr[y^i = 1 | x_1^i, Z^i] = G(\beta_0 + \beta_1 x_1^i + \delta Z^i)$$

Where $G(u) = \frac{\exp(u)}{1+\exp(u)}$, y^i is a dummy variable that takes the value 1 if the firm i hedges commodity risk, x_1^i is firm i market share, and Z^i is a set of firm i control variables and year controls. The set of control variables reflects previous work on the reasons for hedging, and includes firm size measured by the natural logarithm of book assets, the ratio of long-term debt to assets, the quick ratio, dividend yield, book-to-market ratio, the ratio of foreign sales to total sales, the ratio of foreign assets to assets, the natural logarithm of one plus the net operating loss carry forward, and the value of options and shares held by the top five executives of the firm.

Our main hypothesis predicts that β_1 should be negative for firms that hedge output and non-significant for firms that hedge inputs. As explained in the previous sub-section, we identify firms that hedge outputs as firms that are in an industry which has a high Output/Input ratio (light users of commodities - potentially sellers of commodities). Firms that are in an industry with a low ratio (buyers of commodities) are identified as input hedgers. We first run subsample analysis. We sort firms by the ratio of Output/Input and study each quartile separately. We report the results in Table III.

[Insert Table III here]

We find that firms which are in input industries (and therefore are more prone to hedge inputs) exhibit a positive and significant relation between the predicted probability of hedging commodity risk and their market share. On the other hand, firms in output industries (which therefore can hedge output) exhibit a negative and significant relation between the predicted probability of hedging commodity risk and firm's market share. These results are consistent with our model – firms are less likely to hedge output commodity risk when they have market power, while this relation reverses when they are likely to hedge input commodity risk. Firms that are in the 2nd and 3rd quartile of the distribution exhibit a negative but less significant relation, which is consistent with the fact that these firms might hedge both input and output.

The other control variables yield results similar to other work. Smith and Stulz (1985) were the first to suggest that bankruptcy costs and the tax function may provide good reasons for hedging. We find indeed that firms tend to hedge more the closer they are to distress and some of these results are significant (higher debt, lower quick ratio- see Graham and Rogers, 2002, Raman and Fernando, 2010). The tax variable is positive, similar to Mian, 1996- however, that variable seems to be somewhat problematic (see Graham and Rogers, 2002). The book to market variable is positive (see Graham and Rogers, 2002, Mian, 1996, or Adam et al. 2006). The R&D results are similar to Graham and Rogers (2002) - a negative relationship for commodity hedging and positive for currency hedging (see table 3 and footnote 20 in their paper and tables III, IV, and V in our work). Mian (1996) finds similar results regarding R&D but his book to market coefficient is negative. R&D and market to book are often interpreted as related to the Froot et al. (1993) theory, however, the interpretation and results are controversial and since this is not the focus of our study, we will just say that our results are similar to what others find. We may add that as far as we can tell, some of our findings support Froot et al. (1993) theories- one would expect firm with many projects to hedge more. Indeed, the only significant coefficient of that variable in our regressions (model 2) shows that high market to book firms tend to hedge more. However, high R&D may be related to harder to value investments and thus we would expect more hedging for such firms but we find that they hedge less often.

2. *Interaction Effects*

In this sub-section, we study the interaction effects, which represent the change in the predicted probability of hedging commodity price risk for a change in both firm's market power and type of industry (Output/Input). Our new empirical specification is in the following equation.

$$\Pr[y^i = 1 | x_1^i, x_2^i, Z^i] = G(\beta_0 + \beta_1 x_1^i + \beta_2 x_2^i + \beta_3 x_1^i x_2^i + \delta Z^i)$$

This equation is similar to the previous one, except that now we include the ratio of Output/Input (x_2^i) and also study the interaction between firm's market share and the ratio Output/Input ($x_1^i x_2^i$).

We predict that β_3 should be significant and negative. The results are reported in Table IV.

[Insert Table IV here]

Consistent with our model, we find that β_3 is significant and negative. However, the Logit regression is a non-linear model, and thus it is not necessarily true that the even if the coefficient is negative, interaction effects are negative for all variable values. To address this issue, we perform several tests. First, we run a linear probability model regression. This specification, which is often used for robustness (LPM model here) shows coefficients which are quiet close to the estimates that we have using the correct methodology.

Second, we employ the methodology proposed by Norton, Wang, and Ai (2004) to compute the interaction effects. As shown in Ai and Norton (2003), the marginal effect for a change in the interaction variable for two continuous variables is[11]:

$$\frac{\partial^2 G(u)}{\partial \mathrm{x}_1 \partial \mathrm{x}_2} = \beta_3\big[G(u)\big(1 - G(u)\big)\big] + (\beta_1 + \beta_3 x_2)(\beta_2 + \beta_3 x_1)[G(u)\big(1 - G(u)\big)(1 - 2G(u))]$$

where $\mathrm{G(u)} = \frac{\exp(\mathrm{u})}{1+\exp(\mathrm{u})} = \Pr[\mathrm{y^i} = 1 \big| \mathrm{x_1^i}, \mathrm{x_2^i}, \mathrm{Z^i}\big]$, and u denotes the regression specification. The above equation shows that the marginal effect depends on the value of the independent variables and thus even though β_3 is negative the marginal effect might be non-negative. Using the above equation, we compute the interaction effects for each of our sample firms (see Norton, Wang, and Ai, 2004). The mean of the interaction effect is significantly negative, which validates the conclusion from our Logit regression. Confirming our previous results, the interaction effect is negative for 93% of our sample firms.[12] We plot the sample firms interaction effects in Figure 1.

[Insert Figure 1 here]

Our evidence clearly confirms that firms in non-competitive output industries are less likely to hedge and it is consistent with our main prediction. To illustrate the economic significance of these results, we show in Figure 2 how the odds of hedging commodity risk change for a 10% increase in market share as a function of the type of industry

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[11] This methodology was used recently in a paper by Lel and Miller (2008, Journal of Finance).

[12] In unreported results, we also find that most of the z-statistics associated to the marginal effects are below -2, which indicate that the interaction effects are significant.

(Output/Input). The computation is based upon the results reported in Table V (3rd specification) for an average firm. For instance, for a firm in an output industry, if its market shares increase by 10%, then the odds of hedging commodity risk decrease by 50%; while in an input industry these odds will not change significantly (odds increase by 5%).

[Insert Figure 2 here]

C. Currency Hedging

Table V describes our currency hedging results and it is indeed murkier, both theoretically and empirically. We first study the decision to hedge currency rate risk. We identify input and output currency hedging by selecting firms that have a large proportion of foreign assets (input) or a large proportion of foreign sales (output). Results are consistent with our model and significant in the linear probability model. The interaction variable of “output” with market power is negative, as expected, but not significant in the logit regression. In a way, the fact that the results are weaker supports the model, since our prediction is that currency hedgers will include firms that hedge for reasons our model incorporates, as well as firms which hedge for other reasons. The results in the 2nd specification say that if market share increases by 10%, then the odds of hedging currency risk increases by 2.6% if the firm had large foreign sales (output) and 14.8% if the firm has large foreign assets (input). In the last two specifications, we study firms which hedge currency risk only, commodity risk only, or both risks. The dependent variable equals zero if the firm doesn’t hedge, equals one if the firm hedges currency risk or commodity risk, and equals two if the firm hedges currency risk and commodity risk. We employ ordered logit regression since the dependent variable can take the value 0, 1, and 2. The results are consistent with our model. Firms in output industries hedge both currencies and commdities less when they have market power.

[Insert Table V here]

Our currency hedging findings also agree with the thrust of such papers as Geczy et al. (1997) or Allayanis and Weston (2001). These papers show that foreign exposure is important in the decision to hedge and that managerial variables may matter, which is what we find as well. Geczy et al. (1997) also take competition into account but in a different way. As noted earlier, our findings regarding the R&D variable are similar to those by Graham and Rogers (2002).

V. Conclusion

This paper shows that hedging can create adverse incentives depending on market structure and tests this idea empirically. A very simple theoretical model concludes that in an oligopolistic setting, output hedging creates detrimental incentives, whereas input hedging does not. Hedging is a matter of indifference for firms in competitive industries. Thus the cost of hedging outputs in non-competitive industries is large and firms in such situations are expected to hedge less.

We test this prediction on a sample of S&P500 firms from 2001 to 2005. We show that firms with high market power are more likely to hedge commodity price risk if they use them as inputs rather than if they produce them as outputs, consistent with our model. These results are robust to various econometric specifications and also robust when considering currency hedging.

VI. APPENDIX: A Cournot Example.

This example will show that non-competitive hedging of output is sub-optimal in a Cournot setting. As we recall, using the notation in Section II, a Cournot equilibrium implies:

$$\tilde{p} = \tilde{\theta} - (q_i + q_j)$$

The new (risk neutral) firm optimization problem is:

$$\max_{\{q_i\}\in\mathbb{R}_+} \left(E[\tilde{\theta}] - (q_i + q_j)\right) \cdot q_i - E[\tilde{r}] \cdot q_i^2 \qquad (1)$$

The FOC of the firm optimization problem will characterize the reaction function:

$$q_i(q_j) = \frac{E[\tilde{\theta}] - q_j}{2 + 2 \cdot E[\tilde{r}]} \qquad (2)$$

Thus,

$$q_i = q_j = E(\theta)\,[1 + 2\,E(r)] / \{[2+2\,E(r)]^2 - 1\} \qquad (3)$$

Again, we will assume some numerical values so as to provide a simple solution. If we assume that the cost E(r)=0, and that E (θ) = 120, we easily solve for the Cournot quantity, qi = qj = 40. The equilibrium price is 40 as well. Each firm earns a profit of 40 x 40 = 1600.

Now, assume that one of the firms hedges its inputs. This implies that in equation (2) and (3) E(r) is replaced by a known r. Since the firm has no control over input prices and is risk neutral, there will be no effect on its decision variable, which is the quantity produced.

Consider however, what happens if the firm hedges its output prices.[13] In that case, θ will become a fixed number, say P independent of the production of the other party. Therefore the optimization problem in equation (1) for the hedging party becomes:

$$\text{Max } (P \text{ x } q_i \text{ - } r \text{ x } q_i^2)$$

Thus P= 2rq and simply,

$$q = P/2r \qquad (4)$$

In the simple numerical example we provided, then, as in the case of a Stackeleberg equilibrium (which is more interesting in this context), we reach a corner solution (since the MC is zero). Thus, the hedging firm will again saturate the market at 120 units. If it hedges at the Cournot price of 40, then it will be owed 4800 from the insurance company, which will charge as much upfront. The second competitor will leave the market. Again, consumers will gain, firms will lose and the insurance company breaks even. It is trivial to see that if the second company hedges as well, then the situation will revert to a Bertrand competition, as discussed in the Stackelberg case, and then, again, the competitors lose, the insurance company breaks even, and the consumers gain.

[13] For simplicity we will assume that inputs are hedged too.

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Table I
Summary Statistics

Table I provides summary statistics of variables used in this study for a sample of non-financial S&P500 firms for the years 2001 to 2005. COM and FX are indicator variables if the firm is hedged for commodity and foreign exchange respectively. MarketPower is firm's sales divided by total sales of the industry (industries are classified by 4 digit SIC code). Output/Input is the total of output of the industry divided by the total of input of the industry (detailed IO industries according to the BEA classification). LogAssets is the natural logarithm of the book value of assets. LTDebt/Assets is the long term debt divided by the book value of assets. QuickRatio is the ratio of current assets minus inventories by current liabilities. DivYield is the annual dividend distributed per share divided by the end-year stock price. BV/MV is the book value of equity divided by the market value of equity. RD/Assets is the research and development expenses divided by the book value of assets. ForeignS/S is foreign sales divided by total sales. ForeignA/A is foreign assets divided by total assets. LogNOL is the natural logarithm of one plus the net operating loss carry forward. MngrOption is the total market value of options held by the top five executives at the firm. MngrStock is the total market value of stocks held by the top five executives at the firm.

Stats	N	Median	Mean	SD	Min	Max
COM	1912	0.00	0.28	0.45	0.00	1.00
FX	1912	1.00	0.59	0.49	0.00	1.00
MarketPower	1881	0.12	0.19	0.21	0.00	1.00
Output/Input	1875	1.92	2.10	0.70	1.05	5.52
LogAssets	1911	8.92	8.97	1.18	5.56	13.53
LTDebt/Assets	1900	0.20	0.21	0.15	0.00	1.32
QuickRatio	1912	1.06	1.45	1.57	0.04	20.36
DivYield	1912	0.90	1.41	1.77	0.00	18.13
BV/MV	1912	0.36	0.46	0.71	-1.78	24.81
RD/Assets	1911	0.00	0.03	0.05	0.00	0.60
ForeignS/S	1903	0.25	0.28	0.24	0.00	1.00
ForeignA/A	1897	0.06	0.12	0.16	0.00	0.89
LogNOL	1912	0.00	1.95	2.81	0.00	9.89
MngrOption	1896	22.66	47.65	74.81	0.00	713.21
MngrStock	1900	74.17	338.46	2601.24	0.00	66423.87

Table II
Proportion of Hedgers by Market Power and Output/Input

Panel A: Proportion of firms that hedge commodity risk

Panel A provides proportions of commodity hedgers for a sample of non-financial S&P500 firms for the years 2001 to 2005. Market Power is firm's sales divided by total sales of the industry (industries are classified by 4 digit SIC code). Output/Input is the total of output of the industry divided by the total of input of the industry (detailed IO industries according to the BEA classification).

		Output/Input					
		1st Quartile (heavy commodity users)		Last Quartile		Total	
Market Power	First (low) Quartile	Mean 34.38%	N 64	Mean 64.44%	N 135	Mean 30.36%	N 471
	Last (high) Quartile	Mean 49.65%	N 143	Mean 17.59%	N 108	Mean 30.36%	N 471
	Total	Mean 42.01%	N 457	Mean 33.18%	N 434	Mean 27.51%	N 1912

Panel B: Proportion of firms that hedge Commodity & Currency Risk by Market Power and Output/Input

Panel B provides proportions of firms that hedge both commodity price risk and currency exchange risk for a sample of non-financial S&P500 firms for the years 2001 to 2005 with foreign exchange exposure (i.e. foreign sales greater than zero). Market Power is firm's sales divided by total sales of the industry (industries are classified by 4 digit SIC code). Output/Input is the total of output of the industry divided by the total of input of the industry (detailed IO industries according to the BEA classification).

		Output/Input					
		1st Quartile (heavy commodity users)		Last Quartile		Total	
Market Power	First (low) Quartile	Mean 10.71%	N 56	Mean 35.71%	N 56	Mean 12.92%	N 325
	Last (high) Quartile	Mean 40.56%	N 143	Mean 19.28%	N 83	Mean 29.44%	N 428
	Total	Mean 32.94%	N 425	Mean 21.64%	N 231	Mean 21.16%	N 1498

Panel C: Proportion of Hedgers by Market Power and Foreign Sales-Assets Proportion

Panel C provides proportions of currency hedgers for a sample of non-financial S&P500 firms for the years 2001 to 2005. MarketPower is firm's sales divided by total sales of the industry (industries are classified by 4 digit SIC code). ForeignS/S is foreign sales divided by total sales. ForeignA/A is foreign assets divided by total assets.

		ForeignS/S				**ForeignA/A**					
		1st Quartile		Last Quartile		1st Quartile		Last Quartile		Total	
Market Power	First Quartile	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
		15.52%	174	71.21%	132	12.21%	172	66.67%	81	43.95%	471
	Last Quartile	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
		12.00%	50	94.57%	129	12.50%	56	86.03%	136	73.88%	471
	Total	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
		9.68%	475	84.24%	476	10.74%	475	76.58%	474	58.73%	1912

Table III
Output/Input Commodity Hedging & Market Power – Subsample Analysis

Table III shows the results of four Logit regressions. The dependent variables are indicator variables if the firm is hedged for commodity risk (COM). The other variables are defined in Table I. Year fixed effects are included in the regressions. Robust standard errors are reported in parentheses. We indicate by *** if the p-value is less than 0.01, ** if less than 0.05, and * if less than 0.1.

	Subsample sorted by Output/Input			
Quartile:	1st (low) Input Industries	2nd	3rd	4th (high) Output Industries
VARIABLES	Logit COM	Logit COM	Logit COM	Logit COM
Market Power	1.183**	-0.166	-2.303*	-3.637***
	(0.531)	(0.751)	(1.203)	(1.102)
LogAssets	1.052***	0.402*	0.434**	1.350***
	(0.159)	(0.232)	(0.183)	(0.263)
LTDebt/Assets	-0.509	-0.537	0.535	7.398***
	(1.276)	(1.727)	(0.979)	(1.799)
QuickRatio	-0.996**	-0.737***	-0.115	-0.0806
	(0.404)	(0.277)	(0.133)	(0.537)
DivYield	0.315**	0.170	0.130	0.404***
	(0.125)	(0.151)	(0.142)	(0.132)
BV/MV	0.0893	-2.301*	0.545	0.587
	(0.398)	(1.198)	(0.451)	(0.661)
RD/Assets	-15.13***	-0.426	-59.65***	-64.17***
	(5.649)	(2.735)	(7.020)	(15.10)
ForeignS/S	-2.989***	-6.604***	4.466***	0.286
	(0.802)	(1.456)	(1.020)	(0.844)
ForeignA/A	1.829	3.356***	-1.326	3.683**
	(1.392)	(1.155)	(1.252)	(1.824)
LogNOL	0.0630	0.195***	0.0703	0.0965
	(0.0464)	(0.0728)	(0.0510)	(0.105)
MngrOption	0.00167	0.00425	-0.00218	0.00203
	(0.00288)	(0.00371)	(0.00266)	(0.00438)
MngrStock	-0.00592***	-0.000911*	-0.00148**	4.92e-05
	(0.00104)	(0.000521)	(0.000725)	(3.11e-05)
Observations	472	379	509	468
Pseudo R-squared	0.428	0.249	0.321	0.58

Table IV
Output/Input Commodity Hedging & Market Power – Interaction Effects

Table IV shows the results of three Logit regressions and one linear probability model (L.P.M.) regression. The dependent variables are indicator variables if the firm is hedged for commodity risk (COM). The other variables are defined in Table I. Year fixed effects are included in the regressions. The interaction effect represents the change in the predicted probability of hedging commodity price risk for a change in both firm's market power and type of industry (Output/Input). It is estimated using the methodology by Norton, Wang , and Ai (2004). Robust standard errors are reported in parentheses. We indicate by *** if the p-value is less than 0.01, ** if less than 0.05, and * if less than 0.1.

	Logit	Logit	Logit	L.P.M.
VARIABLES	COM	COM	COM	COM
MarketPower*Output/Input			-1.925***	-0.320***
			(0.532)	(0.0569)
Output/Input		-0.733***	-0.330**	-0.00902
		(0.104)	(0.138)	(0.0177)
Market Power	-0.355	-0.578*	2.897***	0.490***
	(0.320)	(0.324)	(0.964)	(0.127)
LogAssets	0.581***	0.637***	0.643***	0.0937***
	(0.0727)	(0.0802)	(0.0813)	(0.00989)
LTDebt/Assets	2.358***	2.289***	1.892***	0.319***
	(0.483)	(0.542)	(0.556)	(0.0670)
QuickRatio	-0.448***	-0.506***	-0.506***	-0.00244
	(0.147)	(0.157)	(0.158)	(0.00395)
DivYield	0.414***	0.427***	0.407***	0.0708***
	(0.0582)	(0.0602)	(0.0615)	(0.00914)
BV/MV	0.384*	0.202	0.0932	0.0180
	(0.217)	(0.234)	(0.217)	(0.0198)
RD/Assets	-19.68***	-24.93***	-26.22***	-1.072***
	(2.858)	(3.410)	(3.369)	(0.215)
ForeignS/S	0.665*	0.314	0.395	-0.0723
	(0.375)	(0.415)	(0.414)	(0.0554)
ForeignA/A	1.191**	0.826	0.890	0.185**
	(0.518)	(0.568)	(0.560)	(0.0752)
LogNOL	0.0700***	0.0525**	0.0571**	0.00934***
	(0.0239)	(0.0253)	(0.0257)	(0.00355)
MngrOption	-0.000835	-0.000593	-0.000460	-6.30e-05
	(0.00130)	(0.00144)	(0.00141)	(0.000107)
MngrStock	-0.000141	-0.000168	-0.000167	-5.34e-06**
	(0.000246)	(0.000298)	(0.000277)	(2.12e-06)
Observations	1828	1828	1828	1828
Pseudo R^2/R^2	0.290	0.314	0.322	0.296
Mean Interaction Effects			*-0.2181****	
			(0.0045)	

Table V

Additional Tests concerning Currency Hedging

Table V shows the results Logit regressions, linear probability model (L.P.M.) regression and ordered Logit regressions (O. Logit). The dependent variables are indication variables if the firm is hedged for currency risk (FX), and the number of risks hedged (FX+COM). OutputFX and InputFX indicate if the firm is in the last quartile of ForeignStoS and ForeignAtoA respectively. The other variables are defined in Table I. Year fixed effects are included in the regressions. Robust standard errors are reported in parentheses. We indicate by *** if the p-value is less than 0.01, ** if less than 0.05, and * if less than 0.1.

VARIABLES	Logit FX	Logit FX	L.P.M. FX	O. Logit FX+COM	O. Logit FX+COM	L.P.M. FX+COM
MktPow.*Out./Input					-1.082***	-0.307***
					(0.308)	(0.0733)
Output/Input					-0.539***	-0.138***
					(0.104)	(0.0256)
OutputFX*MktPow.		-0.968	-0.337***	-0.533		
		(0.653)	(0.0646)	(0.414)		
InputFX*MktPow.		0.163	0.0316	-0.189		
		(0.666)	(0.0820)	(0.488)		
MarketPower	1.144***	1.221***	0.294***	0.527*	2.104***	0.623***
	(0.310)	(0.323)	(0.0556)	(0.289)	(0.629)	(0.159)
LogAssets	0.323***	0.328***	0.0483***	0.416***	0.470***	0.136***
	(0.0627)	(0.0631)	(0.00958)	(0.0484)	(0.0514)	(0.0137)
LTDebt/Assets	-0.111	-0.115	-0.0144	1.047***	0.897**	0.284***
	(0.471)	(0.477)	(0.0776)	(0.399)	(0.406)	(0.108)
Quick Ratio	-0.305***	-0.310***	-0.0448***	-0.204***	-0.230***	-0.0505***
	(0.0663)	(0.0680)	(0.00774)	(0.0464)	(0.0495)	(0.00882)
DivYield	0.137***	0.138***	0.0252***	0.375***	0.375***	0.0960***
	(0.0383)	(0.0382)	(0.00690)	(0.0481)	(0.0490)	(0.0127)
BV/MV	-0.385**	-0.373**	-0.0592*	-0.0162	-0.183	-0.0623*
	(0.191)	(0.185)	(0.0309)	(0.111)	(0.120)	(0.0359)
RD/Assets	6.702***	6.710***	1.238***	1.626	0.491	0.00575
	(2.029)	(2.033)	(0.235)	(1.091)	(1.169)	(0.319)
ForeignS/S	6.238***	6.442***	1.082***	3.701***	3.057***	0.803***
	(0.470)	(0.524)	(0.0572)	(0.299)	(0.288)	(0.0726)
ForeignA/A	-0.0501	-0.140	0.0443	0.932**	0.631*	0.210**
	(0.551)	(0.616)	(0.0814)	(0.380)	(0.359)	(0.0985)
LogNOL	0.0457*	0.0438*	0.00684*	0.0658***	0.0593***	0.0146***
	(0.0244)	(0.0244)	(0.00364)	(0.0188)	(0.0196)	(0.00523)
MngrOption	0.000773	0.000718	6.21e-05	0.000255	0.000539	8.28e-05
	(0.000912)	(0.000911)	(0.000141)	(0.000673)	(0.000675)	(0.000181)
MngrStock	3.80e-05*	3.72e-05*	5.77e-06***	7.79e-06	1.27e-05*	2.30e-06
	(2.08e-05)	(2.07e-05)	(1.80e-06)	(6.00e-06)	(6.95e-06)	(1.95e-06)
Observations	1838	1838	1838	1838	1828	1828
Pseudo R^2/R^2	0.287	0.288	0.327	0.170	0.200	0.329

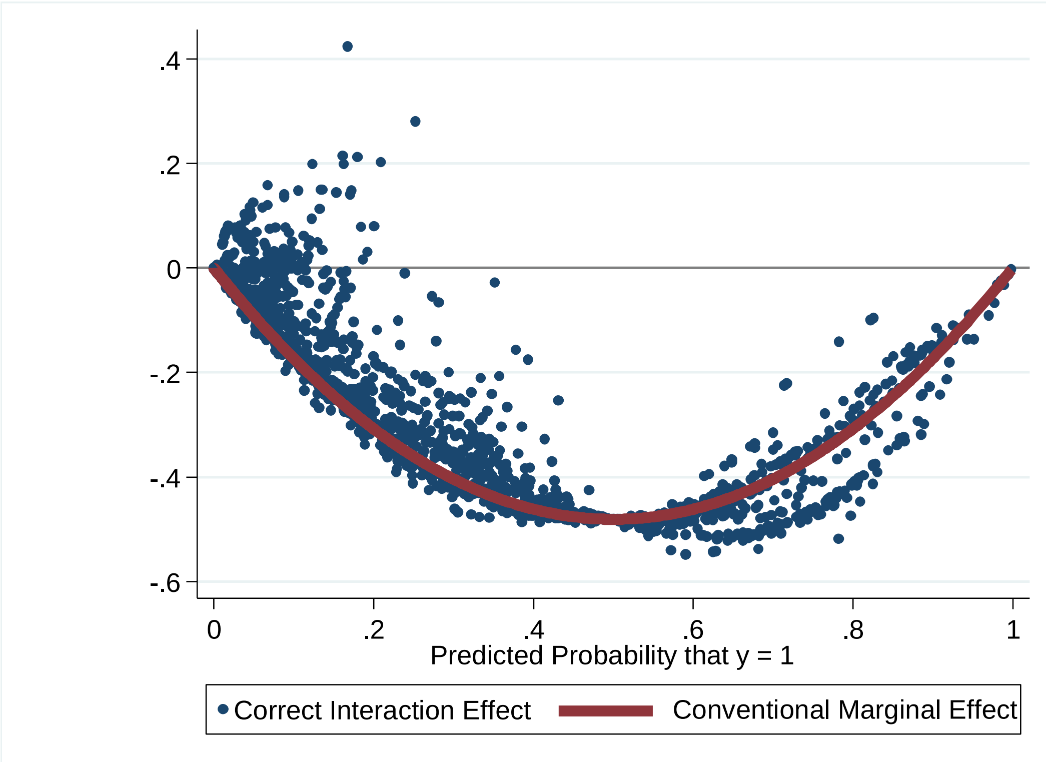

Figure 1. Interaction Effects in the Logit Regression. Figure 1 plots the interaction effects as reported in Table V (3rd specification). The interaction effect represents the change in the predicted probability of hedging commodity price risk for a change in both firm's market power and type of industry (Output/Input). We plot the interaction effect for any level of predicted probability of hedging commodity price risk (X-axis). The points (correct interaction effect) are estimated using the method proposed by Norton, Wang, and Ai (2004) while the thick line represents the interaction effects using the conventional linear method.

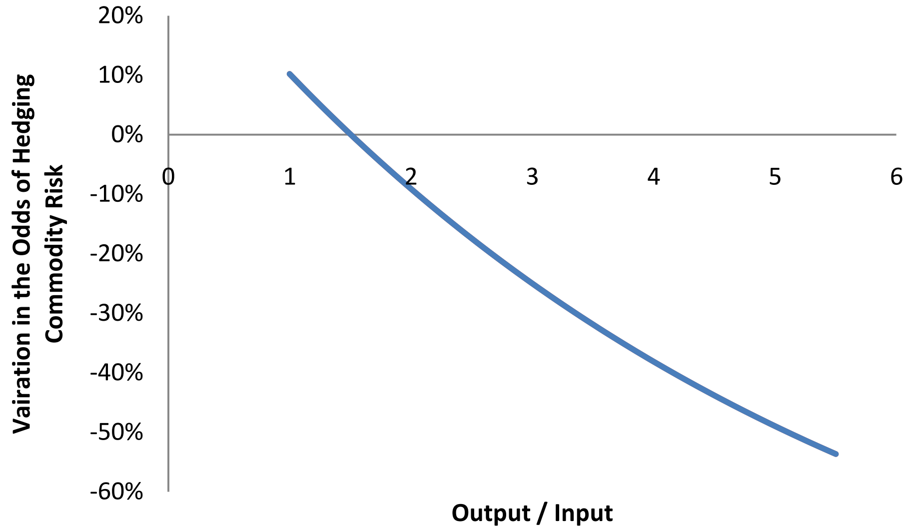

Figure 2. Variations in the Odds of Hedging Commodity Risk for a 10% increase in Market Share. Figure 2 shows how the odds of hedging commodity risk change for a 10% increase in market share as a function of the type of industry (Output/Input). The computation is based on the results reported in Table V (3rd specification) for an average firm.