Original Article

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Does retail trading matter to price discovery?

<https://doi.org/10.1515/ger-2019-0041>

Abstract: The diminishing importance of retail investors and the institutionalization of markets are arguably a result of the general perception that individuals are not well informed and, hence, are better off using professional services (Davis, 2009). However, this paper provides evidence supporting the opposite. Using a global sample, we examine whether retail trading is informative around the world. Overall, retail investors are documented to enhance price efficiency by trading in the same direction as permanent price changes, contributing 24.8 % to price discovery, and accelerating the information from both scheduled and unscheduled news to be impounded into prices.

Keywords: Retail Trading, Price Discovery, Global Markets

JEL Classification: G12, G14, G15

The American retail investor is dying. In 1950, retail investors owned over 90 % of the stock of U.S. corporations. Today, retail investors own less than 30 % and represent a very small percentage of U.S. trading volume... (Davis, 2009)

1 Introduction

The above article paints a gloomy picture of a sharp decline of individuals as direct participants in equity markets. Today, the problem of retail flight is even more evident and is graver, as the latest Gallup Poll in April 2017 shows that stock ownership by Americans stands at merely 54 %, the lowest level since the start of this survey in 1998. In the view of a massive exodus, there is no doubt that holistic

Article note: All errors remain my own responsibility.

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dominance of retail investors would be significantly undermined. Instead, a growing number of individuals nowadays prefer indirect ownership by transferring their wealth to intermediaries who make investments on their behalf, inevitably resulting in the institutionalization of the securities markets (Langevoort, 2009). With the changing composition of market participants, is the loss of direct retail investment beneficial or detrimental to the capital market?

Whether retail investors matter to share prices, market quality, and information flow remains inconclusive, and the evidence is sometimes contradictory after a long-standing controversy over the past decade. The informational efficiency of prices, or lack thereof, as a key feature of capital markets, has a significant impact on the real economy to guide firms in making better-informed investment and financing decisions (Boehmer and Wu, 2013). As indicated by several related prior studies (Kyle, 1985; Shleifer and Summers, 1990), retail investors are characterized as unsophisticated and uninformed traders who tend to commit systematic mistakes under the influence of psychological biases, such as selling winners and holding losers (Grinblatt and Keloharju, 2001), buying attention-grabbing stocks (Barber and Odean, 2008), and constructing undiversified stock portfolios (Goetzmann and Kumar, 2008). Along with these arguments, retail trading may destabilize markets by pushing prices away from fundamentals, which is dubbed the noise trader hypothesis in the literature.

However, this traditional rationale is challenged by numerous empirical evidence that pertains to the collective rationality of retail investors trading on own private information. Some studies of retail investors rely on transaction data, where stocks with intense retail buying persistently underperform those with strong retail selling for at least two years (Hvidkjaer, 2008). Meanwhile, the short-term profitability of retail trading is detected over 1 week (Barber et al., 2009) and at horizons up to 12 weeks (Boehmer et al., 2020). In addition, retail trading is found to predict news about firm cash flows (Kelley and Tetlock, 2013), benefit from liquidity provision during the financial crisis (Barrot et al., 2016), and enhance firm performance (Wang and Zhang, 2015). Taken together, retail trading seems to convey fundamental information and thus improve market efficiency, which is termed the informed trader hypothesis.

Given the conflicting findings, this paper aims to examine whether retail investors are informed by analyzing their role in the price discovery process, an unsettled research question in existing work. Using a global sample, we focus on the following three questions regarding the association between retail trading and price discovery. First, how does retail trading affect the total amount of information? Second, how does retail trading determine the revelation of information throughout the trading day? Third, how does retail trading contribute to the price discovery process when specific informed events occur?

To address the first issue, we follow the state space model (Brogaard et al., 2014) to divide price movements into permanent (information) and transitory (pricing error) portions, and associate price changes with retail trading. We find that retail investors trade (buy or sell) in the direction of permanent price changes, consistent with the informed trader hypothesis. However, their trading also moves in line with temporary price changes, suggesting that the noise is an unavoidable byproduct brought about in the market due to retail engagement.

To study the revelation of information throughout the trading day, the weighted price contribution (Barclay and Warner, 1993) is adopted to inspect how much of a stock's cumulative price change is ascribed to retail investors. Our results indicate that individuals are responsible for 24.8 % of the weighted price contribution in the globe. In comparison to 5.6 % of its trading volume in aggregate, retail trades carry much greater information content than their incidence, in compliance with our reasoning that information revealed by individuals moves stock prices in the international market.

Finally, we turn to investigating what types of information retail investors may have acquired and how this information flow is priced. Specifically, two informed events are identified from the literature, namely, scheduled earnings announcements and unscheduled information release over the weekend. An examination of these informed scenarios lead to a better understanding of how retail trading facilitates new information to be factored into markets. Overall, we unveil that retail investors are able to gain access to the information ahead of these events and that they push information into prices by preemptive trading.

Our study contributes to research in two aspects. First, the coexistence of supporting evidence for both the informed trader hypothesis and the noise trader hypothesis calls for a unified framework to reconcile these inconsistent findings. To examine these hypotheses jointly, this paper capitalizes on a state space model that comprises an equation for the permanent portion of observed prices and another for the transitory component. This setting enables us to simultaneously look into the impact of retail trading on the permanent price component and the transitory component, and hence, it sheds light on the joint validity of both hypotheses. Our results indicate that informed retail trades go hand in hand with noise. The informativeness of retail trading in this paper echoes recent studies (Kelley and Tetlock, 2013). Similar to well-established informed traders, such as short sellers, individuals are likely to access valuable private information beforehand.

Second, the majority of earlier work on individual trading uses either brokerage data in the US (Kaniel et al., 2012) and France (Barrot et al., 2016) or transaction data in the US (Barber et al., 2009) and Finland (Keppo et al., 2017). Considering the behavioral heterogeneity of retail participants, it is controversial whether the findings on a single market can be generalized to other countries. The large

global sample allows us to probe the informativeness of retail investors in the cross-section of stocks and in the cross-section of markets, which complements previous studies by exploiting variation in informative retail trading and extending our conclusion to the international context.

In addition to advancing the knowledge of the interaction between retail trading and price discovery, our results provide some practical implications and are thus of great significance to researchers who shape a biased view about categorizing individuals as noise traders, to practitioners who make a profit if predicting future price movements by observing early signals from retail trading, to exchanges that create a fairer market environment for small investors, and to regulators who design a better supervisory rule to protect retail investors.

The remainder of this paper proceeds as follows. Section 2 describes the data and measurement and performs the validation test. In Section 3, we scrutinize the association between retail trading and price discovery. The last section summarizes.

2 Data and measurement

2.1 Data

Consistent with a large body of prior studies (O'Hara, 2014; Chen, 2018; Chen, 2019; Chen, 2020), our intraday tick data are taken from a transaction dataset compiled by Bloomberg from Jan to Dec 2016. Bloomberg renders real-time, historical and descriptive data, analytics, and news on a number of markets and securities in a single integrated platform around the world. Each record comprises the trading time, the transaction price, the number of shares traded, and the quotation code. To avoid massive computations if employing the full data set, a random sample of 100 traded stocks is constructed in each market.

Before enforcing a random selection, we drop the observation satisfying with the following conditions for each stock: (i) outside the normal trading period; (ii) negative prices or sizes; (iii) ask prices less than bid prices; (iv) trades beyond the spread; (v) trades without the normal quotation code; and (vi) prices beyond the range between 50 % and 150 % of prior traded prices.

To be eligible for inclusion in the final sample, we further impose additional screening criterion: (i) stocks must have more than one trade per minute; (ii) stocks prices must be greater than one; and (iii) stocks must be actively traded for more than one hundred days. Our final sample consists of 2,200 stocks across 22 countries.

2.2 Measure of retail trading

The Bloomberg dataset does not include any information on whether the trade is a buy or sell for the vast majority of countries, so the inference of trade direction is made in light of the tick rule. Compared to Lee and Ready's (1991) procedure, the tick rule provides better estimates of signed volume (Finucane, 2000) and of the aggregate side of trading (Easley et al., 2016). Concretely, this rule determines the trade direction with current prices relative to prior ones. The trade is classified as a buy if the current price is higher than the last price (an uptick) or as a sell if lower (a downtick). If there is no price change between trades (a zero tick), the preceding price that differs from the current one is utilized to decide the trade direction.

Owing to the unavailability of the identity code, it is unlikely to identify retail traders in our dataset. To solve this problem, existing work proposes various approaches where transactions are assigned to retail trades if less than a certain threshold. While one strand of literature uses a preset cutoff point of 500 shares (Battalio and Mendenhall, 2005) or of \$5,000 (Barber et al., 2009), the other develops a dynamic methods to calculate different firm-size cutoff points (Hvidkjaer, 2008). To improve the classification accuracy, our paper capitalize on the stock-specific dollar-based methodology to extract individual trades out of the dataset.

To make it work, we first determine the small-trade cutoff point as follows. Each day d , all trades of stock s are sorted based on their trading volumes. The 20th percentile relating to trading volume ($TV20_{sd}$) can be found, which serves the small-trade cutoff point. Subsequently, for stock s on day d , transactions with the trading volume less than $TV20_{sd}$ are used to proxy for individual investor trades in our study. After implementing such a procedure, roughly 20 percent of the trades in our sample belong to retail investors.

Descriptive statistics of small-trade cutoff points are presented for each country in Table 1. After adjusting with inflation rates and exchange rates (Barber et al., 2009), the mean cutoff points in every markets are generally comparable to a trade size of \$5,000, which Lee and Radhakrishna (2000) suggest as an optimal benchmark to identify retail trades.

In line with previous researches (Barber et al., 2009; Kelley and Tetlock, 2013; Barrot et al., 2016), retail trading in this paper is measured by retail order imbalances, which equal the difference between the retail trading volume bought and the retail trading volume sold over the total retail trading volume.

2.3 Validation of retail trading measure

In this subsection, three validation tests are harnessed to verify whether our small-trade cutoff point is a good proxy for separating retail trades from the mar-

Table 1: Summary Statistics for Small-Trade Cutoff Points.

	# Stock	Mean	S.D.	Min	P25	Median	P75	Max
Australia	100	229.9	205.7	2.2	85.8	167.2	308	2,350
Brazil	100	2,296	1,536	150.7	1,209	1,836	3,066	8,094
Canada	100	2,907	2,740	132	957	2,060	4,076	21,054
Germany	100	3,476	1,335	888.8	2,341	3,230	4,324	9,142
HK	100	23,249	17,751	3,212	10,824	17,534	33,220	109,175
Indonesia	100	1,319,628	1,313,275	28,600	516,450	869,550	1,689,600	8,137,250
Israel	100	616,042	128,253	274,197	541,695	574,090	661,320	1,234,750
Japan	100	534,919	672,394	18,040	154,770	324,638	608,300	6,143,500
Mexico	100	6,875	5,556	807.4	2,144	4,729	10,359	27,281
Norway	100	8,489	4,920	298.1	4,730	7,541	10,846	37,380
Pakistan	100	36,633	23,676	3,812	18,654	31,772	48,070	202,125
Philippines	100	6,437	4,925	618.2	2,852	5,046	8,874	46,695
Poland	100	1,543	1,253	11	745.8	1,277	1,942	8,429
Saudi	100	23,631	4,628	11,766	21,010	22,770	25,160	150,535
Singapore	100	765.6	818.4	155.1	331.1	431.2	840.4	4,924
Spain	100	1,348	434.5	133.1	1052.7	1,332	1,668	2,796
Taiwan	100	141,368	394,568	7,843	24,530	53,103	96,965	3,360,500
Thailand	100	10,985	10,069	310.2	4,373	7,810	14,190	54,340
Turkey	100	262.9	379.5	1.1	38.5	132	342.1	5,486
UK	100	1,295	521.4	140.8	921.8	1,198	1,580	3,908
US	100	9,196	4,169	2,486	5,947	8,590	12,404	19,246
Vietnam	100	3,591,246	3,320,120	18,700	1,474,000	2,706,000	4,553,043	56,221,000

Note: This table reports the summary statistics for small-trade cutoff points, which are proxied by the 20th trading volume percentile for each stock day. Statistics include the mean (Mean), standard deviation (S.D.), minimum (Min), 25th percentile (P25), median (Med), 75th percentile (P75), and maximum (Max).

ket. First, we examine the reliability of the assumption that individual market participation is positively related to retail trading. It serves as a necessary condition for the accuracy of the chosen measure. If there is no positive relationship between these two, our proxy is very unlikely to capture the overall activity of retail investors. We obtain retail participation ratios (populations) directly from Grout et al. (2009). Cross-country correlations are estimated in Table 2 Panel A, where country-based retail trading has a positive association with the participation ratio (0.270) and population (0.717). These preliminary findings are consistent with the assumption used to develop our measure of retail trading.

Second, we form a retail attention measure by using the Google Search Volume (GSV) for each stock with its Bloomberg ticker (Da et al., 2011). Next, we evaluate whether it is positively linked with our retail trading measure. No correlation suggests that our proxy is questionable. Table 2 Panel B provides direct evidence that the 20th percentile of trading volume is a good proxy for retail trades. Specifically, contemporaneous correlations between retail trading and retail attention are shown to be positive in 17 out of 22 countries from the statistical perspective. Moreover, the cross-country average correlation is 0.205, with the significance at the 1 % level.

Inspired by Campbell et al. (2009), we finally check whether individual transaction under the proposed cutoff rule is effective in explaining the weekly change in retail ownership. Because data on retail shareholding are not available, we gauge the change in retail ownership by the change in institutional ownership on the ground that no others would be involved in the trading. Table 2 Panel C shows the average adjusted R^2 after running a stock-level regression of retail ownership changes onto its retail trading lagged level and the lagged change in retail ownership. Overall, these statistics range from 4.0 % (Taiwan) to 65.2 % (US) with a global mean of 13.8 %, which are greater than the 10.9 % reported by Campbell et al. (2009). Besides, there are 11 countries with an adjusted R^2 above 10 %, suggesting that our measure track retail trading. To some degree, all three tests justify the utilization of the 20th trading volume percentile to identify retail trading.

3 Retail trading and price discovery

3.1 State space model: Informed or noise traders?

The first analysis of price discovery depends on a trading environment where true prices (permanent components) are unobserved and observed traded prices are linked by measurement errors (transitory components). Therefore, the state

Table 2: Validation Tests of Retail Trading.

	<i>Panel A:</i> <i>Retail Participation</i>		<i>Panel B:</i> <i>Retail Attention</i>	<i>Panel C:</i> <i>Retail Ownership Change</i>
	Ratio	Population	Correlation	Adjusted R ²
Australia	31.88	6,700,000	0.035	0.084
Brazil	1.62	3,123,425	0.172***	0.186
Canada	37.52	12,400,000	0.172***	0.139
Germany	11.32	9,317,000	0.048	0.234
HK	22.98	1,618,000	0.111***	0.094
Indonesia			0.382***	0.069
Israel			0.357***	0.064
Japan	30.75	39,300,000	0.102***	0.196
Mexico			0.080	0.050
Norway	7.30	340,821	0.228***	0.216
Pakistan	0.03	46,475	0.011	0.055
Philippines			0.301***	0.039
Poland	2.70	1,029,000	0.381***	0.198
Saudi	38.20	10,700,000	0.384***	0.057
Singapore	11.97	473,915	0.028	0.136
Spain	2.22	954,348	0.137***	0.119
Taiwan	34.78	7,920,000	0.108***	0.040
Thailand	0.61	375,891	0.323***	0.127
Turkey	5.90	4,303,000	0.282***	0.086
UK	15.09	9,060,260	0.316***	0.105
US	21.20	62,900,000	0.125***	0.652
Vietnam	0.27	229,521	0.416***	0.095
Global	0.270*	0.717***	0.205***	0.138

Notes: This table validates the measure of retail trading. Panel A reports the cross-country correlation between retail trading and retail participation ratio (retail investor population). Retail trading is the absolute value of retail order imbalances calculated over the whole sample period. The retail participation ratio and population is collected from Grout et al. (2009). Panel B shows the mean contemporaneous correlation between retail trading and retail attention. Retail attention is quantified by the Google Search Volume with its Bloomberg ticker (Da et al., 2011) for each stock after adjusting by the sign of its stock return in the same period. Retail trading is the weekly retail order imbalances that match the frequency of retail attention. Panel C reveals the explanatory power for the weekly change in retail ownership using the 20th trading volume percentile as a cutoff point (Campbell et al., 2009). The change in retail ownership is gauged by the change in institutional ownership. ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

space model is a natural choice (Menkveld et al., 2007) for exploring the interdependence among retail trading, permanent price changes, and temporary price changes. In concrete terms, the transaction price of a stock is represented by a nonstationary efficient element, which is represented as an unobservable state variable plus a stationary temporary element capturing the price error.

$$p_{s,t} = m_{s,t} + s_{s,t} \quad (1)$$

where $p_{s,t}$ is the transaction price after taking the log at time t for stock s , $m_{s,t}$ is the permanent portion of observed prices at time t for stock s , and $s_{s,t}$ is the transitory portion of observed prices at time t for stock s . In its simplest form, the efficient price is assumed to be a martingale process consisting of two components:

$$m_{s,t} = m_{s,t-1} + w_{s,t} \quad (2)$$

where $w_{s,t}$ is an innovation that affects the price permanently by reflecting the arrival of new information at time t for stock s . In line with Brogaard et al. (2014), the permanent price increment is further modeled to introduce the overall impact of retail trading.

$$w_{s,t} = \alpha_s \widehat{RT}_{s,t} + \varepsilon_{s,t} \quad (3)$$

where $\widehat{RT}_{s,t}$ is the residual of an autoregressive model with 10 lags on retail trading at time t for stock s . Its coefficient (α_s) can be used to examine whether retail investors impart information that impacts permanent price changes. Positive (negative) coefficients indicate retail trading in the same (opposite) direction of permanent price changes. Moreover, $\varepsilon_{s,t}$ is the firm-specific information disturbance irrelevant with retail trading, which follows a white noise process.

To quantify temporary price elements, we specify them as an equation encompassing an autoregressive component and retail trading as follows:

$$s_{s,t} = \beta_s s_{s,t-1} + \gamma_s RT_{s,t} + v_{s,t} \quad (4)$$

where $RT_{s,t}$ is retail trading (the difference between buyer- and seller-initiated trading volume standardized by the total volume). Hence, the coefficient (γ_s) can be used to evaluate the noise trader hypothesis.

The state space model conditional on 1-minute retail trading is estimated for each stock day. The estimated coefficients are averaged cross-sectionally for each country and then presented in Table 3. In terms of global impact, retail trading is positively associated with permanent price changes, indicating a positive contribution made by individuals to price discovery. Coupled with the presence of similar findings in individual countries, our results are consistent with the informed trader hypothesis.

Table 3: Retail Trading: Informed or Noisy?

	Permanent Price Changes		Temporary Price Changes			
	RT		s_{t-1}		RT	
	Coef	t-stat	Coef	t-stat	Coef	t-stat
Australia	0.038***	23.11	0.488***	36.02	0.062***	22.59
Brazil	0.021***	5.12	0.522***	45.21	0.072***	11.53
Canada	0.007**	2.36	0.714***	148.03	0.055***	15.91
Germany	0.049***	17.78	0.738***	103.14	0.111***	16.76
HK	0.047***	8.03	0.330***	14.60	0.043***	20.28
Indonesia	0.063***	15.94	0.292***	11.11	0.052***	19.37
Israel	0.006***	2.68	0.636***	40.28	0.060***	17.10
Japan	0.019***	10.96	0.575***	42.51	0.081***	32.08
Mexico	0.026***	6.33	0.577***	27.43	0.051***	9.52
Norway	0.012**	2.19	0.685***	54.95	0.105***	11.53
Pakistan	0.015***	7.09	0.671***	58.80	0.067***	25.91
Philippines	0.020***	4.97	0.578***	36.13	0.038***	11.78
Poland	0.020***	3.97	0.503***	25.33	0.072***	24.25
Saudi	0.036***	9.30	0.529***	27.71	0.089***	32.46
Singapore	0.067***	8.11	0.166***	4.22	0.041***	9.03
Spain	0.017***	2.70	0.736***	60.98	0.110***	11.64
Taiwan	0.026***	16.99	0.176***	7.77	0.038***	10.79
Thailand	0.080***	14.94	0.128***	9.43	0.052***	17.67
Turkey	0.044***	15.40	0.383***	19.87	0.047***	28.71
UK	0.035***	13.07	0.786***	139.87	0.110***	21.07
US	0.003***	3.40	0.705***	59.61	0.028***	3.89
Vietnam	0.040***	8.16	0.350***	12.57	0.069***	15.08
Global	0.031***	7.13	0.512***	11.99	0.066***	12.19

Note: This table presents the mean impact of retail trading on permanent/temporary price changes. Specifically, the impact on permanent/temporary price changes is estimated at the stock-day level by a state space model (Brogaard et al., 2014) using 1-minute retail order imbalances, which equal the difference between retail buyer- and seller-initiated trading volumes over the total volume. The cross-country average is shown in the Global row. ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

However, we also find a positive and significant coefficient on RT in the equation for the temporary price element, demonstrating that retail investors on average move in the same direction of pricing errors. In addition, this transitory price change continues with an AR(1) coefficient of approximately 0.512. Therefore, the persistent pricing errors caused by retail trading seem to lend support to the noise trader hypothesis.

To sum up, while we discover that retail trading is so informative as to improve price efficiency, it has the side effect of introducing noises into the market. Our findings reconcile these conflicting hypotheses developed in the prior literature because empirical evidence in favor of either is sought in our study.

3.2 Weighted price contribution: Incorporation of new information

In the last subsection, we show that retail trading delivers information about future price movements. However, the level of retail trading activity as a whole remains below that of other market participants, such as institutional investors. To study the amount of price discovery throughout the trading session, we follow Barclay and Warner (1993) to gauge how much new information belonging to retail trades is incorporated into prices via the weighted price contribution.

Given that stock s has N trades on day d , either retail or other, we use the trade index (n) to denote the transaction sequence. Consequently, the weighted price contribution (WPC) attributable to retail trading on day d for each country with S stocks is defined as follows:

$$WPC_d = \sum_{s=1}^S \left(\frac{|\sum_{n=1}^N r_{s,d,n}|}{\sum_{s=1}^S |\sum_{n=1}^N r_{s,d,n}|} \right) \times \left(\frac{\sum_{n=1}^N \varphi_n r_{s,d,n}}{\sum_{n=1}^N r_{s,d,n}} \right) \quad (5)$$

where φ_n is an indicator taking the value of one if trade n falls in the retail category, and $r_{s,d,n}$ is the price difference between trade n and trade $n - 1$ for stock s on day d . The first term represents the ratio of absolute returns for each stock over the sum of absolute returns for all stocks. This weighting factor helps alleviate the heteroskedasticity in calculating WPC (Barclay and Warner, 1993). The second term reflects the relative contribution of retail trading to the total return on day d .

Table 4 presents the results on the WPC of retail trading. Several findings emerge from this table. First, on average, 24.8 % of the price discovery is contributed by retail trading around the world. In contrast with its aggregate share of volume (5.6 %), retail trades release more information content than their incidence from the statistical viewpoint. Second, a positive and significant WPC is observed in all countries, ranging from 1.3 % in Australia to 62.4 % in Singapore, indicating that informed retail trading takes place globally. Third, our WPC s are comparable to those reported in O'Hara et al. (2014), who focus on the odd-lot trades in the US. Combined, retail investors reveal information through their trading to move the price in international markets, in tandem with the informed trader hypothesis stated before.

Table 4: Weighted Price Contribution of Retail Trading.

	WPC		%Vol	H ₀ : WPC = %Vol	
	Coef	t-stat		T test	Wilcoxon test
Australia	0.013 ^{**}	2.43	0.010	2.11 ^{**}	2.06 ^{**}
Brazil	0.264 ^{**}	2.38	0.115	2.34 ^{**}	2.29 ^{**}
Canada	0.181 ^{***}	12.24	0.139	2.82 ^{***}	2.92 ^{***}
Germany	0.244 ^{***}	4.85	0.025	4.35 ^{***}	4.88 ^{***}
HK	0.581 ^{***}	3.65	0.081	3.15 ^{***}	2.84 ^{***}
Indonesia	0.511 ^{***}	3.40	0.028	3.21 ^{***}	2.71 ^{***}
Israel	0.268 ^{***}	9.83	0.048	8.06 ^{***}	7.02 ^{***}
Japan	0.123 ^{**}	2.31	0.086	2.39 ^{**}	2.68 ^{***}
Mexico	0.257 ^{***}	3.21	0.051	2.58 ^{***}	2.85 ^{***}
Norway	0.193 ^{***}	6.08	0.026	5.26 ^{***}	5.31 ^{***}
Pakistan	0.153 ^{***}	6.77	0.025	7.89 ^{***}	7.14 ^{***}
Philippines	0.102 ^{***}	2.75	0.021	2.40 ^{**}	3.17 ^{***}
Poland	0.091 ^{**}	2.35	0.070	2.08 ^{**}	2.38 ^{**}
Saudi	0.111 ^{***}	2.94	0.075	2.64 ^{***}	2.84 ^{***}
Singapore	0.624 ^{**}	2.50	0.070	2.78 ^{***}	22.39 ^{***}
Spain	0.277 ^{***}	7.41	0.028	6.67 ^{***}	6.47 ^{***}
Taiwan	0.211 ^{**}	2.15	0.126	2.84 ^{***}	2.23 ^{**}
Thailand	0.120 ^{**}	2.44	0.024	2.53 ^{**}	2.44 ^{**}
Turkey	0.183 ^{***}	2.70	0.009	2.56 ^{**}	2.33 ^{**}
UK	0.294 ^{***}	17.19	0.035	15.14 ^{***}	9.79 ^{***}
US	0.159 ^{***}	7.33	0.131	2.31 ^{**}	2.98 ^{***}
Vietnam	0.493 ^{***}	2.73	0.009	2.68 ^{***}	2.44 ^{**}
Global	0.248^{***}	7.07	0.056	5.29^{***}	4.11^{***}

Note: This table presents the mean weighted price contribution (*WPC*) and percentage of trading volume (*%Vol*) for retail trading. Following Barclay and Warner (1993), the weighted price contribution of retail trading is calculated using price changes attributable to individuals. The t-stat (z-stat) for the T (Wilcoxon) test performed on the null hypothesis of $WPC = \%Vol$ is also reported. The cross-country average is shown in the Global row. ^{***}, ^{**} and ^{*} denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

3.3 Price discovery surrounding earnings announcements

According to the above analysis, retail trades carry information relevant with future price changes. However, it remains ambiguous as to what types of information retail investors can explore. Therefore, we aim to shed light on this question by examining an earnings announcement in which retail investors are capable of accessing information benefiting price discovery.

The purpose of an earnings announcement is to release firm-specific information that draws significant attention from various types of investors in the market.

If individuals are well informed in advance, they would trade around financial disclosures aggressively using small quantities of shares. Meanwhile, retail trading faces less constraints in terms of diversification requirements or short sales compared to institutional counterparts. Hence, this reasoning points to a notion that retail trading around earnings announcements may matter to price discovery.

To proceed, we collect the announcement dates of our sample stocks from Bloomberg in 2016. Consistent with earlier studies, we uncover post-earnings-announcement drifts, suggesting traders' failure to fully absorb the information surrounding events. Consequently, such a setting creates an opportunity to investigate how retail investors improve the price discovery process. If informed individuals do contribute to price discovery, their trading around financial announcements should positively predict the ensuing drifts. Otherwise, if individuals move prices beyond their efficient level following earnings disclosures and exacerbate inefficient price changes (i. e., overshooting), we expect a negative relation between retail trading and post-event returns. In the spirit of Kaniel et al. (2012), the subsequent model is specified to examine our conjecture.

$$CAR_{s,[2,11]} = \alpha + \beta CART_{s,[-1,1]} + \gamma CAR_{s,[-1,1]} + \varepsilon_i \quad (6)$$

where $CAR_{s,[2,11]}$ is the cumulative abnormal return from 2 to 11 days post announcement for stock s , and $CART_{s,[-1,1]}$ is the cumulative abnormal daily retail trading from 1 day before to 1 day after an announcement for stock i . Since many announcements happen either before market open or after market close (Johnson and So, 2018), we set the event window as one day before and after the announcement date.

Next, the pooled regression is performed for all stocks with announcements in each country with the results tabulated in Table 5. Overall, the cross-country coefficient on retail trading (0.112) is positive and significant at the 1 % level, suggesting that individuals move in the same direction as subsequent price changes. It is equivalent to implying that retail investors are able to acquire information released from the announcement and continue to push prices toward efficient levels by their trading.

When looking at individual markets, retail trading is documented to exert a positive impact on price discovery across the board. In particular, this positive relation is witnessed in the US, parallel to Kaniel et al. (2012) who show that pre-announcement retail buying predicts post-announcement returns. To summarize, our results regarding earnings announcements seek favorable evidence in line with the view that retail trading facilitates the incorporation of new information from the scheduled event rather than triggers the transitory price movement.

Table 5: Retail Trading around Earnings Announcements.

	Dependent Variable: CAR _[2,11]				Adj R ²
	CART _[-1,1]		CAR _[-1,1]		
	Coef	t-stat	Coef	t-stat	
Australia	0.036**	2.38	0.670	1.58	0.112
Brazil	0.045***	2.91	0.587**	2.30	0.112
Canada	0.032***	2.79	-0.372***	-2.90	0.048
Germany	0.066**	2.04	0.070	0.19	0.040
HK	0.073**	2.20	0.172	0.62	0.101
Indonesia	0.151**	2.29	0.052	0.16	0.142
Israel	0.142**	2.19	-0.272	-0.93	0.221
Japan	0.189**	2.20	-0.298	-0.52	0.093
Mexico	0.064***	2.89	0.508	1.57	0.119
Norway	0.378**	1.96	-0.128	-0.28	0.156
Pakistan	0.420**	2.38	0.474	0.74	0.398
Philippines	0.017**	2.35	-0.198	-0.68	0.044
Poland	0.059***	2.81	0.143	0.50	0.048
Saudi	0.301***	3.05	-0.893***	-4.02	0.237
Singapore	0.002**	2.02	0.512	1.02	0.083
Spain	0.067***	2.73	-0.494*	-1.74	0.092
Taiwan	0.018***	2.89	-0.746***	-3.25	0.229
Thailand	0.024**	2.36	-0.302	-0.84	0.014
Turkey	0.026**	2.47	-0.222	-0.64	0.009
UK	0.142***	2.94	-0.373*	-1.94	0.183
US	0.197***	2.55	-0.129	-0.43	0.328
Vietnam	0.025**	2.35	-0.485	-1.21	0.037
Global	0.112***	4.43	-0.078	-0.85	0.129

Note: This table examines whether retail trading explains the post-earnings-announcement return. A country-level regression of cumulative abnormal returns ($CAR_{[2,11]}$) after an announcement is performed on cumulative abnormal retail trading ($CART_{[-1,1]}$) and cumulative abnormal returns ($CAR_{[-1,1]}$). Abnormal returns are estimated by the CAPM model over the period $[-11, -1]$ prior to an announcement. Abnormal retail trading is standardized using the mean and standard deviation of the retail imbalances over the period $[-11, -1]$ prior to an announcement. Order imbalances is equal to the difference between buyer- and seller-initiated trading volumes over the total volume. The cross-country average is shown in the Global row. ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

3.4 Unscheduled news release

Besides the scheduled earnings announcement, retail investors are likely to gather information from an unscheduled event. In order to look for an unscheduled news release, we take advantage of the weekend effect as an alternative sce-

nario. In other words, stock prices may alter dramatically after a weekend close due to the disclosure of unscheduled news. Compared to weekday overnight periods, the weekend poses increased uncertainties and heightened inventory risks (French, 1980). Thus, the weekend effect offers a unique platform to ascertain the role of retail trading in price discovery. If informed individuals continue buying (selling) on Friday in anticipation of good (bad) news over the weekend, it leads to a positive relation between their trading and weekend returns, which is identical to the prevalence of price discovery. Conversely, a negative or insignificant association illustrates the absence of price discovery. To figure out this problem, we perform the following regression for each stock:

$$r_{s,wkd} = \alpha + \beta ART_{s,Fri} + \gamma mr_{s,wkd} + \varepsilon_{s,wkd} \quad (7)$$

where $r_{s,wkd}$ ($mr_{s,wkd}$) is stock s 's weekend (market) return, calculated by the difference between the closing price (benchmark index) on Friday and the opening price (benchmark index) on the coming Monday, and $ART_{s,Fri}$ is the abnormal last-hour retail trading on Friday for stock s .

The regression results of Eq. (7) are given in Table 6. As expected, the cross-country mean coefficient pertinent to retail trading is 0.044 and statistically different from zero, substantiating the aforementioned hypothesis that retail investors are conducive to reflect the impact of unscheduled news over the weekend into prices before its arrival. That is to say, individual trading plays a crucial role in accelerating the price discovery process. Furthermore, this coefficient of interest is positive and significant in all markets. A relatively high adjusted R^2 (0.199) indicates that our model has an explanatory power for the weekend return. In a nutshell, we demonstrate evidence that retail investors are beneficial for the price discovery process when confronting scheduled news (earnings announcements) or unscheduled information (weekend effects).

4 Conclusion

Based on a global sample of intraday transaction data, this paper looks into whether individuals matter to the price discovery process in the international context. Overall, we document that retail investors improve price efficiency by trading in the direction of permanent price changes, contributing 24.8 % to price discovery due to embedded information content, and speeding up the incorporation of both scheduled and unscheduled information into markets. The efficiency enhancement of retail trading corroborates the informed trader hypothesis in previous literature (Barber et al., 2009; Kaniel et al., 2012; Kelley and Tetlock, 2013).

Table 6: Retail Trading and Weekend Effects.

	Dependent Variable: r_{wkd}				Adj R^2
	ART_{Fri}		mr_{wkd}		
	Coef	t-stat	Coef	t-stat	
Australia	0.003**	2.29	0.463***	22.04	0.172
Brazil	0.022**	2.18	0.331***	15.80	0.214
Canada	0.102**	2.39	0.353***	9.11	0.153
Germany	0.001**	2.02	0.271***	11.31	0.105
HK	0.029***	2.65	0.717***	16.85	0.492
Indonesia	0.005**	2.16	0.325***	5.31	0.044
Israel	0.008**	2.22	0.800***	17.82	0.493
Japan	0.328**	2.35	0.780***	18.54	0.488
Mexico	0.011**	2.54	0.223***	7.93	0.127
Norway	0.082**	2.32	0.247**	2.31	0.170
Pakistan	0.014**	2.53	0.318***	5.79	0.045
Philippines	0.002**	2.06	0.192***	5.15	0.104
Poland	0.013***	2.57	0.400***	13.11	0.300
Saudi	0.019**	2.40	1.303***	25.05	0.442
Singapore	0.026***	2.79	0.441***	10.37	0.142
Spain	0.015**	2.10	0.051	0.53	0.028
Taiwan	0.013**	2.53	0.282***	7.51	0.050
Thailand	0.056***	3.12	0.559***	9.98	0.099
Turkey	0.049***	3.43	0.053**	2.53	0.018
UK	0.024**	2.41	0.247***	12.08	0.197
US	0.013**	2.25	0.545***	14.49	0.299
Vietnam	0.137***	3.68	0.416***	2.98	0.206
Global	0.044***	2.86	0.423***	7.04	0.199

Note: This table examines whether retail trading explains the weekend effect. A stock-level regression of weekend stock returns (r_{wkd}) is performed on abnormal retail trading on Friday (ART_{Fri}) and weekend market returns (mr_{wkd}). Weekend stock (Market) returns are estimated by closing stock prices (benchmark indexes) on Friday and opening stock prices (benchmark indexes) on the next Monday. Abnormal retail trading on Friday is calculated by standardizing last-hour retail order imbalances using the mean and standard deviation of its imbalances from Monday to Thursday. Order imbalances is equal to the difference between buyer- and seller-initiated trading volumes over the total volume. The cross-country average is shown in the Global row. ***, ** and * denote statistical significance at the 1 %, 5 %, and 10 % level, respectively.

In addition, we complement the ongoing debate on why retail trading contributes to share prices, market quality, and information flow. Our evidence appears to imply that individuals possess the ability to attain information beforehand and to integrate it into prices by preemptive transactions around the world.

Finally, we should exercise extra caution when interpreting these findings. Although our method to infer retail trades is extensively validated, it may capture some institutional trades in that institutions have an incentive to conceal their activities by using computer algorithms to break down large orders into small ones. From this perspective, the likely misclassification of retail trades becomes the main limitation of our study.

Funding: I acknowledge the Start-up Research Grant (SRG2018-00115-FBA) from the University of Macau.

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