PRICE DISCOVERY AND FOREIGN PARTICIPATION IN THE REPUBLIC OF KOREA'S GOVERNMENT BOND CASH AND FUTURES MARKETS

Cyn-Young Park; Rogelio Mercado, Jr.; Jaehun Choi; and Hosung Lim

NO. 427

March 2015

ADB ECONOMICS WORKING PAPER SERIES

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No. 427 | 2015

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The authors are deeply indebted to Sungjin Park, Choong Won Park, and Eun Yeong Song for valuable research inputs and discussions during the course of the study. The authors also wish to thank the seminar participants at the Bank of Korea for the midterm review of this study in November 2014.

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ISSN 2313-6537 (Print), 2313-6545 (e-ISSN)
Publication Stock No. WPS157139-2

Note: In this publication, "$" refers to US dollars.

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CONTENTS

TABLES AND FIGURES

TABLES

FIGURES

ABSTRACT

This paper examines the impact of foreign participation in Korean Treasury Bond (KTB) futures and its role in price discovery for KTBs, using daily transactions data from the over-the-counter market for KTBs and from the Korea Exchange for the futures. Our analysis suggests that foreign trading in the KTB futures market leads the price discovery process for the underlying bonds. Empirical results show that foreigners' daily net long positions in the futures market exert significant influence in KTB and KTB futures prices. We also find that it is the unexpected component of foreign investors' net long futures positions that explains a significant share of the pricing effects, suggesting that how foreign trading responds to news carries additional information content.

Keywords: price discovery, emerging market bonds, foreign participation

JEL Classification: G10, G13, G14

I. INTRODUCTION

The fast growth of local currency bond markets, combined with the wave of financial globalization, boosted foreign participation in many emerging Asian markets. Local currency bonds outstanding for nine emerging Asian markets reached $8.0 trillion in September 2014 from about $0.8 trillion in December 2000, up nearly tenfold. Data from *Asian Bonds Online* show a clear upward trend in foreign participation across emerging Asian local currency government bond markets since the mid-2000s.[1] Growth accelerated even more following a dip in late 2008 associated with the global financial crisis, as emerging Asia's economic resilience, in contrast to the financial turmoil in the United States (US) and the eurozone economies, made their local currency government bonds relatively more attractive to global investors.

The Republic of Korea has the second largest local currency bond market in emerging Asia,[2] with total bonds outstanding at $1.8 trillion. Starting with the announcement of the Government Bond Market Stimulus Plan in August 1998, a number of policy reforms have been undertaken, including the introduction of the primary dealer system, interdealer market, and government bond futures in 1999. The Korea Exchange introduced the cash-settled, 3-year Korean Treasury Bond (KTB) futures contract on 29 September 1999.

Foreign holdings of Korean government bonds are now nearly 15%, up from less than 1% in the mid-2000s. Foreign interest in KTB futures has also been strong, effectively accelerating the growth of the KTB market. Foreigners find it easier to trade futures than cash bonds due to taxation, leverage, and liquidity issues.

Foreign investors have played an important role in the Korean bond markets. Their active participation has helped boost market liquidity, depth, and sophistication. There are also concerns, however, about its potentially destabilizing effects during financial turmoil. As foreign participation grows, the local bond markets seem to respond more sensitively to global financial conditions as herding behavior among global funds takes hold (on top of domestic macroeconomic conditions). Similarly, while the introduction of financial futures facilitates price discovery of the underlying financial assets, some market observers note that greater foreign investor participation in the futures market might raise market volatility with relatively large, one-way transaction volumes compared to those of domestic investors. For instance, some note that just several foreign investors can take substantially large positions in the futures market, moving prices and subsequently affecting cash prices. Domestic players also closely monitor foreign traders, who are often viewed as better informed and more sophisticated, which in turn influences domestic trading behavior.

The Korean case merits some discussion in this regard. Following the Asian financial crisis, Korean policy makers actively sought the development of domestic bond markets as an alternative source of funding to bank lending. Since then, the market has seen tremendous growth, in no small part, due to the establishment of KTB futures and the proactive promotion of foreign participation, as many observers note.

But do foreign investors help trigger excessive futures price movements and transmit this instability to the cash market? This concern reflects a lack of understanding about the trading

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[1] Data available at http://asianbondsonline.adb.org/regional/data/bondmarket.php?code=Foreign_Holdings

[2] Emerging Asia in this paper refers to the nine economies in East and Southeast Asia covering the People's Republic of China; Hong Kong, China; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; Thailand; and Viet Nam.

behaviors of foreign investors and their role in financial asset pricing in comparison to those of domestic investors. Price discovery inevitably involves increased market volatility. But if this higher market volatility really only reflects the increase in information as more heterogeneous groups of investors enter the market, with its diverse sources of information, it may not be a concern in itself. Therefore, the real question should be what type of foreign investors does the futures market attract? Are they different from the type of foreign investors participating in the cash market? And does their trading behavior show more inclination toward herding and speculation, leading to excessive market volatility? Better understanding of foreign investors' trading behaviors in futures markets and their role in market efficiency and volatility is critical for assessing the risk of financial liberalization and for designing a macroprudential policy framework appropriate during rapid financial market development.

To our knowledge, no study looks at the impact on price discovery of sovereign bonds of foreign participation in the futures market. This is especially true for emerging market economies, given a lack of quality trading data. Research in this unexplored area could have a profound impact on financial market development, as the findings could guide policy makers in crafting regulatory guidelines that win the benefits of foreign participation in developing futures markets while avoiding the potentially adverse consequences. This paper investigates the price impact of foreign participation in local currency bond futures from the emerging market perspective.

The paper also introduces some important new elements. First, similar to Brandt, Kavajecz, and Underwood (2007),[3] we examine the trading patterns of different investor groups, specifically looking into the impact of the net transactions of foreign and domestic finance institutions (DFI) on KTB futures and cash prices. We also examine in which market price discovery takes place. Second, following Richards (2005), we decompose net buys and net long positions into *expected* and *unexpected* components to examine how the price discovery happens, but add the analysis of the different types of investor groups to assess whether the type of investor matters in price discovery and, if so, by how much. And third, we look at the discovery process by investor groups at three subperiods—precrisis, crisis, and postcrisis—in our sample for any marked changes in the trading behaviors of different investor groups that have influenced price discovery across the subperiods.

Specifically, the paper aims to answer the following three questions:

(i) Which market (cash or futures) leads price discovery in Korean treasury bonds?
(ii) What types of investor groups drive this process?
(iii) Which component (*expected* or *unexpected*) of net purchases and net long positions influences price movements in both markets?

In summary, our findings confirm that price discovery takes place in the futures market, in that our model fit substantially increased when we took the interaction between net transactions in both cash and futures markets into account. This is as opposed to considering the cash market only. We also find that foreigners' net long positions in the futures market are highly associated with futures and cash returns, suggesting that they drive price discovery. Finally, the *unexpected* component of foreigners' net long positions (their private information or idiosyncratic response to news) seems to exert significant influence on prices, although slightly less than their *expected* component; while it is the *expected* component that matters overwhelmingly more for the price impact of DFIs' cash trading.

[3] Brandt, Kavajecz, and Underwood (2007) examine four different investor groups based on whom Chicago Board of Trade (CBOT) members trade for in their accounts.

The paper is structured as follows. Section II reviews the related literature. Section III describes our dataset, provides descriptive statistics showing net buys and net long positions in the cash and futures markets by investor group, and discusses how we decompose *expected* and *unexpected* components of net transactions. Section IV presents the empirical model and discusses the results, and section V summarizes findings and offers policy implications.

II. LITERATURE REVIEW

The financial literature on the impact of foreign participation in domestic bond markets is substantial, and suggests that growing foreign participation could influence domestic asset pricing and market liquidity, with potential costs and benefits. Burger, Warnock, and Warnock (2012), International Monetary Fund (2005), Peiris (2010), and Roldos (2004) discuss some of these advantages and disadvantages. Burger, Warnock, and Warnock (2012), for example, claim that foreign participation could support domestic bond market development, as it has the potential to reduce currency mismatches and serve as alternative funding when domestic investors divest. Focusing on emerging markets, Peiris (2010) finds that foreign participation in the domestic government bond market can substantially reduce long-term sovereign bond yields and may even dampen the volatility of bond yields, contrary to a common misconception that foreign participation disturbs the local market. These authors argue that foreign investors can help lower bond yields, increase liquidity in government bond markets, and minimize financial market volatility if supported by institutional and regulatory frameworks.[4] However, they also note that foreign participation could lead to greater interest rate volatility, and induce adverse spillover into other financial markets.

Little has been explored in the role of foreign investors in the government bond price discovery process through their participation in futures trading for emerging economies. But significant evidence points to the interaction of cash and futures markets for treasury bond price discovery in advanced economies. Some empirical work also suggests the importance of investor type for their trading patterns and role in price discovery. To the extent that foreign investors' information sets are different than those of domestic investors, foreign participation in emerging financial markets is likely to impact price discovery through various channels of information transmission. It is this gap in the empirical literature we aim to fill using the KTB market as a case study.

A significant body of literature illuminates the role of futures markets in the price discovery of assets in the underlying market. In theory, with perfect information, investors must be indifferent to choices between cash and futures markets because new market information is priced in both markets simultaneously. Therefore, the no-arbitrage condition should remove a substantial deviation of futures prices from the prices of the underlying bonds when appropriate risks and transaction costs are taken into account for pricing. However, empirical evidence often points to substantial price gaps between cash and futures markets, with futures generally leading cash markets, suggesting market inefficiency due to high transaction costs and information barriers between cash and futures markets.

[4] Apart from the direct impact of foreign participation on asset prices and market liquidity, some studies also suggest indirect benefits of foreign participation on market discipline and institutional development in local currency bond markets. Burger and Warnock (2007) note that US investors avoid emerging market local currency bonds that have highly volatile and negatively skewed returns, and suggest foreign participation may reinforce market discipline on overall macroeconomic management by showing that emerging markets that reduce macroeconomic instability attract greater foreign participation.

Two aspects of this disconnect between theory and empirics have been studied. The first traces the impact of futures over cash markets or the convergence between futures and cash prices; the second looks at what causes price discovery in the futures market. On the first point, Witherspoon (1993) developed a theoretical model showing that if price discovery in the futures market exceeds a specified critical threshold of dominance over the cash market, the implications for the cash market can be detrimental due to increased autocorrelation, volatility, illiquidity, and even instability in the cash market. Huang and Zhang (1995) use cointegration and error correction models to assess price discovery between cash and futures municipal bonds in the US, and find that a two-way feedback relationship exists between the two markets, although the feedback from futures to cash markets is the stronger of the two, suggesting price discovery takes place in the futures markets. Campbell and Hendry (2007) use the information-share approach to estimate the contribution of trading in the cash and futures markets to the price discovery in Canadian and US government bonds. They also find that price discovery takes place in the futures market, using data from the Montreal Exchange and the over-the-counter cash market data for Canadian government bonds. These studies on price discovery in advanced countries' sovereign debt markets generally confirm the stylized fact that futures markets lead the cash market in price discovery.

On the second aspect, Kim, Szakmary, and Schwarz (1999) surveyed various explanations of why futures markets lead and they suggest lower trading costs as one of the major reasons. The trading cost hypothesis proposed by Fleming, Ostdiek, and Whaley (1996) also suggests that the market with lower overall trading cost will react more instantaneously to new market information, apart from other factors such as differences in market structures, liquidity conditions, short-sale constraints, and regulatory and technical constraints.

In fact, it is widely recognized that exchange-traded futures contracts usually have lower transaction costs relative to their underlying instruments, thanks to the existence of a clearing house for them and minimal margin requirements. Futures contracts are standardized, enabling trades based only on the number of contracts and their prices. Such standardized contracts, and the clearing house, facilitates price discovery and contributes to relatively low transaction costs.

That said, relatively low transaction costs in futures markets may give rise to other issues. Some argue that lower transaction costs and margin requirements allow highly leveraged positions and attract speculators who may destabilize the underlying market. Conversely, others argue that futures markets enable speedy price adjustment to new information and attract more informed investors, leading to tighter pricing between futures and cash markets, and helping improve liquidity and reduce volatility in the underlying market.

So far, empirical work on price discovery between cash and futures markets has concentrated on equity markets. Theissen (2012), analyzing DAX cash and futures equity prices, finds that the futures market dominates price discovery; that is, returns in the cash market depend heavily on lagged returns in the futures market, but not vice versa. One important finding of Theissen (2012) is the presence of arbitrage opportunities that drive price discovery in the futures market, and which are in turn due to lower transaction costs. Richards (2005) adds another layer of analysis by considering the role played by various investor groups in the price discovery between cash and futures equity markets. Specifically, he looks into the impact of foreign participation in both for several Asian economies and finds that foreign investors wishing to change their exposure do so by taking short-term positions in futures markets and then unwinding their futures positions in the subsequent period as they carry out desired changes in their long-term positions in the cash market. His findings corroborate those in Theissen (2012) showing that futures trading impacts cash prices. Zhong, Darrat, and Otero (2004)

also find that the futures market serves an important price discovery function, but they also note that the introduction of futures trading has enhanced volatility in underlying cash markets.

Some note the impact of information or news on bond prices and try to explain the role of trading in price discovery and information/volatility transmission. On the impact of news, Jiang, Lo, and Verdelhan (2011) found that while price jumps in US Treasury bonds often occur at prescheduled macroeconomic announcements, news surprises have limited power in explaining bond price jumps. Similarly, Hautsch and Hess (2007) find that the price impact of more precise news (whether good or bad) is stronger than imprecise news. Balduzzi, Elton, and Green (2001) observe that news can explain a substantial portion of price volatility.[5]

On the information content of trading for price discovery, given the information asymmetry in financial markets, order flows from different investor groups may reveal additional private information. As such, the market microstructure literature looked at how private information by informed traders can be incorporated into asset prices through order flows. Only a few of these studies, however, explored the price discovery in fixed-income markets due to the lack of quality data, and more so, for emerging market economies. Brandt, Kavajecz, and Underwood (2007) look into price discovery in the US Treasury futures markets. They find that although net order flows in both US Treasury cash and futures markets significantly influence prices, types of traders (and their trading purposes) seem to matter for pricing effects in both magnitude and direction. Price discovery also seems to take place more in the futures market as transactions costs in the cash market can be prohibitive. But under illiquid market conditions, price discovery can also take place in the cash market as asymmetric information could be high. Girardi and Impenna (2013) investigate the role of order flows in price discovery for Italian government bonds, using data from two different trading platforms, B2B interdealer and B2C dealer-to-customer markets. They find that the informational role of trading is considerable, with order flow a key variable in price formation, although B2C appears to contribute more than B2B. They note that the explanatory role of order flow is stronger when liquidity conditions are poorer.

This paper builds on Richards (2005) and Brandt, Kavajecz, and Underwood (2007) to investigate the role of foreign investors' trading in price discovery using transaction data for KTB and KTB futures markets.

III. DATASET, DESCRIPTIVE STATISTICS, AND DECOMPOSITION OF NET PURCHASES AND POSITIONS

A. Dataset

We use high quality data on daily net transactions by different investor groups of 3- and 10-year KTBs and their futures. Secondary KTB trading data is collected from the over-the-counter market, while transaction data for KTB futures is from the Korea Exchange. The dataset provides the net buys and net long positions by investor type of 3- and 10-year KTBs and their futures. First, our analysis focuses on two types of investors—foreign and DFIs. To examine the trading behaviors of different investor types, we disaggregate the types of DFIs into banks, asset management companies, and insurance and

[5] On an earlier study, Simpson and Ireland (1985) also noted that futures trading leads to lower volatility in bond yields initially, but the effect disappears as futures trading volume increases. However, they do not differentiate between investor groups.

pension funds for the cash market; and banks, asset management companies, securities companies, and insurance and pension funds for the futures market.

The data include a breakdown of net transactions by foreigners and DFIs in daily KTB and KTB futures transactions. Data on foreign net KTB purchases and net positions in futures capture the trading activity of all registered foreign investors. Foreign investors in the KTB markets are registered with the local exchange or regulator, and brokers must report the nationality of the buyer and seller for each transaction. For KTB transactions, the DFI data are computed using the over-the-counter transactions from domestic banks, asset management companies, and funds; all of which represent the major players in the KTB secondary cash market. Unlike KTB futures traded on the Korea Exchange based on an automated electronic trading system, KTB secondary cash trading data are collected from the over-the-counter market and are based on reports from interdealer brokers. We exclude the domestic securities companies from the DFIs for cash trading data, as it is difficult to estimate the correct net purchase data for them. Domestic securities companies trade bonds for motivations beyond simple transactions (for example, pre-negotiated trading, brokerage, and propriety trading) and as such, they can sell KTBs over the counter while buying them from other sources. We also excluded the transaction data for individual investors, as their participation in secondary cash trading is also quite limited. Because data on futures trading are taken from the Korea Exchange, the net positions of all investor types are of reliable quality.

The dataset runs from 1 January 2001 to 31 December 2013. However, we limit our period coverage to 1 January 2004 to 31 December 2013, as the time series of many variables are complete only after 2004, with more active foreign participation in KTB futures. For 3-year cash and futures market, our dataset runs from 1 January 2004 to 31 December 2013. But for 10-year cash and futures, our data starts on 25 October 2010, even though the data for 10-year cash is available from 1 January 2004. We use the clean price index[6] to compute returns in the cash market, and the closing price index for futures returns. Non-trading holidays are removed from the data series, while we keep inactive trading days for both markets. For subperiod analysis, we define 1 January 2004 to 15 September 2008 as the precrisis period, following the collapse of Lehman Brothers on 15 September 2008. For crisis periods, we chose 16 September 2008 to 31 December 2009,[7] and for the postcrisis period, it's 1 January 2010 to 31 December 2013.

Net long positions of different investor groups in the futures markets are expressed as the number of contracts, where each contract has a value of Korean won (KRW) 100,000,000, as are the net buys of different investor groups in the cash market. Because our dataset is on a daily basis and in contract value, we normalize the daily contract value by the total trading volume for each security. Both 3- and 10-year futures have the same settlement method and cycles.[8] For data accuracy, we exclude trading days corresponding to the settlement dates of government bonds (removing returns on both trading and the following days), as the returns on those dates might deviate from normal returns. The final settlement is on a cash basis. At maturity, Korea Exchange settles the difference between the final settlement price and the price of the futures contract.

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[6] This is calculated by excluding any interest that has accrued since issuance or the most recent coupon payment (Source: Korea Investors Service).

[7] We chose 31 December 2009 as the end of the crisis period as the Korean economy recovered from the global economic slowdown in 2010.

[8] Settlement dates are in March, June, September, and December of each year.

For the cash markets, 3-year KTB refers to treasury bonds with maturities exceeding 2 years up to 3 years, and 10-year KTB with maturities exceeding 5 years up to 10 years. The 3-year KTB futures are more actively traded than the 10-year KTBs. The underlying asset for the 3-year futures is the 3-year treasury bond, with a face value of KRW100 million and a 5% coupon rate, while the underlying asset for the 10-year futures is the 10-year treasury bond with a KRW100 million face value and a 5% coupon rate.

B. Descriptive Statistics

Table 1 presents the descriptive statistics of cash and futures returns (mean, standard deviation, skewness, and kurtosis) for both tenors (3- and 10-year) across different sample periods (full sample, precrisis, crisis, and postcrisis). The data are computed based on daily logarithmic returns, where non-trading days are excluded. First, for the full sample, futures returns are consistently higher than cash returns, although the differences are small. No-arbitrage conditions appear to keep the differences within a certain range because of information and transaction costs. But the differences are generally greater for the 10-year than the 3-year paper, suggesting that the cash and futures markets for 3-year KTBs are better integrated because of greater market liquidity and efficiency given the longer history of trading. Second, futures returns have slightly, but consistently, higher volatility than cash returns. Volatility is also higher for 10-year KTBs and futures compared to the 3-year paper, reflecting its relatively higher yield, and perhaps, because of limited market liquidity for them. Overall, the pattern of high return for high volatility is consistent, with the view that investors must be compensated with higher returns for greater risk. Volatility is also much higher during the crisis period for which data are available for the 3-year KTBs and futures. Third, both cash and futures returns follow a similar distribution pattern, slightly asymmetric and more peaked compared to the normal distribution. Between cash and futures returns for 3-year KTBs, the latter were more skewed to the left, especially in the precrisis period and flatter than the cash returns.

Table 1: Descriptive Statistics for Korean Treasury Bond and Futures Returns

	3-Year		10-Year	
	Cash	Futures	Cash	Futures
Full sample (01 Jan 2004 to 31 Dec 2013)				
Mean	0.002	0.007	0.005	0.014
Standard deviation	0.14	0.16	0.27	0.32
Skewness	−0.04	−0.09	0.34	0.34
Kurtosis	7.86	7.19	6.29	5.89
Observation	2,186	2,276	754	722
Precrisis (01 Jan 2004 to 15 Sep 2008)				
Mean	−0.001	0.003	...	...
Standard deviation	0.13	0.15	...	...
Skewness	−0.30	−0.28	...	...
Kurtosis	7.21	6.61	...	...
Observation	975	1,065	...	...

continued on next page

Table 1 continued

Crisis (16 Sep 2008 to 31 Dec 2009)				
Mean	0.005	0.016	...	...
Standard deviation	0.24	0.26	...	...
Skewness	−0.02	−0.11	...	...
Kurtosis	4.47	4.32	...	...
Observation	301	301	...	...
Postcrisis (01 Jan 2010 to 31 Dec 2013)				
Mean	0.004	0.009	0.005	0.014
Standard deviation	0.11	0.13	0.27	0.32
Skewness	0.34	0.19	0.34	0.34
Kurtosis	6.88	5.74	6.29	5.89
Observation	910	910	754	722

... = not available, KTB Korean Treasury Bond.
Note: Values refer to log returns.
Source: Authors' calculations.

Table 2 presents the trading volume for both cash and futures markets. It reveals that (i) 3-year KTB trading volumes in both cash and futures markets have been rising rapidly, especially futures, with growth after the crisis pronounced; and (ii) for both 3-year and 10-year KTBs, futures trading volumes are greater than cash market volumes, reflecting lower transaction costs in the former.

Table 2: Trading Volume
(KRW100 million)

	3-Year		10-Year	
	Cash	**Futures**	**Cash**	**Futures**
Full sample (01 Jan 2004 to 31 Dec 2013)				
Mean	25,111	158,406	29,352	71,398
Standard deviation	14,413	105,153	19,116	47,535
Skewness	0.81	1.83	1.20	0.12
Kurtosis	4.48	8.45	5.58	2.11
Observation	2,407	2,407	962	766
Precrisis (01 Jan 2004 to 15 Sep 2008)				
Mean	18,970	92,478	...	...
Standard deviation	11,967	47,180	...	...
Skewness	1.08	1.53	...	...
Kurtosis	6.07	6.57	...	...
Observation	1,130	1,130	...	...

continued on next page

Table 2 continued

Crisis (16 Sep 2008 to 31 Dec 2009)				
Mean	33,483	147,361	...	...
Standard deviation	17,823	59,806	...	...
Skewness	0.28	1.78	...	...
Kurtosis	3.41	8.10	...	...
Observation	315	315	...	...
Postcrisis (01 Jan 2010 to 31 Dec 2013)				
Mean	29,584	239,465	29,352	71,398
Standard deviation	12,678	110,322	19,116	47,535
Skewness	0.84	1.80	1.20	0.12
Kurtosis	4.88	7.92	5.58	2.11
Observation	962	962	962	766

... = not available, KRW = Korean won.
Source: Authors' calculations.

Table 3 presents the average net purchases (cash market) and net long position (futures market) by investor group across subperiods. For the cash market, both foreigners and DFIs are net buyers. Because KTB issuance increased over time, all market participants may accumulate net buys, reflecting market demand growth. In the futures market, however, net long positions have to be met by net short positions. It appears that in the futures market, foreign investors are initiating trading, while DFIs are accommodating the net positions of foreigners. For instance, DFIs are selling their holdings in the 3-year futures market as foreigners purchase those assets, but in the 10-year market, foreigners are taking short positions, while DFIs are taking long positions. We also find that foreigners increased their net purchases in the 3-year cash market during the crisis and postcrisis periods and reduced their net long positions in the futures market.

In the cash market, most DFI subgroups are net buyers, except for banks, which are net sellers of 10-year KTBs. We note that foreigners purchased more in the 10-year than the 3-year cash market before the crisis, but this pattern was reversed during the crisis and postcrisis periods. This may be in line with ongoing deleveraging in advanced economies, where foreign investors adjusted their portfolios in favor of shorter tenors. In addition, we also find that among the DFI subgroups, domestic banks have larger net purchases or net long positions compared to other institutions.

For the futures market, banks, among the DFIs, are again the largest players. For 3-year futures, domestic banks, asset management companies, funds, and securities companies are net sellers, although both funds and securities were net buyers during the global financial crisis. For 10-year futures, banks and securities companies are net buyers, while asset management firms and funds are net sellers. Except for banks, other DFIs have smaller positions in the futures market, compared to foreigners. This supports the view that foreign participation instigates price discovery in the futures markets. Foreigners also show a tendency of herding[9] and trend-chasing,[10] amassing a large net position compared to DFIs at times.

[9] A similar type of investor following a similar investment strategy may make a common investment decision; for example, simultaneously buying or selling the same securities.

[10] Buying financial securities after a recent upward trend in prices and selling after a recent downward trend. For example, investors can make a consistent one-directional investment for some time based on their projections of the trend in the policy rate.

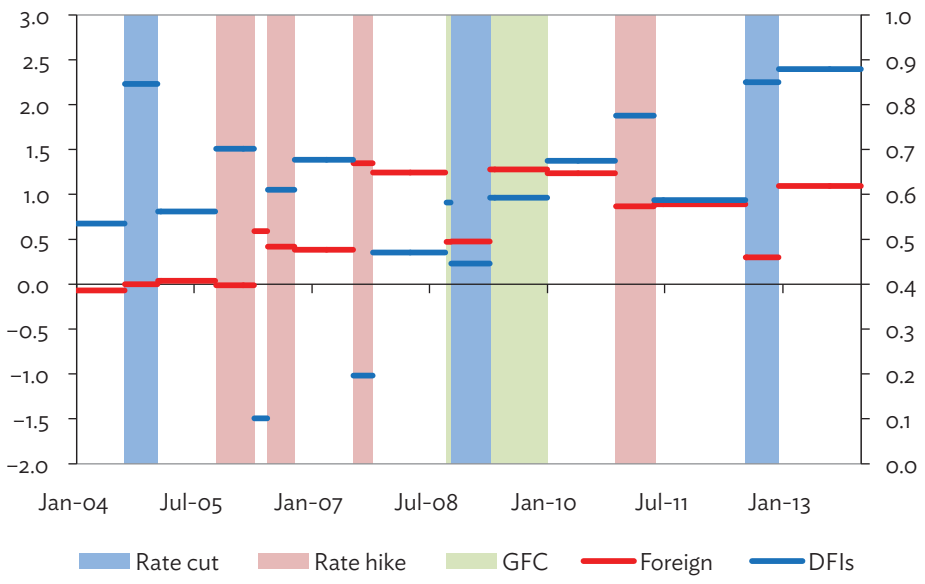
Table 3: Average Net Buy and Net Long Position in Cash and Futures Market

	3-Year						10-Year					
	Foreigners	Domestic Finance Institutions	Banks	Asset Management	Funds	Securities	Foreigners	Domestic Finance Institutions	Banks	Asset Management	Funds	Securities
Average Net Buy in Cash Market												
Full sample	0.700	1.149	0.733	0.143	0.273	...	0.941	6.142	−0.652	0.553	6.241	...
Precrisis	0.421	0.840	0.469	−0.048	0.419	...	1.127	9.091	−1.198	0.738	9.551	...
Crisis	0.933	0.679	0.431	0.101	0.147	...	0.661	5.416	−0.556	0.520	5.452	...
Postcrisis	0.952	1.665	1.141	0.381	0.143	...	0.813	2.914	−0.043	0.347	2.610	...
Average Net Long Position in Futures Market												
Full sample	0.089	−0.068	−0.038	−0.009	−0.006	−0.015	−0.034	0.060	0.046	−0.032	−0.011	0.057
Precrisis	0.138	−0.090	−0.045	−0.009	−0.004	−0.033	...	...	...	...	...	...
Crisis	0.031	−0.058	−0.083	−0.006	0.001	0.033	...	...	...	...	...	...
Postcrisis	0.052	−0.045	−0.016	−0.009	−0.010	−0.009	−0.034	0.060	0.046	−0.032	−0.011	0.057

... = not available.
Note: Values in percent of cash and futures trading volumes.
Source: Authors' calculations.

We also look into how different investor groups react to the monetary policy of the Bank of Korea (BOK) in both cash and futures markets.[11] Figures 1a and 1b show the net purchases and net long positions of foreign and DFIs for 3-year government bonds and futures.[12] Foreigners tend to reduce their net long positions in the futures market during BOK monetary policy actions (either easing or tightening stance), leading to the reverse positions of DFIs. In the cash market, DFIs are more active traders than foreigners, although both foreigners and DFIs seem to respond to BOK policy changes by adjusting their net purchases. These results imply that foreign investors who initiate trading activity in the futures market are different from the foreign investors in the cash market, and their trading decisions are independent of each other. In addition, DFIs are followers in the futures market by adjusting their net positions as a counterpart to the foreign investors' positions, but they act as an independent major player in the cash market.

Figure 1a: Net Purchases of Foreign and Domestic Finance Institutions in the 3-Year Treasury Cash Market

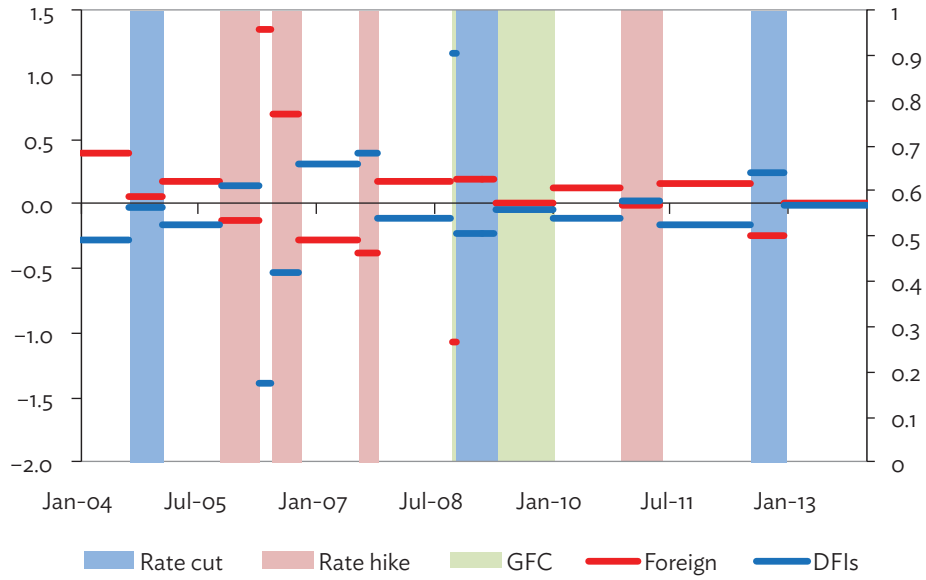


DFI = domestic finance institution, GFC = global financial crisis.
Note: Futures price index scaled by 100.
Source: Authors' calculations.

[11] Policy stance refers to episodes when the BOK increased or decreased the base rate by at least 25 basis points in relation to the previous three interest rate policy decisions.

[12] We do not show the 10-year government bonds due to a shorter sample.

Figure 1b: Net Positions of Foreign and Domestic Finance Institutions in the 3-Year Treasury Futures Market



DFI = domestic finance institution, GFC = global financial crisis.
Note: Futures price index scaled by 100.
Source: Authors' calculations.

C. Decomposition of Net Purchases and Positions

Foreign investors have emerged as important players of increasing influence in the KTB markets, and their trading is closely watched by other market participants. Many observers have also noted that net purchases of foreigners in the KTB futures market seem to be associated with price changes in the KTB and its futures markets. Do these net purchases by foreigners represent additional information to net investor demand in these markets? To understand the price impact of foreign net purchases in KTB cash and futures markets, we try to estimate the new information content of net purchases by foreigners and other investor groups. The trading decisions of foreign investors are presumably based on an information set that may be different from that of domestic investors. Their motivation can be also different from domestic investors, reflecting differences in their overall investment portfolios. For example, foreign investors may be able to extract information from global returns about the future prospects of emerging markets, or they are simply increasing their investment allocations to emerging market assets for other portfolio benefits.

Richards (2005) presented a model to explain what drives net purchases of foreign investors in emerging market equity and futures. Using a model in which the net purchases of foreign investors are regressed on lagged returns of various markets and other lagged variables, such as net flows, he suggests foreign investors tend to respond to price movements in various markets or the information that drives those movements. Such similar trading patterns could be also interpreted as a form of herding by these investors, even if it is unconscious.

Several studies have also looked into the difference between *expected* and *unexpected* components of order flows and transaction volumes in financial futures markets. For instance, Bessembinder and Seguin (1993) examined the *expected* and *unexpected* components of futures

trading volume, and found that unexpected volume shocks have greater impact on volatility. Drawing on the regression methodology in Richards (2005), we decompose net purchases of different investor groups into *expected* and *unexpected* components. It would be interesting to see which component (*expected* or *unexpected*) of net purchases and net long positions drives the discovery process. If the net purchase of foreign investors is largely a response to news and provides additional information to the market, it could be that the *unexpected* component plays a bigger role in price discovery. Richards (2005) tested this hypothesis in his study of foreign participation in Asian equity markets and found both *expected* and *unexpected* components to be significant. However, the coefficients and variance for the *unexpected* component are relatively large, suggesting that the majority of the contemporaneous impact of flows on returns can be attributed to the *unexpected* component.

Following Richards (2005), we decompose the *expected* and *unexpected* components by:

$$NP_t = \alpha + \beta_1 NP_{t-1} + \beta_2 NP_{t-2} + \beta_3 NP_{t-3} + \beta_4 NP_{t-4} + \beta_5 NP_{t-5} + \beta_6 RETURNS_{t-1} + \beta_7 UST10Y_{t-1} + \beta_8 KTB3Y_{t-1} + \beta_9 VIX_{t-1} + \beta_{10} \Delta FX_{t-1} + \varepsilon_t \quad (1)$$

where *NP* is the net purchase (net long position) of investor groups, $RETURNS_{t-1}$ refers to the lagged bond returns (either cash or futures), $UST10Y_{t-1}$ is the lagged US 10-year Treasury bond yield used as proxy for global interest rates, $KTB3Y_{t-1}$ is the lagged yields of 3-year Korean government bonds used as proxy for domestic interest rates, VIX_{t-1} is the lagged VIX used to measure investor risk appetite, ΔFX_{t-1} is the lagged change in nominal exchange rate to account for exchange rate movements, and ε_t is the error term. We sourced daily 10-year US Treasury bond yields, 3-year Korean bond yields, nominal exchange rate (the Korean won per US dollar) from the BOK and the VIX from the Chicago Board Options Exchange. We estimate Equation 1 for foreigners and DFIs (including its subgroups) for both cash and futures bond markets.

We derived the *unexpected* component by estimating Equation 1 and then assuming that the residuals (ε_t) correspond to the *unexpected* component, while the *expected* component corresponds to the fitted values of the above regression. Both *expected* and *unexpected* components derived from Equation 1 are also estimated for the three subperiods (precrisis, crisis, postcrisis). We do so to account for the changing investor expectations during the three sample periods.

Tables 4a–c present the regression results on the determinants of net purchases and net long positions for precrisis, crisis, and postcrisis periods, respectively. We note several findings. First, lagged net purchases are significant for all sample periods. In the model, the lag length is set at five, as Richards (2005) suggests.[13] Net purchases seem to show positive autocorrelation, as investors may build their positions gradually (to mitigate the market impact of their trading) or investors of similar types may respond to new information in similar ways, but with different speeds. Second, net purchases are significantly correlated with lagged returns, which is more pronounced for several investor groups. The lagged returns have significant, negative effects on DFIs' net purchases in the 3-year KTB cash market and on the net long positions of domestic funds and securities companies in the 3-year futures market during the precrisis period. The effects of lagged returns on net purchases in the cash market become rather insignificant during the crisis and postcrisis periods, but the lagged

[13] We also tried to fit the model using one lag, but the R-squared was lower. Using five lags improved the model fit. Although the R-squared is low, our model specification seems to be adequate as the residuals do not show any distinct patterns, which may suggest biases in our estimates.

Table 4a: Determinants of Net Purchases and Net Long Positions (Precrisis Period)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables	for3	fin3	fin3bk	fin3am	fin3fd	fin3sc	spotfb3	spotfinb3	spotfinb3bk	spotfinb3am	spotfinb3fd
NP (-1)	0.0576	0.0639	0.0520	−0.0176	−0.0482	0.0126	0.120**	0.0970**	0.0626	0.149***	0.0783*
	(0.0502)	(0.0497)	(0.0417)	(0.0453)	(0.0385)	(0.0390)	(0.0590)	(0.0481)	(0.0420)	(0.0367)	(0.0423)
NP (-2)	0.122***	0.122***	0.00360	−0.100**	−0.0374	0.0349	0.0536	0.112**	0.0756*	0.0721*	0.0463
	(0.0364)	(0.0364)	(0.0393)	(0.0443)	(0.0344)	(0.0348)	(0.0438)	(0.0437)	(0.0445)	(0.0369)	(0.0337)
NP (-3)	0.0247	0.0287	−0.0160	0.0436	0.0157	0.000330	−0.123**	0.0133	−0.0332	0.0344	0.103***
	(0.0453)	(0.0439)	(0.0400)	(0.0434)	(0.0414)	(0.0342)	(0.0533)	(0.0367)	(0.0395)	(0.0416)	(0.0327)
NP (-4)	0.0427	0.0369	0.0202	0.0101	−0.0397	−0.0509	0.0385	−0.0219	−0.0768**	−0.0137	0.0351
	(0.0395)	(0.0387)	(0.0363)	(0.0380)	(0.0298)	(0.0396)	(0.0521)	(0.0363)	(0.0369)	(0.0364)	(0.0357)
NP (-5)	0.0416	0.0204	0.0716**	−0.0424	−0.0234	0.0241	0.0500	−0.0520	0.0861**	−0.0316	−0.0552
	(0.0425)	(0.0409)	(0.0348)	(0.0528)	(0.0442)	(0.0403)	(0.0526)	(0.0420)	(0.0393)	(0.0393)	(0.0392)
Returns (-1)	0.860	−0.497	1.040	0.584*	−0.272**	−2.301***	0.194	−6.253***	−2.272**	−1.830	−2.195***
	(1.242)	(1.240)	(0.849)	(0.324)	(0.135)	(0.569)	(0.566)	(2.032)	(1.106)	(1.200)	(0.799)
UST 3-Yr (-1)	−0.279	0.271	0.359**	0.0167	0.0359	−0.185	0.290	−0.498	−0.0172	−0.390	−0.0899
	(0.203)	(0.205)	(0.177)	(0.0643)	(0.0290)	(0.116)	(0.215)	(0.386)	(0.289)	(0.250)	(0.169)
KTB 3-Yr (-1)	0.167	−0.194	−0.267	0.0747	−0.0809	0.195	−0.147	−0.217	−0.239	0.254	−0.207
	(0.286)	(0.283)	(0.234)	(0.103)	(0.0504)	(0.177)	(0.176)	(0.465)	(0.314)	(0.307)	(0.199)
VIX (-1)	−0.0213	0.0256	0.0434	−0.00209	0.00575	−0.0397	0.142***	−0.0941	0.0368	−0.105*	−0.0177
	(0.0428)	(0.0424)	(0.0362)	(0.0137)	(0.00620)	(0.0276)	(0.0394)	(0.0841)	(0.0575)	(0.0556)	(0.0334)
ΔFX (-1)	0.453	−0.500*	−0.0422	−0.0946	−0.0366	−0.213	−0.00394	0.0135	−0.379	0.0137	0.333*
	(0.282)	(0.277)	(0.224)	(0.105)	(0.0447)	(0.178)	(0.148)	(0.433)	(0.280)	(0.271)	(0.185)
Constant	0.797	−0.713	−0.912	−0.448	0.168	0.339	−2.257***	5.107**	0.984	1.958	1.891**
	(1.209)	(1.209)	(1.023)	(0.478)	(0.236)	(0.725)	(0.803)	(2.100)	(1.405)	(1.390)	(0.913)
Observations	832	832	832	832	832	832	773	773	773	773	773
R-squared	0.033	0.031	0.016	0.020	0.014	0.028	0.080	0.062	0.030	0.051	0.055

... = not available, DFI = domestic finance institution.
Notes: for = foreign futures; FIN = DFIs futures; _bk = DFI banks futures/spot; _am DFI asset management future/spot; _fd = DFI funds futures/spot; _sc = DFI securities futures; spotfb = foreign spot; spotfin = DFI spot. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

Table 4b: Determinants of Net Purchases and Net Long Positions (Crisis Period)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Variables	for3	fin3	fin3bk	fin3am	fin3fd	fin3sc	spotfb3	spotfinb3	spotfinb3bk	spotfinb3am	spotfinb3fd
NP (-1)	0.215***	0.183***	−0.00428	0.0191	−0.0279	0.0437	0.236**	0.0831	−0.0601	0.0385	0.0468
	(0.0695)	(0.0701)	(0.0595)	(0.0721)	(0.0707)	(0.0621)	(0.108)	(0.0507)	(0.0707)	(0.0633)	(0.0642)
NP (-2)	0.107*	0.134**	0.0624	−0.0224	0.0466	−0.0170	−0.0318	−0.0411	−0.0130	−0.0158	−0.0241
	(0.0630)	(0.0573)	(0.0546)	(0.0553)	(0.0744)	(0.0565)	(0.0618)	(0.0504)	(0.0623)	(0.0672)	(0.0758)
NP (-3)	−0.0335	−0.0416	0.00241	−0.00906	−0.123*	−0.0157	0.0297	−0.00465	−0.0779	0.0655	−0.0735
	(0.0607)	(0.0574)	(0.0553)	(0.0551)	(0.0738)	(0.0640)	(0.0549)	(0.0595)	(0.0596)	(0.0844)	(0.0637)
NP (-4)	0.151**	0.163***	−0.104	0.124***	0.134*	−0.0444	0.100	0.0338	0.00252	−0.0201	0.0870
	(0.0616)	(0.0611)	(0.0664)	(0.0454)	(0.0754)	(0.0653)	(0.0721)	(0.0604)	(0.0537)	(0.0679)	(0.0635)
NP (-5)	0.0569	0.0549	0.0227	0.0636	0.0623	0.131*	0.0624	0.103*	0.0501	−0.0202	−0.00806
	(0.0638)	(0.0632)	(0.0626)	(0.0497)	(0.0649)	(0.0675)	(0.0641)	(0.0545)	(0.0610)	(0.0576)	(0.0628)
Returns (-1)	0.921	−0.820	−1.340**	−0.462***	0.0924	0.595	−0.872*	1.149	1.175	−0.327	−0.255
	(0.705)	(0.721)	(0.540)	(0.172)	(0.125)	(0.476)	(0.484)	(1.142)	(0.834)	(0.611)	(0.458)
UST 3-Yr (-1)	−1.911**	1.847**	0.551	0.349*	0.174	1.411**	−0.663	1.540	0.669	0.389	1.521**
	(0.927)	(0.917)	(0.743)	(0.186)	(0.214)	(0.700)	(0.640)	(1.337)	(1.003)	(0.483)	(0.620)
KTB 3-Yr (-1)	0.491	−0.553	−0.127	−0.0650	−0.0535	−0.286	0.340	−1.018	−0.515	−0.340	−0.584**
	(0.424)	(0.416)	(0.360)	(0.0989)	(0.102)	(0.323)	(0.343)	(0.650)	(0.494)	(0.518)	(0.273)
VIX (-1)	−0.00297	0.00376	0.00682	0.000843	−0.00206	−0.00170	−0.0191**	−0.00723	0.00691	−0.00155	−0.00872
	(0.0118)	(0.0116)	(0.00924)	(0.00313)	(0.00306)	(0.00842)	(0.00936)	(0.0178)	(0.0131)	(0.0108)	(0.00698)
ΔFX (-1)	0.120*	−0.155**	−0.0731	0.0159	−0.0113	−0.0584	−0.0442	0.0154	0.0435	0.0436	−0.0185
	(0.0660)	(0.0688)	(0.0770)	(0.0263)	(0.0212)	(0.0668)	(0.0664)	(0.143)	(0.145)	(0.0666)	(0.0611)
Constant	0.991	−0.684	−0.715	−0.281	0.0416	−0.810	0.817	2.711	1.436	0.234	0.587
	(1.022)	(1.059)	(1.103)	(0.250)	(0.279)	(0.926)	(1.126)	(2.181)	(1.684)	(1.544)	(0.780)
Observations	253	253	253	253	253	253	253	253	253	253	253
R-squared	0.187	0.178	0.052	0.068	0.052	0.048	0.129	0.037	0.028	0.017	0.063

... = not available, DFI = domestic finance institution.
Notes: for = foreign futures; FIN = DFIs futures; _bk = DFI banks futures/spot; _am DFI asset management future/spot; _fd = DFI funds futures/spot; _sc = DFI securities futures; spotfb = foreign spot; spotfin = DFI spot. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

Table 4c: Determinants of Net Purchases and Net Long Positions (Postcrisis Period)

Variables	(1) for3	(2) fin3	(3) fin3bk	(4) fin3am	(5) fin3fd	(6) fin3sc	(7) spotfb3	(8) spotfinb3	(9) spotfinb3bk	(10) spotfinb3am	(11) spotfinb3fd	(12) for10	(13) fin10	(14) fin10bk	(15) fin10am	(16) fin10fd	(17) fin10sc	(18) spotfb10	(19) spotfinb10	(20) spotfinb10bk	(21) spotfinb10am	(22) spotfinb10fd
NP (-1)	0.304***	0.304***	−0.0525	0.00572	−0.153**	0.129***	0.128	0.0813*	0.0619	0.168***	0.0246	0.0842	0.0541	−0.119	0.0270	0.0610	−0.246***	0.160**	0.178**	−0.0529	0.108***	0.196***
	(0.0493)	(0.0491)	(0.0372)	(0.0451)	(0.0634)	(0.0433)	(0.0982)	(0.0427)	(0.0390)	(0.0377)	(0.0869)	(0.0806)	(0.0797)	(0.0785)	(0.0584)	(0.114)	(0.0639)	(0.0699)	(0.0694)	(0.0482)	(0.0402)	(0.0662)
NP (-2)	0.125***	0.113**	−0.0925**	0.0316	−0.0408	0.0451	−0.00525	0.0476	0.0221	0.0710*	0.0217	−0.0327	−0.0203	−0.0977	0.109	0.0601	−0.0905	0.0628	0.149**	0.0536	0.0497	0.0887
	(0.0456)	(0.0458)	(0.0372)	(0.0416)	(0.0579)	(0.0393)	(0.0538)	(0.0382)	(0.0367)	(0.0418)	(0.0364)	(0.151)	(0.132)	(0.0685)	(0.0699)	(0.0861)	(0.0644)	(0.0689)	(0.0614)	(0.0533)	(0.0474)	(0.0732)
NP (-3)	0.117***	0.115***	−0.0227	0.00414	−0.00124	0.0417	0.0139	0.0368	0.00483	0.102**	−0.00898	0.0363	0.0779	0.00539	−0.00580	−0.0440	−0.0140	0.166***	0.00338	0.0780*	−0.00661	0.0903
	(0.0425)	(0.0424)	(0.0370)	(0.0358)	(0.0563)	(0.0430)	(0.0263)	(0.0451)	(0.0372)	(0.0411)	(0.0398)	(0.0495)	(0.0597)	(0.0820)	(0.0564)	(0.0740)	(0.0606)	(0.0561)	(0.0408)	(0.0455)	(0.0419)	(0.0700)
NP (-4)	0.00275	0.0107	−0.0211	−0.0601	−0.0348	0.0658*	0.0159	−0.000967	−0.0223	−0.00682	0.0699	−0.138	−0.125	−0.0234	0.0445	−0.0870	−0.0252	0.0178	0.0276	0.0954**	−0.0101	−0.0506
	(0.0407)	(0.0406)	(0.0385)	(0.0429)	(0.0482)	(0.0395)	(0.0272)	(0.0391)	(0.0331)	(0.0357)	(0.0459)	(0.131)	(0.117)	(0.0638)	(0.0346)	(0.0742)	(0.0596)	(0.0513)	(0.0447)	(0.0421)	(0.0611)	(0.0531)
NP (-5)	−0.0890**	−0.0867**	−0.000215	0.00679	0.0548	−0.0353	0.0207	−0.00607	−0.0378	−0.0354	−0.0441	0.0137	−0.0326	−0.0368	0.0334	0.117	−0.0619	0.0672	−0.0294	−0.0315	−0.0363	0.0942*
	(0.0392)	(0.0390)	(0.0371)	(0.0367)	(0.0484)	(0.0384)	(0.0311)	(0.0401)	(0.0349)	(0.0420)	(0.0465)	(0.0428)	(0.0513)	(0.0845)	(0.0548)	(0.0974)	(0.0635)	(0.0414)	(0.0442)	(0.0472)	(0.0398)	(0.0568)
Returns (-1)	−1.655**	1.656**	−1.462***	0.242*	−0.211	1.849***	0.750	−2.207	−1.998	0.280	−0.512	−0.232	0.170	0.403	0.113**	0.0110	−0.265	0.292	−0.280	0.436	0.136	−0.559
	(0.726)	(0.709)	(0.530)	(0.143)	(0.200)	(0.698)	(0.991)	(2.011)	(1.393)	(0.868)	(0.750)	(0.192)	(0.226)	(0.351)	(0.0558)	(0.111)	(0.347)	(0.283)	(0.895)	(0.515)	(0.215)	(0.855)
UST 3-Yr (-1)	0.337	−0.302	−0.542*	−0.0228	−0.0226	0.145	0.523	0.689	0.807	0.230	−0.274	−0.277	0.363	0.475*	0.0100	0.129**	−0.144	−0.184	0.778	−0.291	−0.0428	0.980
	(0.385)	(0.381)	(0.298)	(0.0638)	(0.147)	(0.386)	(0.374)	(0.828)	(0.568)	(0.312)	(0.315)	(0.217)	(0.224)	(0.261)	(0.0334)	(0.0644)	(0.247)	(0.179)	(0.671)	(0.375)	(0.142)	(0.643)
KTB 3-Yr (-1)	−0.0633	0.0674	0.494*	−0.0656	−0.123	−0.286	−0.497	−1.670*	−1.549***	−0.358	0.203	0.477	−0.515*	0.00744	−0.0986	−0.415**	−0.0699	0.323	0.789	0.348	0.634**	−0.254
	(0.384)	(0.377)	(0.267)	(0.0597)	(0.132)	(0.384)	(0.356)	(0.852)	(0.588)	(0.325)	(0.313)	(0.298)	(0.305)	(0.409)	(0.0624)	(0.193)	(0.413)	(0.303)	(1.116)	(0.612)	(0.246)	(1.140)
VIX (-1)	0.0247	−0.0236	−0.0406***	−0.00190	0.00154	−0.00141	0.0293	−0.0579	0.00145	−0.0137	−0.0502***	−0.0155	0.0160	−0.00856	0.00156	0.0370*	−0.0168	−0.0166	−0.0480	−0.0186	−0.0108	−0.00935
	(0.0160)	(0.0161)	(0.0138)	(0.00301)	(0.00687)	(0.0167)	(0.0303)	(0.0379)	(0.0309)	(0.0158)	(0.0143)	(0.0132)	(0.0137)	(0.0190)	(0.00396)	(0.0191)	(0.0266)	(0.0141)	(0.0531)	(0.0303)	(0.0131)	(0.0475)
ΔFX (-1)	0.182	−0.200	0.104	−0.0462*	−0.0542	−0.231*	−0.454***	−0.460	−0.304	−0.0419	−0.119	0.0294	−0.0358	0.324	−0.00893	−0.0468	−0.335	−0.0511	−1.420***	−0.694**	−0.0329	−0.606
	(0.151)	(0.154)	(0.110)	(0.0274)	(0.0479)	(0.139)	(0.173)	(0.322)	(0.233)	(0.133)	(0.130)	(0.126)	(0.140)	(0.221)	(0.0459)	(0.106)	(0.254)	(0.176)	(0.485)	(0.279)	(0.0897)	(0.382)
Constant	−0.434	0.380	−0.476	0.253*	0.376	0.849	1.448*	7.665***	5.703***	1.569*	0.650	−0.635	0.570	−0.840	0.230	0.358	0.856	−0.0380	−1.762	−0.401	−1.425***	0.186
	(0.982)	(0.964)	(0.611)	(0.144)	(0.252)	(0.963)	(0.868)	(2.218)	(1.576)	(0.835)	(0.764)	(0.554)	(0.584)	(0.940)	(0.160)	(0.382)	(0.986)	(0.619)	(2.061)	(1.196)	(0.492)	(1.973)
Observations	720	720	720	720	720	720	720	720	720	720	720	564	564	564	564	564	564	595	595	595	595	595
R-squared	0.157	0.151	0.038	0.022	0.034	0.034	0.032	0.048	0.028	0.061	0.029	0.031	0.032	0.043	0.036	0.048	0.078	0.096	0.111	0.036	0.044	0.114

... = not available, DFI = domestic finance institution.
Notes: for = foreign futures; FIN = DFIs futures; _bk = DFI banks futures/spot; _am DFI asset management future/spot; _fd = DFI funds futures/spot; _sc = DFI securities futures; spotfb = foreign spot; spotfin = DFI spot. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

returns have significant effects on net long positions of foreign investors in the futures market. The negative coefficients in the cash market suggest lower returns lead to higher net purchases, as opposed to the finding in Richards (2005). This may suggest that there is some underlying demand for KTBs attracting investors to buy when the price falls. In the earlier years, DFIs have increased their holdings of KTBs for various reasons other than pure investment purposes. This pattern has changed over time, as their KTB holdings may have reached adequate levels. On the other hand, the effects of lagged returns have become significant in the 3-year futures market, with foreigners buying on previous day low returns. In the postcrisis period, the effects of lagged returns are more significant for 3- than for 10-year KTBs, implying that for long-term investors, daily returns may not be as important as they are for short-term investors. Third, the muted effects of lagged returns in more recent periods may also suggest that investors extract information from more broadly based information sets and the lagged returns may provide only little new information. What is noticeable is that, the explanatory power of other information variables such as the US and Korean interest rates, risk aversion, and exchange rate changes has become more significant over time. This could imply that investors extract more information from global and domestic economic conditions and potential risk factors for their trading decisions.

Table 5 shows the summary statistics for the *expected* component of net purchases, the fitted values derived from the above regression results. Overall, we find that net purchases in the cash markets are better fitted by the model than the net long positions in the futures, with explanatory variables, including lagged net purchases, lagged returns, and other economic variables. The model seems to explain DFIs' net purchases in the cash market better than foreign investors' net purchases. In the futures market, the net positions of both foreign and domestic investors seem to be driven by news or private information, as suggested by the relatively low value of the *expected* component. Foreign investors and DFI groups take the opposite positions in the futures market. It seems foreign investors have been net buyers of 3-year futures contracts, while DFIs have been net sellers.

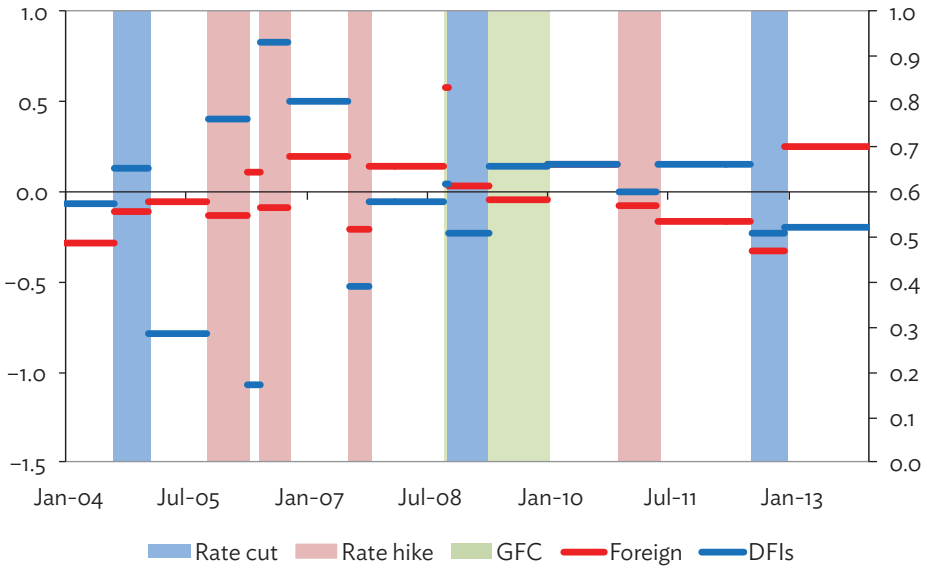
By the nature of the regression model, the *unexpected* component of net purchases is averaged zero as they are residuals from Equation 1. However, when we examine the pattern of *unexpected* components in relation to the BOK monetary policy stance, several observations can be made. Figures 2a and 2b present the *unexpected* component of net buy and net long positions of various investor groups in both cash and futures markets in relation to the BOK monetary policy stance. Overall, the *unexpected* components of foreign investors' net purchases and positions are negative in both the cash and futures markets, while those of DFIs are more positive. In the cash market, the *unexpected* component of foreigner investors' net purchases was more positively responsive to the monetary policy changes during the precrisis period, but became more negative through the global crisis and in the postcrisis period right after the crisis (Figure 2a). On the other hand, the *unexpected* component of DFIs' net purchases increased during the precrisis period running up to the crisis, but decreased during the crisis and postcrisis periods until very recently. We note that for 3-year bond futures, the *unexpected* component of foreigners' net positions is generally negative in response to the BOK's aggressive policy actions (either increasing or decreasing the base rate), while DFIs tend to take net long positions in the futures markets as the counterparts to the foreigners' positions during those periods (Figure 2b).

Table 5: Expected Component of Net Purchases by Investor Groups

Variable	3-Year KTB															10-Year KTB				
	Precrisis					Crisis					Postcrisis					Postcrisis				
	Obs.	Mean	Std. Dev.	Min.	Max.	Obs.	Mean	Std. Dev.	Min.	Max.	Obs.	Mean	Std. Dev.	Min.	Max.	Obs.	Mean	Std. Dev.	Min.	Max.
Foreign future	**867**	**0.29**	**0.74**	**−2.83**	**2.90**	**259**	**0.24**	**1.16**	**−3.93**	**2.69**	**749**	**0.06**	**1.08**	**−4.40**	**3.84**	**588**	**−0.06**	**0.32**	**−2.42**	**2.61**
DFI future	**867**	**−0.28**	**0.71**	**−2.93**	**2.80**	**259**	**−0.26**	**1.12**	**−2.79**	**3.62**	**749**	**−0.05**	**1.05**	**−3.78**	**4.29**	**588**	**0.08**	**0.34**	**−2.38**	**2.74**
DFI bank future	867	−0.15	0.42	−1.54	1.28	259	−0.22	0.47	−1.39	1.73	749	−0.01	0.36	−1.37	0.88	588	0.13	0.53	−2.43	3.18
DFI AM future	867	−0.06	0.20	−1.14	0.97	259	−0.03	0.18	−0.52	0.54	749	−0.02	0.06	−0.22	0.21	588	−0.04	0.08	−0.64	0.34
DFI funds future	867	0.01	0.07	−0.28	0.24	259	0.00	0.15	−0.45	0.39	749	−0.02	0.13	−0.67	0.56	588	0.02	0.28	−0.89	2.08
DFI securities future	867	−0.07	0.43	−2.01	1.88	259	0.00	0.42	−1.25	1.26	749	0.01	0.45	−1.47	1.58	588	−0.04	0.77	−4.12	4.77
Foreign spot	**802**	**0.49**	**0.76**	**−1.57**	**5.62**	**259**	**0.92**	**0.79**	**−1.39**	**3.84**	**749**	**0.88**	**0.53**	**−2.05**	**4.76**	**619**	**0.45**	**0.62**	**−2.14**	**3.72**
DFI spot	**802**	**0.78**	**1.55**	**−5.91**	**7.76**	**259**	**0.51**	**0.78**	**−2.05**	**2.44**	**749**	**1.72**	**1.23**	**−2.77**	**6.26**	**619**	**2.48**	**2.07**	**−4.01**	**14.23**
DFI bank spot	802	0.42	0.74	−1.92	3.30	259	0.47	0.51	−1.12	1.89	749	1.16	0.71	−0.71	4.16	619	−0.39	0.68	−3.18	1.92
DFI AM spot	802	−0.02	0.91	−3.80	4.13	259	0.02	0.27	−0.93	0.83	749	0.40	0.57	−1.49	2.85	619	0.33	0.29	−0.40	2.14
DFI funds spot	802	0.38	0.68	−2.06	3.61	259	0.02	0.42	−1.68	1.39	749	0.16	0.35	−1.32	1.59	619	2.55	1.91	−1.49	16.39

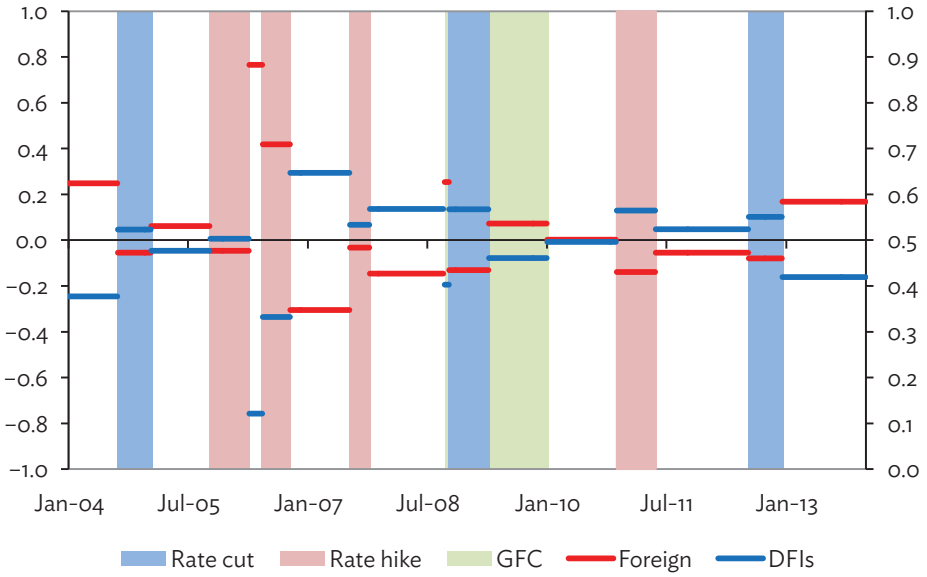
AM = asset management, DFI = domestic finance institutions, KTB = Korean Treasury Bond.
Source: Authors' calculations.

Figure 2a: Unexpected Component of Net Purchases by Foreign and Domestic Finance Institutions in the 3-Year Treasury Cash Market



DFI = domestic finance institution, GFC = global financial crisis.
Note: Futures price index scaled by 100.
Source: Authors' calculations.

Figure 2b: Unexpected Component of Net Positions by Foreign and Domestic Finance Institutions in the 3-Year Treasury Futures Market



DFI = domestic finance institution, GFC = global financial crisis.
Note: Futures price index scaled by 100.
Source: Authors' calculations.

These findings show that foreigners and DFIs take opposite positions in their unexpected net positions in the futures market whenever the BOK takes aggressive policy actions. Furthermore, although foreigners have overall net long positions in the futures market, they tend to take net short positions when unexpected information arrives in the market.

IV. EMPIRICAL SPECIFICATION AND RESULTS

A. Empirical Specification

Following the specifications of Brandt, Kavajecz, and Underwood (2007) in determining which market (cash or futures) leads to price discovery in Korean Treasury bonds, in which investor groups drive the process, and in which component (*expected* or *unexpected*) plays a stronger role, we estimate cash (futures) returns on contemporaneous and lagged net purchases (net long positions) by investor groups as well as lagged cross market returns,[14] given by:

$$R_t = \alpha + \beta_1 FrF_t + \beta_2 FrF_{t-1} + \beta_3 FrS_t + \beta_4 FrS_{t-1} + \beta_5 DFIF_t + \beta_6 DFIF_{t-1} + \beta_7 DFIS_t + \beta_8 DFIS_{t-1} + \beta_9 CR_{t-1} + \varepsilon_t \quad (2)$$

where *R* refers to cash or futures returns, *FrF* is the foreign net purchases in the futures market, *FrS* is their net purchases in the cash market, *DFIF* is the DFIs net purchases in the futures market, *DFIS* is their net purchases in the cash market, *CR* is the cross market returns, and ε is the error term. We then breakdown the net purchases of investor groups by *expected* and *unexpected* components derived in Section III.C. We repeat these two estimations for the three subperiods (precrisis, crisis, and postcrisis) and then later disaggregate DFIs into banks, asset management, funds, and securities.

We stress several important points on our model specification. First, we include both contemporaneous and lagged net purchases to account for the instantaneous as well as delayed impact of trading on returns. In contrast, Brandt, Kavajecz, and Underwood (2007) do not include lagged terms. Second, we include lagged cross-market returns to confirm whether or not previous trading day returns in the cash market exert significant influence on present day futures returns, and vice versa.[15] Third, we break down the net purchases and net long positions by their *expected* and *unexpected* component, following Richards (2005). Here, we expect that both components exert price effects, although the size of that effect could be different depending on how traders extract new information from the trading behaviors. Fourth, unlike other studies, such as those from Huang and Zhang (1995); Kim, Szakmary, and Schwarz (1999); and Theissen (2012)—who used returns and price data for error correction models to test price discovery between cash and futures markets—we follow Brandt, Kavajecz, and Underwood (2007) who regressed returns on cash and futures net purchases

[14] The Brandt, Kavajecz, and Underwood (2007) specification of the interaction between the spot and futures market also looks into different investor categories across maturities. Unlike their specification, we include lagged terms and cross market returns to determine their contribution to net positions.

[15] We initially included contemporaneous cross market returns. The results show that these are a significant driver of spot and future returns, as the coefficients are highly significant and the model fit is substantially better. However, we decided not to include these in the final specification, as this only shows that both spot and future markets are highly interrelated, without adding much to our analysis.

and net long positions in both markets to fully utilize the information content from net transaction data to assess KTB price discovery.[16]

Tables 6 to 16 present our estimation results. We first present the full sample period (Tables 6, 7, and 8) before showing the precrisis (Tables 9 and 10), crisis (Tables 11 and 12) and postcrisis (13 and 14) periods. Tables 8, 10, 12, and 14 present the decomposition of *expected* and *unexpected* components by sample periods. Tables 15 and 16 present the results for disaggregated DFIs by investor subgroups for the full sample period.

For Tables 6–8 and 13–16, we show specifications (1)–(2) and (7)–(8) for the effect of foreign investors' trading on both 3-year [(1) and (7)] and 10-year [(2) and (8)] cash and futures returns, respectively; specifications (3)–(4) and (9)–(10) for the effect of DFIs' on both 3-year [(3) and (9)] and 10-year [(4) and (10)] cash and futures returns, respectively; while specifications (5)–(6) and (11)–(12) include both foreigners and DFIs for both 3-year [(5) and (11)] and 10-year [(6) and (12)] cash and future returns, respectively. For Tables 9–12, estimates for 10-year cash and future returns are excluded due to unavailable data; in which case, specifications (1) and (4) are the effects of foreign investors' trading on 3-year cash and futures returns, respectively; specifications (2) and (5) for the effect of DFIs' on cash and futures returns, respectively; and specifications (3)–(6) include both foreigners and DFIs for cash and futures returns, respectively. For Table 6, we present own-market net purchases, which we use as a benchmark to assess the importance of cross-market interactions between cash and futures markets. Robust standard errors are in parentheses and the significance levels are reported.

We tested whether the net purchases in both cash and futures markets are serially correlated. Using the Ljung-Box test for serial correlation, we were not able to reject the null hypothesis of no serial correlation at one lag. In addition, since we find that the net long positions of foreign investors and DFIs are highly correlated through the variance inflation factor test for multicollinearity, we used the regression residuals of foreign futures on DFI futures as a substitute for DFI futures.[17] Therefore, the results presented in specifications (5), (6), (11), and (12) use the residuals as a substitute for the DFI futures.

The model fit for all specifications (as indicated by the R-squared) is not very high, ranging from 8% to less than 30%. The goodness of fit would improve if we included contemporaneous cross-market returns. But the effects of these are overwhelmingly large, given that these two markets are likely to be cointegrated, as suggested in the previous literature.

B. Analysis of Results

Tables 6 to 16 suggest the following findings. First, comparing Tables 6 and 7, we note that when the model specification considers interaction between the cash and futures market, it has a higher model fit (Table 7) compared to the model specification where we consider own-market net transactions only (Table 6). In fact, specification (5) in Table 6, where we look into the impact of net purchases in the cash market of foreigners and DFIs, the R-squared is only about 6%. But when we consider net

[16] Brandt, Kavajecz, and Underwood (2007) cite several studies which argue that net order flows is the mechanism through which information is impounded into prices. These prices are, in turn, used by other authors to test price discovery via an error correction model.

[17] We found that foreign and DFI futures are highly correlated as they are of similar magnitude, but in the opposite direction. We purged the correlation between the two to capture the real trading pattern of both investor groups when used in the same specification.

Table 6: Full Sample (Own-Market Estimates)

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Foreign (Spot/Futures)	0.00055	0.00151			0.00008	0.00084	**0.01631*** **	−0.00294			**0.01887*** **	−0.00168
	(0.00123)	(0.00662)			(0.00141)	(0.00615)	**(0.00116)**	(0.00679)			**(0.00118)**	(0.00758)
Lag foreign (Spot/Futures)	**−0.00190***	0.00699			−0.00147	0.00501	**−0.00298*** **	−0.00460			**−0.00411*** **	−0.00565
	(0.00105)	(0.00572)			(0.00123)	(0.00478)	**(0.00109)**	(0.00868)			**(0.00117)**	(0.00897)
DFIs (Spot/Futures)			**−0.00604*** **	**−0.01377*** **	**−0.00602*** **	**−0.01370*** **			**−0.01607*** **	0.00096	**0.00654*** **	0.00429
			(0.00061)	**(0.00195)**	**(0.00061)**	**(0.00193)**			**(0.00119)**	(0.00724)	**(0.00172)**	(0.00570)
Lag DFIs (Spot/Futures)			0.00064	**0.00397** **	0.00061	**0.00402** **			**0.00306*** **	0.00324	**−0.00252***	−0.00403
			(0.00055)	**(0.00161)**	(0.00055)	**(0.00161)**			**(0.00109)**	(0.00893)	**(0.00143)**	(0.00662)
Lag cross market returns	0.02123	−0.00599	0.00786	−0.00308	0.00795	−0.00352	−0.00117	0.03450	0.00400	0.03577	0.00599	0.03501
	(0.02730)	(0.03867)	(0.02790)	(0.03882)	(0.02797)	(0.03880)	(0.03485)	(0.05809)	(0.03490)	(0.05781)	(0.03502)	(0.05809)
Constant	0.00240	0.00349	0.00789**	0.03234***	0.00888**	0.02941**	0.00444	0.01598	0.00443	0.01594	0.00452	0.01588
	(0.00341)	(0.01075)	(0.00332)	(0.01138)	(0.00349)	(0.01211)	(0.00343)	(0.01233)	(0.00343)	(0.01228)	(0.00341)	(0.01243)
Observations	2,067	679	2,067	679	2,067	679	2,066	680	2,066	680	2,066	680
R-squared	0.00176	0.00244	0.05601	0.10166	0.05675	0.10284	0.10067	0.00170	0.09656	0.00118	0.10998	0.00457

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. sreturns10 = spot returns 10-year. freturn3 = future returns 3-year. freturn10 = future returns 10-year. Specifications (1) to (6) refers to spot net purchases. Specifications (7) to (12) futures net long positions. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

purchases and net long positions in both cash and futures markets for foreigners and DFIs in specification (5) of Table 7, the R-squared increases to about 12%. In contrast, in specification (11) of both tables for the futures returns, the difference between the two is quite small (11% versus 13%). Drawing on Brandt, Kavajecz, and Underwood (2007), this provides evidence that price discovery takes place in the futures market. That is, the futures market contributes significantly more to the price movement in the cash market, compared to the cash market's contribution in the futures market. Furthermore, the net long positions of foreigners are statistically significant, with higher coefficients than DFIs for the price effect in Table 7, offering evidence that it is foreigners who drive the discovery process in the futures market.

Second, the estimated coefficients for contemporaneous and lagged net purchases and net long positions show opposing signs; that is, when one is positive the other is negative. This could suggest a trading pattern in which investors adjust positions as they reassess information from the previous day. Excess buying the previous day, which suggests lower prices, will increase the price in the current trading period and lead to lower net purchases and net long positions, hence the negative sign.

In Table 7, the foreign net long position in the futures market exerts significant positive influence on both cash and futures returns. In fact, the effect of foreign futures purchases is particularly strong for the 3-year futures market given higher foreign participation in that market than in the 10-year. The net futures positions of DFIs are also significant, but their price effects are almost equal, although of opposite sign to those of foreign net futures positions. This implies that DFIs take offsetting positions for the foreign investors' net positions in the futures market.

On the other hand, foreign trading in the cash market does not seem to influence prices in either market, whereas DFIs' net purchases in the cash market have a significant, negative effect on cash and futures returns. The negative price effect of DFIs' net cash purchases is hard to explain. This may be because DFIs do not represent all of the domestic investor subgroups. Note that our cash DFI data does not include domestic securities companies. Market observers note that domestic securities companies are often aggressive buyers of KTBs, raising the prices, which can subsequently be reversed by the participation of other domestic investor groups.

The estimates also show the dominant effect of foreign futures trading, as the coefficients remain large and significant when combined with the DFI futures in specifications (5)–(6) and (11)–(12). These findings support our first finding that price discovery takes place in the futures market and is driven by foreign net positions.

Third, in Table 8, for both foreign net long positions in the futures market and DFIs' net purchases in the cash market, *expected* components appear to exert more price influence, given the magnitude of the coefficients with statistical significance. Similar to the results of Richards (2005), our estimates show that both *expected* and *unexpected* components play significant roles in bond pricing. However, careful comparison between them in specification (5) suggests that for foreign futures trading, the effect of the *expected* component is just a bit higher than the *unexpected* (0.026 versus 0.011 in the contemporary returns, and 0.013 versus 0.007 in the sum of contemporary and previous day returns). For DFI cash trading, the effect of the *unexpected* component is much smaller, while these effects are weaker for both *expected* and *unexpected* components (–0.02 versus–0.004; –0.008 versus –0.001). This can be interpreted as an indication of how foreign investors' net futures positions change unexpectedly will carry valuable additional information. That is, the market extracts extra information, be it their private information or idiosyncratic portfolio rebalancing, from their trading behaviors. On

Table 7: Full Sample (Market Interaction Estimates)

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Futures foreign	0.01359***	0.00126			0.01161***	0.00010	0.01629***	−0.00326			0.01424***	−0.00498
	(0.00105)	(0.00589)			(0.00110)	(0.00578)	(0.00117)	(0.00689)			(0.00124)	(0.00731)
Lag futures foreign	−0.00191*	−0.00213			−0.00185*	−0.00245	−0.00304***	−0.00487			−0.00296***	−0.00309
	(0.00098)	(0.00642)			(0.00102)	(0.00657)	(0.00109)	(0.00842)			(0.00112)	(0.00897)
Spot foreign	0.00080	0.00156			0.00037	0.00095	0.00093	0.00326			0.00048	0.00283
	(0.00115)	(0.00661)			(0.00131)	(0.00612)	(0.00132)	(0.00781)			(0.00147)	(0.00735)
Lag spot foreign	−0.00161	0.00698			−0.00135	0.00501	−0.00169	0.00940			−0.00140	0.00728
	(0.00101)	(0.00573)			(0.00114)	(0.00488)	(0.00113)	(0.00798)			(0.00126)	(0.00745)
Futures DFIs			−0.01157***	−0.00062	0.00385	−0.02195			−0.01417***	0.00417	0.00290	−0.02214
			(0.00109)	(0.00550)	(0.00590)	(0.01940)			(0.00122)	(0.00706)	(0.00647)	(0.03164)
Lag futures DFIs			0.00178*	0.00255	0.00607	0.01354			0.00287**	0.00309	0.00810	−0.00153
			(0.00101)	(0.00625)	(0.00498)	(0.03038)			(0.00112)	(0.00811)	(0.00541)	(0.04692)
Spot DFIs			−0.00460***	−0.01377***	−0.00457***	−0.01381***			−0.00490***	−0.01679***	−0.00487***	−0.01672***
			(0.00059)	(0.00195)	(0.00059)	(0.00196)			(0.00066)	(0.00237)	(0.00065)	(0.00242)
Lag spot DFIs			0.00094*	0.00391**	0.00093*	0.00412**			0.00123**	0.00623***	0.00122**	0.00646***
			(0.00054)	(0.00164)	(0.00054)	(0.00161)			(0.00062)	(0.00209)	(0.00061)	(0.00205)
Lag cross market returns	0.01718	−0.00561	0.01498	−0.00304	0.01009	−0.00458	−0.00031	0.03190	−0.00063	0.05498	−0.00687	0.05019
	(0.02843)	(0.03866)	(0.02846)	(0.03881)	(0.02846)	(0.03840)	(0.03488)	(0.05812)	(0.03531)	(0.06012)	(0.03536)	(0.05999)
Constant	0.00072	0.00349	0.00467	0.03241***	0.00556	0.02943**	0.00497	0.01035	0.00895**	0.04246***	0.00980**	0.03753**
	(0.00328)	(0.01076)	(0.00327)	(0.01139)	(0.00345)	(0.01204)	(0.00361)	(0.01342)	(0.00364)	(0.01406)	(0.00382)	(0.01517)
Observations	2,067	679	2,067	679	2,067	679	2,066	680	2,066	680	2,066	680
R-squared	0.08978	0.00269	0.11540	0.10198	0.12013	0.10616	0.10154	0.00487	0.12467	0.10052	0.12933	0.10464

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. sreturns10 = spot returns 10-year. freturn3 = future returns 3-year. freturn10 = future returns 10-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

Table 8: Full Sample (Expected and Unexpected Component Estimates)

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Unexpected futures foreign	0.01273***	0.00335			0.01119***	−0.00017	0.01561***	−0.00107			0.01401***	−0.00788
	(0.00117)	(0.00693)			(0.00124)	(0.00638)	(0.00132)	(0.00801)			(0.00141)	(0.00758)
Lag unexpected futures foreign	−0.00357***	−0.00118			−0.00448***	0.00271	−0.00497***	−0.00358			−0.00612***	0.00506
	(0.00137)	(0.00765)			(0.00140)	(0.00834)	(0.00152)	(0.00954)			(0.00153)	(0.01018)
Expected futures foreign	0.02458***	−0.01663			0.02602***	−0.00625	0.02823***	−0.01781			0.03059***	−0.00736
	(0.00603)	(0.04789)			(0.00624)	(0.04251)	(0.00678)	(0.05636)			(0.00697)	(0.05250)
Lag expected futures foreign	−0.01130**	0.01448			−0.01325**	−0.01496	−0.01310**	0.02480			−0.01516**	−0.01221
	(0.00571)	(0.03464)			(0.00566)	(0.04534)	(0.00634)	(0.04249)			(0.00626)	(0.05758)
Unexpected spot foreign	0.00068	−0.00426			0.00010	−0.00347	0.00099	−0.00415			0.00040	−0.00424
	(0.00149)	(0.00770)			(0.00166)	(0.00753)	(0.00170)	(0.00908)			(0.00187)	(0.00899)
Lag unexpected spot foreign	−0.00113	0.00592			−0.00075	0.00593	−0.00174	0.01043			−0.00141	0.00981
	(0.00151)	(0.00931)			(0.00161)	(0.00757)	(0.00172)	(0.01251)			(0.00183)	(0.00970)
Expected spot foreign	0.00595	0.01389			0.00653	0.01476	0.00982	0.00523			0.01102	0.00831
	(0.00823)	(0.04488)			(0.00808)	(0.03354)	(0.00935)	(0.05671)			(0.00914)	(0.04189)
Lag expected spot foreign	−0.00437	−0.00980			−0.00598	−0.01714	−0.00584	−0.00289			−0.00753	−0.01355
	(0.00834)	(0.03174)			(0.00824)	(0.02739)	(0.00951)	(0.04082)			(0.00941)	(0.03440)
Unexpected futures DFIs			−0.01109***	0.00224	−0.00117	0.00010			−0.01384***	0.00937	−0.00225	0.03670
			(0.00123)	(0.00566)	(0.00630)	(0.03758)			(0.00139)	(0.00680)	(0.00710)	(0.05030)
Lag unexpected futures DFIs			0.00434***	−0.00115	0.01970***	−0.05408**			0.00594***	−0.00300	0.02533***	−0.09296***
			(0.00142)	(0.00614)	(0.00630)	(0.02117)			(0.00155)	(0.00793)	(0.00700)	(0.02598)
Expected futures DFIs			−0.02739***	0.00041	−0.07883**	−0.02906			−0.03252***	0.00554	−0.11144***	−0.02794
			(0.00646)	(0.03171)	(0.03212)	(0.10737)			(0.00714)	(0.03963)	(0.03501)	(0.13595)
Lag expected futures DFIs			0.01456**	0.00701	0.03654	0.10030			0.01716***	0.00414	0.05195	0.08346
			(0.00589)	(0.02987)	(0.03164)	(0.08931)			(0.00646)	(0.03911)	(0.03556)	(0.11546)
Unexpected spot DFIs			−0.00409***	−0.01323***	−0.00415***	−0.01280***			−0.00437***	−0.01647***	−0.00443***	−0.01575***
			(0.00066)	(0.00225)	(0.00065)	(0.00223)			(0.00074)	(0.00273)	(0.00073)	(0.00271)
Lag unexpected spot DFIs			0.00258***	0.00117	0.00272***	0.00100			0.00303***	0.00252	0.00322***	0.00192
			(0.00069)	(0.00240)	(0.00070)	(0.00236)			(0.00078)	(0.00302)	(0.00078)	(0.00298)
Expected spot DFIs			−0.02094***	−0.00324	−0.02109***	−0.00472			−0.02269***	0.00155	−0.02292***	−0.00040
			(0.00497)	(0.00917)	(0.00495)	(0.00934)			(0.00556)	(0.01152)	(0.00553)	(0.01164)
Lag expected spot DFIs			0.01279***	−0.00149	0.01303***	−0.00061			0.01434***	−0.00800	0.01487***	−0.00641
			(0.00425)	(0.00737)	(0.00428)	(0.00731)			(0.00473)	(0.00942)	(0.00475)	(0.00932)
Lag cross market returns	0.01273	−0.01879	−0.01316	−0.01843	−0.00203	−0.01890	−0.00199	0.02310	−0.03128	0.03285	−0.01293	0.02659
	(0.03103)	(0.04040)	(0.03495)	(0.03890)	(0.03482)	(0.04003)	(0.03780)	(0.06358)	(0.04312)	(0.06102)	(0.04307)	(0.06204)
Constant	0.00052	0.00559	0.01102*	0.02015	0.01034	0.02213	0.00329	0.01819	0.01549**	0.03586	0.01242	0.03936
	(0.00581)	(0.01756)	(0.00575)	(0.01843)	(0.00788)	(0.02351)	(0.00638)	(0.02191)	(0.00641)	(0.02244)	(0.00860)	(0.02926)
Observations	1,645	528	1,645	528	1,645	528	1,645	528	1,645	528	1,645	528
R-squared	0.08933	0.00638	0.12707	0.09938	0.13326	0.11676	0.10351	0.00679	0.13760	0.10300	0.14610	0.13013

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. sreturns10 = spot returns 10-year. freturn3 = future returns 3-year. freturn10 = future returns 10-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

the other hand, DFI transactions in the 3-year cash market are more predictable, provided that their assessment of overall economic conditions is expected. This finding holds true for futures returns as well.

Fourth, compared to Table 7, the subperiod estimates show several noteworthy issues. During the precrisis period (Table 9), the effects of lagged transaction variables are insignificant, while the effects of lagged cross-market returns are significant. The effects of lagged, cross-market returns disappear during crisis and postcrisis periods (Tables 11 and 13). The results seem to suggest that during the precrisis period, investors did not pay as much attention as in the later periods to the information content of trading. Rather, they tried to extract information from observing prices in other markets and exploited arbitrage opportunities. Over time, investors have become much more active in their information gathering from intraday price movements. As information transmission quickens to nearly instant, the effects of lagged returns are not important anymore. This reasoning seems to have worked well in recent years, whereby cash and futures trading has been much more closely watched, and there is now instant and intraday price transmission between the two markets.

Table 9: Precrisis Estimates

Variables	(1) sreturns3	(2) sreturns3	(3) sreturns3	(4) freturn3	(5) freturn3	(6) freturn3
Futures foreign	0.01124***		0.01075***	0.01317***		0.01270***
	(0.00119)		(0.00121)	(0.00130)		(0.00133)
Lag futures foreign	−0.00081		−0.00081	−0.00144		−0.00150
	(0.00127)		(0.00130)	(0.00142)		(0.00145)
Spot foreign	−0.00161		−0.00251	−0.00194		−0.00288
	(0.00187)		(0.00198)	(0.00209)		(0.00220)
Lag spot foreign	−0.00231		−0.00180	−0.00262		−0.00204
	(0.00167)		(0.00190)	(0.00197)		(0.00221)
Futures DFIs		−0.01070***	−0.00177		−0.01265***	−0.00332
		(0.00120)	(0.00598)		(0.00131)	(0.00662)
Lag futures DFIs		0.00092	0.00549		0.00164	0.00844*
		(0.00128)	(0.00426)		(0.00143)	(0.00492)
Spot DFIs		−0.00233***	−0.00253***		−0.00244***	−0.00269***
		(0.00067)	(0.00067)		(0.00074)	(0.00075)
Lag spot DFIs		0.00088	0.00075		0.00112	0.00097
		(0.00069)	(0.00069)		(0.00079)	(0.00079)
Lag cross market returns	0.10453***	0.10265***	0.09440**	0.11010**	0.11121**	0.09996**
	(0.03733)	(0.03708)	(0.03697)	(0.04669)	(0.04673)	(0.04648)
Constant	−0.00141	−0.00191	0.00036	0.00057	−0.00034	0.00225
	(0.00433)	(0.00424)	(0.00438)	(0.00483)	(0.00474)	(0.00489)
Observations	920	920	920	919	919	919
R-squared	0.11615	0.12214	0.12932	0.11985	0.12501	0.13263

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. freturn3 = future returns 3-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

Table 10: Precrisis Estimates (Expected and Unexpected)

Variables	(1) sreturns3	(2) sreturns3	(3) sreturns3	(4) freturn3	(5) freturn3	(6) freturn3
Unexpected futures foreign	0.0102***		0.0101***	0.0123***		0.0122***
	(0.00122)		(0.00127)	(0.00137)		(0.00143)
Lag unexpected futures foreign	−0.00191		−0.00241*	−0.00263*		−0.00330**
	(0.00133)		(0.00137)	(0.00151)		(0.00154)
Expected futures foreign	0.0173		0.0199*	0.0182		0.0211
	(0.0107)		(0.0115)	(0.0124)		(0.0135)
Lag expected futures foreign	−0.00417		−0.00173	−0.00380		−0.00130
	(0.00975)		(0.00880)	(0.0112)		(0.0101)
Unexpected spot foreign	−0.00273		−0.00337	−0.00289		−0.00361
	(0.00209)		(0.00217)	(0.00237)		(0.00247)
Lag unexpected spot foreign	−0.00413*		−0.00354	−0.00435		−0.00378
	(0.00229)		(0.00244)	(0.00267)		(0.00283)
Expected spot foreign	0.0179		0.0171	0.0197		0.0193
	(0.0119)		(0.0118)	(0.0139)		(0.0138)
Lag expected spot foreign	−0.0187		−0.0187	−0.0215		−0.0212
	(0.0132)		(0.0133)	(0.0157)		(0.0158)
Unexpected futures DFIs		−0.0101***	−0.00837		−0.0121***	−0.00954
		(0.00129)	(0.00654)		(0.00145)	(0.00737)
Lag unexpected futures DFIs		0.00229*	0.0110*		0.00313**	0.0151**
		(0.00133)	(0.00581)		(0.00150)	(0.00671)
Expected futures DFIs		−0.0222*	−0.0386		−0.0236*	−0.0476
		(0.0122)	(0.0430)		(0.0143)	(0.0485)
Lag expected futures DFIs		0.00299	0.000503		0.00298	0.00478
		(0.00909)	(0.0394)		(0.0104)	(0.0446)
Unexpected spot DFIs		−0.00210***	−0.00235***		−0.00230***	−0.00260***
		(0.000729)	(0.000714)		(0.000827)	(0.000814)
Lag unexpected spot DFIs		0.00167	0.00163		0.00174	0.00174
		(0.00106)	(0.00104)		(0.00123)	(0.00121)
Expected spot DFIs		−0.00968	−0.00962		−0.00863	−0.00894
		(0.00756)	(0.00696)		(0.00894)	(0.00810)
Lag expected spot DFIs		0.00787	0.00713		0.00775	0.00718
		(0.00606)	(0.00584)		(0.00693)	(0.00660)
Lag cross market returns	0.0954**	0.0596	0.0612	0.103*	0.0715	0.0723
	(0.0437)	(0.0587)	(0.0546)	(0.0565)	(0.0821)	(0.0746)
Constant	−0.00322	−0.00364	−0.00238	−0.00152	−0.00325	−0.00165
	(0.00585)	(0.00605)	(0.00770)	(0.00654)	(0.00699)	(0.00879)
Observations	726	726	726	726	726	726
R-squared	0.118	0.126	0.137	0.123	0.129	0.141

DFIs = domestic finance institutions. |
Notes: sreturns3 = spot returns 3-year. freturn3 = future returns 3-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

In the crisis period (Table 11), the effects of foreign net positions in the futures market are significant and large compared to pre and postcrisis periods. However, during 2008–2009, the share of foreign net long positions in 3-year KTB futures was not very big in absolute terms, although compared to DFIs, their transactions were relatively larger. During the postcrisis period (Table 13), the effect of

the DFIs' net long positions in the futures market is greater than the effect of foreign investors' net long positions. The price effect of DFI trading increased significantly after the crisis, reflecting their increased size and sophistication.

Table 11: Crisis Estimates

Variables	(1) sreturns3	(2) sreturns3	(3) sreturns3	(4) freturn3	(5) freturn3	(6) freturn3
Futures foreign	0.03362***		0.03032***	0.04173***		0.03875***
	(0.00551)		(0.00584)	(0.00607)		(0.00651)
Lag futures foreign	−0.01326***		−0.01378***	−0.01838***		−0.01867***
	(0.00423)		(0.00459)	(0.00462)		(0.00487)
Spot foreign	0.00766		0.00053	0.00608		−0.00078
	(0.00482)		(0.00602)	(0.00543)		(0.00671)
Lag spot foreign	−0.00019		0.00012	−0.00068		−0.00018
	(0.00559)		(0.00590)	(0.00587)		(0.00622)
Futures DFIs		−0.02922***	−0.00483		−0.03754***	−0.00944
		(0.00539)	(0.02489)		(0.00604)	(0.02658)
Lag futures DFIs		0.01349***	−0.01423		0.01819***	−0.01585
		(0.00434)	(0.03031)		(0.00459)	(0.03000)
Spot DFIs		−0.01385***	−0.01355***		−0.01338***	−0.01328***
		(0.00382)	(0.00425)		(0.00415)	(0.00460)
Lag spot DFIs		−0.00257	−0.00287		−0.00220	−0.00258
		(0.00334)	(0.00350)		(0.00349)	(0.00368)
Lag cross market returns	−0.04208	−0.04061	−0.04761	−0.08516	−0.08468	−0.09363
	(0.06496)	(0.06670)	(0.06694)	(0.07446)	(0.07629)	(0.07647)
Constant	−0.00525	0.01036	0.00954	0.00746	0.02050	0.02108
	(0.01640)	(0.01357)	(0.01797)	(0.01739)	(0.01468)	(0.01952)
Observations	288	288	288	288	288	288
R-squared	0.14829	0.19642	0.20214	0.18954	0.22507	0.23176

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. freturn3 = future returns 3-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

In terms of the *expected* and *unexpected* components subperiods, Tables 10, 12, and 14 show that the *unexpected* foreign net long position in the futures market seems to consistently exert price influence across subperiods. However, our results also confirm the significance of the *expected* component, with its larger price effect, but the results are not consistent across periods and specifications. The greater impact of the *expected* component, albeit inconsistent across specifications and periods, might be due to increased transparency, and access to information has raised the effectiveness of expected net long positions, and therefore increased their effect on returns relative to *unexpected* net long positions.

Table 12: Crisis Estimates (Expected and Unexpected)

Variables	(1) sreturns3	(2) sreturns3	(3) sreturns3	(4) freturn3	(5) freturn3	(6) freturn3
Unexpected futures foreign	0.03024***		0.02670***	0.03984***		0.03642***
	(0.00663)		(0.00690)	(0.00732)		(0.00770)
Lag unexpected futures foreign	−0.02577***		−0.01894*	−0.03375***		−0.02679**
	(0.00902)		(0.00998)	(0.00953)		(0.01091)
Expected futures foreign	0.09851***		0.06878**	0.11288***		0.08663***
	(0.02835)		(0.02902)	(0.02976)		(0.03125)
Lag expected futures foreign	−0.05696**		−0.04478*	−0.06612**		−0.05555**
	(0.02575)		(0.02487)	(0.02741)		(0.02733)
Unexpected spot foreign	0.00911		0.00156	0.00725		−0.00025
	(0.00559)		(0.00685)	(0.00645)		(0.00770)
Lag unexpected spot foreign	0.01387		0.01153	0.01548		0.01347
	(0.00956)		(0.01039)	(0.01009)		(0.01118)
Expected spot foreign	−0.04301		−0.04099	−0.05183		−0.05093
	(0.03440)		(0.03297)	(0.03580)		(0.03549)
Lag expected spot foreign	0.02041		0.02355	0.02705		0.03091
	(0.02880)		(0.02868)	(0.03062)		(0.03130)
Unexpected futures DFIs		−0.02548***	0.00754		−0.03464***	0.00591
		(0.00633)	(0.02676)		(0.00709)	(0.03012)
Lag unexpected futures DFIs		0.02208***	0.02886		0.02942***	0.02629
		(0.00779)	(0.03301)		(0.00800)	(0.03416)
Expected futures DFIs		−0.07663***	−0.09797		−0.09408***	−0.10225
		(0.02478)	(0.09078)		(0.02600)	(0.09849)
Lag expected futures DFIs		0.05404**	0.04283		0.06496***	0.04044
		(0.02276)	(0.07993)		(0.02458)	(0.08772)
Unexpected spot DFIs		−0.01125***	−0.01064**		−0.01102**	−0.01067*
		(0.00430)	(0.00499)		(0.00478)	(0.00549)
Lag unexpected spot DFIs		0.00291	0.00327		0.00296	0.00318
		(0.00312)	(0.00340)		(0.00344)	(0.00379)
Expected spot DFIs		−0.06336***	−0.06481***		−0.05699***	−0.05800**
		(0.02092)	(0.02215)		(0.02131)	(0.02286)
Lag expected spot DFIs		−0.00267	0.00197		0.00303	0.00794
		(0.01820)	(0.01990)		(0.01984)	(0.02159)
Lag cross market returns	−0.15983*	−0.04137	−0.07315	−0.22654**	−0.08679	−0.13908
	(0.08399)	(0.08151)	(0.09352)	(0.08963)	(0.08807)	(0.09901)
Constant	0.02272	0.03643*	0.05034	0.03431	0.04066*	0.05624
	(0.03578)	(0.02198)	(0.03857)	(0.03655)	(0.02390)	(0.04124)
Observations	243	243	243	243	243	243
R-squared	0.16715	0.22449	0.23670	0.21385	0.24787	0.26147

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. freturn3 = future returns 3-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

Table 13: Postcrisis Estimates

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Futures foreign	0.01289***	0.00126			0.00598***	0.00010	0.01574***	−0.00326			0.00799***	−0.00498
	(0.00170)	(0.00589)			(0.00199)	(0.00578)	(0.00187)	(0.00689)			(0.00216)	(0.00731)
Lag futures foreign	−0.00231*	−0.00213			−0.00129	−0.00245	−0.00366**	−0.00487			−0.00228	−0.00309
	(0.00138)	(0.00642)			(0.00150)	(0.00657)	(0.00154)	(0.00842)			(0.00167)	(0.00897)
Spot foreign	0.00135	0.00156			0.00262**	0.00095	0.00207	0.00326			0.00349**	0.00283
	(0.00117)	(0.00661)			(0.00127)	(0.00612)	(0.00140)	(0.00781)			(0.00142)	(0.00735)
Lag spot foreign	−0.00149	0.00698			−0.00181	0.00501	−0.00147	0.00940			−0.00189	0.00728
	(0.00134)	(0.00573)			(0.00133)	(0.00488)	(0.00149)	(0.00798)			(0.00147)	(0.00745)
Futures DFIs			−0.00660***	−0.00062	0.04708***	−0.02195			−0.00871***	0.00417	0.05548***	−0.02214
			(0.00199)	(0.00550)	(0.01539)	(0.01940)			(0.00217)	(0.00706)	(0.01730)	(0.03164)
Lag futures DFIs			0.00080	0.00255	0.02041	0.01354			0.00172	0.00309	0.01942	−0.00153
			(0.00150)	(0.00625)	(0.01618)	(0.03038)			(0.00167)	(0.00811)	(0.01706)	(0.04692)
Spot DFIs			−0.00652***	−0.01377***	−0.00644***	−0.01381***			−0.00724***	−0.01679***	−0.00716***	−0.01672***
			(0.00091)	(0.00195)	(0.00093)	(0.00196)			(0.00100)	(0.00237)	(0.00101)	(0.00242)
Lag spot DFIs			0.00102	0.00391**	0.00132*	0.00412**			0.00141*	0.00623***	0.00172**	0.00646***
			(0.00075)	(0.00164)	(0.00073)	(0.00161)			(0.00083)	(0.00209)	(0.00083)	(0.00205)
Lag cross market returns	−0.02168	−0.00561	−0.03110	−0.00304	−0.04225	−0.00458	−0.03693	0.03190	−0.04550	0.05498	−0.05952	0.05019
	(0.03417)	(0.03866)	(0.03421)	(0.03881)	(0.03313)	(0.03840)	(0.04367)	(0.05812)	(0.04391)	(0.06012)	(0.04327)	(0.05999)
Constant	0.00382	0.00349	0.01390***	0.03241***	0.01359***	0.02943**	0.00772*	0.01035	0.01907***	0.04246***	0.01809***	0.03753**
	(0.00382)	(0.01076)	(0.00413)	(0.01139)	(0.00428)	(0.01204)	(0.00428)	(0.01342)	(0.00465)	(0.01406)	(0.00478)	(0.01517)
Observations	859	679	859	679	859	679	859	680	859	680	859	680
R-squared	0.08984	0.00269	0.16544	0.10198	0.19006	0.10616	0.10317	0.00487	0.17379	0.10052	0.20137	0.10464

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. sreturns10 = spot returns 10-year. freturn3 = future returns 3-year. freturn10 = future returns 10-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

Table 14: Postcrisis Estimates (Expected and Unexpected)

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Unexpected futures foreign	**0.01343*** **	0.00335			**0.00637** **	−0.00017	**0.01626*** **	−0.00107			**0.00855*** **	−0.00788
	(0.00207)	(0.00693)			**(0.00251)**	(0.00638)	**(0.00226)**	(0.00801)			**(0.00271)**	(0.00758)
Lag unexpected futures foreign	**−0.00720***	−0.00118			−0.00226	0.00271	**−0.01237*** **	−0.00358			**−0.00840***	0.00506
	(0.00380)	(0.00765)			(0.00421)	(0.00834)	**(0.00422)**	(0.00954)			**(0.00458)**	(0.01018)
Expected futures foreign	**0.02808** **	−0.01663			0.01135	−0.00625	**0.04334*** **	−0.01781			**0.02963** **	−0.00736
	(0.01149)	(0.04789)			(0.01278)	(0.04251)	**(0.01278)**	(0.05636)			**(0.01397)**	(0.05250)
Lag expected futures foreign	−0.01429	0.01448			−0.00763	−0.01496	**−0.02417** **	0.02480			**−0.01963***	−0.01221
	(0.00886)	(0.03464)			(0.00935)	(0.04534)	**(0.00990)**	(0.04249)			**(0.01026)**	(0.05758)
Unexpected spot foreign	0.00225	−0.00426			0.00290	−0.00347	**0.00347** **	−0.00415			**0.00429** **	−0.00424
	(0.00149)	(0.00770)			(0.00183)	(0.00753)	**(0.00176)**	(0.00908)			**(0.00207)**	(0.00899)
Lag unexpected spot foreign	0.00357	0.00592			0.00225	0.00593	0.00297	0.01043			0.00124	0.00981
	(0.00220)	(0.00931)			(0.00225)	(0.00757)	(0.00249)	(0.01251)			(0.00253)	(0.00970)
Expected spot foreign	**−0.02250***	0.01389			−0.01085	0.01476	−0.01749	0.00523			−0.00384	0.00831
	(0.01345)	(0.04488)			(0.01440)	(0.03354)	(0.01494)	(0.05671)			(0.01594)	(0.04189)
Lag expected spot foreign	0.00861	−0.00980			0.00029	−0.01714	0.00444	−0.00289			−0.00491	−0.01355
	(0.01015)	(0.03174)			(0.00989)	(0.02739)	(0.01150)	(0.04082)			(0.01094)	(0.03440)
Unexpected futures DFIs			**−0.00728*** **	0.00224	**0.05042*** **	0.00010			**−0.00937*** **	0.00937	**0.05345*** **	0.03670
			(0.00250)	(0.00566)	**(0.01569)**	(0.03758)			**(0.00270)**	(0.00680)	**(0.01790)**	(0.05030)
Lag unexpected futures DFIs			0.00387	−0.00115	0.03263	**−0.05408** **			0.00864**	−0.00300	0.04254	**−0.09296*** **
			(0.00385)	(0.00614)	(0.02716)	**(0.02117)**			(0.00418)	(0.00793)	(0.03128)	**(0.02598)**
Expected futures DFIs			−0.01755	0.00041	0.06854	−0.02906			**−0.03256*** **	0.00554	0.02153	−0.02794
			(0.01097)	(0.03171)	(0.06942)	(0.10737)			**(0.01206)**	(0.03963)	(0.08224)	(0.13595)
Lag expected futures DFIs			**0.01358***	0.00701	0.05536	0.10030			**0.02371*** **	0.00414	0.06659	0.08346
			(0.00824)	(0.02987)	(0.06638)	(0.08931)			**(0.00898)**	(0.03911)	(0.07779)	(0.11546)
Unexpected spot DFIs			**−0.00600*** **	**−0.01323*** **	**−0.00602*** **	**−0.01280*** **			**−0.00664*** **	**−0.01647*** **	**−0.00669*** **	**−0.01575*** **
			(0.00106)	**(0.00225)**	**(0.00109)**	**(0.00223)**			**(0.00115)**	**(0.00273)**	**(0.00117)**	**(0.00271)**
Lag unexpected spot DFIs			**0.00268** **	0.00117	**0.00235** **	0.00100			**0.00299** **	0.00252	**0.00277** **	0.00192
			(0.00107)	(0.00240)	**(0.00113)**	(0.00236)			**(0.00119)**	(0.00302)	**(0.00124)**	(0.00298)
Expected spot DFIs			**−0.02613*** **	−0.00324	**−0.02196** **	−0.00472			**−0.02455*** **	0.00155	**−0.02138** **	−0.00040
			(0.00843)	(0.00917)	**(0.00929)**	(0.00934)			**(0.00933)**	(0.01152)	**(0.01005)**	(0.01164)
Lag expected spot DFIs			**0.01364***	−0.00149	0.01131	−0.00061			0.01174	−0.00800	0.01015	−0.00641
			(0.00750)	(0.00737)	(0.00858)	(0.00731)			(0.00830)	(0.00942)	(0.00916)	(0.00932)
Lag cross market returns	0.04906	−0.01879	−0.02726	−0.01843	−0.04295	−0.01890	0.06957	0.02310	−0.00301	0.03285	−0.01981	0.02659
	(0.04677)	(0.04040)	(0.04714)	(0.03890)	(0.05210)	(0.04003)	(0.05863)	(0.06358)	(0.05888)	(0.06102)	(0.06504)	(0.06204)
Constant	0.01686	0.00559	0.02791***	0.02015	0.03406***	0.02213	0.02112	0.01819	0.03322***	0.03586	0.03812***	0.03936
	(0.01189)	(0.01756)	(0.00807)	(0.01843)	(0.01254)	(0.02351)	(0.01370)	(0.02191)	(0.00927)	(0.02244)	(0.01427)	(0.02926)
Observations	676	528	676	528	676	528	676	528	676	528	676	528
R-squared	0.11216	0.00638	0.18809	0.09938	0.21397	0.11676	0.12992	0.00679	0.19921	0.10300	0.22587	0.13013

DFIs = domestic finance institutions.
Notes: sreturns3 = spot returns 3-year. sreturns10 = spot returns 10-year. freturn3 = future returns 3-year. freturn10 = future returns 10-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

What these findings imply is that, over the sample period, the trading patterns of investor groups have evolved. The pricing effect of foreign participation is consistently significant and positive in both 3-year cash and futures markets across all subperiods, and particularly high during the crisis period. During the latter, both the *expected* and *unexpected* components of foreign transactions exert strong influence on prices, but the impact of the *expected* component is substantially higher than that of the *unexpected*, and visibly increases compared to pre and postcrisis periods. This suggests very active foreign trading in response to announcements in global and domestic macroeconomic conditions. On the other hand, foreign participation in the cash market has a negligible, if any, price effect. In addition, the pricing effect of foreign participation does not seem to be significant for 10-year cash and futures returns, reflecting relatively inactive foreign trading in the 10-year KTB futures.

Fifth, across subgroups of DFIs (Tables 15 and 16), different groups show different trading patterns in both markets. In futures markets, apart from the significant effect of foreigners' net positions, net positions of asset management funds and DFIs played an important role in pricing with independent trading decisions. Banks and securities companies seem to react to foreign investors' trading, as their coefficients are significant only when DFI subgroups are run, but their effects disappear if foreign trading is included. In futures markets, domestic securities companies account for the largest share (about 30% in 2004 and 60% in 2013), while banks are also sizable.[18] But when compared to foreign investors,[19] DFIs are fragmented; that is, they consist of a large number of smaller accounts, which dilutes their collective influence on pricing. This could explain the weaker price effects of banks and security companies in the futures market compared to foreigners.

In contrast, banks and funds appear to be dominant players in the cash markets, and their transactions have a significant impact on cash prices. In addition, the pricing effects of different DFI subgroups are different for different bond tenors. Domestic asset management and funds are long-term investors, exerting a significant, large influence on 10-year KTBs, and then affect the futures prices through hedging. In the 10-year KTBs, the *expected* components of these subgroups are very important pricing factors. However, these effects are neither very consistent nor significant across specifications (Table 16).

[18] Banks have hedging demand for their cash bond holdings and are likely to take a large short position in the futures market, based on a similar market view through relatively long-term market analysis; similarly, domestic securities companies may take a short position for hedging.

[19] Usually, it is only several large foreign investors who make very large investments and drive market prices.

Table 15: Full Sample by Composition of Domestic Finance Institutions

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Futures foreign	**0.01359*** **	0.00126			**0.01785*** **	−0.01915	**0.01629*** **	−0.00326			**0.01997*** **	−0.02535
	(0.00105)	(0.00589)			**(0.00549)**	(0.01735)	**(0.00117)**	(0.00689)			**(0.00601)**	(0.02930)
Lag futures foreign	**−0.00191*** **	−0.00213			0.00183	0.01918	**−0.00304*** **	−0.00487			0.00261	0.00449
	(0.00098)	(0.00642)			(0.00483)	(0.02727)	**(0.00109)**	(0.00842)			(0.00529)	(0.04001)
Spot foreign	0.00080	0.00156			0.00055	−0.00232	0.00093	0.00326			0.00069	−0.00174
	(0.00115)	(0.00661)			(0.00137)	(0.00666)	(0.00132)	(0.00781)			(0.00152)	(0.00775)
Lag spot foreign	−0.00161	0.00698			−0.00130	0.00393	−0.00169	0.00940			−0.00137	0.00527
	(0.00101)	(0.00573)			(0.00112)	(0.00508)	(0.00113)	(0.00798)			(0.00124)	(0.00740)
Futures bank			**−0.00903*** **	0.00252	0.00858	−0.01416			**−0.01100*** **	0.00793	0.00871	−0.01498
			(0.00146)	(0.00566)	(0.00570)	(0.01661)			**(0.00164)**	(0.00702)	(0.00624)	(0.02797)
Lag futures bank			0.00102	0.00439	0.00270	0.02180			0.00167	0.00691	0.00409	0.01090
			(0.00127)	(0.00552)	(0.00481)	(0.02694)			(0.00141)	(0.00692)	(0.00526)	(0.03903)
Futures asset management			−0.00612	0.00366	**0.01141***	−0.01175			**−0.00888** **	−0.01992	0.01074	−0.04163
			(0.00382)	(0.02693)	**(0.00677)**	(0.03103)			**(0.00408)**	(0.03351)	(0.00727)	(0.04440)
Lag futures assets management			**0.00635** **	0.01171	0.00795	0.02939			**0.00927*** **	0.02997	**0.01163** **	0.03452
			(0.00273)	(0.02559)	(0.00535)	(0.03758)			**(0.00298)**	(0.03264)	**(0.00589)**	(0.05257)
Futures funds			**−0.04754*** **	**−0.02035** **	**−0.02969*** **	**−0.03735** **			**−0.05369*** **	−0.01888	**−0.03369*** **	−0.04159
			(0.00544)	**(0.00907)**	**(0.00766)**	**(0.01816)**			**(0.00567)**	(0.01179)	**(0.00813)**	(0.03002)
Lag futures funds			−0.00202	0.01172	0.00050	0.02918			−0.00005	**0.01826***	0.00329	0.02264
			(0.00407)	(0.00825)	(0.00634)	(0.02710)			(0.00444)	**(0.01024)**	(0.00691)	(0.03982)
Futures securities			**−0.01023*** **	0.00084	0.00765	−0.01567			**−0.01286*** **	0.00656	0.00713	−0.01538
			(0.00135)	(0.00588)	(0.00569)	(0.01682)			**(0.00150)**	(0.00824)	(0.00627)	(0.02932)
Lag futures securities			0.00146	0.00529	0.00355	0.02133			0.00247	0.00746	0.00535	0.01055
			(0.00141)	(0.00628)	(0.00510)	(0.02670)			(0.00150)	(0.00824)	(0.00551)	(0.03998)
Spot banks			**−0.00419*** **	**−0.00802*** **	**−0.00411*** **	**−0.00814*** **			**−0.00436*** **	**−0.00714** **	**−0.00429*** **	**−0.00758** **
			(0.00079)	**(0.00282)**	**(0.00082)**	**(0.00281)**			**(0.00087)**	**(0.00347)**	**(0.00090)**	**(0.00347)**
Lag spot banks			0.00039	0.00057	0.00042	0.00057			0.00061	0.00180	0.00063	0.00174
			(0.00071)	(0.00261)	(0.00071)	(0.00260)			(0.00080)	(0.00355)	(0.00081)	(0.00351)
Spot asset management			−0.00164	−0.00919	−0.00168	−0.00996			−0.00159	−0.01013	−0.00163	−0.01050
			(0.00107)	(0.00812)	(0.00108)	(0.00800)			(0.00117)	(0.00944)	(0.00119)	(0.00938)
Lag spot asset management			0.00078	0.01769**	0.00069	**0.01784** **			0.00111	**0.02112** **	0.00101	**0.02111** **
			(0.00103)	(0.00752)	(0.00103)	**(0.00757)**			(0.00113)	**(0.00916)**	(0.00113)	**(0.00926)**
Spot funds			**−0.00871*** **	**−0.01697*** **	**−0.00866*** **	**−0.01715*** **			**−0.00956*** **	**−0.02184*** **	**−0.00950*** **	**−0.02186*** **
			(0.00155)	**(0.00225)**	**(0.00155)**	**(0.00227)**			**(0.00168)**	**(0.00283)**	**(0.00167)**	**(0.00289)**
Lag spot funds			0.00166	**0.00369** **	0.00153	**0.00400** **			0.00196	**0.00635*** **	0.00181	**0.00669*** **
			(0.00124)	**(0.00184)**	(0.00123)	**(0.00180)**			(0.00136)	**(0.00236)**	(0.00134)	**(0.00230)**
Lag cross market returns	0.01718	−0.00561	0.01109	0.00043	0.00680	0.00084	−0.00031	0.03190	−0.00276	0.05738	−0.00837	0.05619
	(0.02843)	(0.03866)	(0.02894)	(0.03941)	(0.02892)	(0.03916)	(0.03488)	(0.05812)	(0.03610)	(0.05933)	(0.03610)	(0.05950)
Constant	0.00072	0.00349	0.00538*	0.03592***	0.00589*	0.03518***	0.00497	0.01035	0.00971***	0.04937***	0.01014***	0.04771***
	(0.00328)	(0.01076)	(0.00326)	(0.01175)	(0.00339)	(0.01271)	(0.00361)	(0.01342)	(0.00363)	(0.01432)	(0.00376)	(0.01566)
Observations	2,067	679	2,067	679	2,067	679	2,066	680	2,066	680	2,066	680
R-squared	0.08978	0.00269	0.15199	0.13429	0.15748	0.13843	0.10154	0.00487	0.16178	0.14618	0.16729	0.14877

Notes: sreturns3 = spot returns 3-year. sreturns10 = spot returns 10-year. freturn3 = future returns 3-year. freturn10 = future returns 10-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

Table 16: Full Sample by Composition of Domestic Finance Institutions (Expected and Unexpected)

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Unexpected futures foreign	0.01273***	0.00335			0.01332**	0.00889	0.01561***	−0.00107			0.01555**	0.02865
	(0.00117)	(0.00693)			(0.00589)	(0.03197)	(0.00132)	(0.00801)			(0.00658)	(0.04269)
Lag unexpected futures foreign	−0.00357***	−0.00118			0.00437	−0.04515*	−0.00497***	−0.00358			0.00494	−0.07797**
	(0.00137)	(0.00765)			(0.00575)	(0.02522)	(0.00152)	(0.00954)			(0.00645)	(0.03072)
Expected futures foreign	0.02458***	−0.01663			0.01889**	0.01015	0.02823***	−0.01781			0.02038*	0.05166
	(0.00603)	(0.04789)			(0.00938)	(0.04870)	(0.00678)	(0.05636)			(0.01056)	(0.05995)
Lag expected futures foreign	−0.01130**	0.01448			−0.00223	−0.07664*	−0.01310**	0.02480			−0.00116	−0.12023**
	(0.00571)	(0.03464)			(0.00918)	(0.04332)	(0.00634)	(0.04249)			(0.01046)	(0.05255)
Unexpected spot foreign	0.00068	−0.00426			0.00035	−0.00834	0.00099	−0.00415			0.00064	−0.00881
	(0.00149)	(0.00770)			(0.00167)	(0.00771)	(0.00170)	(0.00908)			(0.00189)	(0.00926)
Lag unexpected spot foreign	−0.00113	0.00592			−0.00066	0.00951	−0.00174	0.01043			−0.00131	0.01341
	(0.00151)	(0.00931)			(0.00170)	(0.00768)	(0.00172)	(0.01251)			(0.00193)	(0.00989)
Expected spot foreign	0.00595	0.01389			0.00499	−0.00374	0.00982	0.00523			0.00914	−0.01418
	(0.00823)	(0.04488)			(0.00902)	(0.03501)	(0.00935)	(0.05671)			(0.01017)	(0.04331)
Lag expected spot foreign	−0.00437	−0.00980			−0.00984	−0.02324	−0.00584	−0.00289			−0.01105	−0.01852
	(0.00834)	(0.03174)			(0.00836)	(0.02769)	(0.00951)	(0.04082)			(0.00948)	(0.03426)
Unexpected futures banks			−0.00827***	0.00513	0.00496	0.01285			−0.01058***	0.01190*	0.00480	0.03797
			(0.00160)	(0.00565)	(0.00608)	(0.03075)			(0.00185)	(0.00711)	(0.00682)	(0.04115)
Lag unexpected futures banks			0.00236	0.00162	0.00705	−0.04728*			0.00336**	0.00274	0.00847	−0.07622**
			(0.00155)	(0.00811)	(0.00574)	(0.02756)			(0.00171)	(0.00926)	(0.00645)	(0.03372)
Expected futures banks			−0.02251*	−0.01258	−0.00890	−0.04556			−0.02711**	−0.00004	−0.01075	−0.02594
			(0.01182)	(0.04954)	(0.01290)	(0.06194)			(0.01271)	(0.06196)	(0.01402)	(0.07655)
Lag expected futures banks			0.01915*	0.00931	0.02213*	−0.02014			0.01978	0.00401	0.02351	−0.05100
			(0.01150)	(0.03206)	(0.01299)	(0.03726)			(0.01263)	(0.03904)	(0.01445)	(0.04510)
Unexpected futures asset management			−0.00708*	0.01899	0.00618	0.01947			−0.00991**	−0.00387	0.00556	0.01101
			(0.00410)	(0.03060)	(0.00710)	(0.04307)			(0.00442)	(0.03767)	(0.00779)	(0.05594)
Lag unexpected futures asset management			0.00894***	0.05889	0.01308**	0.01382			0.01289***	0.09351**	0.01743**	0.01976
			(0.00292)	(0.03692)	(0.00633)	(0.04673)			(0.00321)	(0.04638)	(0.00717)	(0.05801)
Expected futures asset management			0.00027	−0.22616	0.01026	−0.18510			0.01164	−0.57024**	0.02115	−0.49447*
			(0.02467)	(0.22493)	(0.02561)	(0.23863)			(0.02666)	(0.25127)	(0.02786)	(0.26724)
Lag expected futures asset management			0.00798	−0.04250	0.01706	−0.06975			−0.00044	0.00827	0.00848	−0.05308
			(0.02344)	(0.16501)	(0.02411)	(0.16426)			(0.02629)	(0.19763)	(0.02703)	(0.19580)
Unexpected futures funds			−0.04266***	−0.01406	−0.02930***	−0.00862			−0.04846***	−0.01190	−0.03290***	0.01184
			(0.00532)	(0.00968)	(0.00772)	(0.03234)			(0.00558)	(0.01233)	(0.00839)	(0.04326)

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Table 16 continued

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Lag unexpected futures funds			**−0.01586****	0.00587	−0.01044	−0.03516			**−0.01593****	0.00822	−0.00977	**−0.06161****
			(0.00662)	(0.00828)	(0.00888)	(0.02541)			**(0.00750)**	(0.01000)	(0.01000)	**(0.03117)**
Expected futures funds			**−0.15130*****	−0.05060	**−0.13782*****	−0.05369			**−0.17037*****	−0.05310	**−0.15443*****	−0.03766
			(0.04011)	(0.03585)	**(0.04039)**	(0.04647)			**(0.04530)**	(0.04276)	**(0.04566)**	(0.05643)
Lag expected futures funds			0.00391	**0.11558****	0.01144	0.04671			0.00734	**0.15463*****	0.01650	0.04836
			(0.02685)	**(0.05135)**	(0.02814)	(0.06511)			(0.03046)	**(0.05632)**	(0.03164)	(0.07354)
Unexpected futures securities			**−0.01018*****	0.00219	0.00331	0.01003			**−0.01296*****	0.00951	0.00275	0.03610
			(0.00145)	(0.00615)	(0.00616)	(0.03176)			**(0.00164)**	(0.00800)	(0.00692)	(0.04287)
Lag unexpected futures securities			0.00217	0.00385	0.00736	**−0.05419***			**0.00354***	0.01860	0.00929	**−0.07324***
			(0.00189)	(0.01572)	(0.00600)	**(0.03206)**			**(0.00203)**	(0.01943)	(0.00663)	**(0.03870)**
Expected futures securities			**−0.03233*****	0.00006	−0.01782	−0.05099			**−0.03795*****	0.05954	−0.02213	0.00823
			(0.01212)	(0.05892)	(0.01480)	(0.06603)			**(0.01292)**	(0.07539)	(0.01617)	(0.07952)
Lag expected futures securities			**0.02265****	0.01711	0.02410	−0.01292			**0.02663****	0.01047	**0.02924***	−0.04020
			(0.01034)	(0.01816)	(0.01488)	(0.02476)			**(0.01192)**	(0.02255)	**(0.01728)**	(0.02991)
Unexpected spot bank			**−0.00345*****	**−0.00775****	**−0.00353*****	**−0.00840*****			**−0.00359*****	**−0.00749****	**−0.00366*****	**−0.00877****
			(0.00086)	**(0.00307)**	**(0.00087)**	**(0.00310)**			**(0.00096)**	**(0.00379)**	**(0.00098)**	**(0.00378)**
Lag unexpected spot bank			0.00044	0.00137	0.00046	0.00199			0.00078	0.00174	0.00084	0.00244
			(0.00090)	(0.00317)	(0.00092)	(0.00320)			(0.00102)	(0.00400)	(0.00105)	(0.00402)
Expected spot bank			0.00348	0.00395	0.00334	0.01056			0.00352	−0.00147	0.00288	0.00663
			(0.00621)	(0.01850)	(0.00637)	(0.01872)			(0.00683)	(0.02428)	(0.00706)	(0.02407)
Lag expected spot bank			−0.00600	−0.00203	−0.00470	−0.00776			−0.00627	0.00731	−0.00515	−0.00349
			(0.00545)	(0.01629)	(0.00540)	(0.01602)			(0.00613)	(0.02111)	(0.00606)	(0.01995)
Unexpected spot asset management			−0.00157	−0.00952	−0.00169	−0.00867			−0.00170	−0.01097	−0.00179	−0.00871
			(0.00115)	(0.00936)	(0.00115)	(0.00962)			(0.00127)	(0.01092)	(0.00128)	(0.01111)
Lag unexpected spot asset management			0.00265	−0.01553	0.00268	−0.01864			0.00301	−0.02085	0.00282	−0.02401
			(0.00279)	(0.01577)	(0.00292)	(0.01662)			(0.00307)	(0.01948)	(0.00321)	(0.02066)
Expected spot asset management			−0.01649	**0.30482****	−0.01699	**0.33668****			−0.01763	**0.37531****	−0.01681	**0.40952*****
			(0.01661)	**(0.12443)**	(0.01749)	**(0.13230)**			(0.01835)	**(0.14695)**	(0.01923)	**(0.15828)**
Lag expected spot asset management			0.01012	**−0.18143***	0.00975	**−0.19552***			0.01100	**−0.25752****	0.01023	**−0.27331****
			(0.01108)	**(0.09908)**	(0.01136)	**(0.10435)**			(0.01209)	**(0.12066)**	(0.01238)	**(0.12823)**
Unexpected spot funds			**−0.00782*****	**−0.01710*****	**−0.00786*****	**−0.01648*****			**−0.00845*****	**−0.02242*****	**−0.00849*****	**−0.02171*****
			(0.00175)	**(0.00231)**	**(0.00174)**	**(0.00238)**			**(0.00191)**	**(0.00290)**	**(0.00190)**	**(0.00295)**
Lag unexpected spot funds			**0.00266***	0.00274	**0.00274***	0.00216			**0.00291***	0.00572	**0.00297***	0.00415
			(0.00142)	(0.00342)	**(0.00143)**	(0.00355)			**(0.00156)**	(0.00425)	**(0.00156)**	(0.00441)

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Table 16 continued

Variables	(1) sreturns3	(2) sreturns10	(3) sreturns3	(4) sreturns10	(5) sreturns3	(6) sreturns10	(7) freturn3	(8) freturn10	(9) freturn3	(10) freturn10	(11) freturn3	(12) freturn10
Expected spot funds			**−0.01796***	**−0.02704****	**−0.02101****	**−0.02634****			−0.01712	**−0.03020****	**−0.01952***	**−0.02711***
			(0.00959)	**(0.01265)**	**(0.01015)**	**(0.01300)**			(0.01058)	**(0.01532)**	**(0.01118)**	**(0.01566)**
Lag expected spot funds			0.00244	0.01307	0.00345	0.01154			0.00088	0.01313	0.00203	0.01016
			(0.00848)	(0.01035)	(0.00901)	(0.01086)			(0.00981)	(0.01328)	(0.01037)	(0.01387)
Lag cross market returns	0.01273	−0.01879	−0.02678	−0.01884	−0.03495	−0.02583	−0.00199	0.02310	−0.04451	0.09165	−0.05222	0.08215
	(0.03103)	(0.04040)	(0.03504)	(0.05004)	(0.03512)	(0.05468)	(0.03780)	(0.06358)	(0.04400)	(0.07389)	(0.04393)	(0.07699)
Constant	0.00052	0.00559	0.01021	−0.00561	0.01352	0.00810	0.00329	0.01819	0.01487*	0.00492	0.01619	0.01981
	(0.00581)	(0.01756)	(0.00708)	(0.02419)	(0.00946)	(0.03015)	(0.00638)	(0.02191)	(0.00779)	(0.02836)	(0.01032)	(0.03661)
Observations	1,645	528	1,645	528	1,645	528	1,645	528	1,645	528	1,645	528
R-squared	0.08933	0.00638	0.16716	0.18543	0.17228	0.20037	0.10351	0.00679	0.17678	0.20516	0.18194	0.22564

Notes: sreturns3 = spot returns 3-year. sreturns10 = spot returns 10-year. freturn3 = future returns 3-year. freturn10 = future returns 10-year. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimates.

V. SUMMARY AND POLICY IMPLICATIONS

This paper sheds light on the role of foreign investors in price discovery through their participation in KTBs and their futures markets. We examine how price discovery takes place in the Korean government bond cash and futures markets by considering how various investor groups interact in trading and how their transactions affect the prices in both markets during the 2004–2013 sample period. We show (i) which market (cash or futures) leads price discovery in KTBs, (ii) which investor types drive this process, and (iii) which component (*expected* or *unexpected*) of net purchases and positions influence price movements in these markets.

Using daily net transaction data from the over-the-counter market for secondary cash trading and from the Korea Exchange for futures trading, we find that the futures market leads price discovery in the Korean bond markets. The model fit for the price effects of trading improves substantially if trading in both cash and futures markets is included, as opposed to considering only one of these two markets. Furthermore, the futures market contributes significantly to price movement in the cash market, while the converse is not true. This finding is in line with previous literature for advanced economies such as the US and Canada.

Our results also suggest that foreign investors' net long futures positions drive price discovery in the KTB cash and futures markets. These exert significant influence in cash and futures returns, but their net purchases in the cash market do not. The trading behavior of foreign investors participating in the futures market also appears to be different from that of foreign investors in the cash market. As for DFIs, their net cash purchases impact both cash and futures returns. Although the effects of DFI net positions on the futures returns are also significant, these seem to be explained largely by a mirror-effect of foreigners' trading, as DFIs take the offsetting positions for the foreign investors' net positions in the futures market.

Empirical results also suggest that the pricing effects of how foreign and domestic investors trade are different. Compared to DFIs, foreign net futures positions are more unpredictable, driven by factors beyond the usual domestic and global economic conditions, such as their inclination to herding and speculation, and other private information. On the other hand, DFI trading decisions in the 3-year cash market are more predictable and based on overall economic conditions (*expected*).

In terms of the pricing effects of their transactions, both *expected* and *unexpected* components exert significant influence on bond prices. Although the *expected* component of both investor groups' trading decisions appears to be more important for pricing than the *unexpected*, there is a difference in the degree of pricing effects of how foreign and domestic investors trade, based on their responses to news and private information. That is, for DFIs, the *expected* component weighs much more than the *unexpected* in the pricing effect of their cash trading, while for foreign investors, the *unexpected* component plays an important role comparable to the *expected* component in the pricing effect of their futures trading.

Overall, our findings suggest that foreign participation in KTB futures has been useful for price discovery by helping investors exploit extra information from their trading behaviors, whether this additional information is based on their response to global and local news or private information. It also appears that both foreign investors and DFIs have improved information gathering and sharing through their trading. However, our findings also suggest that the price effect of foreign net futures positions is significant and affected by the *unexpected* component of their trading. To the extent that the type of foreign investors entering the futures market is different from the one in the cash market (that is,

potentially more speculative and inclined to herding behavior), the possibility of a destabilizing effect of foreign participation in the futures market cannot be overlooked. Further research is warranted to understand the motivations behind foreign investors' participation in futures market based on their types and how these are related to market volatility.

A few policy implications can be drawn from our study. Price discovery seems to improve as the futures market develops; indeed, the Korean experience well illustrates how information transmission through trading can become more efficient in emerging bond markets over the course of futures market development. However, the Republic of Korea's experience suggests that foreign investors' trading decisions may be driven by factors that are very different from those driving domestic investors and potentially less predictable. These factors may include motivations for portfolio rebalancing, private information, idiosyncratic responses to new information, and herding. Nevertheless, the unexpected component of foreign participation in the futures market is shown to have a significant price impact on the local currency bonds. This suggests that there may be merit in making more effort to understand what types of foreign investors enter into futures markets, especially in developing economies. Different types of investors with different investment strategies and motivations—regardless of their nationalities—will likely bring in diversity, adding market liquidity and stability in the long run. However, in emerging markets, where the market remains small and shallow, foreign investors—especially if their investment strategies and motivations are similar as a group—could have a disproportionately large impact on market liquidity and volatility. This rather unpredictable, but common as a group, trading strategy of any certain investor group could have implications for sudden price movement and market instability. Therefore, promoting participation of diverse foreign investor groups and increasing the size and sophistication of domestic investors can help enhance market resilience and stability in emerging local currency bond markets.

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Price Discovery and Foreign Participation in the Republic of Korea's Government Bond Cash and Futures Markets

The authors assess the impact of foreign participation in Korean Treasury Bond (KTB) cash and futures markets and their role in the price discovery process. Using daily data from the over-the-counter market for cash and the Korea Exchange for futures transactions, the results show that foreign trading in the KTB futures market leads the price discovery process for the underlying bonds. Specifically, foreigners' daily net long positions in the futures market exert significant influence in both KTB cash and futures prices. The empirical findings also indicate that it is the unexpected component of foreign investors' net long futures positions that explains a significant share of the pricing effects.

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