The effect of oil price shocks on stock market returns and exchange rates: Evidence from oil inventory announcements

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Abstract

This paper measures the impact of oil prices on exchange rates and stock returns. We construct a series of exogenous oil price shocks based on crude oil inventory announcements that allow us to identify the causal impact of oil prices on financial variables. Preliminary results provide evidence for intriguing information flows from commodity to financial markets.

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1 Introduction

The impact of oil price fluctuations on exchange rates, stock market returns and other financial variables has received a lot of attention by policy makers and market participants over the last years. Alongside changes in the real economy, oil price shocks have been linked to variations in stock markets (Kilian and Park 2009), exchange rates - particularly those of commodity exporting countries (Akram 2004; Ferraro, Rogoff, and Rossi 2015) - and financial market measures of inflation expectations,[1] among others.

While early studies used to treat oil prices as exogenous to financial markets, we have now compelling evidence for a bidirectional causality between oil prices and financial variables, and that oil and many financial asset prices are jointly determined with other macroeconomic variables in general equilibrium (Frankel 2006; Akram 2009; Kilian 2009; Chen, Rogoff, and Rossi 2010).[2] Moreover, the impact of oil price changes on asset prices depends crucially on the underlying cause of the oil price movement (see e.g. Kilian and Park 2009). These findings pose serious challenges to the identification and measurement of the effects arising from oil price shocks.[3]

In this study, we are interested in understanding and quantifying the role that exogenous oil price shocks play for the fluctuations of different financial assets. We exploit exogenous variations in the oil price in order to identify its causal impact on a set of fast moving financial variables. The analysis is carried out in two steps. First, a series of exogenous oil price shocks are derived from surprises in weekly crude oil inventory announcements. Each Wednesday at 10.30am, the EIA announces its figures for oil market fundamentals such as inventories for the week ending the preceding Friday. As seen in figure (4), these announcements often lead to substantial oil price adjustments that typically occur within a few minutes after such an announcement (empirical evidence for this effect is provided by Halova, Kurov, and Kucher 2014, among others) Given the oil market specific nature of the announcements, the oil price changes observed in a very short window around the announcement can be plausibly treated

[1] See e.g. Elliott, David, Chris Jackson, Marek Raczko and Matt Roberts-Sklar (2015, October 20). Does oil drive financial market measures of inflation expectations? Retrieved from http://bankunderground.co.uk/2016/01/20/does-oil-drive-financial-market-inflationexpectations/#more-700.

[2] Take for example the US exchange rate. Since most of global oil is traded in US dollar but produced outside of the US, an (exogenous) increase in the US dollar will decrease oil prices. At the same time, an (exogenous) decrease in the oil price improves the US terms of trade and will appreciate the US dollar. Also, changes in other macroeconomic variables can lead to a simultaneous movement in the US exchange rate and commodity prices through various channels (Frankel 2006). Observing a co-movement of the US exchange rate and the oil price in different directions is therefore not sufficient to determine the cause and effect of these fluctuations.

[3] For example, Ferraro, Rogoff, and Rossi (2015) investigate the effect of oil price changes on exchange rates of oil exporting countries and find a robust relationship at the daily frequency. However, the authors also recognize that their evidence for a stable correlation between oil price changes and exchange rates is "not informative regarding the economic causality in the data".

as exogenous with respect to macroeconomic and financial variables such as exchanges rates, interest rates or stock market changes. In a second step we then evaluate the effect of the announcement-induced oil price changes on intraday changes in exchange rates and stock market returns.[4] For each of these variables the existing literature and empirical evidence postulates a close interconnectedness to oil prices, but is divided over the importance and size of the impacts, as well as the direction of causality.

This study makes several contributions to the existing literature. First, we propose a novel measure of exogenous oil price shocks that can be used to evaluate the causal effect of oil price changes. One advantage with regard to the existing literature is that the timing of these shocks can be determined precisely. Existing studies relying on monthly data (e.g. Kilian and Park 2009) typically require auxiliary assumptions regarding the contemporaneous feedback between financial market and oil market shocks that might be unrealistic given the fast price adjustments that can occur in these markets.[5] Moreover, while the existing literature has focused mainly on daily or lower frequencies, we provide evidence for an intraday relationship between oil price changes and financial variables. Given that stocks and currencies are very liquidly traded on electronic exchanges, we would expect the adjustment to take place within several minutes. We show that this is indeed the case. Second, to our best knowledge this is the first paper to consider effects from oil inventory announcements on financial variables. Instead, the existing literature hitherto has has been confined either on the impact of oil inventory announcements on oil and gas prices or on the impact of scheduled macroeconomic news releases on oil and asset prices (e.g. Kilian and Vega 2011; Evans 2011). Finally, noise in the informational content of news announcements can be shown to bias classical estimators and needs to be taken into account when evaluating the high-frequency response of asset prices to announcements (Rigobon and Sack 2004). We therefore extend econometrics of "noisy inventory announcements" (see e.g. Halova, Kurov, and Kucher 2014) to a setting where these announcements are used as an instrument.

The paper that comes closest to our study is Fratzscher, Schneider, and Van Robays (2014). The authors exploit the heteroscedasticity in daily oil, exchange rate and VIX returns in order to identify the causal impact of oil price changes on the US exchange rate and other asset prices. However, their model is based on additional assumptions and confined to a limited number of variables that can explain the co-movement in oil and asset prices. Our results provide new evidence as they are based on a less restrictive methodology and higher

[4]Since the announcement induced oil price adjustments typically take place within a matter of minutes, it is necessary that the endogenous variables can be observed at a similar high frequency (intraday). Even at a daily frequency there is too much noise in order to estimate these effects precisely. This limits our analysis to financial variables observable at intraday frequencies.

[5]Our shocks also yield a more precise measure of oil price shocks as it is less susceptible to measurement and estimation errors or structural breaks than e.g. popular VAR-based measures.

frequency. In addition, we consider a larger number of endogenous financial variables for which the existing empirical evidence is limited.

The next sections briefly outline the empirical methodology and discusses some preliminary results.

2 Data and Methodology

The first step - the construction of inventory surprises and oil returns - follows Halova, Kurov, and Kucher (2014):

Inventories: The data on U.S. inventory of crude oil and other petroleum products are obtained from the EIA Weekly Petroleum Status Report. The data include weekly ending commercial stocks of crude oil, gasoline, and distillate fuel oil. The data included in the Petroleum Status Report are collected by the EIA on weekly surveys from a sample of operators at several key points along the petroleum production and supply chain. The key data in the Petroleum Status Report are released at 10:30 a.m. (Eastern Time) every Wednesday for the week ending the previous Friday. For some weeks which include holidays, releases are delayed by 1 day.

Inventory Surprises: To compute the unexpected changes in inventory, or inventory surprises, we need a proxy for the market expectations at the time of the inventory announcement. Following the previous literature, we use the Bloomberg consensus forecasts to measure expected changes in inventory. The consensus forecast is computed as the median of individual analyst forecasts. We compute inventory surprises as the difference between the actual and expected change in inventory, divided by the inventory level.

Futures and Financial data: To examine the response of oil prices to inventory news, we use intraday futures prices for WTI crude oil traded on the New York Mercantile Exchange (NYMEX). We construct a continuous contract by rolling over the front to the second contract on the sixth business day prior to the last trading day of the front.[6] To compare our results to existing studies using the slope of the futures curve as a proxy for precautionary oil demand (e.g. Anzuini, Pagano, and Pisani 2014), the spot-futures spread is computed as the difference between the front and the 6th contract. Finally, we construct intraday returns for our several financial variables: (a) exchange rates for major U.S. trading partners (USD-EUR, USD-YPY and USD-GBP); (b) exchange rates for oil exporting countries (USD-CAD) and (USD-NOK) and (c) major stock indexes (S&P 500, EuroStoxx and FTSE).[7]

Methodology: We compute continuously compounded returns for oil futures and financial

[6]Contrary to spot prices, WTI futures are traded in very deep markets for which intraday data is readily available. The front contract is typically a very good proxy for the spot price.

[7]The intraday data is obtained from the providers Tickdata, tickmarketdata and Bloomberg.

variables in an intraday event window surrounding the inventory announcement surprises using prices of the nearby futures contract. We define the event window from 5 minutes before to 15 minutes after the announcement time. In a typical event study, asset returns are regressed on the unexpected component of the data release. Based on the work by Rigobon and Sack (2004), Halova, Kurov, and Kucher (2014) show that the noisiness of the news announcement biases classical estimators and needs to be taken into account. For estimating the effect on oil prices, we use an estimation strategy similar to these authors, which is based on a bias correction based on the relative price volatility on announcement and non-announcement days.

In order to evaluate the causal effect of oil price changes on financial variables we employ an instrumental variable approach. We first test the first stage by verifying that the inventory announcements do indeed have a sufficiently strong impact on oil prices.[8] We argue that the surprises are exogenous, i.e. these are shocks that (a) originate in the oil market and (b) are the cause but not a consequence of general equilibrium adjustments - in other words, the the only channel through which these inventory announcements will affect asset prices is through the oil price adjustment. This idea is visualized in figures (1) and (2).

Figure (1) depicts what can be considered the "traditional view" of causality and information flows between the oil and the (US) stock market, where the main channels channels are labeled a, b, and c. A negative (exogenous) shock to oil prices (i.e. a shock that lowers oil prices) increases the economic outlook for the US (a), which leads to a rise in the US stock market (c). The correlation between oil and stock market returns, $\sigma_{O,S}$ is negative. Very roughly speaking, we might call these shocks, i.e. shocks originating in the oil market, "supply shocks".[9]

(Exogenous) positive news about current or future economic developments, on the other hand, should increase the price of oil through higher expected demand (b) and the stock market (c) simultaneously. The correlation between oil and stock market returns, $\sigma_{O,S}$ is positive. Very roughly speaking, we might call these shocks, i.e. shocks originating in (news about) economic developments, "demand shocks".[10]

Figure (2) depicts the idea of using inventory announcements as an instrument for shocks originating in the oil market ("supply shocks"). The idea is that the main channel through

[8]Preliminary estimations and results from existing literature indicate large effects, especially when correcting for the bias introduced through the noisiness of inventory announcements.

[9]kilian2009impact also consider "speculative oil demand shocks", i.e. shocks associated with uncertainty about relative future oil supply and demand. Using a VAR methodology with monthly data, these authors find significant negative impacts on the US stock market arising from these shocks, which implies that they have a similar effect as described here.

[10]Potentially, there exist also direct channels between the stock and the oil market through e.g. example portfolio effects, or changes in the price of risk rather than changes in the risk, but these channels are expected to play a minor role.

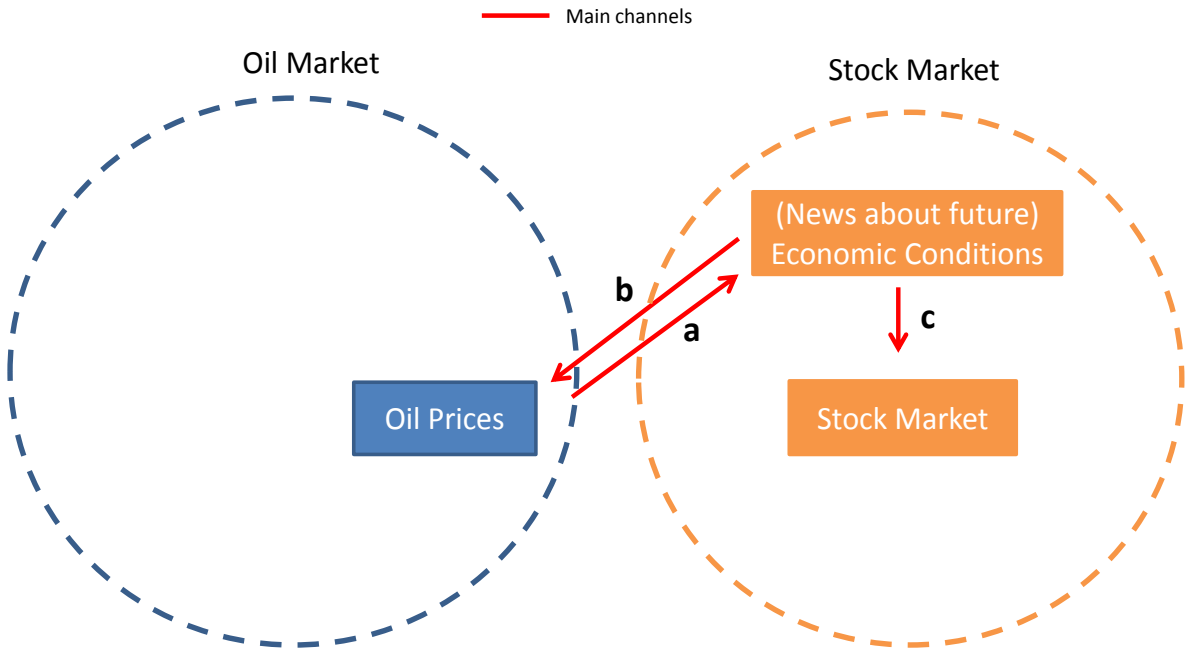

Figure 1: Traditional view about the information flows and relationship between the oil market and the stock market.

which these announcement should impact stock prices is through oil prices (d). These is based on the exclusion restriction that channel (e) is negligible. If this is indeed the case, than we should be able to isolate the effect of "supply shocks" on the stock market: we expect that following higher (lower) than expected inventories, the oil price would fall (rise) and the stock market rise (fall) (i.e. conditioning on the shock originating from inventories -i.e. in the oil market - the correlation between oil and stock market returns, $\sigma_{O,S} < 0$.)

Finally, to investigate the stability of our results, we also split our sample period and consider the pre- and post-financial-crisis periods separately.

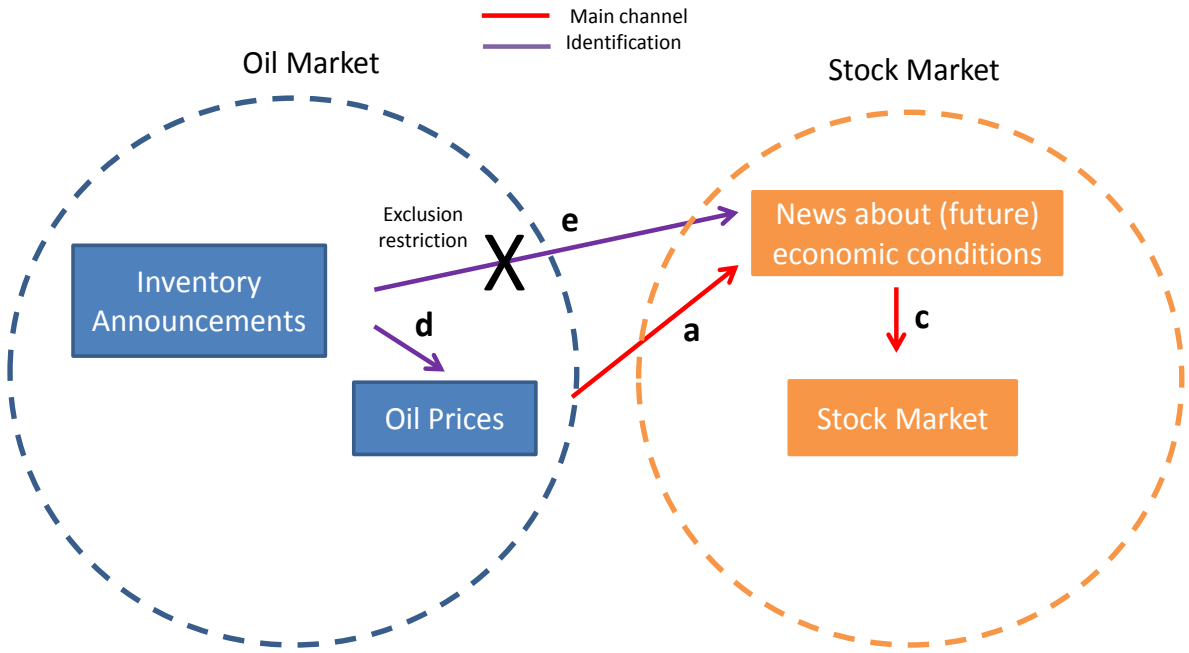

Figure 2: Original idea of exploiting inventory announcements.

3 Preliminary Results and Discussion

Preliminary estimates indicates the following findings:[11]

A Inventory surprises explain most of the movements of oil prices during the announcement window: higher (lower) inventories than expected lead to an instant downward (upward) movement in the oil price. However, the strength of this effect seems to be time varying.

B We find only small effects on the US exchange rate vis-a-vis major trade partners that are also oil importing countries.

C We find statistically and economically significant effects on the US exchange rate vis-

[11]The preliminary evidence is based on the 2003 - 2012 sample period for the currency pairs USD-GBP and USD-CAD, as well as the S&P 500.

a-vis oil exporters.

D We find significant effects on the US stock market. However, the effects are negative (i.e. a higher oil price after a lower than expected inventory announcement *depresses* the S&P 500) before the financial crisis, while they are positive (i.e. a higher oil price after a lower than expected inventory announcement *increases* the S&P 500).

Results A, B and C are consistent with the existing literature, where the latter can be explained with an adjustment in the market expectations of future terms of trade of oil importing and exporting countries, respectively. Likewise, the time varying impact of oil price shocks on the US stock market coincides with a documented increase in the correlation between stock market and oil returns (Lombardi and Ravazzolo 2013). Kilian and Park (2009) have also shown that the US stock market impact differs according to the underlying cause of the oil price shock. Result D is consistent with the idea that market participants attribute surprise changes in inventories to either demand or supply shocks, which have been shown to individually have very different implications for the stock market. It is also intriguing for several reasons. First, the exogenous oil price shocks considered here seem to resemble what are known as "precautionary demand shocks".[12] This contrasts Kilian and Park (2009)'s results, who show that precautionary demand shocks identified from a structural VAR have a strong and consistently negative stock market impacts. Our preliminary findings indicate that rather, market participants seem to use surprise changes in the oil inventories in order to make inference about current state variables that are difficult to observe in real time and attribute these changes to either demand (global economic activity) or supply.[13]

Figure (3) depicts an updated version of the identification scheme in light of the empirical evidence that after inventory announcement shocks, $\sigma_{O,S} < 0$ when using pre-09/2008 data and $\sigma_{O,S} > 0$ when using post-09/2008 data. This means that - unless the effect of exogenous

[12] According to Kilian and Park (2009), precautionary demand arises from the uncertainty about shortfalls of expected supply relative to expected demand and reflects the convenience yield from having access to inventory holdings of oil that can serve as insurance against an interruption of oil supplies. One would therefore expect the surprise changes in inventories considered here to be closely connected to precautionary demand. Based on the analysis by Alquist and Kilian (2010), Anzuini, Pagano, and Pisani (2014) use changes in the slope of the oil futures curve to proxy precautionary demand shocks. We plan to include a discussion on the relationship between inventory announcements and changes in the futures curve in the final version of this manuscript.

[13] One might also be worried that the recent surge in US oil production could cause time variation in the impact of oil price shocks on US stock returns (Kang, Ratti, and Vespignani 2015). However, this effect should work in the opposite direction, i.e. it should make stock returns more responsive to surprise changes in (US) production. Another concern is that the crude oil inventory figures are released simultaneously with gasoline inventory figures, and that these gasoline inventory figures might be more closely connected to information on consumption (demand) and hence economic activity. However, we obtain similar results working with crude oil surprises only and when we use the crude oil inventory surprise that is orthogonal to the other surprises.

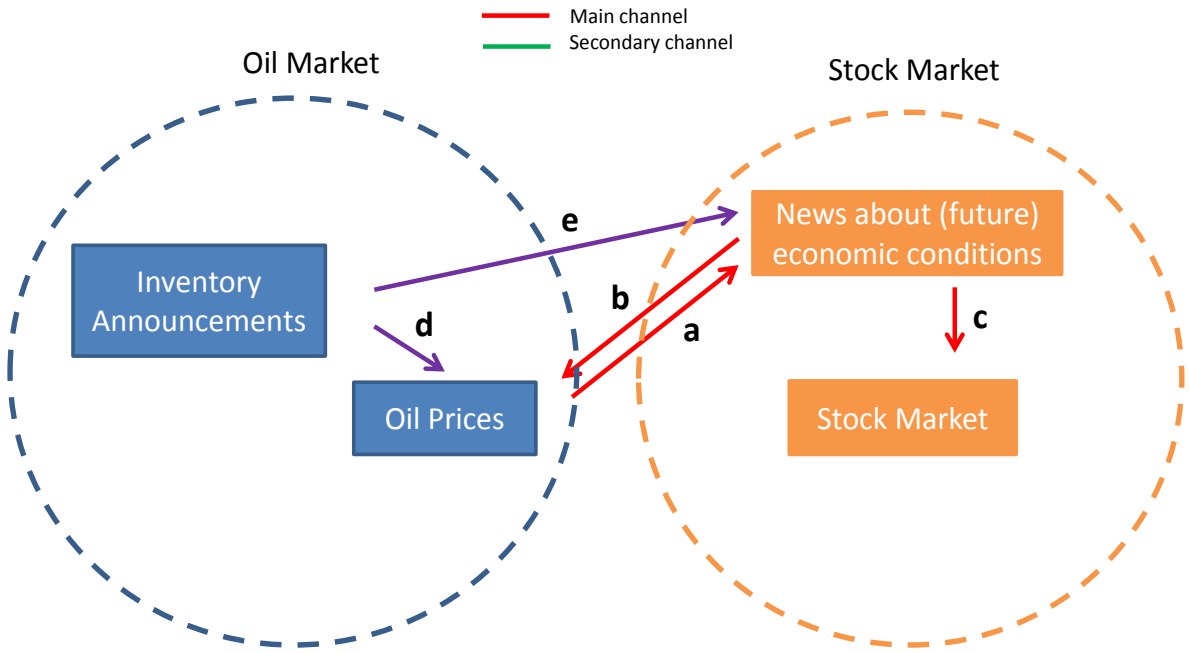

Figure 3: Potential channels in light of the empirical evidence.

oil price changes on the stock market changes dramatically[14] - the exclusion restriction is likely to be violated, i.e. market participants use inventory announcements also to make direct inferences about economic conditions (demand). On the one hand, this seems actually plausible because inventories changes are the difference between flow supply and flow demand, and the latter is certainly influenced by current (and future expected) economic conditions. On the other hand, it is still an open question why the importance of this channel should change so much over time.

[14]Sockin and Xiong (2015) have forwarded the hypothesis that commodity price changes themselves can provide important information of the current state on the economy to economic agents. In their model, agents only imperfectly observe current economic conditions (say current GDP), and will use (a part of) a rise in commodity prices to update their believe about the current state of the economy. In this case, exogenous positive oil price shocks could also affect the stock market positively, at least until agents recognize their "error". However, it would still be an open question as to why this mechanism seemed to be week before the financial crisis and strong afterwards.

Recently, Hu and Xiong (2013) and Sockin and Xiong (2015) have forwarded a similar hypothesis, arguing that commodity price changes themselves can provide important information of the current state on the economy to economic agents that are otherwise unobservable. We plan to compute the results for the other financial assets in the near future, and expect to be able to obtain a clearer picture on this hypothesis.

Appendix: Figures

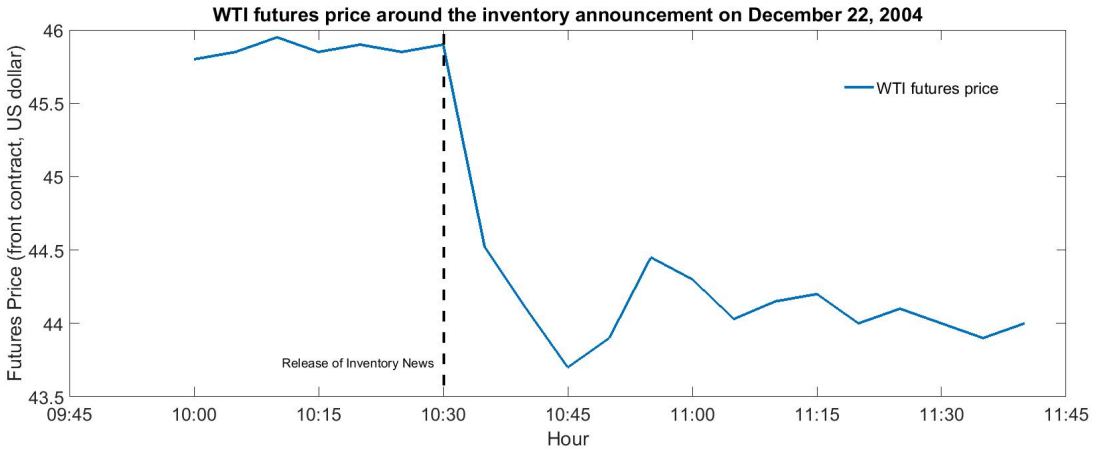

Figure 4: Movements in the crude oil futures price around the inventory announcement on December 22, 2004. On this day, the crude oil inventories figures in the news release indicated that inventories where 1.44% higher than implied by the median forecast provided by Bloomberg.

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