The Changing Role of Foreign Investors in Tokyo Stock Price Formation

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Abstract

Recent research suggests that foreign investors improve the informational efficiency of national stock markets. This paper examines what types of information foreign investors contribute to stock prices. We investigate the information content of foreign and domestic investors' trades on the Tokyo Stock Exchange over 39 years. The influence of foreign investors' trades on the efficient price has increased since around 2000. We find this is due to a substantial increase in the importance of global stock price and exchange rate information in stock price formation. Our results suggest that foreign investors have shifted toward trading equities based on global information as international financial factors have increasingly influenced the domestic market in recent decades.

Keywords: Equities, Foreign investors, Information content of trade, Investor behaviour, Market microstructure

JEL: C32, G14, G15

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1. Introduction

Foreign portfolio investors have become important participants on the Tokyo Stock Exchange (TSE) over the last forty years. Unique for a market classified as developed since 1969[1], the shares of Japanese total stock ownership and trading volume attributed foreign investors have increased dramatically since the 1980s. Increased foreign participation has coincided with a substantial unwinding of large strategic cross-shareholdings by domestic financial and corporate investors[2]. Figure 1 shows the ownership share of various investor groups in Panel (a) and the share of trading volume in Panel (b). The investor groups included in the figure are non-resident investors (Foreign), non-financial business corporations (Corporation), financial institutions including city, regional and trust banks, life and non-life insurers (Financial), individual or retail investors (Individual) and investment trusts that may be considered the same as mutual funds (Trust). Financials and corporations once dominated stock holdings. However, ownership by foreign investors has increased from less than 10 percent in the 1980s to around 30 percent in the current decade. Meanwhile, foreign investors' transaction volumes have grown from around 10 percent to over 60 percent. The turnover share of other groups has declined, particularly individuals who were the largest traders up to the early 1990s. The presence and importance of foreign investors in the market have grown substantially since the late-1989 peak in stock prices.

What has this increased participation of foreign investors brought to the Japanese stock market? Given that trading was dominated by individuals, and ownership by individuals and strategically-motivated financials and corporations, a reasonable hypothesis may be that profit-motivated foreign, mostly institutional, investors would increase the informational efficiency of the market. Then, what type of information do foreign investors contribute to price formation, and how has this changed over time?

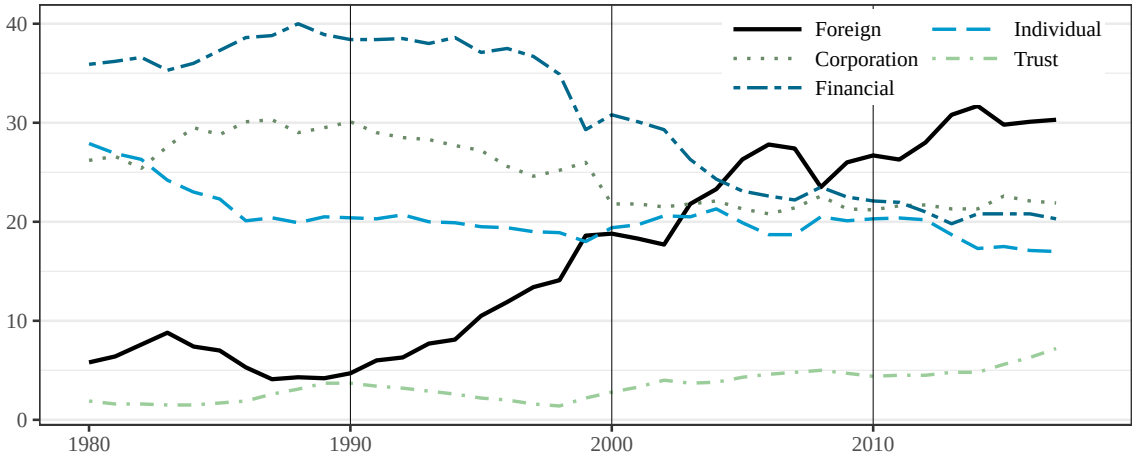
We investigate the information content of foreign and several types of domestic investors' trades on the Tokyo Stock Exchange over 39 years using a long and consistent time series of transactions in Japanese stocks. Our focus is on transactions rather than the holdings used in He and Shen (2014) and others, as transactions are more closely aligned with efficiency and the

[1] Japan has been classified as a developed market by MSCI since 1969 (MSCI, 2012).

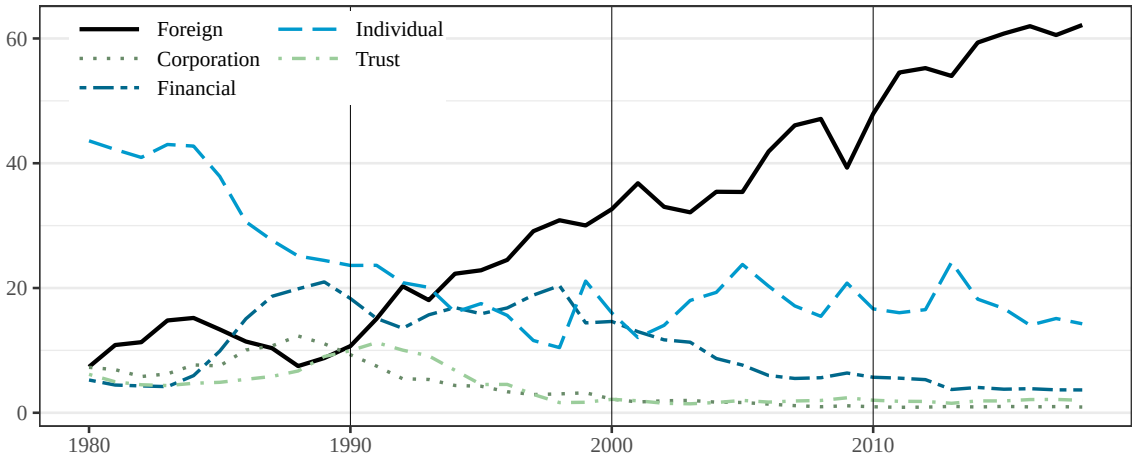
[2] Miyajima et al. (2015) provide a detailed discussion of the transition in ownership shares of domestic insiders and foreign investors. Cross-shareholdings were unwound starting in the 1990s, mostly between banks and corporations. Since the mid-2000s there has been limited renewed interest in strategic cross-shareholdings between corporations.

Figure 1: Investor Participation on the Tokyo Stock Exchange

(a) Ownership (annual, percent share)



(b) Trading Volume (annual, percent share)



impounding of information in prices than holdings[3]. The long period over which we conduct our study allows us to examine how the information content of trade has evolved, from when foreign investors were minor participants in the early 1980s, to recent years in which they dominate both ownership and trading activity.

We adapt the method proposed by Hasbrouck (1991a,b) to identify the informativeness of trades by foreign and domestic investors on the TSE. Hasbrouck analyses the interaction of order flow and price revisions using a bivariate structural vector autoregression (SVAR) that isolates the random-walk and stationary components of price. The former is considered as the efficient price and the latter mispricing. This approach measures the information content of

[3]Boehmer and Kelley (2009) find that both the transactions and holdings of institutions matter, and transactions are more important where the stock was previously mispriced.

trade by decomposing the efficient price variance into a trade-related component and a non-trade-related component. Investor groups having a substantial influence on the efficient price are considered informed. We adapt Hasbrouck's approach by specifying a multivariate vector autoregression (VAR) of transactions and relevant returns series to identify the influence of foreign and domestic investors' trades on the efficient price, as well as the importance of public information. Our benchmark model contains the transactions of foreign, financial, trust and individual investors, and returns on the TOPIX index. We compare the benchmark model with models including global stock price and exchange rate returns.

Our benchmark model shows that foreign investors are informed and that their influence over the efficient price of Japanese stocks has increased since around 2000. Domestic financial, trust and individual investors are uninformed. We then compare the benchmark model with models including global stock prices and the exchange rate. We find that the increase in foreign investors' information share is due to a substantial increase in the importance of global stock price and exchange rate information in Japanese stock price formation. Global stock prices have become more important since around 2000 while the exchange rate is important in the 2010s. Comparing the trade-related information in the transactions of foreign, financial, trust and individual investors, we show the information advantage of foreign investors relative to individual investors is lower when global equity prices and the exchange rate are taken into account. The information share of financials and trusts is consistently negligible. Our results suggest that foreign investors have shifted toward trading equities based on global information as international financial factors have increasingly influenced the domestic market in recent decades.

The article proceeds as follows. We survey the relevant literature in Section 2. Section 3 covers our VAR model, and discusses the transactions and returns data used for estimation. We explain our empirical results and their implications in Section 4. Section 5 concludes.

2. Relevant Literature

Several recent studies show that foreign investors contribute to the efficiency of equity markets. Kacperczyk et al. (2018) build a cross country database for over twenty three thousand firms in forty countries and document that stocks with higher foreign institutional ownership have more informative prices. Similarly, He et al. (2013) demonstrate a positive relationship between ownership by large foreign investors and price informativeness in forty markets. He and Shen (2014) show that Japanese stock prices deviate less from a random walk for stocks

with a large change in foreign ownership. The participation of foreign investors in many emerging markets with has been increasing. Vo (2017) finds that foreign ownership improves stock price informativeness in the Vietnamese market. Using data for over four thousand stocks in twenty one emerging markets, Bae et al. (2012) find that greater investibility reduces price delay to global market information and infer that financial liberalisation yields efficiency improvements. However, Qin and Bai (2014) find fully investible emerging market stocks have no post-earnings-announcement drift but do exhibit stronger long-run price momentum than those which are non-investible for foreigners.

A related area of literature pertains to the information asymmetry between domestic and foreign traders, and their relative investment performance. Evidence published to date suggests that foreigners may be at an advantage or disadvantage to locals. Numerous studies suggest that domestic investors have superior local information and for that reason they have a performance advantage over foreign investors. Kang and Stulz (1997) show that foreign investors hold more stocks of large firms than small firms in Japan, and suggest this may indicate foreign investors have a greater information disadvantage in trading small stocks. Foreign investors may be at a disadvantage due to their distance from a firms' headquarters (Coval and Moskowitz, 1999, 2001) or language difference (Grinblatt and Keloharju, 2001)[4]. Looking over thirty two countries, Ferreira et al. (2017) find foreign institutional investors are disadvantaged relative domestic institutions in countries with difficult investment environments, and during market downturns or periods of high market uncertainty. On the other hand, several studies provide evidence that foreign investors have superior information or generate higher trading profits than domestic investors. Seasholes (2000) shows that foreign investors time Taiwanese firm's earnings announcements well, and Grinblatt and Keloharju (2000) provides evidence from the Finnish equity market that foreigners are better stock pickers than domestic investors. In a study of the Japanese stock market over 1995 to 2001, Karolyi (2002) found foreign investors were profitable and appeared to be good market timers, while domestic investors performed poorly. Similarly, Kamesaka et al. (2003) found foreign investors in Japanese stocks made profits while retail investors did not. Bae et al. (2006) also demonstrates that foreigners have superior market timing ability in Japanese stocks. Albuquerque et al. (2009) provides a model and evidence suggesting that that US investors exploit superior global information when they invest in foreign

[4]MSCI (2019) notes that a lack of company and market information available in English, and a relatively poor general level corporate governance for a developed market, as well as unconventional dividend practices, constitute access impediments for foreign investors in the Japanese stock market.

markets.

Another relevant literature investigates the question of whether stocks are priced internationally or locally. If foreign investors play an important role in incorporating global information into stock prices, this supports the case for global pricing. Karolyi and Stulz (2003) discuss strong evidence suggesting national equity risk premia are determined internationally. For instance, a number of papers suggest that exchange rates influence country stock market risk premia (Dumas and Solnik, 1995; De Santis and Gérard, 1998). On the other hand, Karolyi and Stulz see less of an established case for the influence of international factors on the the cross-section of expected returns, and they note that home bias increases the local influence on asset prices.

Our work is also related to the literature on the time-varying international dependence between equity markets. Phenomena such as greater financial openness and international capital flows, improvements in information and communications technology, increases in international economic linkages through complex supply chains and trade in goods and services, greater multinational operation of listed firms, and the trend toward globalisation in general point to the likelihood of increased international financial market integration over time. With greater integration, the increased comovement of stock returns on national markets would seem a reasonable hypothesis. Longin and Solnik (1995) found an increase in international correlation between developed market stocks, including Japan, over the 1960 to 1990 period. Berben and Jansen (2005) found evidence suggesting the correlation between German, US and UK equities had doubled over the period 1980 to 2000, but correlations with Japanese markets had stayed the same. Looking across 16 developed (including Japan) and 17 emerging market over 1973 to 2009, Christoffersen et al. (2012) show that correlations have increased markedly in both, while remaining lower in emerging than developed markets. Okimoto (2014) demonstrates increased asymmetric dependence between the stock markets of France, Germany, the UK and US over the period 1973 to 2008. Evidence that cross market linkages in the Pacific Basin region are time-varying and have become stronger over the period 1993 to 2014 is presented in Chevallier et al. (2018)[5] However, examining specific country-industry and country-style portfolios in developed markets, Bekaert et al. (2009) suggest that only return correlations within Europe have increased over 1980 to 2005. A common finding is that national equity market correlations rise during, or following, periods of high volatility or financial crisis (Longin and Solnik, 1995; von

[5]Chevallier et al. (2018) found that the Japanese stock market receives more spillover effects from other markets than it transmits.

Furstenberg and Jeon, 1989; Koch and Koch, 1991; King et al., 1994; Liu et al., 1998)[6].

3. Methodology and Data

3.1. VAR Model of Transactions and Returns

We estimate multivariate VAR models of trade ratios and returns of the form:

$$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \cdots + \Phi_P Y_{t-P} + \epsilon_t \tag{1}$$

where Y_t contains the trade ratio and returns variables, and the Φ_i are coefficient matrices for lag $i = 1 \ldots P$ included in the VAR[7]. We estimate a benchmark model including trade ratios for four investor groups (foreign, financial, trust and individual) and TOPIX returns, where the number of variables, N, is five. The construction of the trade ratios is explained in Section 3.2. We also estimate models that include global returns variables which are, either and both of, S&P 500 returns and USD/JPY exchange rate returns.

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

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

$$p_t = m_t + s_t \tag{2}$$

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

[6] Also see articles from the contagion literature such as Bekaert et al. (2011) who suggest crisis periods lead to the international transmission of information as described by the "wake-up call hypothesis".

[7] Following the approach in the literature, the block-recursive identification framework is used. The number of lags to be included in each VAR model is determined using Akaike's Information Criterion (AIC) and the models were estimated using ordinary least squares.

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

$$m_t = m_{t-1} + \omega_t \tag{3}$$

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

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

The VAR model shown in equation (1) can be inverted to the Vector Moving Average (VMA) representation:

$$Y_t = \left(I + \theta_1 L + \theta_2 L^2 + \theta_3 L^3 + \ldots\right) \epsilon_t = \theta\left(L\right) \epsilon_t \tag{4}$$

where L is the lag operator, the θ_i are $N \times N$ matrices of coefficients for N variables in the model, and ϵ_t is a white noise error process with $E\left(\epsilon_t\right) = 0$ and $Var\left(\epsilon_t\right) = \Omega$.

The variance of the shock to the permanent component of the security's price is estimated from the VMA representation in (4) as:

$$\sigma_\omega^2 = \left[\theta\left(1\right)\right]_N \Omega \left[\theta\left(1\right)\right]_N' \tag{5}$$

where $\left[\theta\left(1\right)\right]_N$ denotes the N^{th} row of $\left[\theta\left(1\right)\right]$ that corresponds to the returns equation, and $\left[\theta\left(1\right)\right] = I + \theta_1 + \theta_2 + \ldots$.

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

$$\sigma_{\omega,x_g}^2 = \left[\theta^\star\left(1\right)\right]_N \Omega \left[\theta^\star\left(1\right)\right]_N' \tag{6}$$

where $\theta^\star$ represents θ from the VMA with the coefficients related to all other investor groups and the nontrade-related coefficients set to zero. Similarly, the variance of the non-trade-related component $\sigma_{\omega,r}^2$ is calculated by setting $\theta^\star$ to the θ from the VMA with zeros for the coefficients related to all investor groups.

As the trading behaviour of the different investor groups is correlated, we expect Ω to be a non-diagonal covariance matrix. Accordingly, we use Cholesky factorisation to extract σ^2_ω. Set $\Omega = F'F$, where where F is the upper triangular Cholesky factor, and let $d = [\theta(1)]_N F'$. Then the variance of the permanent shock is the sum of the squares of the elements of d:

$$\sigma^2_w = \sum d_i^2 \tag{7}$$

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

3.2. Transactions and Returns Data

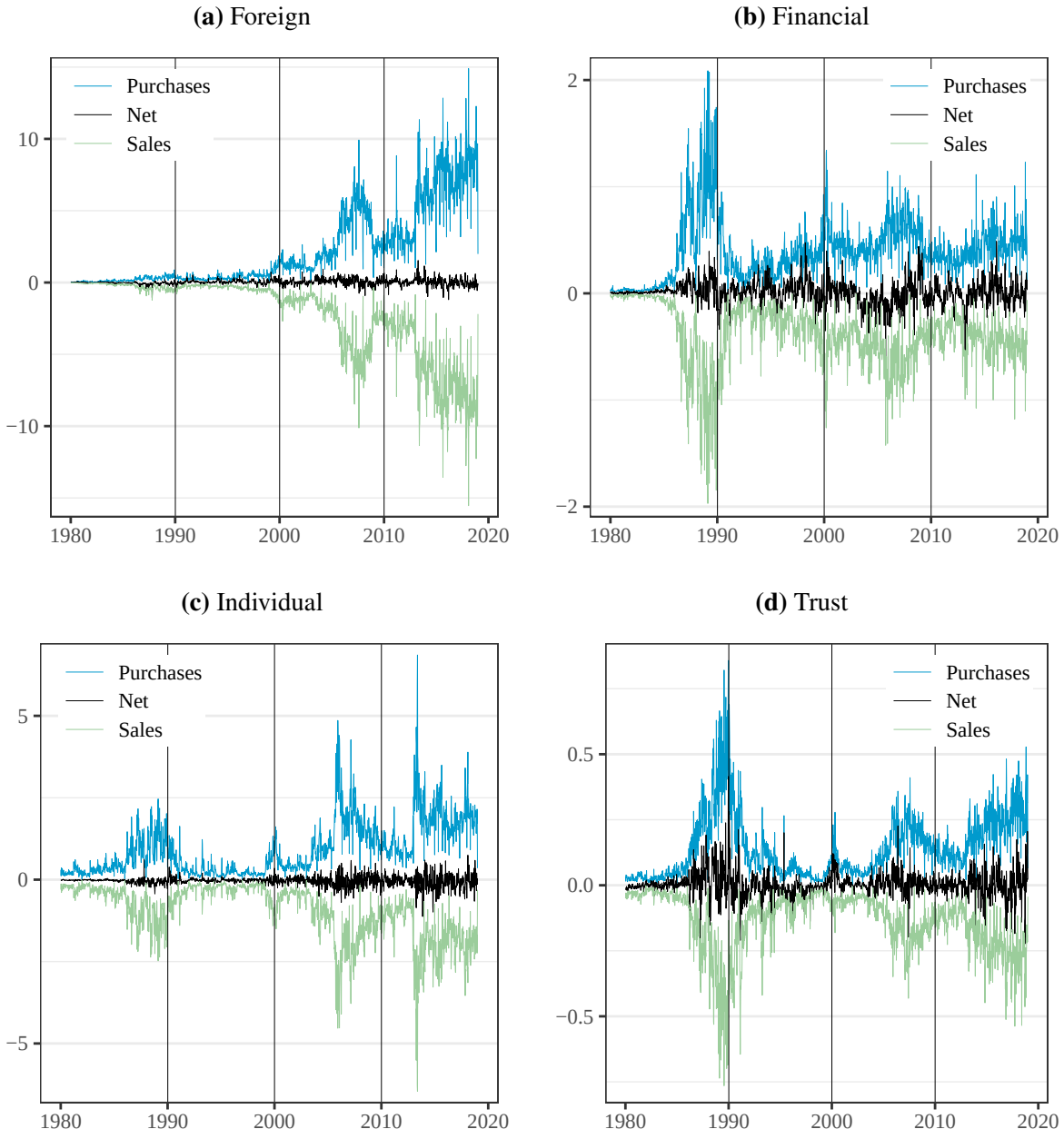
We use weekly data on the yen value of trading by different types of investors on the TSE from the first week of January 1980 to the last week of December 2018. The transactions are for Japanese stocks that are listed on the First Section of the Exchange, which contains large firms[8]. The transactions data is collected by the TSE from its member firms (general trading participants) on the exchange who have a minimum capital of three billion yen. It includes all the member firms' proprietary and client initiated brokerage transactions. We exclude the member firm's proprietary trades given that these trades include liquidity provision for client orders as well as trades on their own book. The client brokerage transactions represent around 80 percent of all trades on TSE. The transactions data set was obtained from the Nikkei Financial Quest database.

The transactions are broken down into the value of purchases and sales by different types of investor[9]. We include four investor groups in our analysis: foreign, individual, investment trusts (refereed to as "trusts"), and financials. Foreign investors are defined as all non-resident investors. While the category includes both foreign institutional and individual investors, the vast majority of trades are by institutions. Financials is composed of various types of domestic

[8]The TSE First Section contains 2150 large firms, as of 16 August 2019. The minimum capitalisation for First Section listing is currently two billion yen.

[9]The TSE data contains the following breakdown. Total trading value is divided into proprietary trading and client initiated brokerage trading. Client initiated brokerage transactions are divided into institutions; individuals; foreigners; and securities companies. Institutions are decomposed into investment trusts; business corporations; other corporations; and financial institutions. Financial institutions are further divided into life and non-life insurers; city and regional banks; trust banks; and other financials.

Figure 2: Transactions Data (weekly, trillions of yen, sales shown as negative)

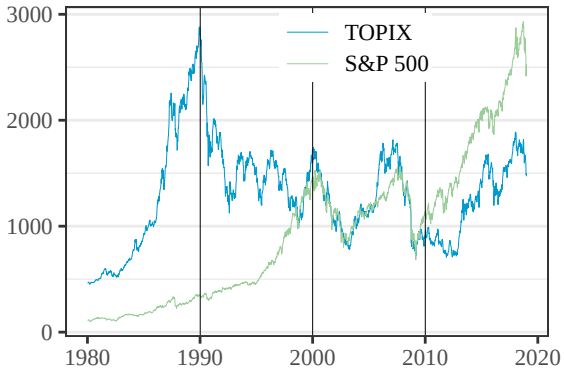


financial institutions, including life and non-life insurers, city and regional banks, trust banks and others. We exclude the trades of corporations and securities firms from our analysis. Both groups constitute a small share of trades, and corporate transactions reflect, in part, changes in strategic cross-shareholdings rather than profit motivated trades.

Plots of the purchases, sales (shown as negative values) and net purchases for each investor group are shown in Figure 2. Note the different vertical axis scales in each panel. The plots give a clear visualisation of when the four investor groups have been relatively active traders, by yen value of their transactions. Foreign investors trading activity increased substantially in

Figure 3: Equity Index and Exchange Rate Data (weekly)

(a) TOPIX and S&P 500



(b) USD/JPY Exchange Rate

the 2000s and 2010s. Individuals have also been relatively active over the last two decades. Financials and trusts were relatively active during the 1980s bull market in Japan.

Using the TSE transactions data we calculate the trade ratio, $x_{g,t}$, for each investor group, $g = 1, \ldots, 4$, as:

$$x_{g,t} = log\left(\frac{B_{g,t}}{S_{g,t}}\right) \tag{8}$$

where $B_{g,t}$ and $S_{g,t}$ represent the yen value of stock purchases and sales by investor group g at time t, respectively[10].

We also use weekly logarithmic returns on the TOPIX, S&P 500 and the USD/JPY exchange rate. TOPIX returns represent the return on domestic stocks[11]. S&P 500 returns are used as a proxy for foreign or global equity returns. The USD/JPY return is used to represent foreign information from the currency market. Returns on the TOPIX and S&P 500 are calculated using the weekly close index value, while the USD/JPY return is calculated using the New York close rate. TOPIX is obtained from the Nikkei Financial Quest database while the S&P 500 and USD/JPY are taken from Bloomberg. Plots of the equity indices and exchange rate are shown in Figure 3.

We divide our 39 year sample into four approximately equal length subsamples to study changes in the information content of trades. One of the advantages of our study is the ability to examine these changes over a very long horizon using consistent time series of transactions

[10]We considered two alternative trade ratio indicators: (i) the difference between each group's purchases and sales, and (ii) the difference between each group's purchases and sales divided by purchases plus sales. The logarithm of purchases divided by sales appears has the mildest variation over the sample.

[11]The TOPIX is a capitalisation-weighted index of all firms in the TSE First Section.

data. The decision to divide the sample agnostically into four equal periods rather than search for potential break points was primarily driven by the practicality of having enough observations in each subsample to estimate the VAR model. The subsamples span the first week in January to the last week in December for the following periods: 1980 to 1989 (referred to as the 1980s), 1990 to 1999 (1990s), 2000 to 2009 (2000s) and 2010 to 2018 (2010s). The number of weekly observations in each subsample is 520, 521, 522 and 470 for the 1980s, 1990s, 2000s and 2010s, respectively. The vertical lines in Figures1, 2 and 3 delineate the subsamples.

3.3. Summary Statistics

Summary statistics for the equity transactions and returns data are provided for each subsample in Tables 1 and 2. We show summary statistics for the purchases, sales and net transactions of foreign, financial, trust and individual investors. Also included are statistics for total transactions, which includes proprietary trades and client initiated brokerage trades for all investor groups in the TSE data set. There are differences in the net transactions of the four investor groups over the subsamples. Foreign investors are net sellers in the 1980s and net buyers thereafter. Individuals are net sellers in all subsamples. Financials are net buyers in the 1980s and 1990s, and net sellers in the 2000s and 2010s. Trusts are net buyers in the 1980s, 2000s and 2010s, and sellers in the 1990s. Foreign investors have the largest average purchases and sales in all subsamples, except the 1980s when individuals are the largest. Purchases and sales generally show high autocorrelation, while net purchases are somewhat less autocorrelated, particularly in the latter half of the sample.

Foreign investors' trading behaviour is very different to that of domestic investors. Table 3 shows the correlations between foreign and domestic investor groups' trade ratios, which are negative and significant in all subsamples. The relationship between trading and equity returns is also different for foreign versus domestic investors. Foreign investors' trades are positively and significantly correlated with TOPIX and S&P 500 returns in all subsamples. In contrast, the significant correlations between domestic investors' trades and the equity indices are all negative.

Japanese and foreign equity returns are more positively correlated in the latter half of the sample, consistent with a greater influence of international factors on the Japanese equity market in recent decades. Foreign trades are more positively correlated with TOPIX and S&P 500 returns in the 2000s and 2010s compared with the 1980s and 1990s. Conversely, individuals' trades are more negatively correlated with both indices in the latter two subsamples.

Table 1: Summary Statistics for the 1980s and 1990s

	Mean	Med	Max	Min	Sum	S.D	Skew	Kurt	ρ_1	ρ_2	ρ_3
1980s Equity Transactions											
Total purchases	2084.85	1050.03	9778.34	46.30	1084.12	2058.27	1.33	3.84	0.88	0.83	0.82
Total sales	2073.33	1040.86	9793.53	43.43	1078.13	2050.81	1.33	3.85	0.89	0.83	0.82
Net purchases	11.52	8.70	109.93	-142.02	5.99	25.47	0.24	7.84	0.43	0.23	0.18
Foreign purchases	189.16	134.97	881.95	3.02	98.36	153.75	1.21	4.10	0.69	0.54	0.51
Foreign sales	224.06	150.78	1226.62	5.09	116.51	196.79	1.20	4.24	0.88	0.82	0.81
Foreign net purchases	-34.90	-11.86	203.05	-1045.39	-18.15	94.21	-4.05	34.84	0.85	0.80	0.77
Financial purchases	358.07	84.20	2087.08	5.03	186.20	468.55	1.39	3.99	0.90	0.86	0.85
Financial sales	326.65	61.77	1969.98	1.88	169.86	443.75	1.46	4.24	0.89	0.85	0.84
Financial net purchases	31.43	12.15	394.24	-182.94	16.34	66.98	1.44	7.59	0.56	0.39	0.38
Trust purchases	142.34	49.28	857.57	3.02	74.02	168.94	1.62	5.02	0.89	0.86	0.86
Trust sales	132.07	48.85	764.97	1.15	68.67	157.57	1.69	5.16	0.89	0.86	0.85
Trust net purchases	10.28	1.73	415.08	-212.28	5.34	49.37	1.87	16.78	0.51	0.19	0.14
Individual purchases	595.13	407.91	2464.17	16.12	309.47	493.63	1.39	4.26	0.84	0.76	0.75
Individual sales	631.47	431.55	2477.82	18.71	328.36	518.85	1.35	4.15	0.84	0.76	0.75
Individual net purchases	-36.34	-19.60	623.10	-434.08	-18.90	65.94	0.55	25.50	0.48	0.28	0.22
1980s Equity and Exchange Rate Returns											
TOPIX	0.3497	0.3461	6.9552	-12.1678		1.8468	-0.57	7.77	0.00	0.06	0.07
S&P 500	0.2300	0.4604	8.4617	-13.0071		2.2416	-0.61	6.42	0.01	0.04	-0.04
JPY	-0.0943	0.0373	6.3120	-8.6974		1.5251	-0.64	5.73	0.09	0.09	0.04
1990s Equity Transactions											
Total purchases	1804.39	1584.91	5415.19	125.43	940.09	928.42	1.32	4.78	0.80	0.70	0.64
Total sales	1793.86	1570.32	5405.68	121.51	934.60	929.53	1.33	4.81	0.80	0.70	0.64
Net purchases	10.52	11.37	133.24	-146.73	5.48	20.62	-0.77	16.76	0.43	0.30	0.13
Foreign purchases	422.40	346.24	1860.58	19.42	220.07	266.30	1.95	7.92	0.83	0.75	0.71
Foreign sales	376.88	320.11	1465.84	13.67	196.36	220.95	1.69	6.99	0.87	0.79	0.76
Foreign net purchases	45.52	30.84	719.86	-519.35	23.72	126.99	0.65	6.76	0.62	0.52	0.40
Financial purchases	306.64	285.93	952.35	12.64	159.76	161.18	1.12	4.79	0.75	0.63	0.57
Financial sales	293.38	242.74	1044.81	5.75	152.85	190.53	1.30	4.67	0.77	0.65	0.59
Financial net purchases	13.26	19.23	476.02	-543.45	6.91	109.08	-0.38	5.37	0.63	0.48	0.43
Trust purchases	103.41	70.81	689.14	5.74	53.88	99.26	2.22	8.95	0.86	0.81	0.76
Trust sales	114.31	83.61	644.84	1.95	59.55	97.45	1.91	6.94	0.86	0.81	0.76
Trust net purchases	-10.90	-9.84	280.44	-210.18	-5.68	45.90	0.93	10.99	0.59	0.37	0.26
Individual purchases	325.45	220.77	1629.21	21.00	169.56	264.91	1.84	6.38	0.83	0.72	0.65
Individual sales	343.49	246.58	1408.17	24.19	178.96	251.76	1.64	5.54	0.82	0.72	0.66
Individual net purchases	-18.04	-19.29	384.58	-264.93	-9.40	68.53	1.20	9.15	0.48	0.38	0.20
1990s Equity and Exchange Rate Returns											
TOPIX	-0.0956	-0.0381	10.8383	-11.9169		2.7857	-0.03	4.74	-0.01	0.08	0.04
S&P 500	0.2741	0.3456	7.0619	-6.8626		1.8624	-0.05	3.77	-0.12	0.07	0.01
JPY	-0.0650	0.1094	5.9878	-14.9794		1.7284	-1.48	13.56	-0.04	0.05	-0.01

Notes:
1. The summary statistics are the mean (Mean), median (Med), maximum (Max), minimum (Min), sum (Sum), standard deviation (S.D.), skewness (Skew), excess kurtosis (Kurt), and the autocorrelation coefficients for one (ρ_1), two (ρ_2) and three (ρ_3) lags.
2. Transactions are in billions of yen per week, except for the sum which is stated as trillions of yen for the whole subsample. Returns are in percent per week.

The USD/JPY exchange rate return has a strengthening positive relationship with both domestic and foreign equity returns in the second half of the sample. In particular, the correlation between exchange rate and TOPIX returns in the 2010s is more than double its magnitude in the 2000s. The relationship between the exchange rate and the investor groups' trades evolves over the sample. In the 1980s, the correlation between foreign trades and the exchange rate is negative and significant, while financials' and individuals' trades are positively and significantly correlated with the USD/JPY. The pattern in the 2010s is the opposite, as the exchange

Table 2: Summary Statistics for the 2000s and 2010s

	Mean	Med	Max	Min	Sum	S.D.	Skew	Kurt	ρ_1	ρ_2	ρ_3
2000s Equity Transactions											
Total purchases	6655.49	5507.85	18911.57	170.15	3474.16	3712.40	0.81	2.74	0.88	0.82	0.82
Total sales	6651.60	5496.66	18907.18	169.55	3472.14	3713.76	0.81	2.75	0.88	0.82	0.82
Net purchases	3.88	4.15	84.70	-87.00	2.03	20.27	-0.20	4.33	0.20	0.08	0.03
Foreign purchases	2699.85	2033.32	9921.18	61.52	1409.32	1795.67	0.94	2.93	0.90	0.85	0.85
Foreign sales	2638.04	1930.63	10122.76	61.90	1377.06	1794.86	1.04	3.26	0.90	0.84	0.83
Foreign net purchases	61.81	48.65	932.43	-911.73	32.27	224.04	-0.03	4.15	0.39	0.31	0.27
Financial purchases	504.76	481.61	1341.30	18.86	263.49	185.05	0.78	4.83	0.62	0.48	0.42
Financial sales	525.80	494.05	1424.84	5.86	274.47	211.07	0.85	4.42	0.64	0.46	0.43
Financial net purchases	-21.03	-18.64	438.73	-692.50	-10.98	131.90	0.12	4.90	0.62	0.48	0.42
Trust purchases	130.32	115.94	410.57	2.23	68.03	75.89	0.69	2.72	0.82	0.78	0.76
Trust sales	120.66	99.21	431.36	1.45	62.98	74.17	0.89	3.32	0.83	0.78	0.77
Trust net purchases	9.66	6.08	226.39	-197.84	5.04	33.82	0.60	9.25	0.45	0.39	0.26
Individual purchases	1196.72	1010.39	4859.04	30.65	624.69	825.24	1.31	5.17	0.89	0.84	0.82
Individual sales	1233.22	1078.94	4534.86	28.43	643.74	831.54	1.16	4.47	0.89	0.85	0.83
Individual net purchases	-36.51	-32.87	587.79	-691.38	-19.06	173.81	0.03	4.29	0.16	0.10	0.04
2000s Equity and Exchange Rate Returns											
TOPIX	-0.1227	0.1026	9.2469	-22.0185		2.9393	-0.94	8.72	-0.06	0.04	-0.03
S&P 500	-0.0528	0.0958	11.3559	-20.0837		2.7847	-0.86	10.07	-0.06	0.06	-0.09
JPY	-0.0186	0.0208	4.5521	-7.5236		1.4609	-0.37	4.42	-0.07	0.06	-0.03
2010s Equity Transactions											
Total purchases	10170.49	10462.93	23617.75	2048.79	4780.13	3936.67	0.16	2.42	0.77	0.68	0.68
Total sales	10167.24	10466.92	23664.30	2047.38	4778.60	3934.44	0.16	2.43	0.77	0.69	0.68
Net purchases	3.25	2.11	89.91	-80.64	1.53	17.38	0.40	7.88	0.33	0.12	0.06
Foreign purchases	5961.64	6160.41	14896.54	1029.23	2801.97	2545.00	0.14	2.20	0.80	0.73	0.72
Foreign sales	5930.58	6214.47	15535.88	844.97	2787.37	2574.39	0.20	2.33	0.81	0.74	0.73
Foreign net purchases	31.06	17.93	1535.62	-1193.50	14.60	289.11	0.23	6.27	0.44	0.30	0.18
Financial purchases	417.12	402.15	1229.02	50.77	196.05	149.76	1.02	6.05	0.48	0.30	0.27
Financial sales	421.62	406.18	1179.05	49.61	198.16	155.32	0.99	5.68	0.47	0.37	0.37
Financial net purchases	-4.49	-6.39	487.89	-543.13	-2.11	116.46	-0.14	5.15	0.61	0.45	0.37
Trust purchases	196.11	187.37	527.98	21.28	92.17	88.32	0.56	2.97	0.69	0.62	0.59
Trust sales	195.97	184.74	537.65	19.70	92.11	91.58	0.71	3.46	0.71	0.61	0.60
Trust net purchases	0.14	0.74	205.39	-223.45	0.07	51.88	-0.38	6.16	0.40	0.17	0.07
Individual purchases	1677.21	1660.68	6855.67	351.73	788.29	775.06	1.46	8.95	0.78	0.69	0.66
Individual sales	1742.05	1699.22	6456.86	303.72	818.76	819.34	1.29	7.37	0.77	0.68	0.65
Individual net purchases	-64.83	-47.90	746.69	-1124.51	-30.47	237.41	-0.47	5.03	0.31	0.11	0.01
2010s Equity and Exchange Rate Returns											
TOPIX	0.1028	0.3788	8.4911	-13.4842		2.6198	-0.62	4.91	0.03	0.00	-0.06
S&P 500	0.1745	0.2835	7.1284	-7.4603		1.9800	-0.60	4.93	-0.11	0.00	-0.05
JPY	0.0327	0.0635	4.2261	-4.8477		1.3253	-0.10	3.54	-0.02	-0.01	0.00

Notes:
1. The summary statistics are the mean (Mean), median (Med), maximum (Max), minimum (Min), sum (Sum), standard deviation (S.D.), skewness (Skew), excess kurtosis (Kurt), and the autocorrelation coefficients for one (ρ_1), two (ρ_2) and three (ρ_3) lags.
2. Transactions are in billions of yen per week, except for the sum which is stated as trillions of yen for the whole subsample. Returns are in percent per week.

rate is positively and significantly correlated with foreign trades and negatively and significantly correlated with the trades of financials, trusts and individuals.

3.4. Order of Variables in the VAR

The order in which variables enter a VAR can influence the orthogonalized impulse responses. Variables should be ordered from most to least exogenous. We assume that global returns are the most exogenous and thus enter the VAR first. The daily close of trade on TSE

Table 3: Correlations Between Trade Ratio and Returns Variables for Each Subsample

	For	Fin	Tru	Ind	TOP	SP5	For	Fin	Tru	Ind	TOP	SP5
	1980s						*1990s*					
Fin	-0.24***						-0.49***					
Tru	-0.37***	0.01					-0.27***	0.15***				
Ind	-0.43***	-0.04	-0.20***				-0.29***	-0.14***	0.06			
TOP	0.33***	-0.21***	0.01	-0.29***			0.24***	-0.30***	-0.10**	-0.26***		
SP5	0.25***	-0.15***	0.03	-0.19***	0.37***		0.11***	-0.13***	-0.05	-0.17***	0.33***	
JPY	-0.10**	0.12***	-0.04	0.14***	-0.16***	-0.04	0.02	0.00	-0.04	-0.04	-0.07	0.11**
	2000s						*2010s*					
Fin	-0.55***						-0.45***					
Tru	-0.25***	0.30***					-0.21***	0.43***				
Ind	-0.56***	0.17***	0.07*				-0.63***	0.16***	0.19***			
TOP	0.48***	-0.18***	-0.03	-0.64***			0.51***	-0.10**	-0.11**	-0.75***		
SP5	0.25***	-0.12***	0.00	-0.34***	0.52***		0.28***	-0.06	-0.06	-0.49***	0.56***	
JPY	-0.04	-0.01	-0.02	-0.09*	0.22***	0.22***	0.30***	-0.09*	-0.12***	-0.44***	0.57***	0.28***

Notes:
1. The trade ratios are foreign (For), financial (Fin), trusts (Tru) and individuals (Ind).
2. The returns are TOPIX (TOP), S&P 500 (SP5) and USD/JPY (JPY).
3. Significant at 1% shown by ***, at 5% shown by **, at 10% shown by *.

occurs prior to the NYSE open. However, on a weekly basis it is reasonable to expect that the US equity market influences Tokyo more than the other way around. The market capitalisation of NYSE is far greater than that of TSE and the bulk of global market moving economic and corporate news is released during European and US trading hours, influencing US equity indices before Tokyo. We assume an order for the remaining variables of foreign, financial, trust and individual trade ratios followed by TOPIX, thus assuming that TSE transactions are more exogenous than TOPIX returns.

4. Empirical Results

Table 4 shows the results for the model including the trade ratio for each investor group and TOPIX returns. This is the benchmark model to which we compare the results from models including the returns of the S&P 500 and the exchange rate.

Panel (a) provides the long-run price impact of trade for each investor group, which is the cumulative impulse response to a one standard deviation unanticipated increase in the investor group's trade ratio, evaluated at thirty weeks ahead. The long-run price impact of a shock to TOPIX returns is also provided. A positive (negative) long-run price impact of trade for an investor group shows that an unanticipated purchase is expected to be followed by a cumulative increase (decrease) in price over the following thirty weeks. An investor group may be informed if the long-run price impact of their trades is positive, and uninformed if the long-run price impact is zero or negative.

Table 4: Benchmark Model

	1980s	1990s	2000s	2010s
(a) Long-Run Price Impact of Trade				
Foreign	1.27	1.89	2.07	1.82
Financial	-0.17	-0.44	0.06	0.04
Trust	0.27	-0.10	-0.36	-0.17
Individual	-0.45	-1.05	-1.02	-1.52
TOPIX	1.71	2.39	2.09	1.53
(b) Variance Decomposition of the Efficient Price (%)				
Foreign	33.23	33.84	43.74	41.63
Financial	0.57	1.83	0.04	0.02
Trust	1.49	0.09	1.33	0.34
Individual	4.21	10.45	10.60	28.80
TOPIX	60.49	53.79	44.29	29.20
Trade-related	39.51	46.21	55.71	70.80
(c) Share of the Trade-related Component (%)				
Foreign	84.12	73.23	78.52	58.81
Financial	1.45	3.95	0.07	0.03
Trust	3.78	0.20	2.39	0.48
Individual	10.65	22.62	19.02	40.68

Notes:
1. Models were estimated with 4, 3, 4 and 2 lags for the 1980s, 1990s, 2000s and 2010s subsamples, respectively.
2. Trade-related component includes Foreign, Financial, Trust and Individual investor trade ratios.
3. Order in which the variables were included in the VAR is Foreign, Financial, Trust, Individual and TOPIX.

The variance decomposition of the efficient price in percent share is given in Panel (b). This shows the extent to which an exogenous shock to each variable in the model explains the variance of the efficient price. The share for each investor group reflects the proportion of efficient price variation attributed to their unanticipated trades. These are the trade-related components of the efficient price. We also show the total trade-related component in the table. The variance decomposition share for the TOPIX represents the nontrade-related component of the efficient price, which is the efficient price variation due to a shock in stock prices. The trade-related components are interpreted as private information contained within the trades of investors, while nontrade-related component is considered public information transmitted by price innovations. Investors with a positive long-run impact and relatively large trade-related information share are considered to be more informed. We isolate percent shares of the trade-related component in Panel (c) to enable clear comparison of the investor groups' relative information shares between the benchmark model in Table 4 and the subsequent models that contain foreign returns variables.

In the benchmark model, foreign investors are informed. Foreigners have a positive long-run

Table 5: Model Including S&P 500 Returns

	1980s	1990s	2000s	2010s
(a) Long-Run Price Impact of Trade				
Foreign	0.68	1.59	1.06	1.21
Financial	-0.03	-0.46	0.05	0.12
Trust	0.21	-0.06	-0.21	-0.10
Individual	-0.32	-1.12	-0.71	-0.96
TOPIX	1.66	2.31	1.61	1.27
S&P 500	1.15	1.48	2.23	1.96
(b) Variance Decomposition of the Efficient Price (%)				
Foreign	9.81	22.00	12.15	18.69
Financial	0.02	1.82	0.03	0.19
Trust	0.95	0.03	0.48	0.12
Individual	2.25	10.86	5.39	11.79
TOPIX	58.70	46.33	27.96	20.41
S&P 500	28.27	18.95	54.00	48.79
Trade-related	13.03	34.72	18.04	30.79
(c) Share of the Trade-related Component (%)				
Foreign	75.31	63.37	67.32	60.68
Financial	0.14	5.25	0.16	0.63
Trust	7.30	0.08	2.64	0.40
Individual	17.25	31.29	29.88	38.29

Notes:
1. Models were estimated with 3 lags for the 1980s, and 2 lags for the 1990s, 2000s and 2010s subsamples.
2. Trade-related component includes Foreign, Financial, Trust and Individual investor trade ratios.
3. Order in which the variables were included in the VAR is S&P 500, Foreign, Financial, Trust, Individual and TOPIX.

price impact and a relatively large information share in all subsamples. The influence of foreign investors' trades on the efficient price increased substantially in the 2000s and remained high in the 2010s. Table 4 Panel (c) shows that foreign investors dominate the trade-related component of the efficient price relative to domestic investors. Financials, trusts and individuals are uninformed. Financials and trusts have mixed positive and negative long-run price impacts that are relatively small in absolute value and their information shares are very low suggesting they have almost no influence on the efficient price. Individual investors have a negative long-run price impact in each subsample. Their information share does increase over time, but their trades appear to be supplying liquidity to foreign investors. The share of trade-related information increases from around 40 percent of the variation in the efficient price in the 1980s to about 70 percent in the 2010s. Meanwhile the importance of information coming from shocks to domestic equity prices, as captured by TOPIX returns, declines substantially over the four subsamples. As would be expected, a positive shock to TOPIX returns, or good news, has a positive long-run price impact.

Table 6: Model Including Exchange Rate Returns

	1980s	1990s	2000s	2010s
(a) Long-Run Price Impact of Trade				
Foreign	1.06	1.89	1.86	1.27
Financial	-0.03	-0.44	0.01	0.01
Trust	0.25	-0.12	-0.16	-0.02
Individual	-0.23	-1.08	-1.02	-1.15
TOPIX	1.58	2.39	2.07	1.33
Exchange rate	-0.32	-0.19	0.88	1.82
(b) Variance Decomposition of the Efficient Price (%)				
Foreign	28.96	33.55	36.05	20.10
Financial	0.02	1.78	0.00	0.00
Trust	1.68	0.13	0.26	0.01
Individual	1.41	10.86	10.92	16.52
TOPIX	65.19	53.34	44.74	21.95
Exchange rate	2.73	0.33	8.03	41.42
Trade-related	32.08	46.32	47.23	36.63
(c) Share of the Trade-related Component (%)				
Foreign	90.29	72.44	76.33	54.88
Financial	0.07	3.85	0.00	0.01
Trust	5.23	0.27	0.54	0.01
Individual	4.41	23.44	23.13	45.09

Notes:
1. Models were estimated with 2 lags for the 1980s, 2000s and 2010s subsamples and 3 lags for the 1990s.
2. Trade-related component includes Foreign, Financial, Trust and Individual investor trade ratios.
3. Order in which the variables were included in the VAR is exchange rate, foreign, financial, trust, individual and TOPIX.

Next, we add S&P 500 returns to the benchmark model. S&P 500 returns proxy foreign or global equity market price innovations. The estimated long-run price impacts and efficient price variance decomposition are provided in Table 5. Shocks in S&P 500 returns have an important influence on the efficient price in all subsamples, and in particular during the 2000s and 2010s, where global equity shocks account for about half the variance in the efficient price of Japanese stocks. TOPIX return shocks have a much decreased influence over the efficient price in the 2000s and 2010s compared with the benchmark model. This suggests that global equity market information has become more important for Japanese stock prices over time, particularly in the 2000s and 2010s. At the same time, domestic information has decreased in relative importance. The positive long-run price impact for S&P 500 returns implies the intuitive result that good news for global stocks leads to higher Japanese stock prices.

When S&P 500 returns are included in the model, foreigners' influence over the efficient price is dramatically lower in all subsamples, compared with the benchmark. The total trade-related component is also lower in all subsamples, and by the most (around 40 percentage

Table 7: Model Including S&P 500 and Exchange Rate Returns

	1980s	1990s	2000s	2010s
(a) Long-Run Price Impact of Trade				
Foreigners	0.66	1.60	1.09	0.78
Financial	-0.01	-0.44	0.12	0.15
Trust	0.18	-0.06	-0.20	-0.18
Individual	-0.20	-1.15	-0.64	-0.73
TOPIX	1.47	2.23	1.55	1.21
S&P 500	0.98	1.45	2.25	1.78
Exchange rate	-0.27	-0.52	0.48	1.40
(b) Variance Decomposition of the Efficient Price (%)				
Foreign	11.81	22.35	12.68	7.83
Financial	0.00	1.67	0.17	0.30
Trust	0.92	0.04	0.45	0.40
Individual	1.08	11.63	4.45	6.91
TOPIX	58.43	43.64	25.65	18.89
S&P 500	25.75	18.35	54.16	40.62
Exchange rate	2.00	2.33	2.44	25.04
Trade-related	13.81	35.69	17.75	15.45
(c) Share of the Trade-related Component (%)				
Foreign	85.50	62.63	71.48	50.71
Financial	0.03	4.69	0.94	1.93
Trust	6.65	0.10	2.53	2.61
Individual	7.83	32.58	25.06	44.75

Notes:
1. Models were estimated with 2 lags for the 1980s, 1990s, 2000s subsamples and 1 lag for the 2010s.
2. Trade-related component includes Foreign, Financial, Trust and Individual investor trade ratios.
3. Order in which the variables were included in the VAR is S&P 500, Exchange rate, Foreign, Financial, Trust, Individual and TOPIX.

points) in the 2000s and 2010s. Foreign investors' share of the trade-related component falls by about 10 percentage points in the 1980s, 1990s and 2000s, but is about the same for the 2010s. As global information has become more important for Japanese stock prices, foreign investors appear to be using more global information to trade Japanese stocks.

We add USD/JPY exchange rate returns to the benchmark model and provide the estimates in Table 6. The exchange rate claims a large information share in the 2010s of over 40 percent, which makes it by far the most important influence on the efficient price. The long-run price impact shows a positive relationship between the exchange rate and Japanese stock prices[12]. Foreign investor's information share in the 2010s is about half that of the benchmark model. The information share associated with TOPIX returns is also lower for the 2010s. The trade-related component is over 30 percentage points lower in the 2010s, and is a little lower for the

[12]Popular explanations for this amongst market participants are that a weaker yen increases the profitability of Japanese firms with international sales, and a weaker yen is also consistent with "risk on" trades in which investors are more desirous of risky assets such as stocks.

2000s. The results suggest that exchange rate information became important for Japanese stock price formation in the 2010s, and that foreign investors' trading strategies shifted to incorporate this information.

Finally, we examine the joint effect of both of the global financial market variables. Table 7 provides the estimates when both S&P 500 and exchange rate returns are added to the benchmark model. The main results from the models in Tables 5 and 6 continue to hold. Global stock returns have an important influence over the efficient price in each subsample, and in particular during the 2000s and 2010s. Exchange rate returns have a substantial information share in the 2010s. Global equity and exchange rate information together accounts for around two thirds of the variance in the efficient price of Japanese stocks in the 2010s, up from just over one quarter in the 1980s. Relative to the benchmark model, the influence of TOPIX returns on the efficient price is substantially lower in the 1990s, 2000s and 2010s. Taking account of global financial information, the importance of domestic equity market news has declined relatively swiftly from accounting for around 60 percent of the variance of the efficient price in the 1980s to under 20 percent in the 2010s. In the benchmark model the decline was from around 60 percent to around 30 percent. Global rather than local information has become relatively important in the formation of Japanese stock prices.

Compared with the benchmark model, foreign investors' information share is substantially lower in all subsamples when global stock prices and the exchange rate are taken into account. Foreigner's relative share of the trade related component is also lower in the 1990s, 2000s and 2010s. Unlike under the benchmark model, foreign investors' information share does not increase in the 2000s and 2010s relative to the 1980s and 1990s. Despite this, they remain the most informed but with an information share that is much smaller than in the benchmark model.

Our results suggest that the majority of the information attributed to the trades of foreign investors in the benchmark model relates to global financial factors, as proxied by S&P 500 and exchange rate returns in the model of Table 7. As global financial factors have grown in importance for Japanese stock prices, foreign investors have shifted toward trading Japanese equities based on global information.

5. Conclusion

In this paper, we examined what types of information foreign investors contribute to stock prices. Our empirical analysis investigated the information content of foreign and domestic investors' trades on the TSE over a long sample period of 39 years. The sample was divided

into four approximately decade long subsamples to reveal the changing role of foreign investors in stock price formation. The influence of foreign investors' trades on the efficient price has increased since around 2000. We find this is due to a substantial increase in the importance of global stock price and exchange rate information in stock price formation. Our results suggest that foreign investors have shifted toward trading equities based on global information as international financial factors have increasingly influenced the domestic market in recent decades.

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