Does Risk Management Affect Firm Value? Evidence from a Natural Experiment*

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Abstract

We study how hedging affects firm value and real investment activity. We obtain exogenous variation in access to effective hedging instruments from the unexpected breakdown in the correlation of Canadian oil prices with the benchmark oil price used in NYMEX hedging contracts. Using a difference-in-differences framework we compare Canadian oil producers to their U.S. counterparts, who maintain access to effective hedging instruments. We find that affected firms significantly reduce their capital expenditures. We further show that reduced investment and lower firm valuation is driven by firms with higher leverage, as predicted by theory. Overall, our results provide evidence that hedging affects firm value by alleviating the costs of financial distress and the underinvestment problem.

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1 Introduction

Is hedging valuable? If so, what are the channels through which it affects firm value? In the presence of market imperfections, hedging can be valuable as it allows firms to reduce the probability of entering into costly financial distress (e.g. Smith and Stulz (1985)). Hedging can also help ensure that a firm will have enough internal cash flow and access to external capital to fund attractive investment opportunities, thereby alleviating the underinvestment problem (e.g. Froot et al. (1993), Bessembinder (1991)). In practice the use of derivatives for hedging is widespread, for example, 94% of Fortune Global 500 companies report using derivatives to manage risks.[1] Finance theory provides clear motivations for hedging and while there is widespread adoption of hedging technology, obtaining direct evidence on the causal effect of hedging on firm value and real investment decisions has been challenging. Because hedging decisions and investment policies are endogenously determined, the empirical challenge is to obtain exogenous variation in hedging.

Our contribution to the literature is to use a research design that allows us to establish a causal link between hedging, firm value and real activities. Our empirical design is constructed around a natural experiment in which a set of firms suffer from an exogenous restriction in the use of effective hedging instruments. We then compare firm value and investment decisions for these treatment firms relative to control firms, whose access to effective hedging instruments remains unchanged.

Our natural experiment is based on unexpected events in the North American oil industry, and exploits the difference in the prices at which firms sell their oil (physical delivery) and the underlying price at which they can hedge their oil (financial contract). This is known as basis risk. Specifically, firms in the North American oil industry rely on NYMEX derivatives contracts, which are linked to the benchmark price of West Texas Intermediate (WTI) oil, with a delivery point of Cushing, Oklahoma. However, because oil firms may produce and sell a product geographically far from this delivery point, the effectiveness of their hedging program is based on the correlation between the realized price for their oil and WTI prices.

[1] This figure is based on survey data from the International Swaps and Derivatives Association (ISDA).

Our main comparison in this study is made between U.S. oil producers and Canadian oil producers. The effectiveness of WTI-based hedging tools for Canadian producers relative to their U.S. counterparts is measured by the R^2 of the regression explaining changes in Canadian light oil prices, as proxied by Edmonton Par prices, with changes in WTI prices.[2] The R^2 stands at 0.54 during the pre-event window. We show that this measure of relative hedging effectiveness exhibits a sudden drop as of the first quarter of 2012 due to unexpected infrastructure issues and pipeline capacity constraints.[3]

Between the second quarter of 2012 and the end of the first quarter in 2013 (the post-event window), the R^2 between Edmonton Par and WTI prices drops by half to 0.26. This significant increase in basis risk renders WTI-based hedging instruments significantly less effective for Canadian producers. We show that Canadian producers reduce their use of hedging instruments following the shock. We use this event to identify the effect of hedging on firm value and real activities by comparing Canadian light oil producers (treatment firms) to otherwise similar U.S. oil producers (control firms), both before and after this basis risk shock in a difference-in-differences (DD) framework.

In terms of real effects, we find that the reduction in hedging effectiveness causes treatment (Canadian) firms to lower their capital expenditures in the post-event period. Treatment firms reduce their capital expenditures by 29% relative to the average firm investment levels in the sample. Changes in firm value, as proxied by Tobin's Q, as well as cumulative stock returns following the increase in basis risk are not statistically significant for the sample of treatment firms as a whole. The reason for this result lies in the fact that there is considerable heterogeneity among Canadian firms along one key dimension: Leverage.

Finance theory predicts that hedging is particularly important for reducing the probability of distress and for accessing external capital. Therefore, if the effectiveness of hedging

[2] The effectiveness of a hedging instrument is typically measured by the R^2 of the regression explaining changes in the prices of the underlying asset being hedged with changes in the prices of the benchmark asset used in the financial hedging contracts (e.g. Johnson (1960) and Ederington (1979)).

[3] The rapidly growing domestic oil production in North America has led to an unprecedented tightening in takeaway capacity by pipeline and rail, in particular for Canadian oil. New pipelines, such as the Keystone XL pipeline, take time to build and face significant regulatory hurdles. The U.S. Energy Information Administration (EIA) expects volatility in prices from Canada and the Bakken to persist relative to WTI prices. See for instance: http://www.eia.gov/todayinenergy/detail.cfm?id=10431.

instruments is reduced, firms that have higher ex ante leverage are expected to be relatively more affected by the shock. To directly test this hypothesis, we perform a triple difference (DDD) test. We implement this test by splitting both our treatment and control sample into high and low leverage firms, defined as being above (respectively below) their median group leverage prior to the shock. We find that both investments and firm valuation are significantly lower for the subgroup of highly leveraged treatment firms. Specifically we find that high leverage firms that suffer reduced effectiveness in hedging exhibit a stock performance that is 30% worse than high leveraged firms that maintain access to hedging (control group). Investment is also lower for firms with high leverage and reduced access to hedging, as they invest 56% less relative to the average investment level in the sample.

The fact that low leverage treatment firms significantly outperform high leveraged treatment firms is consistent with predation effects among Canadian oil producers. Leverage and financial constraints are often associated with competitive effects within a given industry (e.g. Bolton and Scharfstein (1990)). A significant reduction in hedging effectiveness leads affected firms to be more exposed to financial distress risk, therefore, we would expect firms with ex ante low leverage to become relatively better positioned to compete on factor markets such as land, labor and capital. To test this predation-based hypothesis, we analyze asset sales patterns following the shock. In particular, we find that high leverage treatment firms have on average significantly higher net asset disposition levels than low leverage treatment firms. This result is consistent with predation effects having a material impact on Canadian oil producers following their reduced ability to hedge effectively.

An underlying assumption of the differences-in-differences framework is that, in the absence of treatment, both treatment and control firms would have exhibited similar trends; this assumption is often referred to as the "parallel trends" assumption. By construction, our treatment and control firms are similar in many aspects; Haushalter (2000) and Jin and Jorion (2006) highlight a considerable degree of homogeneity within the oil and gas industry. Specifically, all producers share a common exposure to oil price risk, and this exposure is the main source of business risk for this industry. Second, their technology and cost structure are similar. Third, prior to the shock under study, all producers have access to a common set of financial hedging instruments. As such, we would expect these firms to behave similarly in the absence of treatment.

One approach to provide evidence supporting the parallel trend assumption is to test whether firms behave similarly in the years prior to the event (see Roberts and Whited (2012)). We have two different pieces of supporting evidence towards the parallel trends assumption. First, we directly test whether U.S. and Canadian firms have similar investment trends prior to 2012. We compare capital expenditures in 2010 with capital expenditures in 2011 in a placebo test. We find no difference in investment policies in this case. Our second piece of evidence relates to firm valuation and stock price changes. Both U.S. and Canadian firms exhibit very similar stock price movements in 2011, it is only in the first quarter of 2012 that there is a divergence in stock prices. This suggests that the underlying operations of these firms are very similar in the run-up to the price dislocation and removal of effective hedging instruments for Canadian firms. Taken together, these different pieces of evidence suggest that had Canadian firms not been differentially affected by the significant increase in basis risk, it is likely both sets of firms would have had similar real investment and valuations.

Standard falsification tests (placebo tests) allow us to tackle unobserved heterogeneity between treatment and control firms (parallel trend assumption). However, they do not rule out confounding explanations specific to the Canadian price dislocation we analyze in this study. For instance, it could be that the drop in stock price valuation and investments is due to the fact that the investment opportunity set is permanently lower for Canadian firms as of Q1 2012. We address this issue in several ways. First, we highlight that there are many time periods between the first quarter of 2012 and the third quarter of 2013 when the differential between Edmonton Par (Canadian light oil crude index) and WTI is reduced down to marginal levels. Investments and valuation do not recover during these periods leading us to believe that the effect is not related specifically to episodes of greater price discounts. Second, we compare the results during our event to those obtained from running the same tests during the biggest price drop in oil over the last decade in 2008, a period during which the correlation between Canadian oil prices and WTI was much higher. During the oil price crash of 2008, we find that highly leveraged Canadian producers do not differ significantly from low leveraged Canadian producers within our treatment group. This result is consistent with the fact that the differences in behavior observed between high and low leverage Canadian firms after the 2012 dislocation is not caused by worse investment opportunities for Canadian firms. Lastly, we run our main DD and DDD tests, whereby we shift the pre-period window by two quarters. In doing so, we closely match the average crude oil prices during the pre-period with the average crude oil prices from the post-period (1.7% difference). As such, we remove the direct price impact between the pre and post period of our main specification. Our results are almost unchanged using this new pre-period window. We conclude that the significant increase in basis risk is a significant driver behind our results.

Overall, our analysis highlights the importance of basis risk for corporate hedging policies. Basis risk renders hedging policies less effective, which in turn can have dramatic effects for highly leveraged firms. By guaranteeing a certain amount of internal cash flow and lowering a firm's cost of debt, Stulz (1996) shows that firms can use hedging to increase their leverage. If holding more debt increases firm value, through tax shield benefits for instance, hedging can help a firm maximize its value. Conversely, if the hedging policies in place are rendered ineffective by an increase in basis risk, a highly leveraged firm will find itself exposed to potential financial distress and underinvestment costs that will negate the benefits of debt and adversely impact its firm value.

The existing literature has documented that hedging practices are consistent with theoretical arguments for hedging (e.g. Mian (1996), Géczy et al. (1997), Haushalter (2000)). However, the evidence on the impact of hedging on firm value remains mixed. Jin and Jorion (2006) and Guay and Kothari (2003) find no relation between firm value and hedging while Allayannis and Weston (2001), Carter et al. (2006) and more recently Pérez-González and Yun (2013) find a positive relation between hedging and the use of financial derivatives. In terms of the real effects of hedging on firms, Cornaggia (2013) shows that agricultural producers who benefit from the introduction of an insurance instrument for their crops increase their productivity. Campello et al. (2011) show empirically that hedging lowers the cost of debt and reduces the number of restrictive covenants put in place, which in turn improves the firm's ability to invest.

Endogeneity concerns due to omitted variables are problematic for the interpretation of results in this literature. An omitted variable, such as management's intrinsic quality, might lead a firm to hedge more and take other corporate actions that lead to a higher firm valuation. If that is the case, then we run the risk of identifying spurious correlations. Both Pérez-González and Yun (2013) and Cornaggia (2013) make strides in addressing these endogeneity concerns. Recent work by Cornaggia (2013) offers compelling new evidence by analyzing the impact of the introduction of crop insurance policies. Using a triple difference-in-differences framework in the context of the introduction of crop insurance policies, he shows that hedging improves the productivity of agricultural firms who benefit from these new policies. Pérez-González and Yun (2013) provide evidence that the introduction of weather derivatives increase investment and firm value for regulated utilities. Importantly, rather than focusing on the introduction of derivatives, our setting focuses on the withdrawal of effective hedging instruments and in doing so we document much larger economic magnitudes than the existing literature. Overall, our results provide important empirical validation of optimal hedging theories based on financial distress.

The paper proceeds as follows. In Section 2, we provide details on our data. In Section 3, we discuss our empirical methodology. In Section 4, we present our main results. Section 5 provides evidence on the validity of our empirical design. Section 6 concludes.

2 Methodology

In this section, we first provide some background on hedging, basis risk and several institutional details behind our empirical setup. In doing so, we outline the hypothesis we test in our data. We then describe our natural experiment and the corresponding difference-in-differences (DD) framework we implement. We close this section by describing our triple differences (DDD) specifications.

2.1 Hedging and Basis Risk

Oil producers face significant volatility in the price they get for their main output. Risk management theories argue that managing risk is valuable if it reduces the deadweight costs associated with bad outcomes (see Stulz (1996)). For oil producers, risk management can take several forms; the most common of which is entering into financial derivatives contracts to hedge the price of oil they expect to sell in the future. By using financial instruments such as puts, forwards and collars, oil producers can guarantee a minimum price (floor) for their output and hence reduce the risk of a negative cash flow shock.

One of the channels through which hedging can improve firm value is through its impact on investments. By lowering the risk of financial distress, hedging allows oil firms to sustain internal cash flows and reduce the cost of external capital, which in turn will improve the likelihood of maintaining a given investment program (see Bessembinder (1991) and Campello et al. (2011)).[4]

Financial derivatives contracts used in hedging are based on the price of an underlying asset. In the case of oil, NYMEX financial contracts are based on the Western Texas Intermediate (WTI) price, which is the price of oil obtained in Cushing, OK. If the prices obtained by Canadian firms are not perfectly correlated with WTI prices, then Canadian producers that hedge with WTI-based contracts will suffer from what is known as basis risk. Johnson (1960) and Ederington (1979) show that the weaker the correlation is between the reference price in hedging contracts and the price the producers actually get for their product, the less efficient hedging is; and hence the less likely the producers will hedge. Haushalter (2000) shows empirically that basis risk is a key factor in the decision to hedge in the U.S. oil market. Firms that face a greater disconnect between the price underlying their financial hedges and the actual prices of their output are significantly less likely to hedge. As such, our study's empirical design builds on Haushalter's work as we make use of an exogenous shock to basis risk in order to analyze how oil producers react to a withdrawal of effective hedging instruments for oil price risk.

[4] Tax optimization and the reduction of risk borne by key stakeholders in the firm (e.g. management) are often cited as other channels through which risk management can add value (see Stulz (1996)).

2.2 Outcome variables and Hypotheses

Theoretical work such as Stulz (1984) and Stulz (1996) offer several explanations as to why risk management policies would be value increasing. Part of the empirical analysis will focus on the mechanisms at work when trying to understand the link between hedging practices and firm value.[5]

2.2.1 Investment policies

Hedging can affect firm value through its impact on investment policies. If hedging lowers the probability of financial distress and if financial distress can lead to costly curtailments in capital expenditures, we would expect the ability to hedge (or lack thereof) to influence a firm's investment policies.[6] Campello et al. (2011) show evidence consistent with a specific channel through which hedging affects investment programs. They show empirically that hedging lowers the cost of debt and reduces the number of restrictive covenants put in place. This in turn improves the firm's ability to invest (see Bessembinder (1991)). As such, our first hypothesis is the following:

- Hypothesis 1a: We expect firms to reduce their capital expenditures in the face of increased basis risk.

The literature has shown that hedging can alleviate financial distress costs, the underinvestment problem and restrictive debt covenants. As a consequence, we would expect that the more leveraged a firm is, the more severe these debt-related distortions to investment become if access to efficient hedging instruments is suddenly curtailed.

- Hypothesis 1b: We expect highly leveraged firms to reduce their capital expenditures significantly more than low leveraged firms in the face of increased basis risk.

[5]Several recent papers aim at understanding the channels through which hedging affect firm value. For instance, Cornaggia (2013) shows that agricultural firms that obtain access to new insurance products for their crop improve their productivity; while Campello et al. (2011) argue that hedging reduces the cost of debt which in turn spurs investments.

[6]One channel through which financial distress can cause costly curtailments in capital expenditures is through the underinvestment problem whereby management, acting in the interest of shareholders, will forgo positive NPV projects if most of the benefits accrue to debt holders (see Myers (1977)).

2.2.2 Valuation impact

As a direct extension to Modigliani-Miller (MM) irrelevance propositions, hedging does not impact firm value in a frictionless world. The presence of market frictions will, however, make hedging value relevant. One of the most significant costs hedging instruments can help alleviate is related to the negative spillover effects associated with financial distress. If deadweight or indirect costs are associated with financial distress and a firm can reduce the probability of financial distress in an efficient manner through risk management, then putting in place a hedging program will add value to the firm by making the scenario of costly financial distress less likely to occur (see Stulz (1996)).

- Hypothesis 2a: We expect firm value to decrease for producers that face an increase in basis risk.

The hedging benefits described above relate to alleviating the negative impact of financial distress on firms. By reducing the probability of financial distress, hedging can create value by allowing the hedged firm to leverage more and extract more of the benefits of debt, such as tax shields. Conversely, we would expect a withdrawal of effective hedging instruments to have a more detrimental effect on firm value for a highly leverage firm given that the likelihood of financial distress will be greater for the more leveraged firm.

- Hypothesis 2b: We expect to see a more significant drop in firm value for high leverage firms relative to low leverage firms in the face of increased basis risk.

2.2.3 Factor market competition

One of the main benefits of hedging is to reduce the risk of financial distress. As such, when hedging effectiveness is significantly reduced, we expect all affected oil producers to be relatively more exposed to financial distress risk. There are well established theories that link financial strength and predation in product markets (e.g. Bolton and Scharfstein (1990), Brander and Lewis (1986), Maksimovic (1990)). In our context, product market predation effects are unlikely given that firms are price takers. However, oil producers compete for the same production factors; namely land, labor and capital. According to these theories, we would expect that any impact related to debt capacity constraints issues might be exacerbated by factor market competition. This reasoning leads us to our third hypothesis:

- Hypothesis 3: Following an industry-wide reduction in hedging effectiveness, we expect low leverage firms to benefit relative to high leverage firms in terms of factor market competition.

2.3 Natural experiment

Our natural experiment is based on unexpected events in the North American oil industry that lead to a significant increase in basis risk for Canadian oil producers. Basis risk in our context arises from the difference in the prices at which firms sell their oil in the local market (physical delivery) and the underlying price at which they can hedge their oil (financial constract). We make use of the fact that firms in the North American oil industry rely on NYMEX derivatives contracts, which are linked to the benchmark price of West Texas Intermediate (WTI) oil, with a delivery point of Cushing, Oklahoma. Thus, because firms may produce and sell a product geographically far from this delivery point, the effectiveness of their hedging program is based on the correlation of the realized price for their oil with WTI prices.

Hedging effectiveness can be defined as the reduction in variance of the hedged position relative to the unhedged position. Johnson (1960) and Ederington (1979) show that this measure of hedging effectiveness can be measured by computing the R^2 of the regression explaining changes in the prices of the underlying asset being hedged with changes in the prices of the benchmark asset used in the financial hedging contracts. In the North American oil markets, most financial contracts used in hedging are based on WTI benchmark prices. As such, the relative effectiveness of WTI-based hedging tools for Canadian oil producers relative to their U.S. counterparts is measured by the R^2 of the regression explaining changes in Canadian light oil prices, as proxied by Edmonton Par prices, with changes in WTI prices. The R^2 stands at 0.54 during the pre-event window. This measure of relative hedging effectiveness exhibits a sudden drop as of the first quarter of 2012 due to unexpected infrastructure issues and pipeline capacity constraints.[7]

This significant increase in basis risk is clearly shown in Figure 1, whereby the correlation between Canadian light oil prices, as proxied by the Edmonton Par reference prices, and WTI prices breaks down after the first quarter of 2012. The lower correlation between Edmonton Par prices and prices for the underlying oil derivative contracts renders WTI-based hedging instruments significantly less effective for Canadian producers after Q1 2012. We use this event to identify the effect of hedging on firm value and real activities by comparing Canadian light oil producers (treatment firms) to otherwise similar U.S. oil producers (control firms), both before and after this basis risk shock in a difference-in-differences (DD) framework.

2.4 Difference-in-differences (DD)

Firms typically decide whether or not to hedge. Hence in a non-experimental setting, causal links between hedging and firm value are difficult to establish. In this section, we describe how we make use of the natural experiment described above to test whether the withdrawal of effective hedging instruments has a significant impact on firm value and real activities.

2.4.1 Implementation of DD

The implementation of our causal tests relies on a quasi-experimental setting whereby we obtain a plausible exogenous variation in the availability of effective hedging instruments for a subset of firms (treatment group) relative to a comparable set of control firms. The treatment group is comprised of Canadian light oil producers while the control group is comprised of their U.S. counterparts. We compare both sets of oil producers before and after the event in a difference-in-differences (DD) framework.

[7] Specifically, the price dislocation hits Canadian producers serving the PADD II region. The United States is divided into five Petroleum Administration for Defense Districts (PADD). PADD II corresponds to the following set of states in the Midwest: Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma, Tennessee, and Wisconsin. In practice, this means that a handful of Canadian producers in Alaska and the Labrador region (East Coast) are not affected by the price dislocation and hence excluded from the study.

In our baseline difference-in-differences regressions, we explain an outcome variable $y_{i,t}$ with a post-event dummy variable ($Post_t$), a treatment dummy ($CADummy_i$) and the post-event dummy interacted with the treatment dummy ($Post_t * CADummy_i$):

$$y_{i,t} = \alpha + \beta_1 CADummy_t + \beta_2 Post_t + \beta_3 Post_t * CADummy_i + FirmFE_i + \varepsilon_{i,t}$$

The key coefficient of interest in determining whether treated firms respond differently after the sharp increase in basis risk is β_3, the coefficient on the interaction term $Post_t * CADummy_i$. The magnitude and sign on the coefficient of this term is an indication of how treated firms respond relative to control firms once their ability to hedge effectively has been curtailed. We also include firm fixed effects to account for time invariant heterogeneity of firm investment policies across firms. With the post-event dummy, the DD framework has the advantage of also controlling for time-invariant differences such as differences in access to capital markets between Canadian and U.S. oil firms.

We estimate the model on three different outcome variables $y_{i,t}$. The first model uses the average quarterly investment intensity over the year prior to the event quarter for the pre-event observation and the average quarterly investment intensity over the year that follows the event quarter for the post-event observation. Averaging all quarterly observations in the pre and post period alleviates potential econometric issues related to time dependence in the outcome variable within each firm (see Bertrand et al. (2004)).

The second model takes the average quarterly Tobin's Q over the year prior to the event quarter for the pre-event observation and the average quarterly Tobin's Q over the year that follows the event quarter for the post-event observation. Tobin's Q is often used as a proxy for firm value in the literature (e.g. Jin and Jorion (2006)).

The third model extends the valuation tests by taking the cumulative stock returns from January 1st 2012, the beginning of the event quarter, up to June 30th 2012 and March 31st 2013, respectively three months and one year after the event quarter. The specifications based on cumulative stock returns can be viewed as a DD model on the market value of equity.

Lastly, to ensure the validity of our empirical design, the dislocation between Canadian and U.S. oil prices should not have been anticipated by Canadian producers. To verify the unanticipated nature of the price dislocation, we read the financial statements and in particular the management discussion and analysis (MD&A) section in Q3 2011 and year-end 2011 of every treated Canadian firm. None of them mention any specific anticipation of a dislocation between realized light oil prices in Canada and WTI prices. Given the regulatory need to disclose any event that could materially impact their results, we take this lack of disclosure as evidence that the event was not anticipated by Canadian oil producers. Our market-value tests further suggest that market participants were also not aware of the impending dislocation.

2.5 Triple differences (DDD)

Finance theory predicts that hedging is particularly important for reducing the probability of distress and for accessing external capital. Therefore, if the effectiveness of hedging instruments is reduced, we would expect firms that have higher leverage at the onset to be relatively more affected by the shock (see hypotheses 1b and 2b in Section 2.2 above).

To directly test these hypotheses, we perform a triple difference (DDD) test. We implement this test by splitting both our treatment and control sample into high and low leverage firms, defined as above and below their respective median group leverage in the quarter prior to the shock.

In our baseline DDD regressions, we explain an outcome variable $y_{i,t}$ with a post-event dummy variable ($Post_t$), a treatment dummy ($CADummy_i$), a high leverage dummy ($HighLev_i$), the double interaction terms ($Post_t * CADummy_i$; $Post_t * HighLev_i$; $CADummy_i * HighLev_i$), and the triple interaction term ($Post_t * CADummy_i * HighLev_i$) :

$$\begin{aligned} y_{i,t} &= \alpha + \beta_1 CADummy_t + \beta_2 Post_t + \beta_3 Post_t * CADummy_i \\ &\quad + \beta_4 HighLev_i + \beta_5 Post_t * HighLev_i + + \beta_6 CADummy_i * HighLev_i \\ &\quad + \beta_7 Post_t * CADummy_i * HighLev_i + FirmFE_i + \varepsilon_{i,t} \end{aligned}$$

The coefficient of interest in determining whether the difference between the differential response of the highly levered treated firms relative to their highly levered control group and the differential response of the low leverage treated firms relative to their low leverage control group after the sharp increase in basis risk is β_7 , the coefficient on the triple interaction term. We also include firm fixed effects to account for time invariant heterogeneity of firm investment policies across firms.

3 Data

In this section, we first detail how we construct our dataset of both treatment (Canadian) and control (U.S.) oil producers. Second, we provide descriptive statistics on the final sample of treatment and control firms used in this study.

3.1 Data Construction

Our empirical design requires us to construct a dataset of Canadian oil producers and a corresponding dataset of U.S. oil producers. In terms of sample size, a key advantage is the fact that the Canadian and U.S. oil industries are among the largest in the world.[8]

The first significant increase in basis risk occurs during the first quarter of 2012; we define this quarter as our event quarter. We use the four quarters from Q1 2011 to Q4 2011 as our pre-event window; and the four quarters after the event from Q2 2012 to Q1 2013 as our post-event window. All quarterly accounting data comes from Worldscope for Canadian firms and Compustat for U.S. firms.

We complement this data with hand-collected measures of (light) oil production relative to total production for both Canadian and U.S. firms as of Q4 2011. Detailed disclosure on production and hedging policies allows us to carefully construct a treatment (Canadian) and control (U.S.) group for our study. This data is necessary in order to determine which Canadian firms are exposed to the basis risk jump in light oil prices that occurs in Q1

[8] As of 2011, Canada's oil industry produced over 2.1 million barrels of oil per day and is currently the sixth largest producer of oil in the world (source: http://www.capp.ca/canadaIndustry/oil/Pages/default.aspx).

2012 and which U.S. firms can serve as an appropriate control group within the oil and gas Exploration and Production (E&P) universe of firms.

3.1.1 Treatment (Canadian) sample

We describe in this subsection how we obtain our sample of Canadian firms. We first download the universe of Canadian oil and gas exploration firms from Worldscope. We then sort the list of firms by total assets at the end of the fourth quarter 2011 (pre-event quarter). From that list, we hand-collect information on the 150 largest firms.

The Canadian Oil and Gas industry is somewhat heterogeneous with regards to the goods they produce and sell on the market. In particular, while most of the oil produced in the U.S. is light to medium grade oil, Canada has a broader variety of oil extracted. For instance, the oil sands of Alberta produce bitumen and heavy oil, which are harder to transport and refine and hence always trade at a discount relative to WTI prices. The differential in prices between light oil (WTI benchmark) and heavy oil (WCS benchmark) can actually be hedged and is commonly hedged by heavy oil producers in Canada. As such, our major task in terms of defining our treatment sample of Canadian firms is to screen the sample based on the amount of light oil produced. To do so, we compute the percentage of light oil revenues relative to total revenues for each firm in the sample. We require a minimum of 30% of all 2011 revenues to be derived from light oil sales in order to be included in the final sample.

With this criteria, most firms in our treatment sample have a majority of their revenues derived from light oil. Hence, this exclusion criteria guarantees a significant exposure to the light oil price dislocation that we observe in 2012. This exclusion criteria along with the exclusion of firms with significant non-Canadian operations is the main reason for the shrinkage of our dataset from 150 to 42 firms. Furthermore, a very small number of Canadian producers operate in the Labrador region (East Coast) and producers in the Alaska region obtain Brent pricing and as such were not affected by the price dislocation. These firms are also excluded from the final sample. The other exclusion criteria include the removal of (1) all firms with major midstream (pipelines) and downstream (refining) operations, such as Suncor; (2) all firms with significant international operations; (3) all firms that have significant exposure to industries outside of oil (conglomerates) and lastly, (4) all firms with less than $50M in total assets at the end of 2011. We obtain a final treatment sample of 42 Canadian light oil producers.

3.1.2 Control (U.S.) sample

We describe in this subsection how we obtain our sample of control (U.S.) firms. We first download the universe of American oil and gas exploration and production (E&P) firms from Compustat (SIC 1311). We obtain 109 firms. This exclusion criterion based on industry already screens out several conglomerates such as ExxonMobil. However, we still need to hand-collect information on all 109 firms to gauge whether these firms are appropriate matches to their Canadian counterparts; in particular we need to screen out firms that are not E&P firms and also those that do not have a significant percentage of their production derived from oil.

There has been a significant rise in the number of studies using propensity score matching (PSM) techniques in order to define a control group (e.g. Almeida et al. (2012)). We do not match one-to-one our Canadian firms to U.S. firms, neither do we apply a PSM technique based on accounting variables to define our control group. We believe our industry focus allows us to perform a finer match based on business characteristics and exposure to similar risks and investment opportunities than those obtained by matching on accounting variables, such as book to market. To do so, we impose the same list of criteria that we applied to the universe of Canadian oil and gas producers.

Specifically, in terms of type of production, we require at least 30% of total revenues to be derived from oil. We exclude every firm with significant operations outside of the U.S. (for instance Apache) and we remove firms that are not focused on exploration and production (E&P). The restriction to SIC 1311 firms automatically removes oil conglomerates such as ExxonMobil but we still have a handful of midstream operators (pipelines) in the sample. All of them are removed. Lastly, given that our sample of Canadian firms focuses on onshore operations, we also remove every U.S. firm that has a majority of its operations in the Gulf of Mexico. Offshore drilling has very different characteristics from onshore drilling; namely its capital projects require significantly greater capital outlays and take much longer to complete. We are left with a final control sample of 37 U.S. oil producers.

3.2 Descriptive statistics

In this subsection, we describe our sample along several accounting-based measures of size, leverage, profitability and production characteristics. The variable definitions follow the literature. Namely, Tobin's Q is defined as the ratio of total assets plus market capitalization minus common equity minus deferred taxes and investment tax credit (atq + prccq × cshoq − ceqq − txditcq) to total assets (atq). Firm size is measured by total assets (atq). Investment intensity is defined as capital expenditures (capxq) normalized by total assets (atq). Book leverage is defined as the ratio of total liabilities (ltq) to total assets (atq). Profitability is defined as operating profits (oancfq) normalized by total assets (atq). Lastly, we compute the share of light oil sales for each firm (Light Oil Percentage) by computing the proportion of light oil revenues to total revenues for the fiscal year ending on December 31st 2011. All numbers shown in Table 1 are averages for the pre-period (Q1 2011 to Q4 2011) and post period (Q2 2012 to Q1 2013) used in our main regression specifications.

Panel A of Table 1 contains the information for the treatment sample of Canadian light oil producers. First, we can highlight that our treatment sample of Canadian firms derive on average more than 60% of their revenues from light oil production in 2011. This level of exposure to light oil production is a desired feature of our research design: It guarantees a significant exposure to the surge in basis risk that occurs as of Q1 2012.

There is heterogeneity in firm size with an average size of more than $1,620M in total assets and a significantly lower median total asset size of $435M. Tobin's Q stands slightly above one while average book leverage stands at 0.4. Quarterly measures of profitability normalized by total assets stand at 0.03. If we annualize this number, it means that operating profits are greater than 10% of total assets. Lastly, the average (median) investment intensity stands at 0.07 (0.05). This number highlights the high investment needs of the industry (see also Gilje and Taillard (2011)).

Panel B of Table 1 contains the information for the control sample of U.S. light oil producers. First, it is interesting to note that our control group of U.S. oil producers derive on average 65% of their revenues from light oil production. This number is very close to the fraction of revenues derived from light oil for our treatment sample of Canadian firms. Total assets average $3,291M with a much lower median standing at $1,666M. Our U.S. control firms are on average larger than our Canadian treatment firms. Tobin's Q is also higher for U.S. firms standing at 1.51 (median 1.38). Book leverage is slightly higher with an average value of 0.54. Lastly, both our profitability and investment measures are comparable to our Canadian firms; highlighting that the sample period was profitable with significant drilling activity on both sides of the border.

In terms of hedging practices, we confirm in untabulated results that most of our final sample of Canadian firms do hedge their light oil exposure as of December 31st 2011. We also confirm that for all the firms that hedge light oil in our sample, the U.S. Western Texas Intermediate (WTI) is the underlying reference asset in their hedging contracts. It is important to note that, even for the handful of Canadian firms that do not hedge as of the onset of the basis risk shock, the availability of effective hedging instruments can be valuable if these firms were to decide to hedge oil production in the future.

4 Results

4.1 Hedging policies

In this section, we analyze the hedging behavior of Canadian oil producers. In particular, we gauge whether hedging policies change before and after the increase in basis risk faced by Canadian producers. The hedging measure we construct is similar to the one used by Jin and Jorion (2006). In particular, we measure both at the yearend 2011 (pre-period) and at the yearend 2012 (post-period) the percentage of the oil production that is hedged for the following year. The future yearly production is estimated as 365 times the average daily production of the most recent quarter. As for the total hedged position, we treat all hedging instruments equally. That is, we apply a $\Delta = -1$ to all linear hedging instruments such as futures, forwards, fixed-price contracts and receive-fixed swaps, as well as all non-linear hedging instruments such as puts and collars. Although the deltas for puts and collars are typically lower than one, we are assuming that firms select puts and collars with guaranteed price levels (floors) that hedge them as effectively as linear hedging instruments against a negative price outcome for oil.

We compute the fraction of future oil production that is hedged by Canadian firms both before and after the basis risk shock. Both the mean and median values of hedged production prior to the basis risk shock stand at about 37%. Following the basis risk shock, we find that only 30.5% of the future production is hedged one year later on average. The median hedged production stands at 31.9% This result corresponds to a 15% to 20% drop in hedging activity among Canadian firms. While the mean and median tests are not statistically significant, a Kolmogorov-Smirnov test of equality of distributions is significant at the 10% level. That is, we find a significant reduction in hedging activity among Canadian producers after the basis risk shock under study.

We also provide more detail on the heterogeneity in hedging behavior among Canadian oil producers. Hedging theories argue that more leveraged firms benefit relatively more from hedging as they are closer to financial distress. At the onset of the shock, we find that highly leveraged Canadian producers hedge on average 43.6% of their future production (47.1% median) while low leveraged firms hedge on average only 30.8% of their production (21.3% median). Statistical tests of differences have low power given the small sample size but in economic terms, highly leveraged firms hedge significantly more than low leverage firms at the onset of the basis risk shock.

4.2 Investment policies

In this section we measure the impact of having access to effective hedging instruments on firm investment policies. Table 2 reports the results of our difference-in-differences specification and triple differencing specification. The treatment firms in our sample are Canadian light oil producers as they are exposed to a significant increase in basis risk on their light oil hedges as of Q1 2012. We find that after the effectiveness of hedging has been reduced, Canadian firms reduce investment intensity by 0.02, or 29% of the average quarterly investment intensity in the sample. This figure is both economically and statistically significant, and provides evidence consistent with hypothesis 1a.

However, the loss of effective hedging instruments likely does not affect all treatment firms uniformly. As hypothesis 1b outlines, firms with higher leverage prior to the loss of effective hedging instruments may be more affected. In specifications (2) and (3) of Table 2, we subdivide our sample into firms with high leverage (2) and firms with low leverage (3), and find that our main result is being driven by firms with high leverage. The economic interpretation of the -0.039 coefficient implies that high leverage firms reduce their quarterly investment intensity by 56% relative to their average quarterly investment intensity. Conversely, firms with low leverage have a small negative coefficient which is not statistically significant. To formally test whether firms with high leverage are affected more than firms with low leverage, we undertake a triple differencing specification in (4), and find that the triple interaction term is negative and statistically significant. These results provide direct evidence that the event under study affects real investment decisions by firms. This adverse impact is significantly more pronounced for firms with high leverage relative to firms with low leverage.

4.3 Firm valuation

In this section we measure the effect of having access to hedging instruments on firm value. Firm value is proxied by Tobin's q as is common in the literature (e.g. Jin and Jorion (2006)). Table 3 reports the results of our specifications which measure the effect of a loss of access to hedging instruments on firm value. Specification (1) in Table 3 documents that there is no overall effect on treatment firms, a result not supportive of hypothesis 2a. However, when we subdivide the sample into high and low leverage firms, we find coefficients that are much larger in magnitude. The interaction coefficient in (2) is negative and large in magnitude, but not statistically significant, while the interaction coefficient in (3) is positive and statistically significant. These specifications imply that the firm value of high leverage firms is adversely affected by the withdrawal of effective hedging instruments, while firm value increases for low leveraged firms. To formally test whether these two types of firms are affected differently, we undertake a triple differencing specification. The triple interaction coefficient is -0.596, negative and statistically significant. This implies that high leverage treatment firms are valued less than high leverage control firms, relative to the change in value of low leverage treatment firms versus low leverage control firms. The -0.596 coefficient, represents a 47% decrease in firm value, a result consistent with hypothesis 2b.

4.4 Stock price performance

In this section, we complement our firm value tests based on Tobin's Q with the impact of restricting access to efficient hedging instruments on firm value as measured by the cumulative stock price returns over the event window. Figure 2 provides visual evidence of the stock price performance of equal weighted portfolios of treatment (Canadian) and control (U.S.) oil producers. It highlights the close correlation of stock prices throughout 2011, and the sharp effect the reduced correlation of Edmonton Par with WTI has on stock returns. We formally test the magnitude of this difference in Table 4. We measure stock returns over a six month window and a fifteen month window (respectively three months and one year after the event quarter). We find that on average stock prices of treatment firms are lower than stock prices of control firms (specifications (1) and specifications (5)), but not by a statistically significant amount.

When we subdivide our sample into high leverage and low leverage firms, we observe that high leverage treatment firms have significantly lower stock returns relative to the high leverage control firms. We first provide graphical evidence of changes in stock prices in the pre-event and post-event periods for the high and low leverage subgroups separately in Figure 3A and Figure 3B. The results are striking. While high leverage treatment (Canadian) firms significantly underperform their high leverage control (U.S.) group in Figure 3a, the low leverage treatment (Canadian) firms maintain a stock performance almost on a par with their low leverage control (U.S.) firms. We formally test whether the impact on stock prices for high leverage firms is larger than the difference we observe for low leverage treatment and control firms in specifications (4) and specifications (8) of Table 4. The coefficients in both (4) and (8) of Table 4 are statistically significant, indicating that high leverage firms are affected relatively more by the loss of effective hedging than low leverage firms.

4.5 Factor Market competition

Our valuation results imply a significant dichotomy: After the shock, firm value is reduced for high leverage firms, while it increases for low leverage firms. One interpretation of the increase in firm value for low leverage firms is that they gain a competitive edge when competing with high leverage firms for limited resources including land, human capital and external financing from capital markets. As such, our valuation results provide indirect evidence that the impact of the withdrawal of effective hedging instruments can be compounded by strategic interactions among industry players. This result provides a potentially interesting extension to the extensive literature on product market competition and leverage (see Bolton and Scharfstein (1990)).

To test more directly for factor market competition effects, we gauge whether low leverage firms behave differently than high leverage firms in terms of asset sales after the shock. Specifically, we define a commonly used measure of net asset acquisitions as asset acquisitions minus asset dispositions divided by beginining of period total assets.We then test whether this measure differs systematically across highly leveraged and low leveraged Canadian oil producers during the post-event period. We compute the net acquisitions measure over two time periods: (1) 2012 and (2) 2012-Q3 2013 (up to the most recent quarterly filing for all sample firms). The results are shown in Table 5. We find that high leverage firms have significantly more net asset sales than their low leverage counterpart. The difference between the two groups is statistically significant at the 10% level for both sample periods. While low leverage firms are net acquirers on average, high leverage firms are net sellers of assets on average.This test provides more direct evidence that factor market competition effects play a significant role in explaining differences between low and high leverage Canadian oil firms after the shock.

5 Validity of Empirical Design

In this section, we provide further evidence that our empirical design has internal validity. In particular, the difference-in-differences framework relies on the assumption that treated and control firms behave similarly prior to the treatment period ("parallel trend" assumption). We perform a series of falsification tests to assess the validity of this assumption in our data as well as discuss the influence of other potential confounding factors in the context of our study.

5.1 Parallel trend assumption

The key identifying assumption in DD estimators is the "parallel trend" assumption. The control group acts as the counterfactual in our experiment and the parallel trend assumption implies that, in the absence of treatment, the average change in the outcome variable would be no different across treatment and control firms. Although it is not possible to directly test this assumption, the oil and gas industry has the advantage of offering a relatively homogenous group of firms. In particular, the treatment and control firms are similar across many dimensions, including technology, production output, and cost structure. An informal confirmation of this assumption can be found in Figure 2, 3a and 3b. The graphical evidence shown in these figures highlight a very high degree of correlation in daily stock returns between treatment and control firms both overall and within high and low leverage firms prior to the event quarter. This graphical evidence can be construed as evidence that the markets do not view the treatment and control firms as subject to significant unobservable differences in the absence of treatment.

To more formally gauge the validity of the "parallel trend" assumption, we perform several placebo tests to assess whether firms behave similarly in prior years (see Roberts and

Whited (2012)). In particular, we test whether U.S. and Canadian oil producers have similar investment trends prior to 2012. For this test, we create a placebo event in Q4 2010, and compare capital expenditures in the four quarters after this placebo event with the four quarters before this placebo event.[9] The results from these regressions are presented in Table 6. None of the interaction coefficients are statistically significant, indicating that both treatment (Canadian firms) and control (U.S. firms) had parallel trends prior to the treatment event. Additionally, none of the interactions with the high leverage dummy variable are statistically significant, indicating that high leverage and low leverage firms also had similar trends prior to treatment. The coefficient on the placebo post dummy is positive and statistically significant, indicating that there was an overall positive trend in investment by all firms over the placebo period. Oil prices were 19% higher in 2011 than in 2010, so a positive coefficient on the placebo dummy is not surprising and does not invalidate the parallel trend assumption as both treatment and control firms increased their drilling activity during the period.

We conduct a similar set of placebo event tests using Tobin's Q as the dependent variable of interest in Table 7. None of the coefficients in the specifications are statistically significant. This provides supporting evidence towards treatment and control firms, as well as low and high leverage firms, having similar trends in firm value in the two years leading up to the oil price dislocation event in Q1 2012.

While the graphical evidence and placebo regressions do not offer a definitive test of the parallel trend assumption, the evidence provided by these two exercises supports the identifying assumption of our empirical strategy.

5.2 Comparison to 2008 macro shock

Standard placebo tests described in the previous section allow us to tackle unobserved heterogeneity between treatment and control firms (parallel trend assumption). However, they do not rule out confounding explanations specific to the Canadian dislocation we analyze in this study. For instance, it could be the case that whenever there is a negative shock to

[9] The choice of Q4 2010 as the placebo event quarter is driven by the desire to be as close to the real event quarter as possible without having the placebo post-event window overlap with the real event quarter.

investment opportunities (e.g. lower oil prices), firms with more leverage are more adversely affected. If it is the case that real investment and firm valuation of high leverage firms is always lower when there is a negative macro shock to oil prices, then this might be a cause for concern for the interpretation of our results.

To address this concern, we compare the stock price performance of high leverage and low leverage Canadian firms during the negative commodity price shock of 2008 and subsequent recovery. Table 8 reports the estimated coefficients from regressions of cumulative stock returns on a high leverage dummy for Canadian firms over time windows similar to those reported in Table 4, but here relative to Q3 2008. The coefficient on high leverage is not statistically significant, which suggests that the underlying operations of these firms responded similarly to the negative macro shock to oil prices in 2008. The evidence provided by this test suggests that the dislocation to Edmonton Par oil prices in 2012 is different in nature and that the differential observed between high and low leverage treatment (Canadian) firms in 2012 is not driven by lower prices.

5.3 Hedging changes vs. Investment opportunity changes

A key issue in our study is whether the treatment firm responses we identify are due to the inability to hedge effectively going forward or due to lower investment opportunities (lower realized Edmonton Par prices). Our comparison with the 2008 price shock already shows that the signifcant differences observed between high and low leverage firms in our sample are not found during an even more severe price drop episode during the financial crisis. In this section, we perform another falsification test to distinguish between the two potentially confounding explanations of hedging ability vs. lower investment opportunities.

The idea behind our additional test is straightforward. In order to disentangle the two potential effects, we select a pre-period window that removes the "lower investment opportunity" explanation from the equation. By selecting a pre-period window during which the average oil prices equates the average post-period prices, investment opportunities are kept constant in the difference-in-differences (DD) framework. Specifically, by shifting the pre-period window by two quarters, we reduce the average price difference to only 1.7% instead of 11.7%. We estimate our baseline investment and firm value regressions with this new timeline. The results are shown in Table 9 and 10.

Both for the investment regression results in Table 9 and the firm valuation (Tobin's Q) results in Table 10, we find strikingly similar results to our baseline results when applying the new pre-period window that removes differences in oil prices between the pre and post-period window. These new tests provide strong support for the fact that hedging ability has significant valuation and real effects in our study.

6 Conclusion

Hedging is ubiquitous, as more than 90% of all Fortune Global 500 companies report using derivatives to manage risks. Moreover, the benefits of hedging are theoretically well understood. Yet empirical evidence showing clear benefits to hedging is limited. The main reason for this lack of evidence is due to the endogenous nature of hedging. Firms that decide to hedge might adopt other business practices that are value enhancing. As such, inferring causality is a delicate exercise in most situations.

The objective of this study is to use a natural experiment to identify the causal impact of hedging on firm investment activity and firm value. We use the unexpected reduction in correlation between Edmonton Par oil prices and the West Texas Intermediate price used in hedging instruments to obtain exogenous variation in the effectiveness of hedging instruments. We find that Canadian firms, our treatment firms, reduce investment activity by an economically significant amount following the reduced effectiveness of their hedges. Furthermore, we find that investment, firm value, and stock price effects are concentrated among Canadian firms that have high ex ante leverage. The economic magnitudes identified in this study are larger than in prior studies, and point towards significant value implications for hedging, particularly for firms that have high operational and financial leverage. Our results provide direct empirical evidence that hedging affects firm value by alleviating the costs of financial distress and the underinvestment problem, as predicted by theory.

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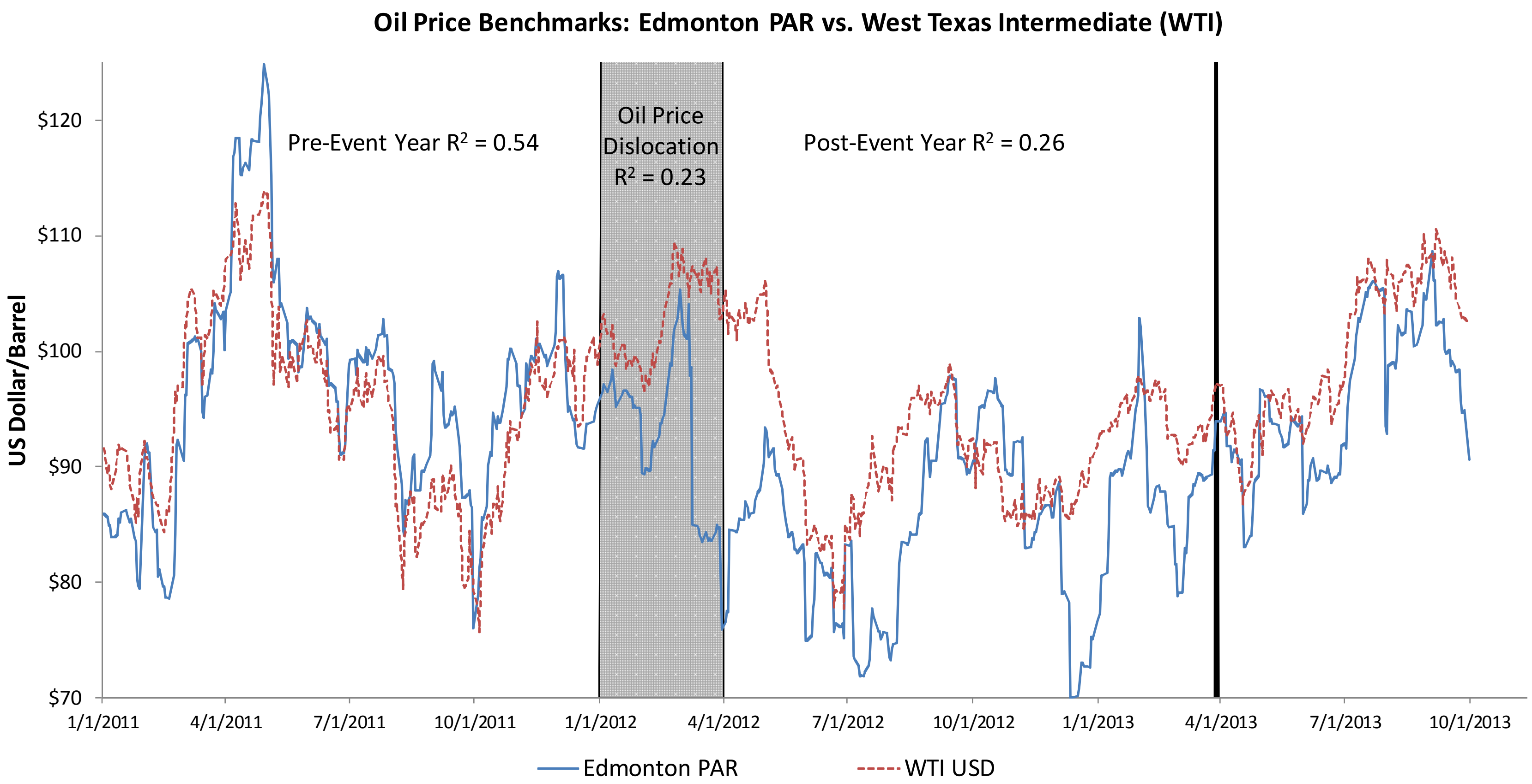

Figure 1:
This figure separately plots the benchmark light oil prices for the treatment (Canadian) and control (U.S.) firms in this study. The Canadian benchmark is the Edmonton PAR and the U.S. benchmark is the West Texas Intermediate (WTI). The pre-event year used in the main tests in this study is the year prior to the reduced R^2. The first major dislocation and drop in R^2 is highlighted in Q1 2012. The post-event period used to measure firm outcomes in this study is the post-event year, running from Q2 2012 to Q1 2013.

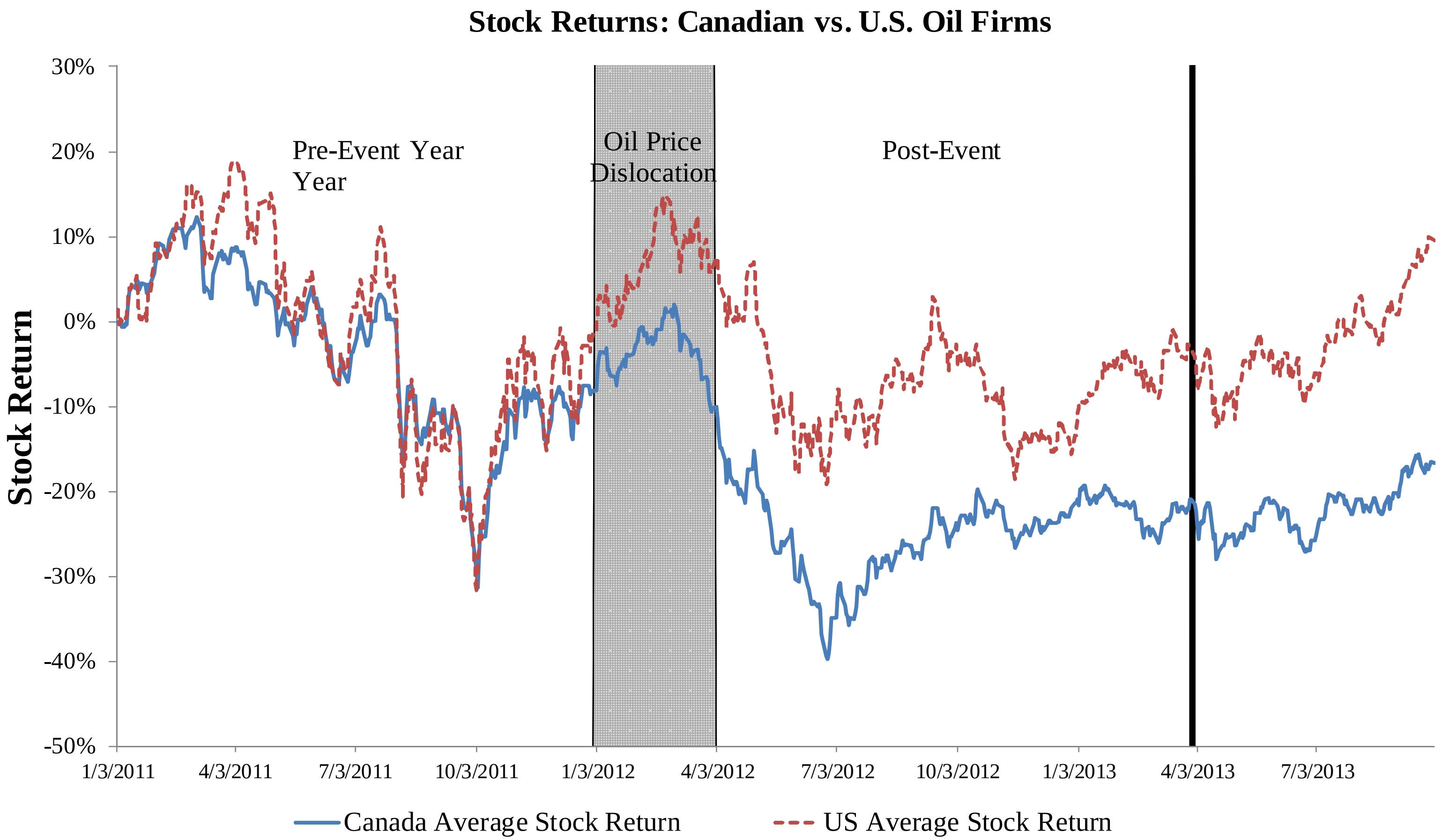

Figure 2:
This figure separately plots the cumulative stock returns for the equal weighted portfolio of treatment (Canadian) and control (U.S.) firms used in this study. The pre-event year used in the main tests in this study is the year prior to the reduced correlation of oil prices, running from Q1 2011 to Q4 2011. The first major price dislocation and drop in correlation between Canadian and U.S. benchmark prices is highlighted in Q1 2012. The post-event period used to measure firm outcomes in this study is the post-event year, running from Q2 2012 to Q1 2013.

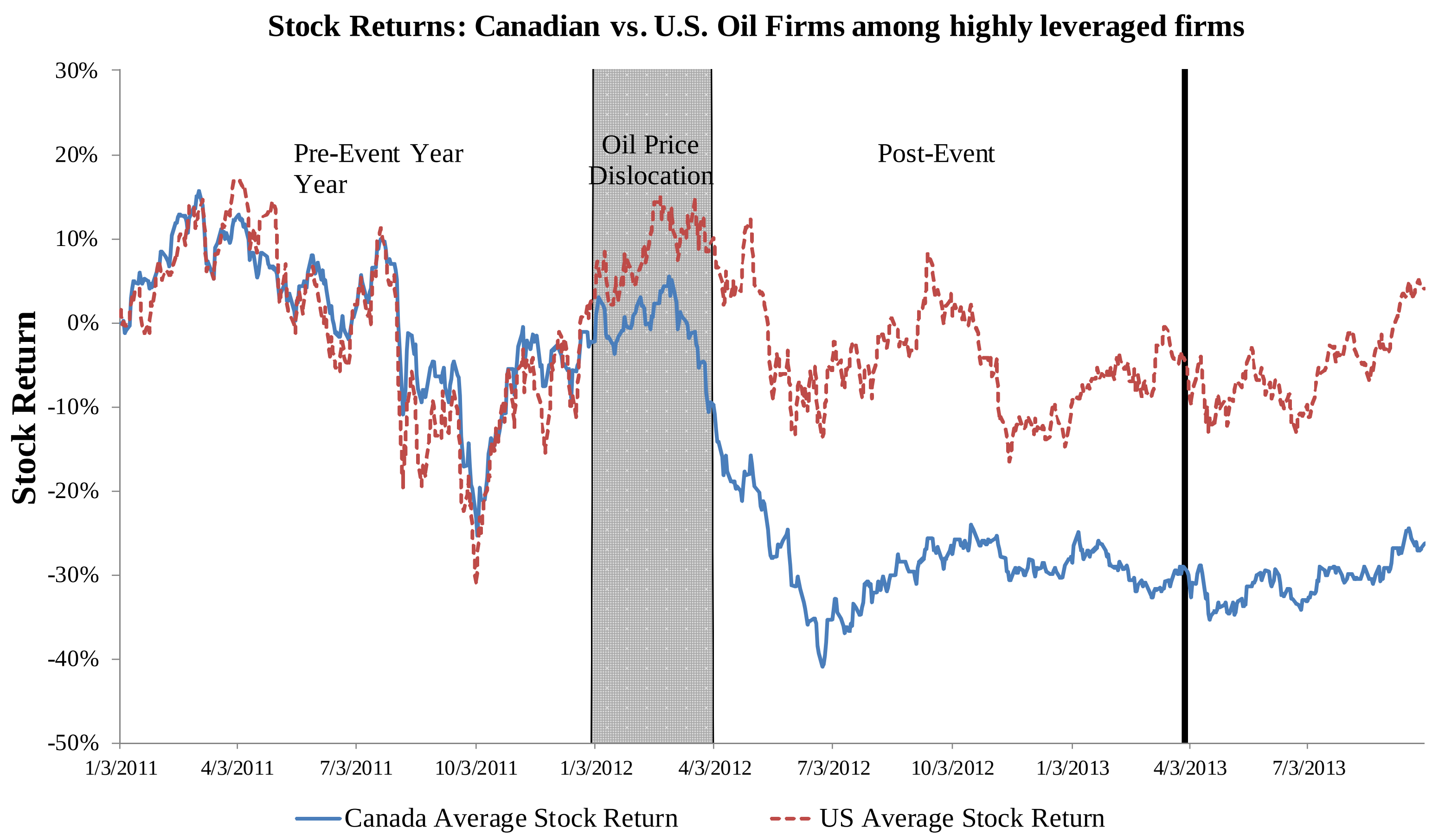

Figure 3A:

This figure separately plots the cumulative stock returns for the equal weighted portfolio of highly leveraged treatment (Canadian) and control (U.S.) firms used in this study. Highly leveraged firms are defined as firms with leverage above their peer median leverage as of Dec 31, 2011. The pre-event year used in the main tests in this study is the year prior to the reduced correlation of oil prices, running from Q1 2011 to Q4 2011. The first major dislocation and drop in correlation is highlighted in Q1 2012. The post-event period used to measure firm outcomes in this study is the post-event year, running from Q2 2012 to Q1 2013.

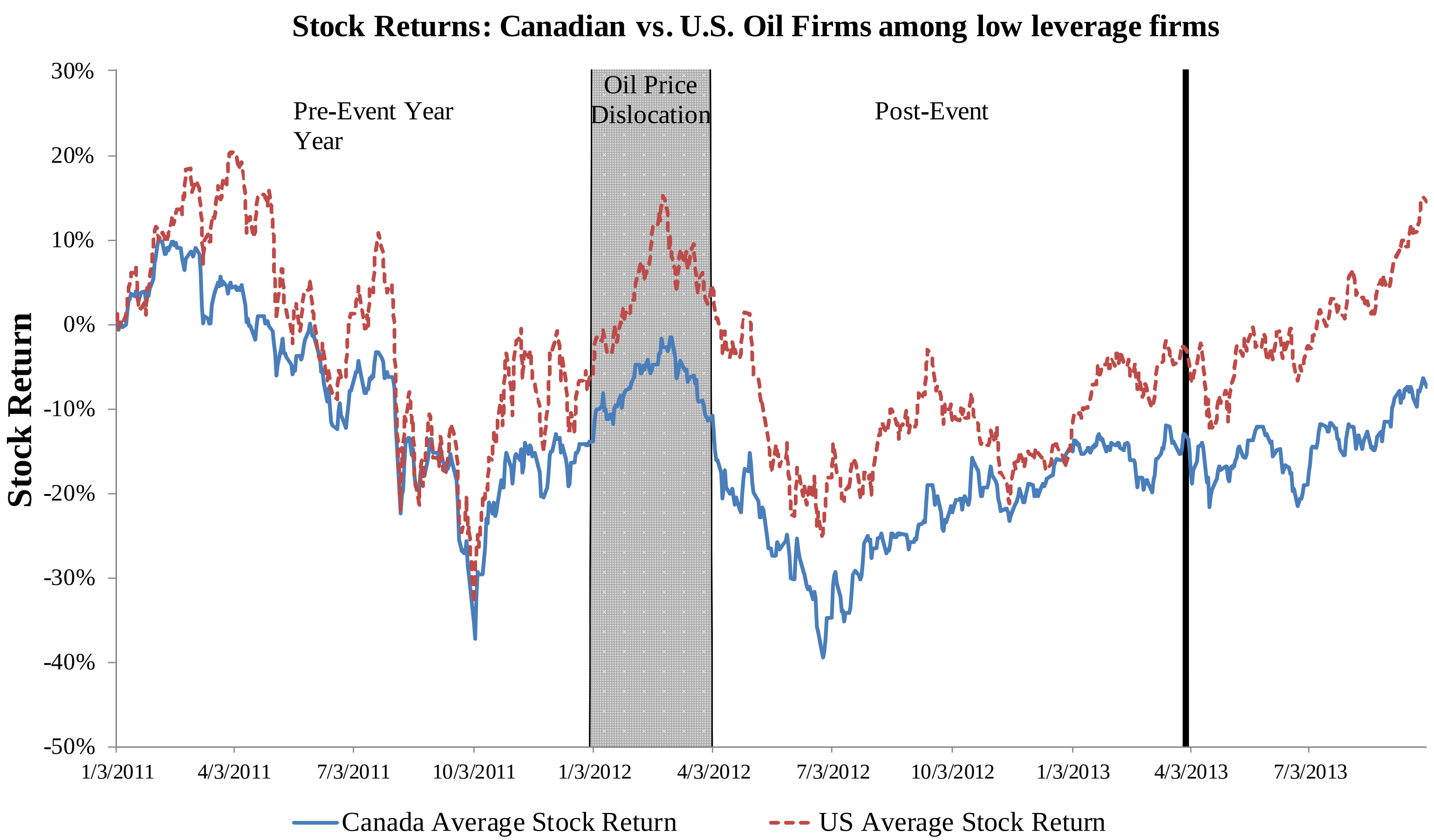

Figure 3B:

This figure separately plots the cumulative stock returns for the equal weighted portfolio of low leverage treatment (Canadian) and control (U.S.) firms used in this study. Low leverage firms are defined as firms with leverage below their peer median leverage as of Dec 31, 2011. The pre-event year used in the main tests in this study is the year prior to the reduced correlation of oil prices, running from Q1 2011 to Q4 2011. The first major dislocation and drop in correlation is highlighted in Q1 2012. The post-event period used to measure firm outcomes in this study is the post-event year, running from Q2 2012 to Q1 2013.

Table 1. Summary Statistics

This table contains summary statistics on data for treatment (Canadian) and control (U.S.) firms used in this study. Our study covers the time period from Q1 2011 to Q1 2013; nine quarters in total. The summary statistics below exclude the event quarter in our study, Q1 2012, as this quarter is excluded from our tests. The variable definitions are as follows. Tobin's Q is defined as the ratio of total assets plus market capitalization minus common equity minus deferred taxes and investment tax credit (atq + prccq × cshoq − ceqq − txditcq) to total assets (atq). Firm size is measured by total assets (atq). Investment intensity is defined as quarterly capital expenditures (capxq) normalized by total assets (atq). Book leverage is defined as the ratio of total liabilities (ltq) to total assets (atq). Profitability is defined as quarterly operating profits (oancfq) normalized by total assets (atq). Lastly, we compute the share of light oil sales for each firm (Light Oil Percentage) by computing the proportion of light oil revenues to total revenues for the fiscal year ending on December 31st 2011.

Panel A: Treatment Firms (Canada)

Number of Firms	42		
Number of Firm Quarters	336		
	Mean	Median	Standard Dev.
Assets ($ Millions)	1620.86	435.91	2993.87
Light Oil Percentage	61%	58%	21%
Tobins q	1.28	1.02	0.87
Book Leverage	0.39	0.40	0.13
Profitability	0.03	0.03	0.02
Investment Intensity	0.07	0.05	0.05

Panel B: Control Firms (U.S.)

Number of Firms	37		
Number of Firm Quarters	296		
	Mean	Median	Standard Dev.
Assets ($ Millions)	3291.99	1666.65	4871.79
Light Oil Percentage	65%	63%	23%
Tobins q	1.51	1.38	0.64
Book Leverage	0.54	0.54	0.17
Profitability	0.04	0.04	0.03
Investment Intensity	0.08	0.07	0.05

Table 2. Hedging and Capital Expenditures

This table reports firm level regressions that measure the change in investment activity for treatment (Canadian) firms impacted by the withdrawal of effective hedging instruments due to a significant increase in basis risk. The dependent variable is capital expenditures scaled by beginning of quarter assets. Firm quarter level observations are aggregated into two separate time periods, one for the average investments in the four quarters prior to the loss of effective hedging instruments (Q1 2011 to Q4 2011) and one for after (Q2 2012 to Q1 2013). The resulting dataset has two time periods per firm, one for the time period before the loss of hedging instruments by treatment (Canadian) firms and one for the time period after the loss of hedging instruments by treatment (Canadian) firms. U.S. oil producers serve as the control group. The Canada dummy variable takes the value of one for treatment (Canadian) firms. The Post dummy takes a value of one for the time period after the event. High (respectively low) leverage firms are firms with above (respectively below) median book leverage as of Dec. 31 2011. The High Leverage dummy variable takes the value of one for firms with high leverage. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I/K_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + FirmFE_i + \varepsilon_{i,t}$$

$$I/K_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + \beta_4 High\ Leverage_i$$
$$+ \beta_5 High\ Leverage_i * Post_t + \beta_6 High\ Leverage_i * CA\ Dummy_i + \beta_7 High\ Leverage_i * CA\ Dummy_i * Post_t + FirmFE_i + \varepsilon_{i,t}$$

Dependent Variable = Capital Expenditures/Assets

	Pre-Period = [Q1 2011 to Q4 2011], Post-Period = [Q2 2012 to Q1 2013]			
	All Firms	High Leverage	Low Leverage	All Firms
	(1)	(2)	(7)	(8)
(β_1) Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_2) $Post_t$	-0.001	0.004	-0.007	-0.007
	[-0.20]	[0.52]	[-0.68]	[-0.68]
(β_3) Canada $Dummy_i$ * $Post_t$	-0.020**	-0.039***	-0.001	-0.001
	[-2.13]	[-2.80]	[-0.10]	[-0.10]
(β_4) High $Leverage_i$	Absorbed by $FirmFE_i$			
(β_5) High $Leverage_i$ * $Post_t$				0.011
				[0.86]
(β_6) High $Leverage_i$ * Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_7) High $Leverage_i$ * Canada $Dummy_i$ * $Post_t$				-0.038**
				[-2.08]
$FirmFE_i$	Yes	Yes	Yes	Yes
R^2 Within	0.124	0.257	0.040	0.181
N - Total Firm Years	158	78	80	158

Table 3. Hedging and Firm Value

This table reports firm level regressions that measure the change in firm value for treatment (Canadian) firms impacted by the withdrawal of effective hedging instruments due to a significant increase in basis risk. Firm value is proxied by Tobin's Q. Firm quarter level observations are aggregated into two separate time periods, one for the average Tobin's Q in the four quarters prior to the loss of effective hedging instruments (Q1 2011 to Q4 2011) and one for after (Q2 2012 to Q1 2013). The resulting dataset has two time periods per firm, one for the time period before the loss of hedging instruments by treatment (Canadian) firms and one for the time period after the loss of hedging instruments by treatment (Canadian) firms. U.S. oil producers serve as the control group. High (respectively low) leverage firms are firms with above (respectively below) median book leverage as of Dec. 31 2011. All indicator variables are defined in Table 2. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$Q_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + FirmFE_i + \varepsilon_{i,t}$$

$$Q_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + \beta_4 High\ Leverage_i + \beta_5 High\ Leverage_i * Post_t + \beta_6 High\ Leverage_i * CA\ Dummy_i + \beta_7 High\ Leverage_i * CA\ Dummy_i * Post_t + FirmFE_i + \varepsilon_{i,t}$$

Dependent Variable = Tobin's Q

	Pre-Period = [Q1 2011 to Q4 2011], Post-Period = [Q2 2012 to Q1 2013]			
	All Firms	High Leverage	Low Leverage	All Firms
	(5)	(6)	(7)	(8)
(β_1) Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_2) $Post_t$	-0.351***	-0.262***	-0.435***	-0.435***
	[-5.71]	[-3.98]	[-4.36]	[-4.38]
(β_3) Canada $Dummy_i$ * $Post_t$	0.004	-0.297	0.299**	0.299**
	[0.03]	[-1.32]	[2.61]	[2.63]
(β_4) High $Leverage_i$	Absorbed by $FirmFE_i$			
(β_5) High $Leverage_i$ * $Post_t$				0.173
				[1.46]
(β_6) High $Leverage_i$ * Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_7) High $Leverage_i$ * Canada $Dummy_i$ * $Post_t$				-0.596**
				[-2.38]
$FirmFE_i$	Yes	Yes	Yes	Yes
R^2 Within	0.259	0.274	0.456	0.317
N - Total Firm Years	158	78	80	158

Table 4. Hedging and Stock Returns

This table reports regressions that measure cumulative stock returns for treatment (Canadian) firms impacted by the withdrawal of effective hedging instruments due to a significant increase in basis risk. The dependent variable is the nominal cumulative stock return from January 1, 2012 (onset of event quarter) to June 30, 2012 and March 31st 2013. U.S. oil producers serve as the control group. High (respectively low) leverage firms are firms with above (respectively below) median book leverage as of Dec. 31 2011. All indicator variables are defined in Table 2. T-statistics are reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$StockReturn_i = \alpha + \beta_1 CA\ Dummy_i + \beta_2 HighLeverage_i + \beta_3 CA\ Dummy_i * HighLeverage_i + \varepsilon_i$$

Dependent Variable = Cumulative Stock Returns

	Window = [Jan 1, 2012 to June 30, 2012]				Window = [Jan 1, 2012 to Mar 31, 2013]			
	All Firms	High Leverage	Low Leverage	All Firms	All Firms	High Leverage	Low Leverage	All Firms
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(β_1) Canada Dummy$_i$	-11.316	-30.072**	7.377	7.377	-8.306	-27.276***	10.665	10.665
	[-1.14]	[-2.47]	[0.50]	[0.55]	[-1.13]	[-3.11]	[1.05]	[1.13]
(β_2) HighLeverage$_i$				2.330				-0.002
				[0.17]				[-0.00]
(β_3) High Leverage$_i$ * Canada Dummy$_i$				-37.449*				-37.941***
				[-1.94]				[-2.81]
R^2 Within	0.017	0.141	0.006	0.102	0.016	0.207	0.028	0.197
N - Total Firm Years	79	39	40	79	79	39	40	79

Table 5. Asset Acquisitions/Dispositions by Canadian Firms

This table reports acquisition and disposition activity by Canadian light oil producers after the basis risk shock. Specifically, it reports the net acquisitions conducted by Canadian firms, scaled by assets: (Acquisitions$_t$ - Dispositions$_t$)/Assets$_{t-1}$. The reported acquisitions and dispositions activity periods correspond to (1): Q1-Q4 2012 and (2): Q1 2012-Q3 2013 (up to most recent quarterly filing). Mean activity is computed for high and low leverage Canadian oil producers separately. High (low) leverage firms are defined as having book leverage above (below) median book leverage as of Q4 2011, the quarter prior to the event under study. Differences in means are computed where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Canadian firms		
	High Leverage	Low Leverage	Difference
(1) 2012 Net Acquisitions/Dispositions	-5.85%	0.77%	-6.62%*
(2) 2012 and 2013 Net Acquisitions/Dispositions	-6.31%	2.87%	-9.18%*

Table 6. Placebo Test: Hedging and Capital Expenditures

This table reports firm level regressions which measure the change in investment activity for treatment (Canadian) firms in response to a placebo event which occurs over the 9 quarters prior to the actual withdrawal of effective hedging instruments in Q1 2012. The dependent variable is capital expenditures scaled by beginning of quarter assets. Firm quarter level observations are aggregated into two separate time periods, one for the average investment in the quarters prior to the placebo event (Q4 2009 to Q3 2010) and one for average investment in the quarters after the placebo event (Q1 2011 to Q4 2011). The resulting dataset has two time periods for a firm, one for the time period before the placebo treatment and one for the time period after the placebo treatment. U.S. oil producers serve as the control group. High (respectively low) leverage firms are firms with above (respectively below) median book leverage as of Oct 31, 2010. All indicator variables are defined in Table 2. The PostPlacebo indicator variable indicates a post-placebo event observation. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I/K_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 PostPlacebo_t + \beta_3 PostPlacebo_t * CA\ Dummy_i + FirmFE_i + \varepsilon_{i,t}$$

$$I/K_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 PostPlacebo_t + \beta_3 PostPlacebo_t * CA\ Dummy_i + \beta_4 High\ Leverage_i + \beta_5 High\ Leverage_i * PostPlacebo_t + \beta_6 High\ Leverage_i * CA\ Dummy_i + \beta_7 High\ Leverage_i * CA\ Dummy_i * PostPlacebo_t + FirmFE_i + \varepsilon_{i,t}$$

Dependent Variable = Capital Expenditures/Assets

	Pre-Period = [Q4 2009 to Q3 2010], Post-Period = [Q1 2011 to Q4 2011]			
	All Firms	High Leverage	Low Leverage	All Firms
	(1)	(2)	(7)	(8)
(β_1) Canada Dummy$_i$	Absorbed by FirmFE$_i$			
(β_2) PostPlacebo$_t$	0.032***	0.025***	0.037***	0.037***
	[4.78]	[2.80]	[3.90]	[3.93]
(β_3) Canada Dummy$_i$ * PostPlacebo$_t$	-0.015	-0.006	-0.023	-0.023
	[-1.40]	[-0.47]	[-1.38]	[-1.39]
(β_4) High Leverage$_i$	Absorbed by FirmFE$_i$			
(β_5) High Leverage$_i$ * PostPlacebo$_t$				-0.012
				[-0.92]
(β_6) High Leverage$_i$ * Canada Dummy$_i$	Absorbed by FirmFE$_i$			
(β_7) High Leverage$_i$ * Canada Dummy$_i$ * PostPlacebo$_t$				0.017
				[0.78]
FirmFE$_i$	Yes	Yes	Yes	Yes
R^2 Within	0.242	0.252	0.249	0.250
N - Total Firm Years	147	72	75	147

Table 7. Placebo Test: Hedging and Firm Value

This table reports firm level regressions which measure the change in firm value for treatment (Canadian) firms in response to a placebo event which occurs over the 9 quarters prior to the actual withdrawal of effective hedging instruments in Q1 2012. The dependent variable is Tobin's Q. Firm quarter level observations are aggregated into two separate time periods, one for the average Tobin's Q in the quarters prior to the placebo event (Q4 2009 to Q3 2010) and one for average Tobin's Q in the quarters after the placebo event (Q1 2011 to Q4 2011). The resulting dataset has two time periods for a firm, one for the time period before the placebo treatment and one for the time period after the placebo treatment. U.S. oil producers serve as the control group. High (respectively low) leverage firms are firms with above (respectively below) median book leverage as of Oct 31, 2010. All indicator variables are defined in Table 2. The PostPlacebo indicator variable indicates a post-placebo event observation. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$Q_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 PostPlacebo_t + \beta_3 Post_t * CA\ Dummy_i + FirmFE_i + \varepsilon_{i,t}$$

$$Q_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 PostPlacebo_t + \beta_3 PostPlacebo_t * CA\ Dummy_i + \beta_4 High\ Leverage_i + \beta_5 High\ Leverage_i * PostPlacebo_t + \beta_6 High\ Leverage_i * CA\ Dummy_i + \beta_7 High\ Leverage_i * CA\ Dummy_i * PostPlacebo_t + FirmFE_i + \varepsilon_{i,t}$$

Dependent Variable = Tobin's Q

	Pre-Period = [Q4 2009 to Q3 2010], Post-Period = [Q1 2011 to Q4 2011]			
	All Firms	High Leverage	Low Leverage	All Firms
	(1)	(2)	(7)	(8)
(β_1) Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_2) $PostPlacebo_t$	0.092	0.055	0.130	0.130
	[1.21]	[0.62]	[1.04]	[1.04]
(β_3) Canada $Dummy_i$ * $PostPlacebo_t$	-0.270	-0.090	-0.436	-0.436
	[-1.40]	[-0.33]	[-1.59]	[-1.60]
(β_4) High $Leverage_i$	Absorbed by $FirmFE_i$			
(β_5) High $Leverage_i$ * $PostPlacebo_t$				-0.075
				[-0.49]
(β_6) High $Leverage_i$ * Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_7) High $Leverage_i$ * Canada $Dummy_i$ * $PostPlacebo_t$				0.346
				[0.90]
$FirmFE_i$	Yes	Yes	Yes	Yes
R^2 Within	0.027	0.003	0.072	0.041
N - Total Firm Years	153	75	78	153

Table 8. Placebo test: Effect of Negative Macro Shock and Leverage on Stock Price Return

This table reports regressions which measure the change in stock price of treatment (Canadian) firms during the 2008 financial crises and commodity price collapse. The dependent variable is gross stock return, relative to July 1, 2008 (onset of oil price crash). High leverage firms are firms with above median book leverage as of July 1, 2008, while low leverage firms are firms with below median leverage as of July 1, 2008. T-statistics are reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$StockReturn_i = \alpha + \beta_1 HighLeverage_i + \varepsilon_i$$

Dependent Variable = Cumulative Stock Returns

	Window = [July 1, 2008 to Dec 31, 2008]	Window = [July 1, 2008 to Sep 30, 2009]
	Canadian Firms	Canadian Firms
	(1)	(2)
(β_1) High Leverage$_i$	11.069	3.713
	[0.78]	[0.30]
R^2 Within	0.019	0.003
N - Total Firm Years	33	33

Table 9. Hedging and Capital Expenditures (Similar Oil Prices in Pre and Post Period)

This table reports firm level regressions that measure the change in investment activity for treatment (Canadian) firms impacted by the withdrawal of effective hedging instruments due to a significant increase in basis risk. The dependent variable is capital expenditures scaled by beginning of quarter assets. Firm quarter level observations are aggregated into two separate time periods, one for the average investments in four quarters prior to the loss of effective hedging instruments, (Q3 2010 to Q2 2011) and one for after (Q2 2012 to Q1 2013). This comparison is done such that the oil prices in the pre and post period are similar (1.7% difference). The resulting dataset has two time periods per firm, one for the time period before the loss of hedging instruments by treatment (Canadian) firms and one for the time period after the loss of hedging instruments by treatment (Canadian) firms. U.S. oil producers serve as the control group. The Canada dummy variable takes the value of one for treatment (Canadian) firms. The Post dummy takes a value of one for the time period after the event. High (respectively low) leverage firms are firms with above (respectively below) median book leverage as of Dec. 31 2011. The High Leverage dummy variable takes the value of one for firms with high leverage. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$I/K_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + FirmFE_i + \varepsilon_{i,t}$$

$$I/K_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + \beta_4 High\ Leverage_i + \beta_5 High\ Leverage_i * Post_t + \beta_6 High\ Leverage_i * CA\ Dummy_i + \beta_7 High\ Leverage_i * CA\ Dummy_i * Post_t + FirmFE_i + \varepsilon_{i,t}$$

Dependent Variable = Capital Expenditures/Assets

	Pre-Period = [Q3 2010 to Q2 2011], Post-Period = [Q2 2012 to Q1 2013]			
	All Firms	High Leverage	Low Leverage	All Firms
(β_1) Canada Dummy$_i$	Absorbed by FirmFE$_i$			
(β_2) Post$_t$	0.005	0.014	-0.002	-0.002
	[0.63]	[1.63]	[-0.15]	[-0.15]
(β_3) Canada Dummy$_i$ * Post$_t$	-0.028**	-0.053***	-0.004	-0.004
	[-2.52]	[-3.66]	[-0.28]	[-0.28]
(β_4) High Leverage$_i$	Absorbed by FirmFE$_i$			
(β_5) High Leverage$_i$ * Post$_t$				0.016
				[0.97]
(β_6) High Leverage$_i$ * Canada Dummy$_i$	Absorbed by FirmFE$_i$			
(β_7) High Leverage$_i$ * Canada Dummy$_i$ * Post$_t$				-0.049**
				[-2.26]
FirmFE$_i$	Yes	Yes	Yes	Yes
R^2 Within	0.112	0.314	0.011	0.176
N - Total Firm Years	156	76	80	156

Table 10. Hedging and Firm Value (Similar Oil Prices in Pre and Post Period)

This table reports firm level regressions that measure the change in firm value for treatment (Canadian) firms impacted by the withdrawal of effective hedging instruments due to a significant increase in basis risk. Firm value is proxied by Tobin's Q. Firm quarter level observations are aggregated into two separate time periods, one for the average Tobin's Q in four quarters prior to the loss of effective hedging instruments (Q3 2010 to Q2 2011) and one for after (Q2 2012 to Q1 2013). This comparison is done such that the oil prices in the pre and post period are similar (1.7% difference). The resulting dataset has two time periods per firm, one for the time period before the loss of hedging instruments by treatment (Canadian) firms and one for the time period after the loss of hedging instruments by treatment (Canadian) firms. U.S. oil producers serve as the control group. High (respectively low) leverage firms are firms with above (respectively below) median book leverage as of Dec. 31 2011. All indicator variables are defined in Table 2. Standard errors are clustered by firm, with t-statistics reported in brackets below the coefficient estimates, where * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

$$Q_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + FirmFE_i + \varepsilon_{i,t}$$

$$Q_{i,t} = \alpha + \beta_1 CA\ Dummy_i + \beta_2 Post_t + \beta_3 Post_t * CA\ Dummy_i + \beta_4 High\ Leverage_i + \beta_5 High\ Leverage_i * Post_t + \beta_6 High\ Leverage_i * CA\ Dummy_i + \beta_7 High\ Leverage_i * CA\ Dummy_i * Post_t + FirmFE_i + \varepsilon_{i,t}$$

Dependent Variable = Tobin's Q

	Pre-Period = [Q3 2010 to Q2 2011], Post-Period = [Q2 2012 to Q1 2013]			
	All Firms	High Leverage	Low Leverage	All Firms
(β_1) Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_2) $Post_t$	-0.535***	-0.374***	-0.680***	-0.680***
	[-5.38]	[-3.58]	[-4.27]	[-4.29]
(β_3) Canada $Dummy_i$ * $Post_t$	-0.006	-0.436	0.407**	0.407**
	[-0.02]	[-0.99]	[2.35]	[2.36]
(β_4) High $Leverage_i$	Absorbed by $FirmFE_i$			
(β_5) High $Leverage_i$ * $Post_t$				0.306
				[1.62]
(β_6) High $Leverage_i$ * Canada $Dummy_i$	Absorbed by $FirmFE_i$			
(β_7) High $Leverage_i$ * Canada $Dummy_i$ * $Post_t$				-0.843*
				[-1.79]
$FirmFE_i$	Yes	Yes	Yes	Yes
R^2 Within	0.193	0.168	0.492	0.226
N - Total Firm Years	156	76	80	156