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(Citation)
神戸大学経済学研究科 Discussion Paper,1830

(Issue Date)
2018

(Resource Type)
technical report

(Version)
Version of Record

(URL)
https://hdl.handle.net/20.500.14094/81010612

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December 2018
Discussion Paper No.1830

GRADUATE SCHOOL OF ECONOMICS

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Who Influences the Fundamental Value of Commodity Futures in Japan?⋆

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December 2018

Abstract

We present evidence on asymmetric information content in the trades of six investor groups transacting in the gold, platinum, gasoline and rubber futures markets on the Tokyo Commodity Exchange. Microstructure theory suggests that traders with greater information on the efficient price should be more profitable in the long run. Foreign investors have the greatest influence over the efficient price in the gold market, investment funds in the platinum market and retail investors in the gasoline market. Both trade and non-trade related innovations have an equal influence on the efficient price of rubber, with trades by investment funds having the largest information content in this market. We relate differences in the relative influence of investor groups to differences in market interconnectedness, the nature of the commodity and associated fundamental information.

Keywords: Commodities, Futures, Market microstructure, Asymmetric information, Investor behaviour

JEL: C22, G14, G15, Q02

1. Introduction

Financial market analysts and investors routinely attempt to identify the market positioning of "smart money" traders, those who are believed to possess valuable private information on the future course of securities prices and trade profitably. The market positioning of such smart money traders is believed to reveal their return expectations. Mimicking the market positions of the smart money is also expected to be a profitable trading strategy if implemented efficiently

⋆The authors would like to thank Mr. Hiroshi Yamaoka of TOCOM for providing us with the transaction data and the participants at the IAS Focused Program on Time Series Analysis of Higher Moments and Distributions of Financial Data, Hong Kong University of Science and Technology for helpful comments and discussions.

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enough with respect to trading costs and time. On the other hand sophisticated investors often want to invest against "dumb money" traders with the expectation that such traders will be forced to close out of their positions, resulting in a gain for those betting against the dumb money positions.

Who are the smart money investors that trade on private fundamental information on the future path of a security's prices? Central issues in the market microstructure literature include the means by which information enters prices and which traders are informed. Those investors who are informed possess private information and can influence the "efficient price" of financial securities. Their trades have a lasting impact on a security's price as they incorporate new private information into the price, and accordingly their investing activities are expected to be profitable in the long run. Uninformed investors, such as liquidity traders and noise traders, do not have a lasting impact on market prices as their trades convey no information. The influence of uninformed investor trades on market prices may be reversed over time, and accordingly such investors are not expected to be profitable over the long run. As a caveat to this, liquidity providers' trades may be profitable over the long run if the liquidity premium they earn is sufficient. Noise traders are not expected to be long-run profitable.

Hasbrouck (1991a,b) models the interaction between trades and price revisions as a bivariate structural vector autoregression (VAR) to analyse the influence of order flow on a security's efficient price. The approach provides a method to isolate the variance of innovations to the non-stationary permanent component of price, which is considered as the efficient price, and the stationary temporary price component. The variance of the efficient price can be decomposed into the proportions attributable to trade-related and non-trade-related information. Trade-related information may be interpreted as private information contained in the unexpected trades of investors, and non-trade-related information as public information that hits the market. Thus private information is presumed to enter the price of a security through the trading activity of informed investors.

In this study, we adapt Hasbrouck's approach to identify information asymmetry between six investor groups transacting in the gold, platinum, gasoline and rubber futures markets on the Tokyo Commodity Exchange (TOCOM). Using a multivariate structural VAR, we isolate the influence of each investor group's trades on the efficient price in each commodity market which reveals the extent to which the trades of that group are informed. Investor groups having a substantial influence on the efficient price in market are expected to have superior investment performance over the long run. Previous analyses use VAR models that cannot identify the profitability of trader groups as they do not distinguish permanent versus temporary influences of trades on price.

Different types of investor have different motivations for trading. For instance, hedgers seek to offset risk while speculators attempt to capitalise on taking appropriately compensated risk. Investor heterogeneity in this sense allows financial markets to perform their essential risk management functions. Investors with similar attributes, such as their motivation for taking or reducing risk (speculator or hedger), level of sophistication (retail or institutional), their role in facilitating markets (broker or market maker), or domicile (domestic or foreign), may exhibit a degree of homogeneity in trading. We take advantage of investor classifications recently introduced by TOCOM to present new evidence on the information content of the trades of different investor groups trading in commodity futures markets.

We shed light on why differences in the relative influence of investor groups in may be due to differences in market interconnectedness, the nature of the commodity and associated fundamental information. Exchange-traded commodity futures are typically thought of as standardised internationally traded goods with prices that conform to the law of one price. However, there are differences between futures markets for a given commodity in terms of regulation, contract specification, liquidity and the type of market participants active on different exchanges. This implies differences in the centralisation of price discovery, the relationship between supply and demand fundamentals, and the importance of global or region specific economic and financial variables for prices. Commodities have different geographical centres of consumption and production. A popular assumption is that domestic equity investors possess more information on locally listed firms, but it is less clear in commodities which investor groups should be better informed.

We select the gold, platinum, gasoline and rubber markets for analysis as they provide an interesting comparison. TOCOM futures contracts for these commodities have differentiated international connectedness vis a vis contracts for similar underlying commodities on futures exchanges in other countries. The underlying commodities have differing degrees of internationalisation in demand and supply, storage and standardisation. This would suggest different cross-market information and empirical linkages. TOCOM is a relatively small venue for gold trading, while gold futures trading internationally is homogeneous. This contrasts with platinum, for which TOCOM is a globally important trading venue, again for a homogeneous commodity. The Tokyo market for gasoline trades a grade of fuel conforming to a domestic standard, and while it's price is related to international oil prices, domestic demand and supply of the fuel is an important factor. TOCOM is an internationally important venue for the rubber trade, however the underlying commodity is one of several grades of rubber traded in Asia. Comparison of commodities with distinct market characteristics allows us to examine whether different types of investors influence the prices for futures where the underlying commodities have different cross-market linkages. Further, despite TOCOM's importance both internationally and domestically in commodities, relatively few studies have been published examining the microstructure of markets on this exchange.

We find that the efficient price in the gold, platinum and gasoline markets is mainly influenced by trade-related innovations. Foreign investors have the greatest influence over the efficient price in the gold market, investment funds in the platinum market and retail investors in the gasoline market. Both trade and non-trade related innovations have an equal influence on the efficient price of rubber, with trades by investment funds having the largest information content in this market. We explore why these results are obtained.

The article proceeds as follows. We discuss relevant literature in Section 2, our data in Section 3 and explain our model in Section 4. Section 5 presents our empirical results and these are discussed in Section 6. Section 7 concludes.

2. Literature Review

Market participants, regulators and researchers are interested in whether certain types of investors influence prices. An important constraint on empirical work is the lack of suitable transaction level data required to investigate the influence of trades (Dewally et al., 2013). The variety of approaches to, and forms of the data available for, answering questions on the influence of investors in various financial markets means these questions have not been definitively answered.

We examine salient evidence from equity and commodity markets, briefly surveying the literature showing i) foreign investors at an informational disadvantage to domestic investors, ii) foreign investors with a relatively small market impact, iii) foreign investors at an informational advantage, and iv) that in commodity futures some speculative investors are profitable, while hedgers tend to trade at a loss. To our knowledge, there is no published research comparing the profitability of different types of investors in commodity futures markets from the perspective of whether their trades influence the efficient price. Our paper adds to the literature by developing this area.

The information disadvantage of foreign to resident investors is frequently cited as a potential justification for home bias (Karolyi and Stulz, 2003). Kang and Stulz (1997) show that foreign investors hold more stocks of large firms than small firms in Japan, and suggest this may indicate foreign investors have a greater information disadvantage in trading small stocks. Foreign investors may be at a disadvantage due to their distance from a firms' headquarters (Coval and Moskowitz, 1999, 2001) or language difference (Grinblatt and Keloharju, 2001). In an intraday study of Korean stock market trade and price data, Choe et al. (2005) find foreign investment managers pay more than their domestic peers when they buy stocks, and receive less when they sell for medium and large trades. The market moves more against foreign investors before they trade than it does against other investor groups. This may be evidence that foreign investors follow intraday return-chasing strategies because they are at an information disadvantage to domestic investors. Korean retail investors have an edge over foreign investors. Domestic investors earn higher profits than foreign investors on the Jakarta Stock Exchange according to Dvorak's (2005) analysis of transaction data. Clients of global brokerages have an information advantage trades longer than one month, while those of domestic brokerages have an advantage over shorter horizons. However, domestic clients of global brokerages have higher profits than foreign clients. Lakonishok et al. (1992) argue that institutional investors trading is neither as stabilising nor destabilising. In general, the US tax-exempt institutional investors in their sample pursued a wide variety of investment strategies, the effects of which tend to cancel out. Institutional investors do not herd in large cap stocks, while they found some evidence of herding in small cap stocks.

Choe et al. (1999) find that before the Korean crisis of 1997, foreign investors engage in positive feedback trading and herd. However during the crisis, evidence of positive feedback trading is much weaker and they find no convincing evidence to suggest foreign investors destabilised the Korean equity market. Rather the market impact of domestic retail investors outweighed that of foreigners. Inspired by Choe et al. (1999), Yang (2017) examines whether foreign investors destabilise the Korean equity market during the 2008 global financial crisis. Foreign ownership levels and transaction volumes were far higher in 2008 than 1997 due in part to the relaxation of restrictions on foreign investors in 1998. Sales by foreign investors during the crisis were not followed by significantly negative returns over the next 25 minutes of trade.

Korean individual investors had a greater price impact than foreign investors. However, the price impact per trade of foreigners increased sharply during the crisis. Using a VAR model of foreign equity inflows and returns for six Asian emerging equity markets, Richards (2005) finds that foreign flow surprises influence returns for a few days beyond the day of the inflow. Foreign equity returns are also included in the model and are shown to be as important as domestic returns in accounting for the variance in flows suggesting that "push" factors are important.

Several studies provide evidence that foreign investors are more informed or profitable than domestic investors. Seasholes (2000) shows that foreign investors time Taiwanese firm's earnings announcements well, and Grinblatt and Keloharju (2000) provides evidence from the Finnish equity market that foreigners are better stock pickers than domestic investors. Using a trivariate VAR model consisting of NIKKEI equity index returns, USD/JPY currency returns and net equity purchases for a weekly sample from 1995 to 2001, Karolyi (2002) find that foreign investors follow a positive feedback strategy. A positive shock to equity returns is associated with a positive response in net foreign purchases, which decays within about one month. Domestic companies and banks followed a negative feedback strategy. Foreign investors generated positive investment performance and appeared to be good market timers, while the performance of domestic investors was negative, with financial companies being the worst. Kamesaka et al. (2003) examined the trading patterns of seven investor groups on the Tokyo Stock Exchange from 1980 to 1997 using a VAR model of net investment flow and TOPIX returns, and Granger causality to identify market timing trading patterns. Foreign investors and Japanese retail investors followed positive feedback strategies. Foreigners were profitable while retail traders were not, consistent with foreigners trading on information and retail investors trading according to a behavioural model. Securities firms and banks engaged in negative feedback strategies that were profitable.

Recent studies of commodities futures in the United States use non-aggregated transaction level data to infer whether the trading activities of certain types of investors are informed or profitable. Fishe and Smith (2012) use daily positions of traders in twelve commodities to identify who is informed on an intraday and overnight basis. Brokers are over-represented in the overnight informed group, and funds in the intraday informed group. Commercial hedgers are under-represented both overnight and intraday. Informed investors are likely to have greater trading experience, activity, position size, as well as trade on both sides of the market. In the crude oil, gasoline and heating oil markets, Dewally et al. (2013) show that likely hedgers trade at a loss while likely speculators make profits. At the aggregate level, speculator profits are generated from absorbing risk from, or providing liquidity to, hedgers. However at the individual level, some investors have an informational or trading skill advantage. de Roon et al. (2000) show that commercial hedgers bring price pressure to futures markets when they adjusted their positions.

3. TOCOM Commodity Futures Data

In the following sections we explain the characteristics of the commodities selected for analysis, define the investor groups and discuss our data and variables. The four commodities we select differ in terms of the level of centralisation of trading in the commodity and its derivatives, and relationships with similar commodities that are traded on exchanges outside Japan. Further, different types of economic and financial variables from different geographic locations are relevant to fundamental information on commodity demand and supply expected to be incorporated in the efficient prices. This provides an interesting comparison regarding the investor groups that influence the efficient price, and the extent to which trade-related and non-trade related information influence the efficient price.

3.1. Futures Markets

Gold futures and other derivatives are traded on several exchanges around the world. Hauptfleisch et al. (2016) note that the trade in gold is largely decentralised. Examining whether the price of gold futures is set by London or New York, they find that although both markets contribute to price discovery, the New York futures play a larger role on average despite the New York exchange turnover being less than 10 percent of that of the London exchange. TOCOM plays a relatively minor role in the market for gold. For instance, gold futures trade in Tokyo represented approximately 6 percent and 5 percent of the volume of trade on the Commodity Exchange of New York (COMEX) by weight of metal in 2015 and 2016, respectively. Lucey et al. (2014) find that the London and New York markets for gold dominate returns and volatility and affect trade in Tokyo, but there is no significant and consistent effect from Tokyo to other markets. Investment and jewellery make up the bulk of Gold demand, although the metal is also used in industrial processes (O'Connor et al., 2015). As primarily a financial asset wih massive stocks in comparison to annual physical production and consumption, it is difficult to identify non-financial sources of fundamental information on the gold price. There do not appear to be compelling reasons to suspect that Japanese domestic investors have a substantial informational advantage over foreign investors in the gold market.

In contrast, trade in platinum futures is relatively concentrated and centred on TOCOM and the New York Mercantile Exchange (NYMEX). Tokyo's importance in the global platinum market stems from the use of platinum in the the automotive industry. Over 40 percent of global platinum production is used in automotive catalytic converters (McDonald and Hunt, 1982; Eller and Sagerer, 2011). Japanese firms trading in physical platinum for the automotive industry have traditionally used TOCOM to transact in platinum futures for hedging purposes via liquid far dated contracts[1]. TOCOM was the largest futures market for platinum by weight of metal until around the time of the global financial crisis. In 2008, 3.5 million kilograms was traded on TOCOM, or 4.4 times that of NYMEX. Following the crisis, the trade volume on TOCOM declined while that on NYMEX increased. From 2000 to 2007, the average of annual futures volumes on TOCOM equated to around 6.3 million kilograms of platinum. Over 2008 to 2017 the average annual volume declined to just over 2 million kilograms. In the first six months of 2018, futures contracts equivalent to around 4.4 million kilograms were traded on NYMEX, about five times the amount traded on TOCOM over the same period. However despite the decline in TOCOM volume, a substantial share of the global platinum futures trade still occurs on the TOCOM and important end users of physical platinum continue to use the exchange for hedging. While both gold and platinum are considered precious metals, gold tends to be demanded by investors as a safe haven financial asset while platinum is stockpiled during good economic times for industrial use (Chng and Foster, 2012).

TOCOM trades futures contracts based on an underlying domestic grade of regular gasoline conforming with the Japanese Industrial Standard (JIS) K2202 Grade 2, which is refined within Japan or imported, and delivered at refineries or storage tanks in Tokyo, Kanagawa or Chiba[2]. Important factors affecting the gasoline futures price include global crude oil prices (specifically the Dubai crude price), as well as the domestic production and consumption of gasoline, refinery capacity and outages, imports and inventory levels. The gasoline "crack spread", or the differential between the futures prices for gasoline and crude oil, represents the non-crude oil-related components of the gasoline price. The crack spread is time-varying and driven predominantly by domestic factors including private automobile use and transport demand, gaso-

[1]The nature of the platinum futures trade differs between TOCOM and NYMEX. On TOCOM, the far dated contracts are liquid while the near dated contracts are not actively traded (this is also the case for the other commodities examined in this research). The reverse is true for NYMEX.

[2]TOCOM also trades cash settled contracts based on barge and lorry gasoline.

line refinery output, inventory levels, imports and exports of gasoline, seasonal patterns and economic growth. Information on demand, supply and inventory levels is readily available, as is reporting of refinery outages. Within Japan, the trade of gasoline futures is concentrated on TOCOM.

Asia is the centre of the global rubber industry, both in production and consumption. Thailand, Indonesia and Vietnam are the largest producers of natural rubber and China is the largest consumer, by country (IHS Markit, 2017). The Singapore Exchange (SGX) and TOCOM have traditionally been the two most important futures markets in contract volume terms, and for the pricing of natural rubber (Meng and Liang, 2013; Chang et al., 2011). The Shanghai Futures Exchange (SHFE) has been rising in prominence in recent years, and there are some indications that the importance of TOCOM has declined with a portion of trade shifting to Singapore. Craymer (2016) notes that the liquidity of the rubber futures market on TOCOM had declined, volatility had increased and market participants believed prices had become less connected with fundamentals in the physical market. There are also a number of less globally-important exchanges in the region including in India and Thailand.

Several grades of rubber are traded on futures exchanges in Asia. TOCOM has traded contracts based on the Ribbed Smoked Sheets Number 3 grade (RSS-3) since 1952 and recently launched a new contract for Technically Specified Rubber (TSR-20) on 9 October 2018[3]. We model the TOCOM RSS-3 contract since there is no data available for the TSR-20 contract during our sample period. SGX similarly trades RSS-3 and TSR-20. The SHFE trades a contract based on domestic Sinochem brand natural (SCR) rubber and imported RSS-3 as the underlying commodity, and recently the China Securities Regulatory Commission approved the launch of a TSR-20 contract. The National Multi-Commodity Exchange of India trades a contract based on RSS-4 rubber. A common thread linking platinum, gasoline and rubber is automobile transportation. Chng (2009) notes that more than 50 percent of global demand for these commodities originates from the automobile industry and finds cross-market interactions amongst the futures on TOCOM. Around 60 percent of natural rubber production is used to produce tyres and tubes (International Rubber Study Group, 2018b).

[3]RSS rubber is rolled into sheets and dried in a smokehouse, while TSR (also known as block rubber) is washed, shredded, granulated under controlled conditions, and dried as a block (International Rubber Study Group, 2018a). TSR is precisely graded based on the rubber's chemical and quality properties, while RSS rubber is graded by visual inspection.

3.2. *Investor Group Definitions*

With the introduction of TOCOM's J-GATE trading system in September 2016, all trades on the exchange are classified as originating from six investor groups: (i) Commercials (denoted in TOCOM documentation as 40), (ii) Prop/Market Makers (5B), (iii) Funds/Investment Trust (5C), (iv) General Investors (5D), (v) Agency (5E), (vi) Foreign Investors (5F). The classification of an investor placing a trade is determined from information reported by the broker that places the trade on the exchange. The investor classification provided by TOCOM is considerably more detailed than those provided by other commodity futures exchanges in their publicly available data. The classifications used with J-GATE are more intuitive and useful for examining information asymmetry among investor groups than TOCOM's investor classifications used prior to the introduction of the new trading system[4]. The new classifications are more easily attributable to different types of investors, while the old groups were aligned with how trades were placed on the exchange.

Commercials are entities hedging physical positions. Although the commercials classification includes foreign firms, most are domestic Japanese firms. We abbreviate the group name slightly to "Commercial". Prop/Market Makers are proprietary traders, futures commission merchants (FCMs) and market making brokers or dealers that have direct access to trade on TOCOM. We call this group "Dealer". Funds/Investment Trusts covers all types of funds managed by financial institutions, which may be active or passive, and includes Toshin, exchange traded funds (ETFs), mutual funds, hedge funds and Commodity Trade Adviser (CTA) funds. We refer to this group as "Fund". General Investors are mainly individual domestic retail traders who access the markets via on-line and traditional individual broker services, and we refer to this group as "General". Agency, referred to simply as "Agency", includes financial intermediaries who cannot place their trades directly on TOCOM and access the markets via domestic intermediaries who are members of the exchange. This classification may include trades originating from investors that could be classified under the other groups. Foreign Investors include both short and long-term investors, and perform similar investment activities to the domestic market participants classified as Prop/Market Makers and Funds/Investment Trusts. Foreign Investors access TOCOM via foreign FCMs. We refer to the Foreign Investors category as "Foreign".

[4]Prior to the introduction of J-GATE, investors were classified according to seven groups: (i) commercials with direct access to TOCOM (1A), (ii) commercials without direct access to TOCOM (21), (iii) commercials with access to TOCOM but trading through intermediaries (31), (iv) other commercials (3A), (v) intermediaries (1B), (vi) intermediaries that trade through other intermediaries (32), (vii) individual and institutional investors, and financial institutions (22).

Using our terminology, we have the following six investor groups: Commercial, Dealer, Fund, General, Agency, and Foreign.

3.3. Data and Variables

The sample period runs from 20 September 2016 to 28 February 2018. The beginning of the sample corresponds to the introduction of TOCOM's J-GATE trading system, under which all trades are classified as originating from the six investor groups described in Section 3.2[5]. With the introduction of J-GATE, the exchange trading time was extended to begin earlier in morning and finish later at night. Trading hours span 08:45 Japan Standard Time (JST) to 05:30 the next day. TOCOM runs a day session from 8:45 to 15:15 JST. The night session runs from 16:30 to 05:30 JST for gold, platinum and gasoline, and 16:30 to 19:00 JST for rubber. The trading day is defined as beginning at the start of the TOCOM night session and running through to the end of the day session on the following day.

We obtained daily futures close price and transaction data for gold, platinum, gasoline and rubber from TOCOM[6]. Prices are denominated in Japanese yen per gram for the gold and platinum contracts, yen per kilolitre for gasoline and yen per kilogram for rubber futures.

Contract months for gold and platinum futures are all even months of the year, and six non-expired contracts will exist at any time. For gasoline and rubber, futures contracts are generated for six consecutive months, and as for gold and platinum, six non-expired contracts will trade at any time. Contract months begin from the current month (up to the last trading day) for rubber and the month following the current month (again up until the last trading day) for gasoline. An important characteristic of the trade in these futures on TOCOM is that the farthest contract is the most liquid and actively traded while the near contract is illiquid. This contrasts with most other futures exchanges where trading activity is concentrated around the near contract. Accordingly, we use the prices for the farthest contract in each commodity to calculate the return over the trading day, r_t, as:

$$r_t = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100 \tag{1}$$

where P_t represents the close price at the end of the day session at time t.

[5]The investor group classifications used in J-GATE differ from those used under the previous trading system, and accordingly, we are limited to using data beginning in September 2016 for the analysis of the new investor groups.

[6]The data is publicly available from `http://www.tocom.or.jp`.

The transaction data comprises of the number of contracts for each commodity bought and sold on each trading day by each investor group. TOCOM aggregates investor group transactions over all six non-expired contract maturities. While we would prefer to measure transactions in the farthest contract only, the aggregated data is reasonable for our purpose as transactions in the farthest contract constitute a high proportion of total volume over all non-expired maturities. We calculate the following daily trade ratio, $x_{g,t}$, for each investor group, $g = 1, \ldots, 6$, at time t defined as:

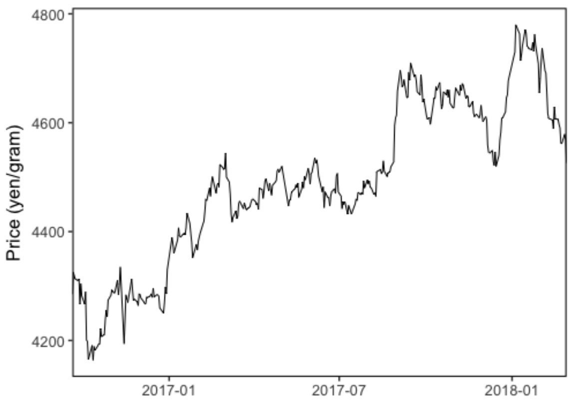
$$x_{g,t} = \frac{B^{\star}_{g,t} - S^{\star}_{g,t}}{B^{\star}_{g,t} + S^{\star}_{g,t}} \tag{2}$$

where $B^{\star}_{g,t}$ and $S^{\star}_{g,t}$ represent the number of futures contracts bought and sold by investor group g at time t, respectively. The resulting trade ratio series are stationary and range between -1 and 1. A positive (negative) trade ratio shows the investor group bought (sold) more contracts than it sold (bought) during the trading day, the same time interval over which returns are calculated.

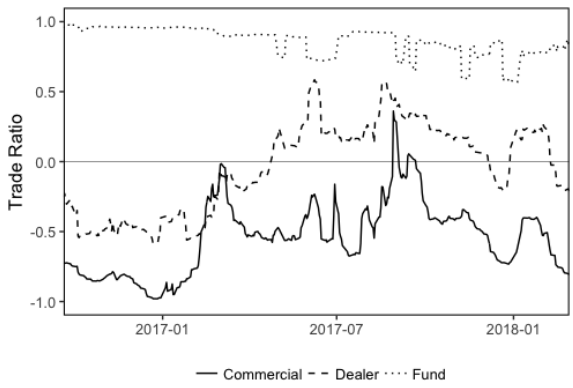
Plots of the daily prices, returns and trade ratios are provided in Figures 1 to 4. Panel (a) shows price, panel (c) has the return, panel (b) gives the trade ratio for Commercial, Dealer and Fund, while panel (d) contains the trade ratio for General, Agency and Foreign. Summary statistics for the transactions series and returns are given in Tables 1, 3, 5 and 7. Correlations between the different investor group trade ratios are provided in Tables 2, 4, 6 and 8.

Figure 1: Gold Futures Market

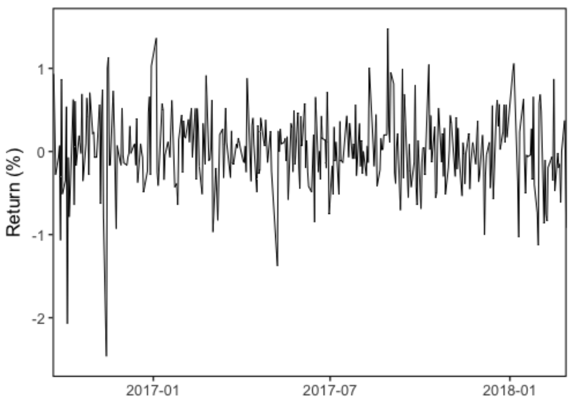
(a) Price



(b) Trade Ratio (Commercial, Dealer, Fund)



(c) Return



(d) Trade Ratio (General, Agency, Foreign)

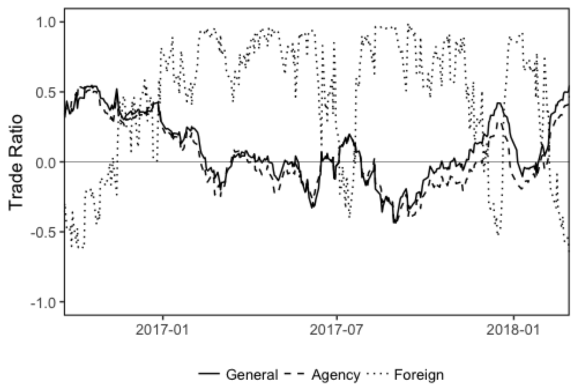


Table 1: Summary Statistics for Gold Trades and Return

	Commercial		Dealer		Fund		General		Agency		Foreign		Return
	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	
Mean	6248	23876	13382	14774	601	35	50212	40898	6745	6023	12017	3682	0.017
Median	6292	21724	12602	13938	459	25	47802	41257	6209	6007	13008	2539	0.022
Maximum	11991	49951	28053	25434	1201	99	82821	63654	11509	9009	27273	15317	1.480
Minimum	326	4193	5569	4107	336	12	24505	20954	3422	3311	1337	188	-2.465
Std. Dev.	2986	10375	5807	5646	251	20	13562	9778	1997	1322	5969	3248	0.474
Skewness	0.03	0.36	0.94	0.13	0.84	1.58	0.38	0.08	0.73	0.15	-0.07	1.44	-0.490
Kurtosis	2.35	2.34	3.00	1.88	2.01	4.81	2.16	2.38	2.53	2.47	2.11	4.78	2.776
Obs.	354	354	354	354	354	354	354	354	354	354	354	354	353

Table 2: Correlations Amongst Gold Trade Ratios

	Commercial	Dealer	Fund	General	Agency	Foreign
Commercial	1.00					
Dealer	0.74	1.00				
Fund	-0.36	-0.57	1.00			
General	-0.88	-0.80	0.31	1.00		
Agency	-0.88	-0.79	0.42	0.96	1.00	
Foreign	0.54	0.42	-0.16	-0.79	-0.79	1.00

Figure 2: Platinum Futures Market

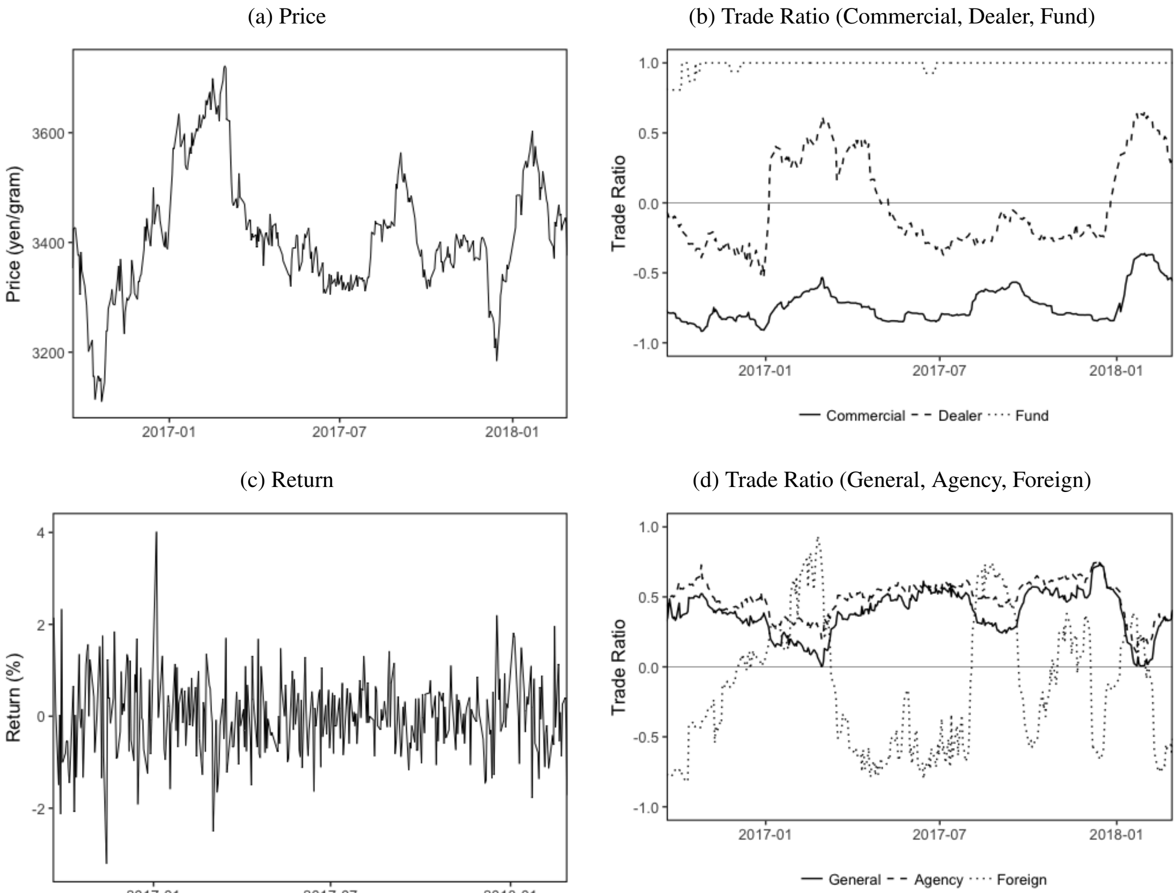


Table 3: Summary Statistics for Platinum Trades and Return

	Commercial		Dealer		Fund		General		Agency		Foreign		Return
	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	
Mean	4055	26599	3627	4136	282	2	37895	16615	5056	1678	5027	6991	0.006
Median	3710	25953	3640	3266	266	0	38520	16938	5266	1697	3768	7157	0.000
Maximum	8140	35920	7781	10167	476	42	53752	23572	6383	2544	15705	19301	4.014
Minimum	1083	14910	700	1003	224	0	20792	6435	2625	816	1093	162	-3.204
Std. Dev.	1744	6206	1447	2666	51	8	7965	3810	972	335	3486	4071	0.862
Skewness	0.67	-0.28	0.02	0.71	1.66	4.02	-0.09	-0.45	-0.91	-0.37	0.87	0.79	0.185
Kurtosis	2.61	1.76	3.03	2.30	4.59	18.56	2.40	2.51	2.77	2.68	2.72	3.87	1.322
Obs.	354	354	354	354	354	354	354	354	354	354	354	354	353

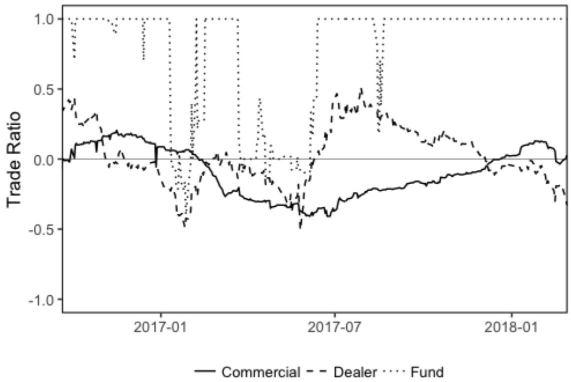
Table 4: Correlations Amongst Platinum Trade Ratios

	Commercial	Dealer	Fund	General	Agency	Foreign
Commercial	1.00					
Dealer	0.72	1.00				
Fund	0.22	0.17	1.00			
General	-0.71	-0.71	-0.08	1.00		
Agency	-0.73	-0.75	-0.09	0.94	1.00	
Foreign	0.40	0.21	0.27	-0.61	-0.48	1.00

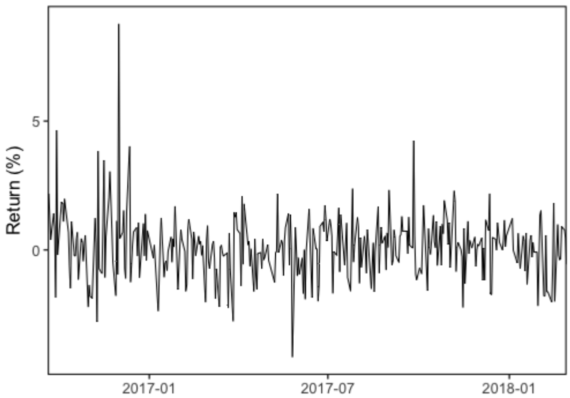
Figure 3: Gasoline Futures Market

(a) Price

(b) Trade Ratio (Commercial, Dealer, Fund)



(c) Return



(d) Trade Ratio (General, Agency, Foreign)

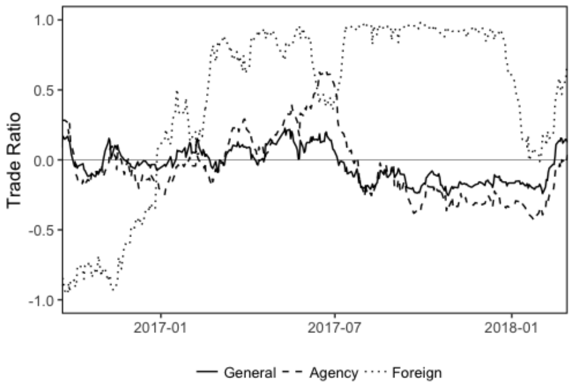


Table 5: Summary Statistics for Gasoline Trades and Return

	Commercial		Dealer		Fund		General		Agency		Foreign		Return
	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	
Mean	4344	3574	1577	1756	7	42	2649	2436	301	257	497	1296	0.111
Median	4301	3593	1479	1577	0	28	2619	2393	283	247	203	1502	0.170
Maximum	6334	5777	2859	3114	65	171	3749	3454	560	503	2435	2356	8.774
Minimum	1791	1567	676	410	0	23	1436	1269	94	131	20	48	-4.157
Std. Dev.	1192	1082	492	720	13	30	557	365	118	62	588	671	1.245
Skewness	-0.15	0.10	0.66	0.13	1.69	2.52	0.14	0.46	0.43	1.11	1.47	-0.49	1.070
Kurtosis	1.85	2.20	2.80	1.75	4.69	9.32	2.02	3.07	2.35	4.72	4.20	1.84	6.886
Obs.	354	354	354	354	354	354	354	354	354	354	354	354	353

Table 6: Correlations Amongst Gasoline Trade Ratios

	Commercial	Dealer	Fund	General	Agency	Foreign
Commercial	1.00					
Dealer	-0.16	1.00				
Fund	0.34	0.58	1.00			
General	-0.25	-0.43	-0.52	1.00		
Agency	-0.57	-0.09	-0.43	0.84	1.00	
Foreign	-0.73	-0.03	-0.19	-0.21	-0.02	1.00

Figure 4: Rubber Futures Market

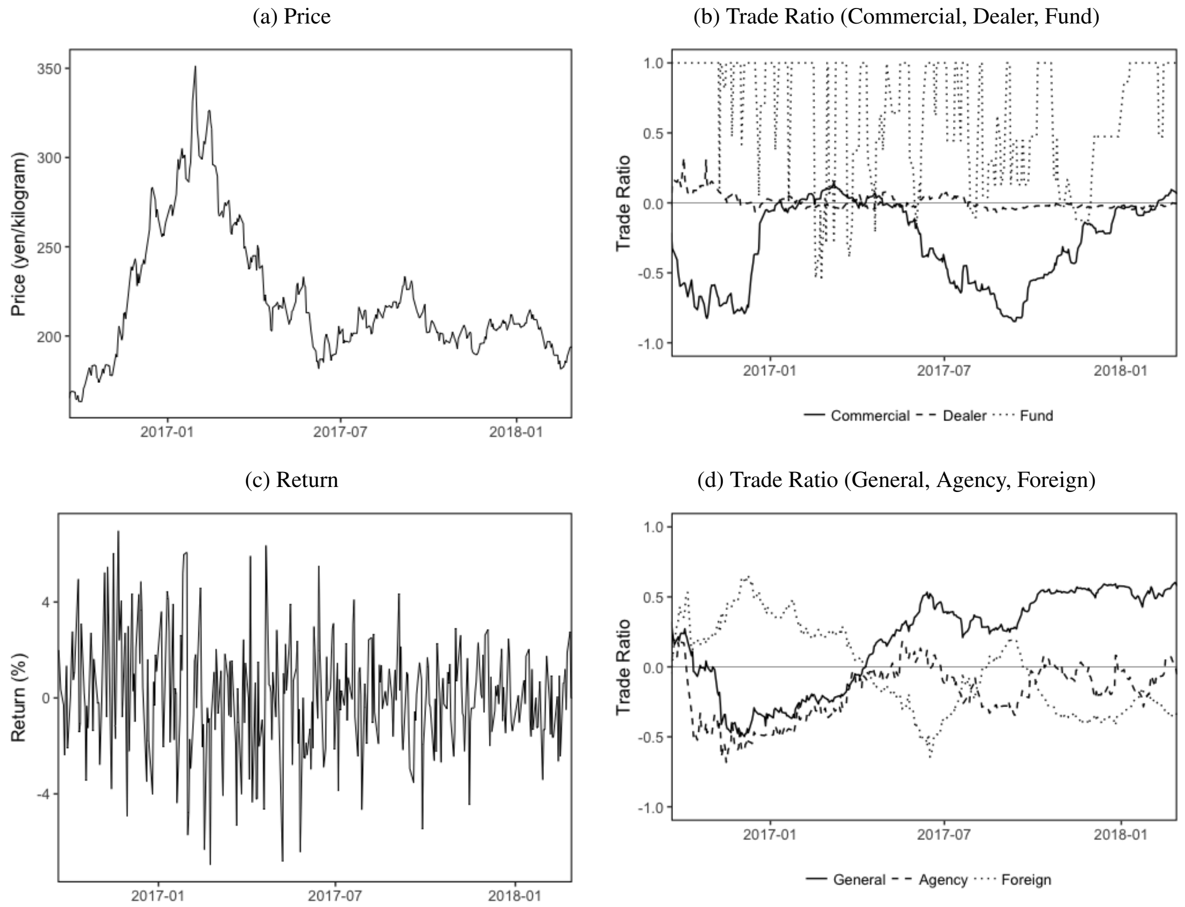


Table 7: Summary Statistics for Rubber Trades and Return

	Commercial		Dealer		Fund		General		Agency		Foreign		Return
	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	
Mean	2254	4195	1676	1675	24	5	8538	5798	792	1229	8575	8993	0.072
Median	2332	4029	1526	1515	14	0	8434	4782	793	1063	8002	8076	0.061
Maximum	4587	9615	4435	4472	122	35	13780	12327	1130	2684	19430	21464	6.969
Minimum	336	1337	620	326	9	0	2529	2672	300	517	1835	2016	-6.943
Std. Dev.	1174	1585	660	690	22	6	3055	2626	175	456	3598	3873	2.297
Skewness	0.17	0.88	1.26	1.10	2.56	1.65	0.01	0.94	-0.40	1.13	0.79	0.98	-0.012
Kurtosis	1.91	4.04	5.04	4.40	9.56	6.13	1.92	2.44	2.77	3.61	3.64	3.87	0.747
Obs.	354	354	354	354	354	354	354	354	354	354	354	354	353

Table 8: Correlations Amongst Rubber Trade Ratios

	Commercial	Dealer	Fund	General	Agency	Foreign
Commercial	1.00					
Dealer	-0.27	1.00				
Fund	-0.04	0.35	1.00			
General	-0.04	-0.21	-0.18	1.00		
Agency	0.25	-0.05	-0.18	0.76	1.00	
Foreign	-0.18	0.25	0.23	-0.89	-0.77	1.00

The time series of prices for the four commodity futures display reasonably different behaviour over the sample period. Gold and gasoline prices trend up over the sample while platinum prices go sideways and the price of rubber declines from a peak in early 2017. A common feature of the price series is a rise in prices in late 2016 to early 2017. This coincides with a period of substantial depreciation in the Japanese yen over the last quarter of 2016, from around 100 to the US dollar to 117. The contracts are yen denominated, suitable for hedging domestic exposures.

Average daily returns are close to zero for all of the commodities over the sample. The gasoline and rubber markets appear to be the most volatile. The maximum and minimum daily returns are substantial in gasoline and rubber, and to a lesser extent also in platinum. In standard deviation terms, the gold futures are the least risky securities, followed by platinum, and gasoline while rubber futures returns have the greatest dispersion. Gold returns are negatively skewed, while platinum and gasoline returns are positively skewed. Gasoline returns are particularly leptokurtic.

The transactions summary statistics, trade ratio plots and correlations reveal a number of interesting characteristics of the trading activities of the six investor groups in each market. The gold market has the greatest median buy and sell transactions across all groups. General investors are the largest traders in the market judging by the median of the daily number of buy and sell transactions, while investment Funds are the smallest participants in the market. The Commercial, Dealer, Foreign and Agency groups all have reasonably large transactions volumes. Dealer, General and Agency investor median buy and sell volumes are broadly balanced, while Foreign and Fund investors have more buys than sells. Commercial investors have more sells than buys. The trade ratios for General and Agency investors are almost perfectly correlated in the gold market, suggesting that the trades recorded under Agency may largely originate from retail investors are placed with the exchange via brokers without direct trading access to TOCOM. The Foreign trade ratio has a high negative correlation with the trade ratios of General and Agency investors, and a positive correlation with Commercial and Dealer investors. Commercial and Dealer trade ratios are highly correlated, however the trade ratio for Commercial investors is usually more negative than Dealers, suggesting relatively short market positioning. Fund investor transactions have a low correlation with those of other groups, and the trade ratio varies between 0.5 and one, suggesting the Funds group may be dominated by long-only or passive index tracking investors.

The relationships between the six investor groups' trades in the platinum market are similar to those in the gold market. General investors are the largest participants and Funds are the smallest. Commercial investors are also substantial traders in platinum futures. As in the gold market, the General and Agency trade ratios are almost perfectly correlated with each other, and negatively correlated with the Commercial, Dealer and Foreign trade ratios. Commercial and Dealer trading is positively correlated as in the gold market. The Commercial trade ratio is negative over the sample, while the Dealer trade ratio fluctuates above and below zero. Looking at the trade ratio plots, it would appear that in both gold and platinum the General and Agency investors are trading against the Commercials and Dealers. Foreign investors also generally place more sells than buys, while General and Agency investors place more buys than sells. Funds predominantly make buy transactions, with their trade ratio close to one, but with some variation over the sample.

The characteristics of gasoline trading differ from those of the metals markets. There is noticeably less trading activity in gasoline than in the gold or platinum. Some of the correlations between investor group trade ratios also differ. Commercials are the largest gasoline market participants, followed by General investors. Fund participation is very low during the sample. Again, General and Agency trade ratios are positively correlated, but to a lesser extent than in the gold and platinum markets. In contrast to the metals markets, Commercial and Dealer trading has a low negative correlation, and Dealer and Fund trading is moderately positively correlated. The Fund trade ratio is positively correlated with Dealers and negatively with that for Agency investors. The Commercial and Foreign trade ratios are the most negatively correlated of all trade ratios in gasoline. In general, the trade ratio correlations seen in the metals markets are greater in absolute value terms than those seen in the gasoline and rubber markets.

Trading in the rubber market also differs somewhat from that in the other three commodities. Foreign investors place the most trades during the sample, followed by General investors who are amongst the largest traders in all four markets. Commercials the third largest traders in rubber, versus the largest in gasoline and second largest in the metals. Again Fund participation is very low. However in rubber, the Fund trade ratio is relatively volatile. Of the groups with larger trade volumes, Foreign investors buy and sell about the same number of contracts in median terms, while General buy more than they sell, and Commercials sell more than they buy. Dealers have balanced buys and sells and the dealer trade ratio is close to zero for the sample. As is the case for gold, platinum and gasoline, the General and Agency trade ratios are positively correlated, albeit more moderately for rubber. General and Agency trades are negatively correlated with those of Foreign investors. The other rubber trade ratio correlations are relatively low.

4. Modelling the Information Content of Trades

The following subsections describe the model we use to determine the influence of investor groups' trading on the efficient price and differentiate between trade-related and nontrade-related information.

4.1. VAR Model of Orderflow and Return

We adapt the structural bivariate VAR model proposed by Hasbrouck (1991a,b) of orderflow and price revisions to examine the information content of the trades of the six trader groups in each commodity futures market. Our multivariate model can be expressed in vector form as:

$$BY_t = \Phi_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \epsilon_t \tag{3}$$

where: $$Y_t = \begin{bmatrix} X_t \\ r_t \end{bmatrix}, \quad X_t = \begin{bmatrix} x_{1,t} \\ x_{2,t} \\ x_{3,t} \\ x_{4,t} \\ x_{5,t} \\ x_{6,t} \end{bmatrix} \quad \text{and} \quad B = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & -b_1 \\ 0 & 1 & 0 & 0 & 0 & 0 & -b_2 \\ 0 & 0 & 1 & 0 & 0 & 0 & -b_3 \\ 0 & 0 & 0 & 1 & 0 & 0 & -b_4 \\ 0 & 0 & 0 & 0 & 1 & 0 & -b_5 \\ 0 & 0 & 0 & 0 & 0 & 1 & -b_6 \\ -c_1 & -c_2 & -c_3 & -c_4 & -c_5 & -c_6 & 1 \end{bmatrix}.$$

In our model, Y_t contains the trade information X_t for each of the six investor groups and the futures mid-price return r_t. X_t contains the trade ratios for the six investor groups, $x_{g,t}$, where $g = 1, \ldots, 6$, corresponding to the investor groups Commercial, Dealer, Fund, General, Agency and Foreign, respectively. The Φ_i are 7×7 coefficient matrices, where i represents the number of lags included in the VAR. In contrast with typical VAR applications, contemporaneous trade ratios and returns enter the system as explanatory variables. There are contemporaneous relationships between trade ratios and returns, and returns and trade ratios, but not between the trade ratios which constitute restrictions to identify the model. The b_g coefficients are those on the contemporaneous returns variable in the six trade ratio relationships, while the c_g coefficients are those on the six contemporaneous trade ratio terms that appear in the returns relationship. The first six rows of the system represent, for each investor group, the relationship between the trade ratio as the dependent variable, and its lags and the contemporaneous return as explanatory variables. The innovations include unexpected trading activity. The final row is the relationship between return as the dependent variable and its lags plus the contemporaneous trade ratio for each investor group.

The number of lags to be included in the VAR model for each commodity was determined using the Akaike Information Criterion (AIC). Lags included in the models are as follows: for gold two lags, platinum three, gasoline two and rubber one. Each VAR model was estimated using maximum likelihood. The empirical results are discussed in the Section 5.

4.2. The Efficient Price and Mispricing

Hasbrouck (1991b) provides a method to isolate the variance of the permanent component of a security's price, and the proportions attributable to trade- and non-trade-related information. The permanent component of a securities price is interpreted as the efficient price reflecting the fundamental valuation of the security. Only where trades influence the permanent component of price do investors influence the efficient price. The trade-related part of the permanent component may be interpreted as the private information incorporated in the security's price through the unexpected trades of informed investors. The non-trade-related part of the permanent component reflects public information. We adapt this approach to estimate the influence trades on the efficient price and asymmetry in the information content of the trades of the different investor groups.

The price of a security, p_t, may be decomposed into the efficient price, m_t, and mispricing, s_t:

$$p_t = m_t + s_t \tag{4}$$

where m_t follows a random walk process, s_t is a mean-zero covariance stationary process, and $\lim_{h\to\infty} E\left(s_{t+h}\right) = 0$.

The permanent component of price, or efficient price, can be modelled as:

$$m_t = m_{t-1} + \omega_t \tag{5}$$

where $\omega_t \sim N\left(0, \sigma_\omega^2\right)$, and $E\left(\omega_t, \omega_s\right) = 0$ for $t \neq s$.

The efficient price, m_t, is driven by the previous period's efficient price and an innovation that reflects new fundamental information, ω_t, which is incorporated in the efficient price at time t. The efficient price shock, ω_t, has a permanent influence on the security price, while the mispricing shock, s_t, is has only a temporary effect. The s_t component represents transitory effects on the security's price, or mispricing, arising from non-information based microstructure effects, liquidity provision and noise trading. The variance of the information innovation, σ_ω^2, measures the variation in the permanent component of the price related to fundamental information.

The structural VAR model shown in equation (3) can be inverted to the Vector Moving Average (VMA) representation:

$$Y_t = \left(I + \theta_1 L + \theta_2 L^2 + \theta_3 L^3 + \ldots\right)\epsilon_t = \theta(L)\,\epsilon_t \tag{6}$$

where L is the lag operator, the θ_i are 7×7 matrices of coefficients, and ϵ_t is a white noise error process with $E(\epsilon_t) = 0$ and $Var(\epsilon_t) = \Omega$.

The variance of the shock to the permanent component of the security's price is estimated from the VMA representation in (6) as:

$$\sigma_\omega^2 = [\theta(1)]_7\,\Omega\,[\theta(1)]_7' \tag{7}$$

where $[\theta(1)]_7$ denotes the seventh row of $[\theta(1)]$ that corresponds to the returns relationship, and $[\theta(1)] = (I + \theta_1 + \theta_2 + \ldots)$.

The variance of the trade-related component for an investor group, g, is:

$$\sigma_{\omega,x_g}^2 = [\theta^\star(1)]_7\,\Omega\,[\theta^\star(1)]_7' \tag{8}$$

where $\theta^\star$ represents θ from the VMA with the coefficients related to all other investor groups and and the coefficients related to returns set to zero.

Similarly the variance of the non-trade related component is:

$$\sigma_{\omega,r}^2 = [\theta^{\star\star}(1)]_7\,\Omega\,[\theta^{\star\star}(1)]_7' \tag{9}$$

where $\theta^{\star\star}$ represents θ from the VMA with the coefficients related to all investor groups set to zero.

As the trading behaviour of the different investor groups is correlated, we expect Ω to be a non-diagonal covariance matrix. Accordingly, we use Cholesky factorisation to extract σ_ω^2. Set $\Omega = F'F$, where where F is the upper triangular Cholesky factor[7], and let $d = [\theta(1)]_7\,F'$. Then

[7]We order the factorisation with the trade ratios first, then returns.

the variance of the permanent shock is the sum of the squares of the elements of d:

$$\sigma_w^2 = \sum d_i^2 \tag{10}$$

We can obtain the variance due to trade-related, σ^2_{ω,x_g}, and non-trade-related, $\sigma^2_{\omega,r}$, components using this procedure, and express these relative to the total variance of the permanent component σ^2_ω. The relative trade-related variance for an investor group provides a measure of the relative influence of that group's trades on the efficient price. The relative non-trade-related variance gives a measure of the influence of public information on the efficient price.

4.3. The Price Impact of Trade

The price impact of trade by an investor group is calculated as the sum of the coefficients in $\theta^\star$ for that group multiplied by a shock to that group's trade. This can be seen clearly if the VMA model can be re-written as:

$$\begin{bmatrix} x_{1,t} \\ x_{2,t} \\ x_{3,t} \\ x_{4,t} \\ x_{5,t} \\ x_{6,t} \\ r_t \end{bmatrix} = \begin{bmatrix} a_1(L) & b_1(L) & \cdots & & & & g_1(L) \\ a_2(L) & b_2(L) & \cdots & & & & g_2(L) \\ \vdots & & \ddots & & & & \vdots \\ \vdots & & & & & & \vdots \\ \vdots & & & & & & \vdots \\ \vdots & & & & & \ddots & \vdots \\ a_7(L) & b_7(L) & c_7(L) & d_7(L) & e_7(L) & f_7(L) & g_7(L) \end{bmatrix} \begin{bmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \\ \epsilon_{3,t} \\ \epsilon_{4,t} \\ \epsilon_{5,t} \\ \epsilon_{6,t} \\ \epsilon_{7,t} \end{bmatrix} \tag{11}$$

Then the ultimate effect of unexpected trade by the Commercial investor group ($g = 1$) on price thirty days after the shock is:

$$\Psi_{30} = \sum_{k=0}^{30} a_{7,k}\left(\epsilon_{1,0}\right) \tag{12}$$

which is equivalent to the cumulative impulse response of return to a shock to the Commercial trade ratio, $\epsilon_{1,0}$. This measure includes both the permanent and temporary influences on a security's price. Over a sufficiently long period subsequent to the shock, the temporary components of the price impact would be expected to reverse out, leaving the permanent influence on price. While the trades of uninformed investors influence prices in the short-run, their trades do not have a lasting long-run impact on price because the short-run influence is reversed over time.

In this sense, the price impact on trade is one way to isolate which investor groups influence price permanently, and thus which groups influence the efficient price. However, the permanent component that we can isolate using the impulse response function does not indicate whether the information that appears to be related to the trades is private or public. A positive price impact on trade suggests that the investor group trades as an informed investor. That is, a positive shock in the trade ratio is associated with a positive response in returns. Whereas, a negative price impact on trade suggests that the investor group trades as a liquidity provider[8], that is a positive shock to the trade ratio is associated with a negative response in returns. A high (low) absolute number suggests unexpected trades have a large (small) total long-run influence on the security's price. The relative magnitudes of the price impact of trade across markets can be interpreted as indicating relative liquidity levels. In a more liquid market, a given shock to trade will have a lower impact on price.

4.4. Interpreting the Information Content of Trades

Using the information content of trade modelling, we differentiate three types of investor. Informed investors successfully use private information to trade at a profit. Their trades contain fundamental information that is impounded in the market price and has a persistent influence on the market price, affecting the efficient price. We assume that the long-run price impact of informed investors is positive, that is, the CIRF is positive and significant within the 30-day horizon. Informed investors have a positive long-run price impact and a relatively large impact on the efficient price, represented by a large share in the variance decomposition of the efficient price. Informed investors may or may not represent a large share of the forecast error variance decomposition.

We also allow for investors who influence the efficient price, but who have an indeterminate or negative long-run price impact of trade. Such investors may be hedgers who' trades contain fundamental information on expected future demand or supply conditions for the commodity. Although the trades contain fundamental information, hedgers may on average trade at a loss, and this compensates risk bearers in the market. Hedgers are likely to have a negative long-run price impact of trade, but may have constitute a substantial share of the variance decomposition of the efficient price if their trades contain fundamental information. Liquidity providers operating over a longer trade horizon than 30 days may also have a negative price impact of trade

[8] A negatively signed cumulative impulse response function does not necessarily imply that a group is unprofitable, as a liquidity provider may earn a premium for providing liquidity over a period longer than 30 days.

and their trades may constitute a substantial share of the long-run price impact of trade. We assume that 30 trade days reflects the long-run, but acknowledge that the trade horizons for some investors may be much longer. To that extent, they should appear to influence the efficient price, but their long-run price impact of trade may be negative even though over a longer horizon they may be profitable.

Investors who trade on noise are not expected to be profitable over the long run. Their trades do not contain fundamental information, and do not have a persistent affect on the price, and thus do not influence the efficient price. Such investors' trades may be a large share of the forecast error variance decomposition because their trades may influence the price over the short run. If so, the short-run influence will be reversed out and thus have no persistent influence. This is because the forecast error variance decomposition calculation attributes a greater weight to short-run influences on price, and thus may show a substantial influence on price by noise traders. Noise traders share of the variance decomposition of the efficient price will be close to zero.

5. Empirical Results

We present the following empirical results from the VAR model: the long-run price impact of trade, the forecast error variance decomposition and the variance decomposition of the efficient price.

5.1. Long-Run Price Impact of Trade

The cumulative impulse response function (CIRF) is used to indicate the long-run price impact of trade, following Hasbrouck (1991a). We evaluate the CIRF at 30 days, which we assume is sufficient time for the short-term influence of trade on return to reverse out. The long-run interpretation of the CIRF requires this assumption that temporary influences on price will reverse out within the 30-day period over which the CIRF is calculated. However as discussed in the previous section, the long-run price impact of trade does not isolate the efficient price, nor does it provide a useful means to distinguish between trade- and nontrade-related information.

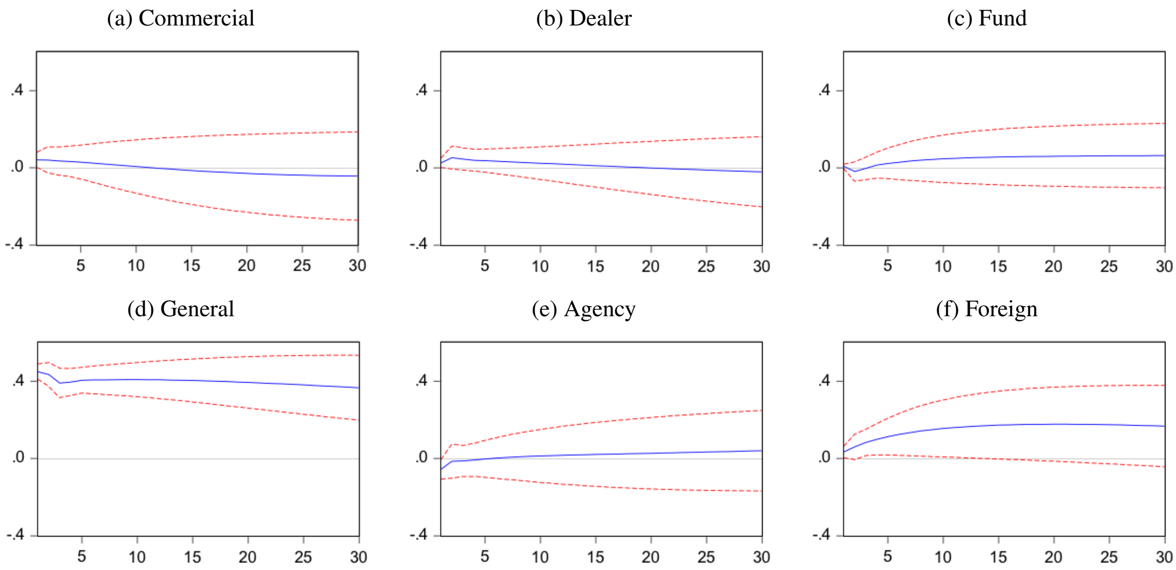
Table 9 summarises the price impact of trade evaluated at 30 days. This represents the cumulative response of return to a positive shock in the trade ratio of each investor group, in each market. A positive sign on the long-run price impact of trade allows for the possibility that the investor group may be informed, as a positive trade ratio shock corresponding with an increase in buys relative to sells is followed by positive returns. A negative sign opens the

Table 9: Long-Run Price Impact of Trade Evaluated at 30 Days

	Gold	Platinum	Gasoline	Rubber
Commercial	-0.04	-0.29	-0.43	-0.79
Dealer	-0.02	-0.15	-0.94	1.09
Fund	0.06	0.20	0.14	1.13
General	0.37	-0.31	0.75	-1.01
Agency	0.04	-0.13	0.26	-0.84
Foreign	0.17	-0.26	0.25	0.55
Return	-0.04	0.29	0.16	2.57

possibility that the investor group is a liquidity provider, since a positive shock to the trade ratio is followed by negative returns. We also include in the table the response of return to a shock in return, to evaluate persistence in returns shocks. Figures 5 to 8 contain plots the CIRF over the same 30-day horizon. The dotted lines represent two standard deviations either side of the CIRF estimate. We omit the return charts given that we are primarily interested in the impact of shocks in the trade ratios on return.

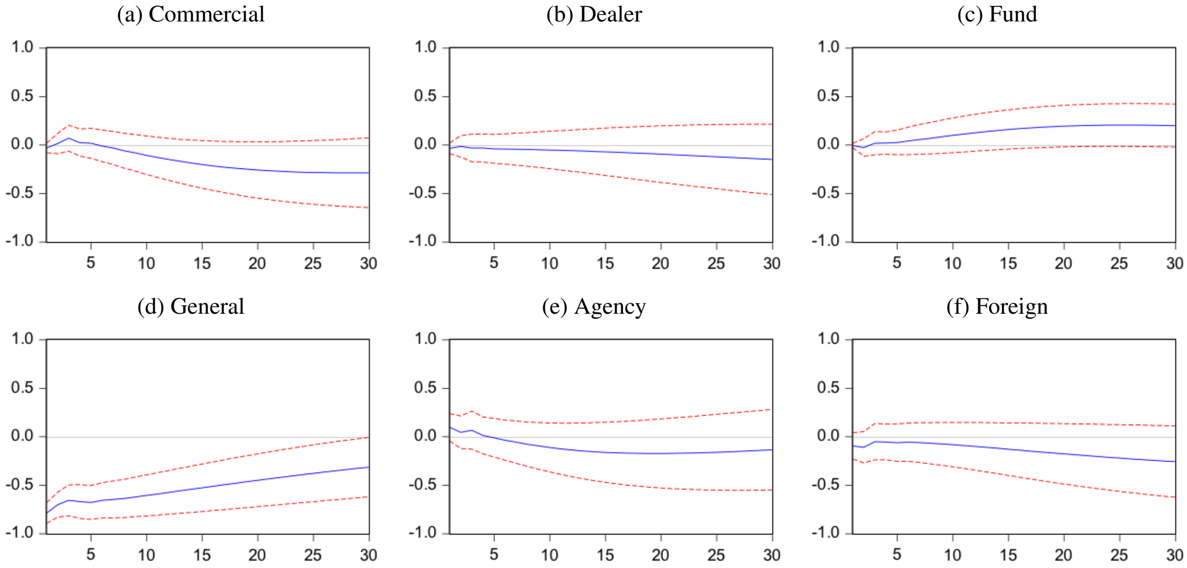
Figure 5: Cumulative Impulse Response Functions of Return for Gold



In the gold market (see Figure 5), General investors have a relatively large positive and significant long-run price impact and thus appear to be informed. The impact of Foreign investors is less than half that of General investors, but it is relatively large when compared with the other groups and is borderline significant. While the CIRFs for commercial and dealer investors are negative, suggesting the groups are are liquidity providers, the values are small and not significant. Shocks to returns do not have a persistent influence on returns.

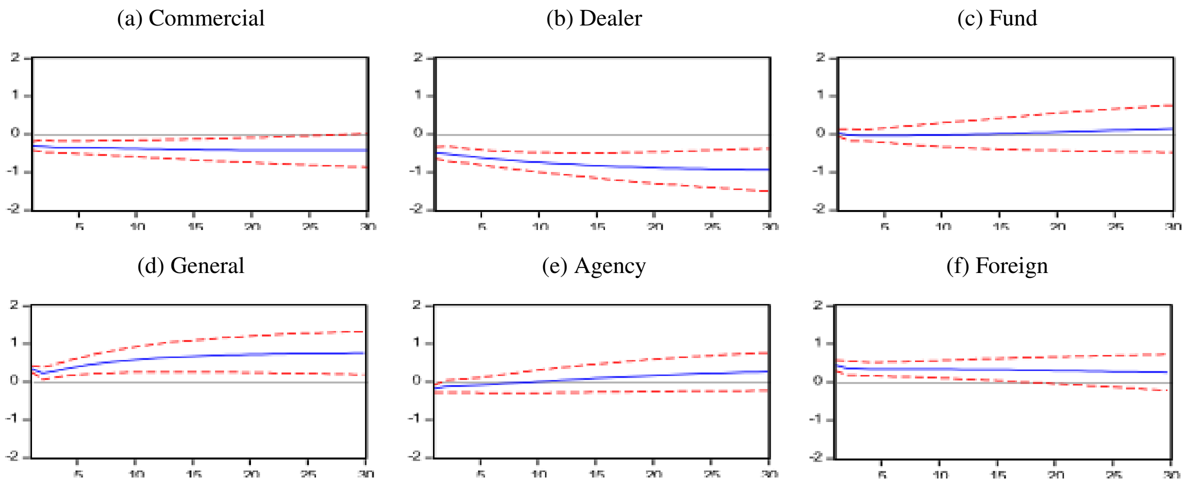
The CIRFs for platinum are shown in Figure 6. Funds appear to be informed, with a positive

Figure 6: Cumulative Impulse Response Functions of Return for Platinum



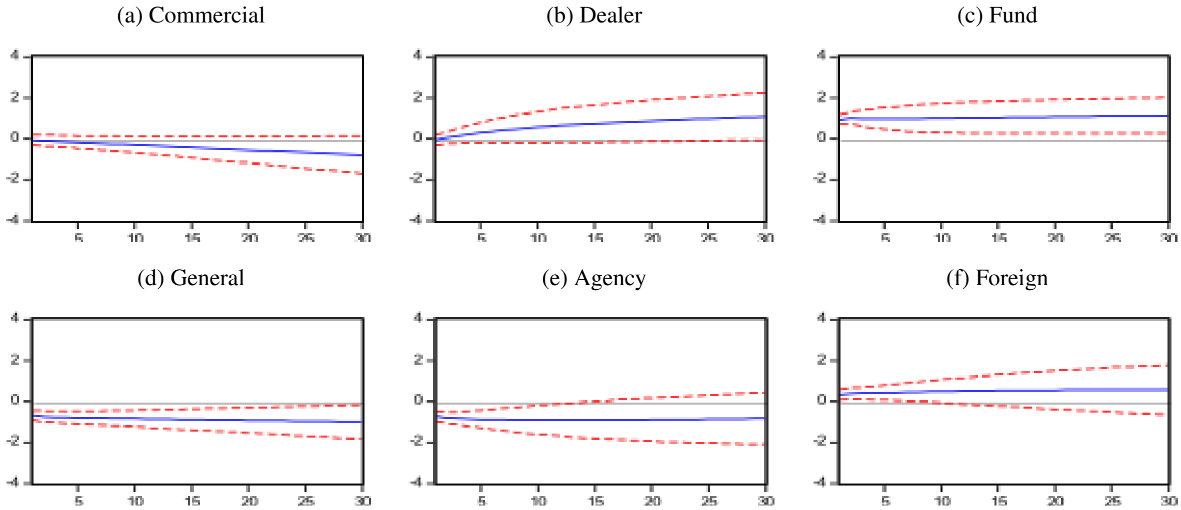
and borderline significant long-run price impact. The remaining groups have negative long-run price impacts, of which only Commercial and General appear significant. The CIRF of General investors declines markedly over the 30 day horizon suggesting that much of the initial price impact is transitory. In contrast, the cumulative impact of Commercials increases over time. The cumulative impact of Foreign investors is of similar magnitude to Commercials, but is not significant. Commercial and General investors appear to be the liquidity providers in platinum. Shocks to platinum returns have a significant and positive persistent impact on returns.

Figure 7: Cumulative Impulse Response Functions of Return for Gasoline



The long-run price impact of trades by the General group in the gasoline market (see Figure 7) is positive and significant, suggesting General investors may be informed. Dealers, and to a lesser extent Commercials, have a negative and significant CIRF suggesting they may be liquidity providers. The Fund, Agency and Foreign long-run price impacts are relatively low and statistically insignificant. Shocks to returns are insignificant, and thus not persistent in this market.

Figure 8: Cumulative Impulse Response Functions of Return for Rubber



The CIRFs for rubber futures shown in Figure 8 suggest that Funds and Dealers are informed, while General investors are liquidity providers. The impacts of trades by Commercial, Agency and Foreign investors are relatively low and are not significant. A shock to returns produces a large and significant CIRF for returns.

As discussed in Section 4, the long-run price impact of return can be interpreted as an indicator of market liquidity. Our results indicate that the gold futures market is most liquid, followed by platinum, gasoline and finally the rubber market is the least liquid. Accordingly, shocks to trade in gold have a relatively low impact on returns, while shocks in rubber trade have a relatively high impact. This ranking of market liquidities is intuitively consistent with the characteristics of the futures markets discussed in Section 3.3. The median number of daily futures contract transactions over all investor groups in gold, platinum, gasoline and rubber are 86,228, 56,508, 9,002, and 21,724, respectively. This CIRF ranking of relative liquidities is broadly in line with the ranking of gold, platinum and gasoline by median daily transactions volumes. However, despite having more than double the daily median volume of gasoline transactions by number of contracts, the rubber market is less liquid in terms of the long-run price impact of trade.

5.2. Forecast Error Variance Decomposition

A VAR forecast error variance decomposition for each commodity calculated over 30 days is provided in Table 10. This corresponds to a decomposition in terms the price of a security, p_t, as shown in equation (4). While the standard decomposition is informative in terms of the importance of unexpected trading by each of the investor groups on returns, it is not ideal for our purpose of determining each group's influence on the efficient price, m_t, in equation (5). Our prior is that the transitory influence of an investor group's unexpected trades on price (mispricing) will reverse out over time. However, the standard variance decomposition places a higher weight on the shorter lag influences of an innovation relative to the longer lag influences. Initial mispricing influences will be more important in the decomposition than subsequent reversals even if mispricing is reversed within the period over which the decomposition is calculated.

Table 10: Forecast Error Variance Decomposition (%, 30 days)

	Gold	Platinum	Gasoline	Rubber
Commercial	0.88	1.91	8.08	1.59
Dealer	0.71	0.32	20.14	2.80
Fund	0.70	0.65	0.43	32.02
General	89.23	86.67	11.42	5.16
Agency	2.21	2.58	3.41	8.07
Foreign	1.42	1.95	15.73	0.83
Return	4.85	5.92	40.79	49.53

Noting the above caveat, our interpretation of the forecast error variance decomposition is as follows. Trade-related information has the most influence over price in the gold and platinum markets, while both trade- and nontrade-related information appear broadly equal in importance for gasoline and rubber prices. The unexpected trades of General investors have the greatest influence over prices in the gold and platinum markets. Dealer, Foreign and General investors are important in Gasoline. Funds have the greatest trade-related influence over the rubber price.

5.3. Variance Decomposition of the Efficient Price

Table 11 provides the variance decomposition of the efficient price, m_t in equation (5), for each commodity market. The efficient price in the gold, platinum and gasoline markets is mainly influenced by trade-related innovations, which can be interpreted as the private information contained in investors' trades. Foreign investors have the greatest influence over the efficient price in the gold market, followed by Commercials. The trades of Dealer, Fund, General and Agency investors are relatively unimportant for the efficient price of gold, at least at the level of aggregation we are working with. Funds, followed by commercials, have the greatest influence over platinum's efficient price. While trade-related information accounts for most of the variation in the efficient price of platinum, almost 20 percent is accounted for by nontrade-related information that we interpret as public information. In the gasoline market, General investors have the most influence over the efficient price, followed distantly by Dealers. Both trade and non-trade related innovations have an equal influence on efficient price of rubber, with trades by Funds having the largest information content in this market, followed by General investors.

Table 11: Variance Decomposition of the Efficient Price (% Share)

	Gold	Platinum	Gasoline	Rubber
Commercial	39.48	27.55	4.86	0.29
Dealer	8.06	0.43	17.79	1.25
Fund	5.80	29.16	4.08	27.70
General	0.41	6.36	57.94	17.50
Agency	0.36	3.13	3.97	5.65
Foreign	45.64	14.90	7.98	0.28
Return	0.24	18.47	3.38	47.34
Share by trades	99.76	81.53	96.62	52.66

6. Discussion

In this section we discuss our results for each commodity and relate the results to the structure and characteristics of markets.

6.1. Gold

We find that Commercials and Foreign trades have a persistent influence on the gold futures price. Both groups have a relatively large influence on the efficient price. With a positive long-run price impact, foreign investors are deemed informed. The CIRF estimate for Commercials is not significant, so we cannot say whether Commercials are informed or liquidity providers. However, looking at the trade ratio for Commercials it is clear that as a group they are mostly net sellers, likely for hedging purposes. Foreign investors are usually net buyers during the sample period and the trade ratios of these two groups are positively correlated at around 0.5. We interpret these results as intuitively consistent with the structure of the gold market, in which there is a single global price for a globally traded homogeneous commodity, where trade is decentralised over numerous markets around the globe, and where Tokyo does not play a significant role in price discovery. Foreign investors may have access to greater information on global macroeconomic and financial conditions, and be able to better forecast demand for gold as a safe haven or hedge against global inflation.

General investor trades account for almost all of the forecast error variance decomposition but almost none of the variance decomposition of the efficient price. This suggests that Generals have a substantial short-term influence on gold prices, but no persistent impact. TOCOM gold is a favoured market for Japanese retail investors, and the lack of a persistent impact of the General group is consistent with the notion that retail investors are not well informed on the fundamental drivers of the gold futures price.

Gold is the most liquid market in our study and is likely relatively informationally efficient. Accordingly, there is little role for nontrade-related (or public) information either as a short-term or persistent influence on price as there is a high degree of competition among informed traders.

6.2. Platinum

Fund, Commercial and Foreign investor trades influence the efficient price of platinum futures. Funds have a positive long-run impact on price and thus are informed, while commercials have a negative long-run impact and so are liquidity providers. The insignificant CIRF estimate for Foreign investors means we are unable to distinguish whether they are informed investors or liquidity providers. Compared with the gold market, the three groups each have a relatively small influence over the efficient price. Private information is more dispersed over investor groups, and public information also has an influence on the efficient price.

The influence of Commercials on the efficient price is consistent with the role of TOCOM is a globally important hedging venue for companies engaged in the international trade and consumption of physical platinum. The platinum futures trade and hedging activities are concentrated in a small number of markets, of which TOCOM is one. Further, given the large automotive industry in Japan, we expect that commercials and other domestic investors have private information on the demand and supply of platinum. Hedging activities by commercials give rise to profit opportunities for other investor groups willing to take on risk. As a globally homogeneous commodity, foreign investors may possess private information gleaned from other locations and influence the efficient price. Platinum futures trade is concentrated within a small number of exchanges. See Iwatsubo et al. (2018) for explanation of the linkages between the Tokyo and New York markets. While funds are predominantly small buyers of platinum futures, Commercials are always net sellers and Foreign have sustained periods of both net buying and net selling. Trades of the three groups have a relatively evenly shared influence on the efficient price. Given the groups' relative positioning, the result is reasonable despite the low variation in the Fund trade ratio. Similar to our results for the gold market, General investors have a large short-term influence on price but little persistent impact. In platinum, General investors are liquidity providers.

Platinum is the second most liquid market in our study after gold. In this market, nontrade-related information has a small influence on the efficient price, suggesting that public information shocks have some influence on the efficient price.

6.3. Gasoline

The variance decomposition of the efficient price indicates that General and Dealer investor trades have a persistent influence on the price of gasoline. General investors have a relatively substantial influence on the efficient price, and with a significant and positive 30-day CIRF, they are informed investors. Of the four markets analysed, General investors in gasoline have the largest share of the variance decomposition of the efficient price in any market. Dealers are liquidity providers and have a smaller influence on the efficient price than General investors.

The influence of General investors on the efficient price is consistent with the importance of domestic Japanese information in the gasoline market. As discussed in Section 3.1, the gasoline futures price is related to both international crude oil prices and domestic gasoline supply and demand information. Gasoline is, to a large extent, a domestic consumer good. Domestic investors may have an informational advantage by being located close the sources of information about domestic gasoline demand and supply, inventory levels, refinery conditions and outages, and imports and exports of gasoline. Information on domestic gasoline demand, supply and inventories is readily available.

In addition to Dealer and General Investors, the forecast error variance decomposition suggests Foreign investor trades have an influence on price. However, the variance decomposition of the efficient price shows the influence is reversed out within 30-days and Foreign investors do not influence the efficient price of gasoline futures. Similarly, Commercials have also have more influence in the short-term thanon the efficient price.

The gasoline futures market is less liquid than the markets for gold and platinum. Nontrade-related (public) information influences price in the short-term as indicated by the share of the forecast error variance decomposition attributed to return. However, the efficient price is not influenced by public information. In the short-term it appears there may be less competition amongst traders, but in the longer term the market appears efficient.

6.4. Rubber

Funds have the largest trade-related influence on the efficient price of rubber futures, followed by General investors. However, the information share of each group is relatively small. Funds have a significant and positive CIRF and thus are informed investors, while General are liquidity providers. Funds are relatively minor participants in the rubber market when compared with the other investor groups by the number of contracts traded, but Funds' trade ratio is relatively volatile suggesting that, as a group, their investment strategies are conducted over a short horizon. General investors as a group appear to contrarian to a degree, betting against the peak in the rubber price in early 2017. It would appear that Funds may have benefited from the trades of general investors.

The large influence of nontrade-related information on price distinguishes the rubber market from the others we analyse. Public information accounts for around 50 percent of both the forecast error variance decomposition and the variance decomposition of the efficient price. Public information has a greater influence on the efficient price than the two most influential investor groups combined. We rationalise this as follows. The long-run price impact of trade suggests that the rubber market is the least liquid of the four markets analysed. The 30-day CIRFs for rubber are by far the greatest of the four commodities. During our sample, the standard deviation of rubber returns is relatively high. Reports in the financial press suggest that rubber market liquidity has declined substantially and that prices are at times detached from the underlying physical rubber market fundamentals (for example, see Tan (2015); Craymer (2016)), suggesting the market may be inefficient. The large influence of public information on the efficient price is consistent with a low degree of competition among informed investors. Surprising news has a substantial impact on the efficient price because the market is inefficient.

Further, characteristics of the rubber market and its interconnectedness may mean that it is more difficult for investors to acquire private information that is useful for predicting future prices. The market is segregated over two main grades of rubber, RSS-3 and TSR-20, and three main exchanges in Tokyo, Singapore and Shanghai. Additional grades of rubber are used for trade in markets in other locations. Information on rubber demand, supply and inventories is relatively opaque and costly to obtain. The financial press suggests large consumers and producers of rubber are using TOCOM less for hedging (see Craymer (2016)).

7. Conclusion

We present evidence on asymmetric information content of the trades of six investor groups transacting in the gold, platinum, gasoline and rubber futures markets on TOCOM. Our results differ from the previous literature primarily by estimating the influence of investor groups' trades on the efficient price. We find that the efficient price in the gold, platinum and gasoline markets is mainly influenced by trade-related innovations, which we interpret as private information. In the platinum market, nontrade-related, or public, information has a non-negligible influence on the efficient price. Foreign investors have the greatest influence over the efficient price in the gold market, followed by Commercials. In the platinum market, the trades of both Funds and Commercials influence the efficient price. General investors, and to a lesser extent Dealers, influence the efficient price in the gasoline market. Both trade and non-trade related innovations have an equal influence on the efficient price of rubber, with trades by Funds having the largest information content in this market, followed by General investors. Given the implications of microstructure theory, our results suggest these investor groups in their respective markets are profitable traders over the long run. We relate differences in the relative influence of investor groups to differences in market interconnectedness, the nature of the commodity and associated fundamental information.

References

Chang, C.-L., Khamkaew, T., Mcaleer, M., and Tansuchat, R. (2011). Modelling conditional correlations in the volatility of Asian rubber spot and futures returns. *Mathematics and Computers in Simulation*, 81:1482–1490.

Chng, M. T. (2009). Economic linkages across commodity futures: Hedging and trading implications. *Journal of Banking & Finance*, 33(5):958–970.

Chng, M. T. and Foster, G. M. (2012). The Implied Convenience Yield of Precious Metals: Safe Haven versus Industrial Usage. *Review of Futures Markets*, 20(4):349–94.

Choe, H., Kho, B.-C., and Stulz, R. M. (1999). Do foreign investors destabilize stock markets? The Korean experience in 1997. *Journal of Financial Economics*, 54:227–264.

Choe, H., Kho, B. C., and Stulz, R. M. (2005). Do domestic investors have an edge? The trading experience of foreign investors in Korea. *Review of Financial Studies*, 18(3):795–829.

Coval, J. and Moskowitz, T. J. (1999). Home Bias at Home: Local Equity Preference in Domestic Portfolios. *Journal of Finance*, 54(6):2045–2073.

Coval, J. D. and Moskowitz, T. J. (2001). The Geography of Investment: Informed Trading and Asset Prices. *Journal of Political Economy*, 109(4):811–841.

Craymer, L. (2016). World's Leading Rubber Market Isn't Fulfilling Some Basic Functions. The Wall Street Journal, 1 November 2016.

de Roon, F. A., Nijman, T. E., and Veld, C. (2000). Hedging Pressure Effects in Futures Markets. *Journal of Finance*, 55(3):1437–1456.

Dewally, M., Ederington, L. H., and Fernando, C. S. (2013). Determinants of Trader Profits in Commodity Futures Markets. *Review of Financial Studies*, 26(10):2648–2683.

Dvorak, T. (2005). Do Domestic Investors Have an Information Advantage ? Evidence from Indonesia. *The Journal of Finance*, 60(2):817–839.

Eller, R. and Sagerer, C. (2011). An Overview of Commodity Sectors. In *The Handbook of Commodity Investing*, pages 679–711. John Wiley & Sons, Inc., Hoboken, NJ, USA.

Fishe, R. P. and Smith, A. D. (2012). Identifying informed traders in futures markets. *Journal of Financial Markets*, 15(3):329–359.

Grinblatt, M. and Keloharju, M. (2000). The investment behavior and performance of various investor types: a study of Finland' s unique data set. *Journal of Financial Economics*, 55(1):43–67.

Grinblatt, M. and Keloharju, M. (2001). How Distance, Language, and Culture Influence Stockholdings and Trades. *The Journal of Finance*, 56(3):1053–1073.

Hasbrouck, J. (1991a). Measuring the Information Content of Stock Trades. *The Journal of*

Finance, 46(1):179–207.

Hasbrouck, J. (1991b). The Summary Informativeness of Stock Trades: An Econometric Analysis. *The Review of Financial Studies*, 4(3):571–595.

Hauptfleisch, M., Putnins, T. J., and Lucey, B. (2016). Who Sets the Price of Gold? London or New York. *Journal of Futures Markets*, 36(6):564–586.

IHS Markit (2017). Natural Rubber Chemical Economics Handbook.

International Rubber Study Group (2018a). Natural Rubber. http://www.rubberstudy.com/natural.aspx.

International Rubber Study Group (2018b). Story of Rubber. http://www.rubberstudy.com/storyofrubber.aspx.

Iwatsubo, K., Watkins, C., and Xu, T. (2018). Intraday seasonality in efficiency, liquidity, volatility and volume: Platinum and gold futures in Tokyo and New York. *Journal of Commodity Markets*, 11(February):59–71.

Kamesaka, A., Nofsinger, J. R., and Kawakita, H. (2003). Investment patterns and performance of investor groups in Japan. *Pacific-Basin Finance Journal*, 11:1–22.

Kang, J.-K. and Stulz, R. M. (1997). Why is there a home bias? An analysis of foreign portfolio equity ownership in Japan. *Journal of Financial Economics*, 46(1):3–28.

Karolyi, G. A. (2002). Did the Asian financial crisis scare foreign investors out of Japan? *Pacific-Basin Finance Journal*, 10:411–442.

Karolyi, G. A. and Stulz, R. M. (2003). Are financial assets priced locally or globally? In Constantinides, G. M., Harris, M., and Stulz, R. M., editors, *Handbook of the Economics of Finance*, volume 1, chapter 16, pages 975–1020. Elsevier B.V.

Lakonishok, J., Shleifer, A., and Vishny, R. W. (1992). The impact of institutional trading on stock prices. *Journal of Financial Economics*, 31:23–43.

Lucey, B. M., Larkin, C., and O'Connor, F. (2014). Gold markets around the world - who spills over what, to whom, when? *Applied Economics Letters*, 21(13):887–892.

McDonald, D. and Hunt, L. B. (1982). *A history of platinum and its allied metals*. Johnson Matthey.

Meng, L. and Liang, Y. (2013). Modeling the volatility of futures return in rubber and oil - A Copula-based GARCH model approach. *Economic Modelling*, 35:576–581.

O'Connor, F. A., Lucey, B. M., Batten, J. A., and Baur, D. G. (2015). The financial economics of gold — A survey. *International Review of Financial Analysis*, 41:186–205.

Richards, A. (2005). Big Fish in Small Ponds: The Trading Behavior and Price Impact of Foreign Investors in Asian Emerging Equity Markets. *The Journal of Financial and Quantitative Analysis*, 40(1):1–27.

Seasholes, M. S. (2000). Smart foreign traders in emerging markets.

Tan, H. (2015). Rubber Trading Shifts From Tokyo. The Wall Street Journal, 14 April 2015.

Yang, C.-W. (2017). Do Foreign Investors Destabilize Stock Markets? A Reexamination of Korea in 2008. *Asia-Pacific Journal of Financial Studies*, 46(5):734–759.

Appendix A. Contemporaneous Effects

Tables A.12 to A.15 contain the contemporaneous coefficients, the b_g and c_g for $g = 1, \ldots, 6$, from the VAR model of equation (4) for each commodity. The return relationship, labelled Eq.7, refers to the last row of the model where return is a function of the trade ratios of each investor group, and the estimates correspond to the c_g coefficients. Our prior is that the investor group trades generally have both a contemporaneous and lagged influence on return. All trade ratio contemporaneous coefficients are significant in the model for copper, the coefficients for all groups except fund are significant in platinum and gasoline, while the coefficients on fund, general and agency are significant in the rubber market. In each market, there are both positive and negative relationships between contemporaneous return and the trade ratios. A priori, return may or may not have a contemporaneous relationship with each trade ratio in the relationships denoted EQ.1 to Eq.6 for each market. We find significant estimates for the contemporaneous return coefficient, b_g, for each investor group in the gold market, for all except General in platinum, for Dealer, General and Agency in gasoline, and for none of the investor groups in the rubber market.

Table A.12: Contemporaneous Coefficients for Gold

	Dependent variable	Explanatory variable	Coeff.		Standard Error	P-value
Eq.1	Commercial	Return	0.035	***	0.006	0.000
Eq.2	Dealer	Return	0.036	***	0.004	0.000
Eq.3	Fund	Return	-0.008	*	0.004	0.090
Eq.4	General	Return	-0.290	**	0.115	0.012
Eq.5	Agency	Return	-0.066	***	0.004	0.000
Eq.6	Foreign	Return	0.199	***	0.016	0.000
Eq.7	Return	Commercial	14.682	***	1.330	0.000
		Dealer	11.605	***	1.595	0.000
		Fund	3.326	***	1.432	0.020
		General	64.024	***	2.567	0.000
		Agency	-35.243	***	2.324	0.000
		Foreign	4.390	***	0.469	0.000

Table A.13: Contemporaneous Coefficients for Platinum

	Dependent variable	Explanatory variable	Coeff.		Standard Error	P-value
Eq.1	Commercial	Return	0.007	***	0.001	0.000
Eq.2	Dealer	Return	0.024	***	0.003	0.000
Eq.3	Fund	Return	0.002	*	0.001	0.076
Eq.4	General	Return	0.049		0.051	0.334
Eq.5	Agency	Return	-0.018	***	0.003	0.000
Eq.6	Foreign	Return	0.077	***	0.012	0.000
Eq.7	Return	Commercial	-10.750	***	3.763	0.004
		Dealer	-4.216	***	1.321	0.001
		Fund	-1.668		3.639	0.647
		General	-67.258	***	3.997	0.000
		Agency	23.450	***	2.958	0.000
		Foreign	-5.247	***	0.675	0.000

Table A.14: Contemporaneous Coefficients for Gasoline

	Dependent variable	Explanatory variable	Coeff.		Standard Error	P-value
Eq.1	Commercial	Return	-0.002		0.001	0.244
Eq.2	Dealer	Return	-0.007	*	0.004	0.082
Eq.3	Fund	Return	0.001		0.008	0.880
Eq.4	General	Return	-0.019	***	0.002	0.000
Eq.5	Agency	Return	-0.013	***	0.002	0.000
Eq.6	Foreign	Return	-0.001		0.005	0.859
Eq.7	Return	Commercial	23.989	***	4.088	0.000
		Dealer	16.751	***	2.156	0.000
		Fund	0.334		0.543	0.539
		General	18.396	***	2.410	0.000
		Agency	-7.791	***	1.907	0.000
		Foreign	10.713	***	1.435	0.000

Table A.15: Contemporaneous Coefficients for Rubber

	Dependent variable	Explanatory variable	Coeff.		Standard Error	P-value
Eq.1	Commercial	Return	0.000		0.002	0.835
Eq.2	Dealer	Return	0.000		0.001	0.909
Eq.3	Fund	Return	0.004		0.040	0.912
Eq.4	General	Return	-0.002		0.002	0.292
Eq.5	Agency	Return	-0.003		0.004	0.422
Eq.6	Foreign	Return	0.003		0.002	0.107
Eq.7	Return	Commercial	-3.732		2.305	0.106
		Dealer	-1.383		3.225	0.668
		Fund	3.260	***	0.731	0.000
		General	-11.326	***	3.100	0.000
		Agency	-8.696	***	2.167	0.000
		Foreign	-3.075		1.940	0.113