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Miruna-Daniela Ivan, Chiara Banti and Neil Kellard

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Miruna-Daniela Ivan,[1] Chiara Banti[2] and Neil Kellard[3]

Abstract

This paper explores a novel directional liquidity-based transmission channel of monetary policy, which explains the heterogeneity in the response of commodity future prices to monetary policy. Employing an event-study analysis with a high-frequency instrumental variable estimator, we find that the trading volume of our sample of commodity futures declines following FOMC announcements. Further, we find that more traded commodities are also more exposed to monetary policy surprises, suggesting a significant role for trading activity in the transmission of monetary policy shocks to commodity markets. Lastly, we show that the direction of the target rate change matters to this transmission mechanism of monetary policy.

Key words: Monetary policy, monetary transmission, financial liquidity, commodity futures.

JEL classification: E52, G14, G12.

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(1) Bank of England. Email: Miruna-Daniela.Ivan@bankofengland.co.uk
(2) Essex Business School, University of Essex. Email: cbanti@essex.ac.uk
(3) Essex Business School, University of Essex. Email: nkellard@essex.ac.uk

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Bank of England, Threadneedle Street, London, EC2R 8AH
Email: enquiries@bankofengland.co.uk

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1. Introduction

This paper provides empirical evidence of a novel directional liquidity-based transmission channel (DLTC) of monetary policy to the commodity futures market. Commodity price dynamics have been a major source of concern for policymakers during the last decades given their crucial role in shaping the dynamics of global economic activity (Harvey et al., 2017; Ge and Tang, 2020; Miranda-Agrippino and Rey, 2020; Juvenal and Petrella, 2024). Variations in commodity prices have often coincided with shifts in global monetary conditions (Anzuini, Lombardi and Pagano, 2012). Empirical studies on the impact of monetary policy on commodity markets have covered various commodities, with the oil market receiving most attention. Having yet to reach a consensus on the response of energy prices to changing interest rates, the literature has generally documented significant heterogeneity in the response of commodity prices to monetary policy (Kilian and Vega, 2011; Rosa, 2014; Scrimgeour, 2015; Hammoudeh, Nguyen and Sousa, 2015; Basistha and Kurov, 2015). Whereas the extant literature on the commodity market explores several monetary policy transmission mechanisms centred on macroeconomic fundamentals, we adopt a microstructure perspective and document the presence of a new channel related to commodity trading activity.

Differently from macroeconomic fundamentals, our liquidity-based mechanism of monetary policy transmission is based on the microstructure of commodity markets and has become especially important in the context of the increasing financialization of the commodity market. Taking into consideration this microstructure perspective disregarded in prior work we identify a new channel for the transmission of monetary policy that explains the heterogeneity in commodity responses to monetary policy.

To formulate our framework, we adapt the theoretical model of monetary policy transmission to the stock market by Lagos and Zhang (2020) to the specific institutional setting of the commodity market; in particular, this involves additionally noting that changes in interest rates affect commodity futures market liquidity via (i) costs of trading, including funding a margin account and (ii) that such cost changes affect hedgers and speculators differently, with hedgers likely to face a binding constraint earlier when interest rates rise. This binding constraint is derived from the risk of a price decline in the physical commodity position held by hedgers, which impacts the short-term liquidity premium provided by hedgers to speculators (Kang, Rouwenhorst and Tang, 2020), and implies that the direction of the rate change matters to the liquidity-based transmission channel.

To empirically assess this directional liquidity-based mechanism, we use daily data for a sample of 19 commodity futures that comprise the S&P Goldman Sachs Commodity Index (S&P GSCI).[1] We first conduct an event-study analysis, consisting of estimating the response of the trading volume of individual commodity futures to monetary policy surprises on the days of Federal Open Market Committee (FOMC) announcements. Following Lagos and Zhang (2020), we consider a version of the event-study estimator that relies on an instrumental variable identification strategy which uses intra-day, high-frequency tick-by-tick interest rate data (HFIV estimator). Next, we inspect the liquidity-based transmission channel of monetary policy by exploiting the cross-sectional variation in trading volume that exists across commodity futures. We run a fixed effects panel model of the returns of individual commodity future on changes in the policy rate, an interaction term between the change in the policy rate and the average trading volume of individual commodity futures, and several controls. In this second exercise, we allow the responses of commodity returns to monetary policy to vary depending on the direction of the FOMC policy action. To do so, we follow Bernanke and Kuttner (2005), employing interactive dummy variables based on the sign of changes in the federal funds target rate.[2]

[1] Although the S&P GSCI contains 24 commodities, Marshall, Nguyen and Visaltanachoti (2012) excluded five industrial metal commodities (*aluminium, copper, lead, nickel* and *zinc*) and we follow suit - see section 3.1.2 for more details. Motivated by the work of Tang and Xiong (2012) and Basak and Pavlova (2016), we focus on the behaviour of index commodities. Tang and Xiong (2012) find that commodities included in investable commodity indices such as S&P GSCI and DJ-AIG have a greater exposure to common shocks, which is driven by investor interest, rather than macroeconomic fundamentals.

[2] The difference between the federal funds target rate and the target surprise is that the former is not

We find that although the trading volume of commodity futures generally declines with unexpected monetary policy contractions, there is significant heterogeneity across commodities. Building on the cross-sectional variation in the trading volume, we show that the magnitude of the negative effect of target surprises associated with contractionary FOMC announcement days is larger for the most traded commodity futures. Our findings are robust to alternative specifications, including a 1-week estimation window and an alternative proxy for the nominal policy rate.

Our work contributes to the literature on the transmission of monetary policy to financial markets.[3] Empirical studies within this strand of literature have covered various commodity markets, with the oil market receiving most attention (Kilian and Vega, 2011; Rosa, 2014; Scrimgeour, 2015; Hammoudeh, Nguyen and Sousa, 2015; Basistha and Kurov, 2015). Having yet to reach a consensus on the response of the oil prices to changing interest rates, this literature provides evidence of significant heterogeneity in the response of commodity prices to monetary policy. Scholars have attributed this heterogeneity to different factors affecting a particular commodity such as weather conditions, storability, easiness of supply, the strength of demand for commodity inventories, and any overreaction due to speculation (Hammoudeh, Nguyen and Sousa, 2015). To this work we add empirical evidence of a directional liquidity-based transmission channel of monetary policy to the commodity futures market. Conducting our empirical analysis on individual commodity futures, as opposed to an aggregate commodity index (Anzuini, Lombardi and Pagano, 2012; Mallick and Sousa, 2013), enables us to investigate which commodity futures are most sensitive, according to their dollar trading volume, to policy changes. Moreover, we add to this strand of the literature by showing that the direction of the change in the federal funds target rate matters to the transmission of monetary policy to the commodity market. The literature so far has

market determined, but administered by the Federal Reserve.

[3] A large body of literature has examined the response of macroeconomic variables and the stance of monetary policy to changes in commodity prices, with a particular focus on oil price dynamics (Barsky and Kilian, 2002; Kilian, 2008, 2014; Jo, 2014; Kilian and Vigfusson, 2017; Kilian and Zhou, 2022).

been silent on the asymmetries linked to the type of policy action taken by the FOMC.[4]

Our empirical findings provide important new perspectives into how monetary policy operates in the commodity futures market. Considering that the effect of monetary policy interventions on commodity prices can spillover to systemic financial markets, and to the macro economy, these results are informative to policymakers for maintaining financial and price stability, and for the effective implementation of monetary policy. In addition, our findings are of interest to investors for formulating effective investment and risk management decisions, and to commodity producers for designing hedging strategies against volatile commodity prices (Rigobon and Sack, 2004).[5] Noteworthy for commodity producers, the ease of capital reallocation on secondary markets also affects investment in primary markets (Geromichalos et al., 2021).

The outline of the rest of the paper is the following. Section 2 reviews the related literature. We introduces the theoretical framework in Section 3. In Section 4, we describe the data and provide some preliminary analysis. We report the empirical analysis in Section 5. In Section 6, we introduce a series of robustness checks. Finally, Section 7 concludes.

2. Literature review

Since Frankel (1984), global monetary conditions and interest rates have attracted great interest as potential driving factors of movements in the price of commodities. This has led to a growing literature devoted to exploring the relationship between monetary policy and commodity prices. Competing theories attempting to explain how the price of commodities is influenced by monetary policy are based on macroeconomic fundamentals. For

[4]Since Keynes (1975), economists have seen asymmetries as an important aspect of the transmission mechanism of monetary policy to the macro economy and the financial markets Bernanke and Kuttner (2005). Asymmetries in the response of the stock market to monetary policy, related to economic conditions, the direction of the surprise, the size of the policy or the nature of the actual target rate change, have been explored by a growing body of empirical work (Lobo and Tung, 2000; Bernanke and Kuttner, 2005; Basistha and Kurov, 2008; Kurov, 2010).

[5]Basak and Pavlova (2016) find that in the presence of institutional investors, shocks to the fundamentals of index commodities are transmitted to the price of all other commodities.

instance, Barsky and Kilian (2001, 2002) argue that expansionary monetary policy improves expectations of higher inflation and stronger economic growth, which increase demand for all goods, including commodities.[6] Barsky and Kilian (2001) show that the oil price increase of the 1970s could have been caused, at least in part, by anticipated inflation brought on by expansionary monetary policy.

The behaviour of inventories has been highlighted as another key driving factor of movements in the price of commodities. Lower rates decrease the cost of holding inventories in the ground and create an incentive to strategically delay the extraction of exhaustible commodities (see Hotelling (1931), for the formal model and Frankel (2006*a*), for further discussion). This will increase the market price of commodities, as it occurred during the period 2002-2004. An increase in real interest rates will have the opposite effect, increasing the cost of carrying inventories and lowering the price of commodities, similar to the early 1980s. Some authors have argued that speculation has been responsible for some of the price variation over the last decade. Lower interest rates reduce the cost of speculative positions in the commodity market, putting upward pressure on futures prices and, by arbitrage, on spot prices (Frankel, 2006*a*; Frankel and Rose, 2010; Gospodinov and Jamali, 2018). Taylor (2009) finds that the reduction in interest rates by the Federal Reserve was responsible for accelerating the rise in oil prices during the early stages of the Global Financial Crisis (GFC). An explanation for this effect is provided by Frankel (2006*b*), who argues that the very rapid decline in short-term interest rates in the first quarter of 2008 fuelled speculation in the commodity market, with negative real interest rates encouraging investments in physical commodities. A number of studies have looked at jumps in the oil price that occur in immediate response to announcements that change monetary policy perceptions, in an attempt to isolate the macroeconomic effects on commodity prices. Basistha and Kurov

[6]This channel is closely related to the risk-transmission channel discussed in Borio and Zhu (2012), defined as the impact of changes in policy rates on risk perceptions and risk tolerance and hence on the degree of risk in the portfolios and on asset pricing. Precisely, changes in interest rates and central bank's open market operations influence risk-taking, by shifting perceptions of risk, and risk tolerance.

(2015) find that unexpected cuts in the fed funds target rate increases the price a number of energy commodity futures during the intraday event window following the announcement.

Similarly, Rosa (2014) finds that unanticipated hikes in the federal funds target rate decrease the futures price of light crude oil and heating oil during a 1-hour window around the FOMC press release. They also show that the release of the FOMC statement induces significantly higher price volatility and higher trading volumes for crude oil futures compared to non-event days.

While the oil market has received most attention, a number of empirical studies within this strand of literature covering a variety of commodity markets finds ample evidence of significant heterogeneity in the response of other commodity prices to monetary policy (Scrimgeour, 2015; Hammoudeh, Nguyen and Sousa, 2015). For example, Scrimgeour (2015) show that metal commodity prices tend to respond more than agricultural commodities to a raise in the interest rates. The heterogeneous response of commodity prices to interest rate changes is supported by Hammoudeh, Nguyen and Sousa (2015) who find that an increase in policy interest rates leads to a positive and persistent rise in highly volatile food prices, a fall in the prices of beverages and a persistent reduction in the prices of metals.[7]

Our paper contributes to these strands of literature by investigating a new microstructure channel based on the opportunity cost of money arising from the process of financialization of commodities, the observation that trading volume varies across commodity futures, and the direction of policy action.

3. A theoretical framework for commodity futures

We adapt the theoretical model of monetary policy transmission of Lagos and Zhang (2020) to the specific institutional setting of the commodity market (Kang, Rouwenhorst and Tang, 2020). The model of Lagos and Zhang (2020) allows for two types of agents (i.e., investors

[7]Focusing on stock market liquidity, Chung, Elder and Kim (2013) find that liquidity declines more when the information content of the announcement (i.e., the surprise component of the policy target) is larger.

and dealers) and two financial instruments (i.e., equity and money) to trade in an over-the-counter (OTC) market, showing that an increase in the growth rate of money supply (and therefore the expected inflation rate) or the real interest rate, causes equilibrium real money balances to decline. The investor therefore shifts their portfolio away from money towards equity in an attempt to avoid inflation tax, making money balances scarcer.

Consider a potential commodity futures market analog of a liquidity-based transmission channel where investors (either hedgers or speculators) can go long or short in one commodity futures, but now trading takes place on exchange with a central counterparty and margining . A rise in interest rates implies that commodity future spot prices will fall and also that the cost of funding a margin account will rise. The marginal investor now strictly prefers to be short and is less keen to trade (i.e., price and trade probability fall). Given that price increases with turnover and turnover is an increasing function of trade probability, then the diminution in price is greater for commodity futures with higher turnover.

Moreover, the literature documents two risk premia embedded in commodity futures prices, related to position changes: a long-term risk premium paid by hedgers to speculators for obtaining price insurance (the theory of normal backwardation) and a premium paid by speculators to hedgers for accommodating their liquidity needs (Kang, Rouwenhorst and Tang, 2020). Specifically, at shorter-horizons, impatient speculators are provided liquidity by hedgers, implying a short-term liquidity premium from speculators charged to hedgers to adopt a contrarian position. A surprise interest rate rise will not only lessen liquidity through increased funding costs, but also because the liquidity providers (i.e., hedgers) encounter a more binding funding constraint. Indeed, concerns over price falls in the physical commodity positions and the risk of financial distress have been highlighted in Haushalter (2000), Haushalter (2001) and Acharya, Lochstoer and Ramadorai (2013). Combining funding costs with the relative effect of funding constraints on hedgers and speculators provides a new mechanism, which we refer to as the directional liquidity-based transmission channel (DLTC) of monetary policy to commodity futures.

4. Data

4.1. Description of the data

The sample period commences in November 2000 and ends in December 2008.[8] We follow the extant literature on conventional monetary policy and the commodity market in choosing December 2008 as the end of the sample period (Anzuini, Lombardi and Pagano, 2012; Mallick and Sousa, 2013; Hammoudeh, Nguyen and Sousa, 2015; Basistha and Kurov, 2015; Scrimgeour, 2015). The sample ends in the final stages of the GFC, December 2008, after which the federal funds target rate has remained near zero and the FOMC began its unconventional monetary policy operations.[9] Following this period, the literature has argued that changes in asset prices that followed the FOMC announcements are likely to be driven by news about unconventional monetary policy operations (i.e., quantitative easing) (Basistha and Kurov, 2015).[10] The time period we investigate is therefore characterized by monetary policy operating through changes in the federal funds target rate.

The sample period includes a total of 82 scheduled FOMC policy announcement dates. 70 FOMC policy announcement dates are kept for the high-frequency estimation approach. The FOMC holds 8 regularly scheduled meetings each year to decide the monetary policy stance, with the announcement being issued at roughly 2 PM Eastern Time (ET) on the announcement day. The statement notes the change in the federal funds target rate, an explanation for the decision taken and a brief summary of the FOMC view on the current

[8]We use the series of FOMC announcement dates provided by Lagos and Zhang (2020). In building the dataset comprising of FOMC announcement dates, Lagos and Zhang (2020) discard two dates: 9/13/2001 and 9/17/2001 (the two atypical FOMC announcements in the immediate aftermath of 9/11/2001). For the estimation procedure requiring the high-frequency instrumental variable estimator (HFIV estimator), we follow Lagos and Zhang (2020) in using data from Gorodnichenko and Weber (2016). In line with Lagos and Zhang (2020), we discard observations for commodity futures with the return and trading volume in the top and bottom one percentile. We thank Lagos and Zhang (2020) for making this data available.

[9]The federal funds target rate is the interest rate on overnight loans of reserves between banks.

[10]Between 2015 and 2018, there were only 9 FOMC announcements, raising the target federal funds rate from 0.25% to 1.75%. By March 2020, the Fed had 5 announcements returning the federal funds target rate to close to 0%. The Fed began to raise rates again in March 2022. 11 policy announcements delivering interest rate cuts had taken place by July 2023.

and future economic conditions. While the federal funds target rate was volatile from 1987 to 2006, it reached the zero-lower bound in December 2008 (Smales and Apergis, 2017).[11]

The daily settlement time for the commodity futures in our sample varies between contracts, with energy commodities settling after the FOMC policy announcement at 2.30 PM ET, and agricultural, mental and livestock commodities settling before the announcement.[12] In particular, agricultural commodities settle at 2.15 PM ET, while metal and livestock commodities, settle between 1 PM ET and 2 PM ET.[13]

4.1.1. Monetary policy proxies

Following the lead of Gürkaynak, Sack and Swanson (2005), Gertler and Karadi (2015), and more recently, Miranda-Agrippino and Rey (2020), we proxy the the policy rate using the tick-by-tick nominal interest rate implied by the 30-day federal funds futures (FFFR). As an alternative policy rate measure, we also employ the 3-month Eurodollar futures contract due to mature after the FOMC policy announcement.[14] One of the advantages of using the futures rate to proxy the policy rate is that its movement on FOMC policy announcement dates reflects only policy surprises and not anticipated policy rate changes. As noted in Kuttner (2001) and Gürkaynak, Sack and Swanson (2005), the federal funds futures rate provides a high-quality, continuous measure of market expectations for the federal funds target rate.[15] Specifically, daily changes in the current-month futures rate reflect revisions to the market's expectations for the federal funds rate over the remainder of the month.

[11] During our sample period, the FOMC has had two chairs: Alan Greenspan (Aug 1987 to Jan 2006) and Ben Bernanke (Feb 2006 to Jan 2014).

[12] To test that our results are not affected by the different settling times around the announcement dates, we extend the window to calculate future returns to incorporate the full trading day post announcement and results are qualitatively similar. We report these results in section 6 and Tables 7 and 8.

[13] Commodity futures are traded on a number of exchanges such as the Chicago Mercantile Exchange (CME) (livestock), Intercontinental Exchange (ICE) US and Chicago Board of Trade (CBOT) (agricultural), ICE Europe and New York Mercantile Exchange (NYMEX) (energy).

[14] The 3-months Eurodollar futures contract from the Chicago Mercantile Exchange Group (CME Group) is available from DataStream.

[15] Gürkaynak, Sack and Swanson (2005) offers empirical evidence highlighting the effectiveness of futures contracts in measuring policy expectations.

Notably, Krueger and Kuttner (1996) show that forecast errors of the federal funds rate, based on the futures price, are not significantly correlated with other variables known when the contract was priced.

The value of using the surprise component of policy announcement, rather than the anticipated component, to assess the response of asset prices to monetary policy, has been first discussed in Kuttner (2001) and has since been standard in the literature. Specifically, expected changes in the policy rate will be priced into financial assets prior to the announcement. Hence, asset price movements in response to policy rate changes are solely determined by the surprise component of monetary policy.[16]

4.1.2. Commodity future contracts

Following Marshall, Nguyen and Visaltanachoti (2012), we study 19 of the commodities that comprise the S&P GSCI.[17] Daily settlement prices and the daily number of contracts traded for the commodity futures contracts in our samples are obtained from DataStream. Our motivation for using commodity futures data stems from the reliance of policymakers on quotes from commodity futures markets to derive forecasts of the prices of key commodities, as noted by Bernanke (2008). Additionally, commodity futures have received the most coverage in the media and are used in the construction of major commodity indices, as discussed in Marshall, Nguyen and Visaltanachoti (2012).

Our sample consists of 6 energy commodities (*West Texas Intermediate (WTI), Brent crude oil, RBOB gasoline, heating oil, gasoil,* and *natural gas*), 7 agricultural commodities (*wheat composite, red winter wheat, corn, soybeans, cotton, coffee,* and *cocoa*), 3 livestock commodities (*live cattle, feeder cattle,* and *lean hogs)*, 1 industrial metal (*copper*), and 2

[16]Failing to measure the surprise component of the announcement will result in underestimating the impact of monetary policy on the financial market (IMF, 2013).

[17]Commodities qualify for inclusion in the S&P GSCI on the basis of liquidity. Although the S&P GSCI contains 24 commodities, Marshall, Nguyen and Visaltanachoti (2012) excluded five industrial metal commodities (*aluminium, copper, lead, nickel* and *zinc*) due to lack of availability of trade values, leaving 19 commodities for analysis.

precious metals (*gold* and *silver*). These commodity markets have relatively large trading volumes and provide a broad cross-section of commodity futures contracts. We use data from the primary exchange, based on the work of Marshall, Nguyen and Visaltanachoti (2012) and the information provided by S&P GSCI. A detailed description of our dataset can be found in Tables 1A and 2A in the Appendix.

We calculate returns of commodity futures as log changes of the settlement prices of the nearest contract up to one month before maturity; we then roll to the second-nearest contract.

4.1.3. Trading volume as a measure of financial liquidity for commodity futures

The vast academic literature on market microstructure employs various measures reflecting different dimensions of liquidity.[18] We employ the dollar trading volume as a measure of financial liquidity for our sample of commodity futures. This choice is dictated by the conceptual underpinnings of our proposed liquidity-transmission mechanism of monetary policy to the commodity futures market.

Trading volume is a commonly used measure of market liquidity as it reflects the ability of the market to reallocate assets across investors (Brennan and Subrahmanyam, 1995; Datar, Naik and Radcliffe, 1998; Chordia, Roll and Subrahmanyam, 2001; Chordia, Subrahmanyam and Anshuman, 2001). Specifically, Sarr and Lybek (2002) determine that trading volume is a good estimator of market depth, i.e., the existence of numerous trades and market participants. Relevant studies such as Stoll (1978), Glosten and Harris (1988) and Chordia, Subrahmanyam and Anshuman (2001) suggest a strong relationship between trading volume, the bid-ask spread and market liquidity, whereas Brennan, Chordia and Subrahmanyam (1998) argue for trading volume being a better liquidity proxy than the bid-ask spread, with a higher traded volume reflecting an increase in liquidity.

[18]Existing measures of liquidity can be categorized as follows: trading activity measures (i.e., trading volume, turnover, average trade size), transaction costs measures (i.e., bid-ask spread, price impact) and liquidity supply measures (i.e., dealer inventory, order book depth).

The construction of the dollar trading volume as a proxy of financial liquidity in the commodity market follows Marshall, Nguyen and Visaltanachoti (2012). We convert the number of commodity futures contracts traded to a dollar volume variable by multiplying the number of contracts traded by the contract size and then multiplying this by the settlement price. We then take the natural logarithm of the resulting number, as follows:

$$T_t = ln(NrContractsTraded_t * ContractSize_t * SettlementPrice_t) \tag{1}$$

4.2. Preliminary analysis of the variables

As discussed in the previous section, we use the daily imputed change in the 30-day FFFR in a 30-minute window around the FOMC announcement (Δi_t) to capture the target surprise component of the true change in the policy rate. Descriptive statistics for this proxy are presented in Table 1. The surprise component of the policy rate, Δi_t, has a mean of -1.62 bps and a standard deviation of 8.93 bps on the day of the announcement, and a mean of -0.18 bps and standard deviation of 4.98 bps on all trading days. This implies a higher volatility on the days of the announcement than on the rest of the days, and a higher magnitude of the reductions in this proxy on the FOMC announcement days as compared to other days. The descriptive statistics for the returns of individual commodity futures, measured in log changes, are reported in Table 2. The standard deviation of the returns of individual commodity futures on FOMC announcement days is higher than the standard deviation of the returns of individual commodity futures associated with all trading days during the sample period November 2000 to December 2008 for most commodity futures. This implies that commodity futures returns are more volatile on the days of monetary policy announcements than on the rest of the days, which is consistent with policy actions inducing some reaction in the commodity futures market.

Correlation coefficients among our variables of interest, namely our proxy for the surprise component of the policy rate (target surprise), the trading volume and the returns of our sample of commodity futures are generally low, with the exception of the correlation between the target surprise and the returns of our sample of commodity futures that is significant and negative at -10%.[19]

Out of our full sample of 82 FOMC announcement days, 17 represent contractionary monetary policy actions, 23 expansionary monetary policy actions, while the rest of the sample accounts for neutral policy changes.[20] The hikes in the target federal funds rate stood at 25 bps, while the cuts ranged from 25 bps to 100 bps.[21] Following Bernanke and Kuttner (2005), we construct two binary dummy variables reflecting the type of FOMC policy action. The dummy variable representing an easing policy action is equal to 1 on the FOMC announcement day if the Federal Reserve cuts the target rate, and 0 otherwise. Conversely, the dummy variable representing a tightening policy action is equal to 1 on the FOMC announcement day if the Federal Reserve hiked the target rate, and 0 otherwise.

The descriptive statistics for the trading volume of individual commodity futures is reported in Table 3. Energy commodities (*RBOB gasoline, WTI, natural gas, Brent crude oil* and *heating oil)* are the most liquid, with a mean trading volume ranging from \$1.58bn to \$8.36bn. These findings are in line with Marshall, Nguyen and Visaltanachoti (2012), who using mean trade sizes for the period April 2008 to August 2009 find that *WTI, Brent crude oil,* and *gasoil* are the most liquid. Metal commodities (*copper*, *gold* and *silver*) and livestock commodities (*cattle feeder*) are the most illiquid, with a mean trading volume ranging from \$0.02bn to \$0.06bn.

[19]We report the correlation matrix in Table 3A in the Appendix.

[20]We include policy announcements associated with neutral changes in the policy rate, as they reflect market based policy surprises as much as an actual change. This data is published by the Board of Governors of the Federal Reserve System. The historical change in the FOMC's target federal funds rate is reported in Table 4A in the Appendix.

[21]Out of the 23 expansionary monetary policy actions, 10 accounted for 25 bps, 10 for 50 bps, 2 for 75 bps and 1 for 100 bps.

5. Empirical analysis

We follow Lagos and Zhang (2020) in using dis-aggregate and aggregate announcement-day effects to explore our directional liquidity-based transmission of monetary policy to the commodity futures market. In doing so, we first test whether a hike in the nominal rate reduces the liquidity of commodity futures, as measured by their dollar trading volume. Employing aggregate announcement-day effects, we explore whether this effect is transmitted to the price of individual commodity futures, and whether the strength of the mechanism increases with the liquidity of the commodity futures.

5.1. Aggregate announcement-day effects

Event-study analysis represents a popular approach to estimate the impact of monetary policy on asset prices.[22] To test whether an increase in the nominal rate reduces the liquidity of commodity futures, we estimate the response of individual commodity futures to monetary policy surprises on a subsample of trading days consisting exclusively of the days of FOMC announcements, as follows:

$$\Delta T_t = \beta_0 + \beta_1 \Delta i_t + \epsilon_t \tag{2}$$

where T_t represents the daily trading volume for individual commodity futures. Let Δi_t= i_t-i_{t-1} denote the monetary policy shock on policy announcement day t and ε_t is an exogenous shock to the asset trading volume. The estimator β_1 is the high-frequency instrumental variable estimator (HFIV estimator), which is estimated using a two-stage least squares procedure. The HFIV estimator is a version of the event-study estimator that relies on an instrumental variable identification strategy which uses the daily imputed change in the 30-day federal funds futures rate in a very narrow 30-minute window around the time of the FOMC announcement. First, we run the regression $\Delta i_t = k_0 + \ kz_t + \ \eta_t$ where z_t

[22] In the context of monetary policy, this approach was originally used by Cook and Hahn (1989) and and has since been employed in the literature, see Thorbecke (1997), Cochrane and Piazzesi (2002), Kuttner (2001), and Bernanke and Kuttner (2005).

denotes the high-frequency interest change, on a sample consisting of the FOMC policy announcement days, to obtain the OLS estimates of k_0 and k. Second, we construct the fitted values $\overline{z_t} = \overline{k_0} + \overline{k}\ z_t$ and run the event-study regression (2) setting $\Delta i_t = \overline{z_t}$.

The HFIV estimator addresses the concern that a number of other variables (i.e., news about economic outlook) are likely to have an impact on both the policy rate and asset prices, and that the policy rate may itself respond to market conditions on policy announcement days (simultaneity bias). This makes the HFIV estimator superior to the event-study and the heteroscedasticity-based estimators (Lagos and Zhang, 2020).

We report the estimated announcement-day effects of target surprise on the trading volume of individual commodities in Table 4. We find that the trading volume of commodity futures generally declines with unexpected monetary policy changes. For example, a 100 bps surprise increase in the policy rate decreases the trading volume of commodity futures by \$0.37bn to \$0.81bn. This is an economically significant effect since average daily trading volume in commodity futures is around \$1,19bn. These results are consistent with our liquidity-based transmission channel of monetary policy to commodity futures. That is, a surprise interest rate rise will lessen the liquidity of commodity futures, either because of higher funding costs or because liquidity providers encounter a more binding funding constraint.

5.2. Dis-aggregate announcement-day effects: cross-sectional analysis

We then investigate the liquidity-based transmission mechanism of monetary policy to the commodity futures market by exploiting the cross-sectional variation in trading volume that exists across commodity futures. Our theoretical framework implies that the magnitude in the commodity returns induced by the change in the policy rate will depend on the liquidity as measured by its trading volume. To test this prediction, we run a fixed effects panel model of individual commodity future returns on changes in the policy rate, an interaction term between the change in the policy rate and the average trading volume of the individual commodity future, and several controls, as follows:

$$R_{s,t} = \beta_0 + \beta_1 \Delta i_t + \beta_2 T_{s,t-1} + \beta_3 \overline{T}_{s,t-1} * \overline{\Delta i_t} + \beta_4 (\Delta i_t)^2 + \beta_5 (T_{s,t-1})^2 + D_s + \epsilon_{s,t} \quad (3)$$

where $R_{s,t}$ is the individual commodity futures s return, Δi_t is the daily imputed change in the 30-day FFFR from the level it has 10 minute before the FOMC announcement and the level 20 minutes after the FOMC announcement, as $\Delta i_t = \frac{D}{D-d}(i_{t,m_t+20} - i_{t,m_t-10})$, where $i_{t,m}$ denotes the daily imputed 30-day fed funds futures rate on minute m of day t, and D is the number of days in the month of the announcement and d is the day of the announcement. The scaling factor $\frac{D}{D-d}$ accounts for the timing of the FOMC announcement within a month. Let $T_{s,t-1}$ denote the dollar trading volume of the individual commodity futures s during the trading day prior to the day of the policy announcement (day t). We include the interaction term $\overline{T}_{s,t-1}$*$\overline{\Delta i_t}$, where $\overline{T}_{s,t-1}$= $T_{s,t-1}$-T, $\overline{\Delta i_t}$=Δi_t-Δi, and Δi and T are cross-sectional averages of Δi_t and $T_{s,t-1}$. The interaction term estimates how the effect of target surprise changes on individual commodity futures returns varies across commodity futures with different trading volumes. This allows us to test whether policy rate changes affect individual commodity returns through the proposed liquidity-based channel. Hence, the coefficient of interest is β_3, which helps us evaluate whether increases (reductions) in the policy rate cause larger reductions (increases) in the returns of commodity futures with high trading volume. The quadratic terms $(\Delta i_t)^2$ and $(T_{s,t-1})^2$ account for non-linearity. Finally, D_s is the commodity futures cross-section fixed effects, and $\varepsilon_{s,t}$ is the error term corresponding to the commodity futures s, on policy announcement day t. White cross-section t-statistics are used to account for heteroscedasticity in the residuals.

Table 5 presents the estimated announcement-day effects of target surprises, proxied through the federal funds futures rate and associated with tightening policy actions, on the returns of individual commodity futures. The average trading volume is measured in a 1-day window prior to the day of the policy announcement. As expected, commodity returns tend to decline with tightening monetary policy actions. This is in line with previous findings in the literature. Moreover, we find that commodity returns increase with trading volume during tightening actions. The negative and statistically significant coefficients of the interaction term $\bar{T}_{s,t}{}^{*}\overline{\Delta i_t}{}^{*}D_{t,tight}$, in columns (IV) and (V) in Table 5, indicate that the magnitude of the negative effect of monetary policy surprises associated with contractionary FOMC announcement days is higher for the most traded commodity futures. These findings confirm that although the liquidity of commodity futures lessens with contractionary monetary policy surprises, there is significant heterogeneity across commodities.

In the next step, we consider the type of action taken by the FOMC and its effect on the returns of commodity futures. We augment the baseline model by introducing two dummy variables, $D_{t,ease}$ and $D_{t,tight}$, representing the easing and tightening monetary policy actions of the FOMC. We interact the two dummy variables, in turn, with the monetary policy shock, Δi_t, the dollar trading volume of individual commodity futures during the day prior to the announcement day, $T_{s,t-1}$, and the interaction term $\bar{T}_{s,t-1}{}^{*}\overline{\Delta i_t}$, as follows:

$$\begin{aligned} R_{s,t} = \beta_0 + \beta_1 \Delta i_t + \beta_2 T_{s,t-1} + \beta_3 \overline{T}_{s,t-1} * \overline{\Delta i_t} + \beta_4 \Delta i_t * D_{t,tight} + \\ + \beta_5 T_{s,t-1} * D_{t,tight} + \beta_6 \overline{T}_{s,t-1} * \overline{\Delta i_t} * D_{t,tight} + \beta_7 (\Delta i_t)^2 + \beta_8 (T_{s,t-1})^2 + \\ + D_s + \epsilon_{st} \quad (4) \end{aligned}$$

$$\begin{aligned} R_{s,t} = \beta_0 + \beta_1 \Delta i_t + \beta_2 T_{s,t-1} + \beta_3 \overline{T}_{s,t-1} * \overline{\Delta i_t} + \beta_4 \Delta i_t * D_{t,ease} + \\ + \beta_5 T_{s,t-1} * D_{t,ease} + \beta_6 \overline{T}_{s,t-1} * \overline{\Delta i_t} * D_{t,ease} + \beta_7 (\Delta i_t)^2 + \beta_8 (T^S_{t-1})^2 + \\ + D_s + \epsilon_{st} \quad (5) \end{aligned}$$

Turning to expansionary policy actions, in Table 6 we find no evidence that monetary policy surprises on expansionary FOMC announcement days are transmitted to the price of commodity futures through changes in their liquidity.[23] This indicates that the mechanism through which policy rate changes are transmitted to the price of commodities depends on the direction of policy action.

Overall our results provide evidence of the presence of a directional liquidity-based transmission channel (DLTC) of monetary policy to commodity futures. While there is no exposure of commodity futures returns to expansionary policy actions, unexpected tightening actions do affect commodity futures returns, especially those that are most traded. Our theoretical framework suggest that the mechanisms through which surprise tightening policy actions affect commodity markets is via the more binding funding constraints for commodity markets' liquidity providers.

Our results are in line with the extant literature on the asymmetric effects of monetary policy, which finds that the effect of a monetary policy tightening on credit and asset prices is larger than the effect of a monetary policy easing (Gambacorta and Rossi, 2010; Angrist, Jordà and Kuersteiner, 2013; Tenreyro and Thwaites, 2016). In particular, Gambacorta and Rossi (2010) note that the response of loan demand to changes in monetary policy may be asymmetrical due to a differential effect on investment decisions and self-financing. These asymmetric effects are consistent with the 'pushing on the string' view of monetary policy attributed to Keynes (De Long and Summers, 1993; Karras, 1996). This view argues that existing asymmetric aggregate demand movements depend on the sign of the monetary impulse, and when the economy is weak, the Fed's ability to stimulate real economic activity through monetary policy is much more limited. In a similar vein, exploring the monetary policy effect on the dynamics of switching between bull and bear markets, Chen (2007) argues that a tightening monetary policy shock depresses asset returns by lowering the probability of staying in the bull-market regime, and increasing the probability of shifting to a bear-market regime. As financial constraints are more likely to bind in bear markets, their results emphasize the role of financial constraints in the asymmetric transmission of monetary policy.

[23]Expansionary FOMC policy decisions refer to an increase in the federal fund target rate.

6. Robustness tests

This section checks the robustness of the results to several alternative specifications: a wider window to estimate the futures returns, the 3-months Eurodollar rate as an alternative proxy for the policy rate, and a 1-week estimation window for the average dollar trading volume.

6.1. An alternative estimation window for the returns of commodity futures

To account for the fact that the daily settlement time range across the groups of commodity futures contracts in our sample, we extend the estimation window for the returns of commodity futures in our cross-sectional analysis. Specifically, we compute the daily returns as the difference between the closing price at day *t-1* and the closing price at day *t+1*, where t is the day of the announcement. The results are presented in Tables 7 and 8. We find that the response of the returns of commodity futures to both contractionary and expansionary policy actions remains consistent to using the aforementioned estimation returns estimation window.

6.2. An alternative proxy for the policy rate

We further analyse the validity of our results using the CME Group 3-months Eurodollar future rate on the day of the FOMC announcement (ΔEFR_t) to capture the target surprise component of the true change in the policy rate. Descriptive statistics for this alternative proxy are presented in Table 1. The second column shows the daily change in the 3-month Eurodollar futures rate on the day of the FOMC announcement. ΔEFR_t has a mean of -1.63 bps and a standard deviation of 9.04 bps on the day of the FOMC announcement, qualitatively similar to our main measure for policy rate.

We find that the response of the returns of commodity futures to contractionary policy actions remains consistent to using this alternative proxy for the nominal policy rate. Table 9 reports the estimated announcement-day effects of contractionary policy actions on the returns of individual commodity futures, when average trading volume is measured in the 1-day window prior to the day of the policy announcement. The results confirm that the magnitude of the negative effect of target surprises associated with contractionary announcement days on the returns of commodity futures is larger for commodity futures with higher trading volume. Table 10 reports the estimated announcement-day effects of expansionary policy actions on the returns of individual commodity futures, when average trading volume is measured in a 1-day window prior to the day of the policy announcement. We find weak evidence of a monetary policy effect on the returns of commodity futures, which varies across futures contracts with different trading volumes.

6.3. An alternative estimation window for the average trading volume of commodity futures

We further analyse the impact of the monetary policy shock on the returns of individual commodity futures by re-estimating the baseline model and the augmented models, using the average trading volume of the individual commodity future over a longer period including all the trading days during the 1-week prior to the day of the policy announcement.

We report the results in Tables 11 and 12. Our findings remain consistent when expanding the measurement window of the trading volume of commodity futures. In particular, we find weak evidence of liquidity-based monetary policy effects associated with expansionary policy actions. We also note that the estimates are larger for tightening policy actions than for easing.

We then repeat the exercise for the policy rate proxied through the 3-month Eurodollar futures rate. The results are reported in Table 13 confirm that the magnitude of the effects of contractionary announcements, on the returns of commodity futures remains larger for commodity futures with higher trading volume, when trading volume is measured in the 1-week window prior to the policy announcement day. We find weak evidence of a liquidity-based transmission channel of expansionary policy actions.[24]

[24]We do not report the results for brevity, but we report them in Tables 5A and 6A in the Appendix.

7. Conclusion

Commodity price dynamics have been a major source of concern for policymakers given their crucial role in shaping the dynamics of global economic activity. The extant literature on monetary policy and commodity futures price dynamics has provided evidence of significant heterogeneity in the response of commodity prices to monetary policy channeled via macroeconomic fundamentals. Taking a microstructure approach, our paper explores the heterogeneity in the transmission of monetary policy to the commodity futures market through a novel directional liquidity-based transmission channel (DLTC). The proposed theory notes that changes in interest rates affect commodity futures market liquidity via trading costs and, when rates rise, this is compounded by binding constraints faced by liquidity providing hedgers. Any reduction in liquidity causes a fall in futures prices and the decline is greater for commodity futures with higher turnover.

We assess the DLTC by estimating the effects of monetary policy announcements on the trading volume of a sample of 19 individual commodity futures contracts using event-study analysis. Employing a HFIV estimator, we document that policy target surprises affect the trading volume of our sample of commodity futures. Moreover, exploiting the cross-sectional variation in the trading volume of our sample of commodity futures, we find that the magnitude of the negative effect of target surprise associated with tightening FOMC policy announcement days, on the returns of commodity futures, is larger for commodity futures with higher trading volume. These results hold to several robustness checks.

We make three contributions to the related literature on monetary policy and the commodity market. First, to our knowledge, we are the first to provide a theory for a DLTC of monetary policy to the commodity futures market. Second, through our empirical exercises, we show that financial liquidity plays a crucial role in how commodity prices are affected by monetary policy. Third, our paper allows for asymmetric responses by distinguishing between the type of FOMC policy action (restrictive versus expansive) by employing two interactive dummy variables, based on changes in the federal funds target rate. Gaining a deeper understanding of how monetary policy operates in the commodity futures market has a particularly relevance to the current global economic conditions given that major central banks have been tightening monetary policy rapidly to address high levels of inflation led by the recent geopolitical shocks. With respect to policy implications, our findings emphasize the need for policymakers and market participants to consider the policy stance asymmetry in the liquidity-based transmission of monetary policy to the commodity futures market. That is, the effects of tightening monetary policy actions are more powerful for the most traded commodity futures than the effects of easing decisions.

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Table 1: Descriptive statistics for the two proxies for the policy rate employed in the analysis

	Δi_t	ΔEFR_t
Mean	-1.62	-1.63
Median	0.00	0.00
Maximum	14.00	14.00
Minimum	-44.00	-44.00
St. Dev.	8.93	9.04
Obs.	70	70

Notes: Descriptive statistics are reported for the proxies for the unexpected component of the change in the true policy rate, i.e., the effective federal funds rate. The first column shows the daily imputed change in the 30-day FFFR from the level it has 10 minutes before the FOMC announcement and the level 20 minutes after the FOMC announcement. The second column shows the daily change in the 3-month Eurodollar futures rate on the day of the FOMC announcement. The descriptive statistics for the proxies for the policy rate are expressed in basis points.

Table 2: Descriptive statistics for the returns of individual commodity futures

	Mean	Median	St. Dev.	Obs	Mean	Median	St. Dev.	Obs
	(announcement days)				(all trading days)			
Agriculture								
CBoT Corn	36.35	23.22	192.4	82	3.28	0.00	180.86	2044
CBoT Hard Red Winter Wheat	9.66	3.86	186.39	82	3.51	0.00	181.78	2037
CBoT Wheat Composite	26.97	22.99	219.63	82	4.26	0.00	204.13	2044
CBoT Soybean	26.08	36.52	180.00	82	3.54	12.60	187.56	2044
ICE-US Cocoa	4.2	0.00	250.08	82	6.65	6.32	215.14	2023
ICE-US Coffee	28.02	14.44	225.62	82	2.23	0.00	217.68	2024
ICE-US Cotton	-24.13	-8.47	183.49	82	-1.38	-1.41	205.41	2029
Livecattle								
CME Cattle(Feeder)	-4.08	6.44	83.98	82	0.30	2.81	94.75	2042
CME Lean Hogs	-12.27	-30.57	189.45	82	0.54	3.65	221. 93	2043
CME Live Cattle	3.38	4.3	114.81	82	0.76	0.00	158.82	2045
Metals								
COMEX Copper	18.52	5.58	186.06	82	2.58	4.22	194.55	2033
COMEX Gold	3.96	4.2	76.50	82	5.94	7.15	119.15	2029
COMEX Silver	-1.4	4.82	180.67	82	4.35	16.23	201.31	2023
Energy								
Heating Oil	-7.54	-13.3	258.32	82	1.42	0.00	250.35	2031
ICE Europe Brent Crude	-19.58	-34.35	267.51	82	1.61	10.69	231.39	2069
ICE Europe Low Sulphur Gasoil	-12.98	0.00	236.08	82	1.58	0.00	221.98	2069
NYMEX Henry Hub Natural Gas	45.74	38.02	307.84	82	-0.33	-1.62	382.09	2031
NYMEX RBOB Gasoline	32.63	46.74	317.47	34	-7.70	12.12	288.89	815
WTI	-2.6	-30.44	277.45	82	1.21	10.65	252.98	2030

Notes: Descriptive statistics for daily returns of individual commodity futures in basis points. The first four columns are associated with FOMC announcement days, while the last four columns are associated with all trading days during the sample period November 2000 to December 2008.

Table 3: Descriptive statistics for the trading volume of individual commodity futures

	Mean	Median	Max	Min	St. Dev.	Skew	Kurt	Obs
Agriculture								
CBoT Corn	0.83	0.45	9.59	0.00	1.05	2.66	12.79	2046
CBoT Hard Red Winter Wheat	0.13	0.10	1.22	0.00	0.13	1.92	8.46	2039
CBoT Wheat Composite	0.49	0.27	7.34	0.00	0.67	3.02	16.85	2046
CBoT Soybean	1.27	0.77	18.40	0.00	1.62	3.12	18.68	2046
ICE-US Cocoa	0.07	0.05	0.53	0.00	0.08	1.77	7.37	2025
ICE-US Coffee	0.22	0.12	1.81	0.00	0.26	1.48	5.51	2026
ICE-US Cotton	0.16	0.10	1.43	0.00	0.20	1.98	8.49	2031
Livecattle								
CME Cattle(Feeder)	0.06	0.04	0.36	0.00	0.04	1.57	6.62	2044
CME Lean Hogs	0.15	0.11	0.95	0.00	0.12	1.81	7.12	2045
CME Live Cattle	0.21	0.14	1.59	0.00	0.24	2.11	7.99	2047
Metals								
COMEX Copper	0.03	0.02	0.56	0.00	0.05	5.57	44.99	2035
COMEX Gold	0.06	0.00	8.47	0.00	0.39	13.13	210.54	2031
COMEX Silver	0.02	0.00	2.25	0.00	0.12	11.11	148.38	2025
Energy								
Heating Oil	1.58	1.19	9.08	0.00	1.30	1.81	6.93	2033
ICE Europe Brent Crude	3.47	1.74	19.90	0.13	3.61	1.67	5.43	2071
ICE Europe Low Sulphur Gasoil	1.06	0.57	6.61	0.00	1.06	1.66	5.76	2071
NYMEX Henry Hub Natural Gas	2.82	2.19	19.10	0.00	2.12	2.47	11.47	2033
NYMEX RBOB Gasoline	1.69	1.07	11.50	0.00	1.82	0.97	3.38	816
WTI	8.36	4.15	70.50	0.00	9.87	2.11	7.51	2032
19 commodity futures	1.19	0.69						

Notes: Descriptive statistics for the daily trading volume of individual commodity futures associated with all trading days. Daily trading volume is computed by multiplying the number of contracts traded by the contract size and then multiplying this by the settlement price, and is in billion $. Sample period is November 2000 to December 2008.

Table 4: Policy announcement-day response of individual commodity futures trading volume

	HFIV-BASED	
Agriculture		
CBoT Corn	**-0.51****	(-2.38)
CBoT Hard Red Winter Wheat	**-0.42****	(-2.24)
CBoT Wheat Composite	**-0.81*****	(-3.83)
CBoT Soybean	**-0.65*****	(-3.39)
ICE-US Cocoa	**-0.57*****	(-3.42)
ICE-US Coffee	**-0.38***	(-1.76)
ICE-US Cotton	**-0.45****	(-2.23)
Livecattle		
CME Cattle(Feeder)	**-0.39****	(-2.05)
CME Lean Hogs	**-0.43****	(-2.06)
CME Live Cattle	**-0.46****	(-2.23)
Metals		
COMEX Copper	**-0.37****	(-2.06)
COMEX Gold	-0.21	(-0.95)
COMEX Silver	-0.01	(-0.04)
Energy		
Heating Oil	**-0.48****	(-2.08)
ICE Europe Brent Crude	**-0.50****	(-2.13)
ICE Europe Low Sulphur Gasoil	**-0.47****	(-2.09)
NYMEX Henry Hub Natural Gas	**-0.48****	(-2.01)
NYMEX RBOB Gasoline	-0.16	(-0.29)
WTI	**-0.51****	(-2.07)

Notes: The table reports the results of equation (2) of individual commodity futures trading volume to monetary policy surprises on a subsample of trading days consisting exclusively of the days of FOMC announcements. Trading volume is expressed in billion $. *t*-statistics are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 5: Tightening policy announcement-day effects on the returns of individual commodity futures: a 1-day window trading volume estimation

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Δi_t	-0.68	-0.60	-2.11	-0.59	-2.11
	(-0.67)	(-0.58)	(-0.62)	(-0.56)	(-0.61))
$T_{s,t-1}$	-267.73	-609.65	-60150.15	-2274.74	**-69098.09***
	(-0.06)	(-0.14)	(-1.45)	(-0.46)	(-1.66)
$\overline{T}_{s,t-1}$ * $\overline{\Delta i_t}$		427.94	449.69	462.38	485.15
		(1.14)	(1.24)	(1.25)	(1.37)
$D_{t,tight}$				**-564.78*****	**-599.65*****
				(-3.29)	(-3.37)
Δi_t * $D_{t,tight}$				1.47	2.84
				(0.14)	(0.25)
$T_{s,t-1}$ * $D_{t,tight}$				**30417.57*****	**32184.76*****
				(3.16)	(3.24)
$\overline{T}_{s,t-1}$ * $\overline{\Delta i_t}$ * $D_{t,tight}$				**-15518.17*****	**-16027.40*****
				(-3.71)	(-3.74)
$(\Delta i_t)^2$			-0.05		-0.05
			(-0.58)		(-0.56)
$(T_{s,t-1})^2$			1775912.08		1988167.23
			(1.39)		(1.56)
Commodity FE	yes	yes	yes	yes	yes
Obs	1215	1215	1215	1215	1215
R^2	0.02	0.02	0.02	0.03	0.04

Notes: The table reports the results of the estimation of different specifications of equations (3) and (4) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,tight}$ is a dummy for tightening policy actions. Each column reports the coefficients from a separate pooled OLS regression. Regressions include commodity fixed effects. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 6: Expansionary policy announcement-day effects on the returns of individual commodity futures: a 1-day window trading volume estimation

	(I)	(II)	(III)	(IV)	(V)
Δi_t	-0.68	-0.60	-2.11	-9.45	-9.33
	(-0.67)	(-0.58)	(-0.62)	(-1.08)	(-1.05)
$T_{s,t-1}$	-267.73	-609.65	-60150.15	-1469.44	-59655.82
	(-0.06)	(-0.14)	(-1.45)	(-0.27)	(-1.59)
$\overline{T}_{s,t-1}$ * $\overline{\Delta i_t}$		427.94	449.69	-181.50	-262.14
		(1.14)	(1.24)	(-0.16)	(-0.24)
$D_{t,ease}$				-61.34	-46.59
				(-0.47)	(-0.36)
Δi_t * $D_{t,ease}$				10.25	9.25
				(1.17)	(0.99)
$T_{s,t-1}$ * $D_{t,ease}$				5312.60	4613.20
				(0.65)	(0.58)
$\overline{T}_{s,t-1}$ * $\overline{\Delta i_t}$ * $D_{t,ease}$				851.80	950.78
				(0.70)	(0.81)
$(\Delta i_t)^2$			-0.05		-0.03
			(-0.58)		(-0.33)
$(T_{s,t-1})^2$			1775912.08		1752421.41
			(1.39)		(1.50)
Commodity FE	yes	yes	yes	yes	yes
Obs	1502	1502	1502	1501	1501
R^2	0.02	0.02	0.02	0.04	0.04

Notes: The table reports the results of the estimation of different specifications of equations (3) and (5) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,ease}$ is a dummy for expansionary policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 7: Tightening policy announcement-day effects on the returns of individual commodity futures: an alternative 1-day window trading volume estimation

	(I)	(II)	(III)	(IV)	(V)
Δi_t	-0.11	-0.09	**-0.43****	-0.10	**-0.39****
	(-1.12)	(-0.97)	(-2.54)	(-1.02)	(-2.27)
$T_{s,t-1}$	-432.74	-494.28	-4627.84	-772.03	-6099.46
	(-0.89)	(-1.01)	(-1.22)	(-1.51)	(-1.60)
$\overline{T}_{s,t-1} * \overline{\Delta i_t}$		**77.02***	**79.00***	**79.70***	**81.86***
		(-1.91)	(-1.96)	(1.98)	(2.03)
$D_{t,tight}$				**-68.33*****	**-71.64*****
				(-3.03)	(-3.18)
Δi_t* $D_{t,tight}$				-2.52	-2.23
				(-1.56)	(-1.37)
$T_{s,t-1} * D_{t,tight}$				**3837.27 *****	**3990.51*****
				(3.19)	(3.32)
$\overline{T}_{s,t-1} * \overline{\Delta i_t} * D_{t,tight}$				**-1758.40 *****	**-1800.72*****
				(-2.73)	(-2.79)
$(\Delta i_t)^2$			**-0.01****		**-0.01****
			(-2.36)		(-1.99)
$(T_{s,t-1})^2$			122004.81		157566.13
			(-1.08)		(-1.40)
Commodity FE	yes	yes	yes	yes	yes
Obs	1215	1215	1215	1215	1215
R^2	0.01	0.01	0.02	0.03	0.03

Notes: The table reports the results of the estimation of different specifications of equations (3) and (4) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. The commodity returns are calculated as the difference between the closing price at day *t-1* and the closing price at day *t+1*, where t is the day of the announcement. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,tight}$ is a dummy for tightening policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 8: Expansionary policy announcement-day effects on the returns of individual commodity futures: an alternative 1-day window trading volume estimation

	(I)	(II)	(III)	(IV)	(V)
Δi_t	-0.11	-0.09	**-0.43****	**-0.83****	**-0.79***
	(-1.12)	(-0.97)	(-2.54)	(-1.98)	(-1.88)
$T_{s,t-1}$	-432.74	-494.28	-4627.84	30.37	-4545.84
	(-0.89)	(-1.01)	(-1.22)	(-0.05)	(-1.21)
$\overline{T}_{s,t-1} * \overline{\Delta i_t}$		**77.02***	**79.00***	-176.92	-184.07
		(-1.91)	(-1.96)	(-1.28)	(-1.33)
$D_{t,ease}$				3.71	5.85
				(-0.26)	(-0.41)
$\Delta i_t * D_{t,ease}$				0.71	0.41
				(-1.63)	(-0.88)
$T_{s,t-1} * D_{t,ease}$				-404.46	-485.92
				(-0.53)	(-0.63)
$\overline{T}_{s,t-1} * \overline{\Delta i_t} * D_{t,ease}$				**282.85***	**291.30****
				(-1.94)	(2.01)
$(\Delta i_t)^2$			**-0.01****		-0.01
			(-2.36)		(-1.55)
$(T_{s,t-1})^2$			122004.81		137588.51
			(-1.08)		(-1.23)
Commodity FE	yes	yes	yes	yes	yes
Obs	1215	1215	1215	1215	1215
R^2	0.01	0.01	0.02	0.02	0.02

Notes: The table reports the results of the estimation of different specifications of equations (3) and (5) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. The commodity returns are calculated as the difference between the closing price at day *t-1* and the closing price at day *t+1*, where t is the day of the announcement. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,ease}$ is a dummy for expansionary policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 9: Tightening policy announcement-day effects on the returns of individual commodity futures: a 1-day window trading volume and Eurodollar futures rate proxy estimation

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Δi_t	-2.64	-2.64	-3.11	-2.76	-3.28
	(-1.28)	(-1.29)	(-1.26)	(-1.23)	(-1.19)
$T_{s,t-1}$	-2206.71	-2318.97	-36193.96	-3942.62	-45456.27
	(-0.44)	(-0.47)	(-0.78)	(-0.76)	(-1.03)
$\overline{T}_{s,t-1} * \overline{\Delta i_t}$		319.60	325.42	428.79	421.42
		(0.91)	(0.97)	(1.19)	(1.23)
$D_{t,tight}$				**-269.44*****	**-285.30*****
				(-2.36)	(-2.50)
$\Delta i_t * D_{t,tight}$				1.01	2.02
				(0.35)	(0.48)
$T_{s,t-1} * D_{t,tight}$				**15655.22*****	**16376.78*****
				(2.36)	(2.48)
$\overline{T}_{s,t-1} * \overline{\Delta i_t} * D_{t,tight}$				**-3123.00***	**-3093.67***
				(-1.74)	(-1.71)
$(\Delta i_t)^2$			-0.06		-0.06
			(-0.60)		(-0.55)
$(T_{s,t-1})^2$			1012384.06		1235343.01
			(0.69)		(0.88)
Commodity FE	yes	yes	yes	yes	yes
Obs	1430	1430	1430	1429	1429
R^2	0.02	0.02	0.02	0.03	0.03

Notes: The table reports the results of the estimation of different specifications of equations (3) and (4) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. In this specification, policy rates are Eurodollar futures rate. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,tight}$ is a dummy for tightening policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 10: Expansionary policy announcement-day effects on the returns of individual commodity futures: a 1-day window trading volume and Eurodollar futures rate proxy estimation

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Δi_t	-2.64	-2.64	-3.11	**-7.13****	**-6.92****
	(-1.28)	(-1.29)	(-1.26)	(-2.10)	(-1.99)
$T_{s,t-1}$	-2206.71	-2318.97	-36193.96	-3637.82	-30494.60
	(-0.44)	(-0.47)	(-0.78)	(-0.70)	(-0.67)
$\overline{T}_{s,t-1}$ * $\overline{\Delta i_t}$		319.60	325.42	-309.25	-320.32
		(0.91)	(0.97)	(-0.53)	(-0.58)
$D_{t,ease}$				-92.98	-85.67
				(-0.88)	(-0.80)
Δi_t * $D_{t,ease}$				**7.44****	6.90
				(2.00)	(1.46)
$T_{s,t-1}$ * D_{ease}				7585.36	7307.28
				(0.64)	(0.69)
$\overline{T}_{s,t-1}$ * $\overline{\Delta i_t}$* $D_{t,ease}$				**1152.75***	**1148.17***
				(1.70)	(1.79)
$(\Delta i_t)^2$			-0.06		-0.02
			(-0.60)		(-0.25)
$(T_{s,t-1})^2$			1012384.06		805266.68
Commodity FE	yes	yes	yes	yes	yes
Obs	1430	1430	1430	1430	1430
R^2	0.02	0.02	0.02	0.04	0.05

Notes: The table reports the results of the estimation of different specifications of equations (3) and (5) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. In this specification, policy rates are Eurodollar futures rate. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,ease}$ is a dummy for expansionary policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 11: Tightening policy announcement-day effects on the returns of individual commodity futures: a 1-week window trading volume estimation

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Δi_t	-0.73	-0.68	-2.39	-0.67	-2.411
	(-0.71)	(-0.61)	(-0.69)	(-0.58)	(-0.69)
$T_{s,t-7}$	2278.78	2236.33	-51760.25	1326.56	-53866.84
	-0.37	-0.37	(-1.19)	(0.20)	(-1.25)
$\overline{T}_{s,t-7} * \overline{\Delta i_t}$		168.12	163.88	187.36	181.57
		(0.49)	(0.52)	(0.54)	(0.57)
$D_{t,tight}$				**-496.04*** **	**-505.07*** **
				(-2.97)	(-2.96)
$\Delta i_t * D_{t,tight}$				-2.71	-1.18
				(-0.20)	(-0.09)
$T_{s,t-7} * D_{t,tight}$				**26647.37*** **	**27040.08*** **
				(2.81)	(2.80)
$\overline{T}_{s,t-7} * \overline{\Delta i_t} * D_{tight}$				**-12571.40*** **	**-12615.39*** **
				(-3.52)	(-3.49)
$(\Delta i_t)^2$			-0.06		-0.06
			(-0.69)		(-0.69)
$(T_{s,t-7})^2$			1578005.08		1612044.63
			(1.15)		(1.19)
Commodity FE	yes	yes	yes	yes	yes
Obs	1502	1502	1502	1502	1502
R^2	0.02	0.02	0.02	0.04	0.05

Notes: The table reports the results of the estimation of different specifications of equations (3) and (4) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,tight}$ is a dummy for tightening policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 12: Expansionary policy announcement-day effects on the returns of individual commodity futures: a 1-week window trading volume estimation

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Δi_t	-0.73	-0.68	-2.39	-9.49	-9.37
	(-0.71)	(-0.61)	(-0.69)	(-1.08)	(-1.06)
$T_{s,t-7}$	2278.78	2236.33	-51760.25	1265.03	-45553.51
	(0.37)	(0.37)	(-1.19)	(0.20)	(-1.20)
$\overline{T}_{s,t-7}$ * $\overline{\Delta i_t}$		168.12	163.88	-1230.15	-1219.32
		(0.49)	(0.52)	(-1.19)	(-1.18))
$D_{t,ease}$				-161.42	-148.75
				(-1.14)	(-1.06)
Δi_t * $D_{t,ease}$				10.25	8.97
				(1.16)	(0.97)
$T_{s,t-7}$ * $D_{t,ease}$				10750.71	10206.00
				(1.20)	(1.16)
$\overline{T}_{s,t-7}$ * $\overline{\Delta i_t}$ * $D_{t,ease}$				**1890.87***	**1850.98***
				(1.70)	(1.68)
$(\Delta i_t)^2$			-0.06		-0.04
			(-0.69)		(-0.51)
$(T_{s,t-7})^2$			1578005.08		1376903.46
			(1.15)		(1.17)
Commodity FE	yes	yes	yes	yes	yes
Obs	1282	1282	1282	1282	1282
R^2	0.02	0.02	0.02	0.04	0.04

Notes: The table reports the results of the estimation of different specifications of equations (3) and (5) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,ease}$ is a dummy for expansionary policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Appendix

Table 1A: Description of the monetary policy proxies included in the analysis

Variables	**Source**	**Frequency**
3-months Eurodollar futures rate	DataStream	Daily
tick-by-tick nominal interest rate implied by 30-day federal funds futures	Lagos and Zhang (2020)	Intraday

Table 2A: Main exchanges for the commodity futures included in the analysis

Panel A: Agricultural commodities	
Wheat Composite	CBoT
Red wheat	CBoT
Corn	CBoT
Soybean	CBoT
Cotton	ICE-US
Coffee	ICE-US
Cocoa	ICE-US
Panel B: Energy commodities	
Brent	ICE Europe
Gasoil	ICE Europe
WTI	NYMEX
Gasoline	NYMEX
Heating oil	NYMEX
Natural Gas	NYMEX
Panel C: Livestock commodities	
Live cattle	CME
Feeder cattle	CME
Lean hogs	CME
Panel D: Industrial Metal commodities	
Copper	COMEX
Panel E: Precious Metal commodities	
Gold	COMEX
Silver	COMEX

Table 3A: Correlation matrix for our main variables of interest

	Δi_t	$R_{s,t}$
$R_{s,t}$	**-0.10*****	
	(-3.47)	
$T_{s,t-1}$	0.01	0.03
	(0.25)	(0.94)

Notes: Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. t-statistics are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent respectively. Sample period is November 2000 to December 2008. Number of observations is 1215.

Table 4A: Historical change (basis points) in FOMC's target federal funds rate

Date	Increase	Decrease
03 January 2001		50
31 January 2001		50
20 March 2001		50
18 April 2001		50
15 May 2001		50
27 June 2001		25
21 August 2001		25
02 October 2001		25
06 November 2001		25
11 December 2001		25
06 November 2002		50
25 June 2003		25
30 June 2004	25	
10 August 2004	25	
21 September 2004	25	
10 November 2004	25	
14 December 2004	25	
02 February 2005	25	
22 March 2005	25	
03 May 2005	25	
30 June 2005	25	
09 August 2005	25	
20 September 2005	25	
01 November 2005	25	
13 December 2005	25	
31 January 2006	25	
28 March 2006	25	
10 May 2006	25	
29 June 2006	25	
18 September 2007		50
31 October 2007		25
11 December 2007		25
30 January 2008		50
18 March 2008		75
30 April 2008		25
07 October 2008		50
29 October 2008		50
16 December 2008		75-100

Notes: This data is published by the Board of Governors of the Federal Reserve System, Open Market Operations Archive. Sample period is November 2000 to December 2008.

Table 5A: Tightening policy announcement-day effects on the returns of individual commodity futures: a 1-week window trading volume and Eurodollar futures rate proxy estimation

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Δi_t	-2.76	-2.76	-3.06	**-7.13****	**-7.04****
	(-1.37)	(-1.36)	(-1.25)	(-2.19)	(-2.09)
$T_{s,t-7}$	120.99	94.26	-9350.18	-1483.10	-7964.12
	(0.02)	(0.015)	(-0.57)	(-0.24)	(-0.49)
$\overline{T_{s,t-7}} * \overline{\Delta i_t}$		98.96	101.92	-456.70	**-460.23***
		(0.39)	(0.43)	(-1.66)	(-1.70)
$D_{t,tight}$				-29.05	-27.54
				(-0.87)	(-0.81)
$\Delta i_t * D_{tight}$				**7.23****	7.03
				(2.00)	(1.55)
$T_{s,t-7} * D_{tight}$				5836.42	5785.72
				(1.41)	(1.39)
$\overline{T_{s,t-7}} * \overline{\Delta i_t} * D_{t,tight}$				**-965.71*****	**-959.18*****
				(2.69)	(2.71)
$(\Delta i_t)^2$			-0.05		-0.01
			(-0.47)		(-0.09)
$(T_{s,t-7})^2$			402284.60		276548.90
			(0.46)		(0.32)
D_S	yes	yes	yes	yes	yes
Obs	1502	1502	1502	1501	1501
R^2	0.02	0.02	0.02	0.04	0.04

Notes: The table reports the results of the estimation of different specifications of equations (3) and (4) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. In this specification, policy rates are Eurodollar futures rate. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,tight}$ is a dummy for tightening policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.

Table 6A: Expansionary policy announcement-day effects on the returns of individual commodity futures: a 1-week window trading volume and Eurodollar futures rate proxy estimation

	(I)	**(II)**	**(III)**	**(IV)**	**(V)**
Δi_t	-2.76	-2.76	-3.1	**-7.06****	**-6.92****
	(-1.37)	(-1.36)	(-1.27)	(-2.17)	(-2.08)
$T_{s,t-7}$	120.99	93.45	-29449	-2972.33	-17827.2
	(0.02)	(0.01)	(-0.57)	(-0.47)	(-0.35)
$\overline{T_{s,t-7}} * \overline{\Delta i_t}$		65.09	75.84	-706.07	-710.37
		(0.14)	(0.18)	(-1.43)	(-1.47)
$D_{t,ease}$				**-218.75***	-214.96
				(-1.96)	(-1.90)
$\Delta i_t * D_{t,ease}$				**7.04***	6.72
				(1.96)	(1.5)
$T_{s,t-7} * D_{t,ease}$				**14245.11****	**14111.34***
				(1.99)*	(1.93)
$\overline{T_{s,t-7}} * \overline{\Delta i_t} * D_{t,ease}$				**1520.72****	**1512.89****
				(2.41)	(2.45)
$(\Delta i_t)^2$			-0.05		-0.01
			(-0.48)		(-0.16)
$(T_{s,t-7})^2$			867315.6		437910.9
			(0.53)		(0.27)
D_S	yes	yes	yes	yes	yes
Obs	1502	1502	1502	1502	1502
R^2	0.02	0.02	0.02	0.05	0.05

Notes: The table reports the results of the estimation of different specifications of equations (3) and (5) of daily returns of commodity futures on policy rates, commodity trading volume, and a set of interaction terms. In this specification, policy rates are Eurodollar futures rate. Both commodity returns (R_t) and policy rates (Δi_t) are expressed in basis points. Trading volume ($T_{s,t-1}$) is measured at daily frequency and is expressed in billion \$. $\overline{T}_{s,t-1}$ and $\overline{\Delta i_t}$ are the differences between commodity futures trading volume and policy rate changes and their cross-sectional average, respectively. $D_{t,ease}$ is a dummy for expansionary policy actions. Each column reports the coefficients from a separate pooled OLS regression. White cross-section t-statistics have been used to account for heteroscedasticity in the residuals and are reported in parenthesis. ***, **, * indicate significance at 1 percent, 5 percent and 10 percent, respectively. Sample period is November 2000 to December 2008.