Investor Attention and Stock Market Activities: New Evidence from Panel Data

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Abstract

Using the panel VAR method, this paper documents relationships between investor attention and stock market activities; i.e. return, volatility, and trading volume. Our results show that there exists the attention-return, -volatility, and -abnormal trading volume relationships, respectively. However, the relationships are weaker for developing countries, and the investor-volume relationship shows the strongest statistically significant. Moreover, the effects of the investor attention between the developed and developing markets are significantly different. We postulate that the role of the investor attention is global, though it affects the market oddly.

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1. Introduction

Differences in cross-sectional and time-varying investor attention are important components for improving the quality of investment decision-makings as well as for supporting the economic aggregates (Jacobs, 2015), though attention is a scared cognitive resource (Kahneman, 1973). Investors have attention constraints to occupy and analyze all available information, arriving to equity markets, they grab only information of their interests. This in turn suggests that investor attention should be related to activities in the markets. For example, Dellavigna and Pollet (2009) show the Friday inattention effect, in which stock prices on Friday earnings announcements show a larger drift and a slower response than the other days. Seminal works on investor attention at country level show that investor attention measured by the Google SVI influences stock market activities such as return (Da et al., 2011 and Tantaopas et al., 2016), volatility (Dimpfl and Jank, 2016 and Andrei and Hasler, 2015), trading volume (Takeda and Wakao, 2014), and liquidity (Ding and Hou, 2015), respectively. These findings support for a potential of interrelations between investor attention and stock market activities, including predictability. However, at present, there exists no empirical evidence to demonstrate whether investor attention causes stock market return, stock market volatility, and stock market trading volume, respectively, or vice versa in a cross-country analysis.

Even though prior literature shows the attention-stock market activities association in a number of countries,[1] Tantaopas, Padungsaksawasdi, and Treepongkaruna (2016) note that the

[1] For example, see Aouadi et al. (2013) for France, Bank et al. (2011) for German, Ying et al. (2015) for China, Takeda and Wakao (2014) for Japan, Tantaopas et al. (2016) for the Asia-Pacific countries, and Da et al. (2011) for the U.S.

level of investor attention is potentially affected by the shareholder base, cultural, ownership structure, legal protection, law enforcement, and financial education, respectively. These characteristics are unique for individual countries. Thus, from a bird's eye view, studying in an individual country basis might not show comprehensive findings on the attention effect in stock markets. It is likely that each fixed effect factor in each country influences the attention-market activities relationship differently. We question whether prior findings are driven by the sample section bias. This research aims to fill the gap in this regard.

This paper contributes to prior literature at least fourfold shedding light on the role of investor attention in stock markets. First, this study is the first to examine the dynamic attention-stock market activities relationships using the Panel Vector Autoregression (VAR) model. Studies of the attention effect on time series data of an individual stock market potentially lead to conclusions that are subject to the sample selection bias. Thus, the panel VAR is superior to other methodologies by taking into account of the effect of both cross-section and time series. Second, we add to exiting literature by directly comparing and discussing our results in terms of potential differences in the attention-stock market activities relationships between developed and developing countries. Third, our results highlight the significant role of investor attention in financial markets by documenting the relationship of the level of attention and stock market activities at the aggregate level (panel data) and its predictive power of these activities. Last, we reaffirm that the attention effect is an international phenomenon that is not driven by the sample selection bias.

As in Grossman et al. (2014), we apply the panel VAR for our cross-country analysis. Few beneficial issues of using panel VAR making our paper distinguish from prior studies are as follows. First, the concept of VAR is an appropriate technique for explaining unsolid theoretical setup, such as the relationship of investor attention and stock market activities as presented in this paper. Second, both fixed and time-varying effects are taken into consideration

under the panel VAR specification. Thus, our results are not biased from time-invariant unobserved heterogeneous factor and time-varying unobservable factor. Last, we can apply the panel VAR with a short data period. The panel VAR technique takes both cross-sectional and intertemporal data into consideration, which increases the number of observations and subsequently helps improve the quality of parameter estimations.

We employ the panel VAR to investigate the relationship between the Google SVI and stock market activities. Throughout the study, we separate our analyses in to three categories, the full sample, the developed countries, and the developing countries, respectively. The data includes ten countries in the Asia-Pacific region. Mostly, two-way panel Granger causality dynamic relationships between the investor attention and each stock market activity exist, especially for the attention-trading volume relationship that we observe the relationships in all categories. We conjecture that investor attention, as a behavioral factor, is one of the key determinants in stock markets regardless of the effects of unique characteristics (fixed effect) in each country sample, showing that limited investor attention violates the efficient market hypothesis. However, among three attention-stock market activity relationships, only attention-trading volume relationship is statistically significant for the developing markets. We postulate that people search causes excessive trading volumes in stock markets and vice versa, though the impact of the volume to the investor attention seems to be less. This evidence supports that attention is mostly related to abnormal trading volume and is consistent with prominent literature using trading volume as a proxy of attention[2] (Barber and Odean, 2008 and Gervais et al., 2001). We infer that the correlation between trading volume and attention should be notably high. It is interesting to note that we observe one-way causality relationship of the investor attention in the full sample and weak impacts of the volume to the investor attention

[2] Barber and Odean (2008) argue that without investor attention, trading volume cannot happen. Thus, trading volume is a consequence of actual attention.

in the developed and developing countries. In general, people might gather information before they trade. However, when trading volume is high, investors do not gather more information to trade on fundamentals, rather they trade by herding activities. Focusing on the results of the other two relationships in the developing countries, we find investors in these countries do not search for information when they trade stocks.

For the panel VAR estimations, most results are in general consistent with the panel Granger causality. The attention-return relationship is statistically negative with the effect of the return on the SVI is stronger than the other way around. Negative events catch more attention than positive ones, implying that investors concern more on the downside risk (Ang et al., 2006). On contrary, the attention-volatility relationship is positive and significant. The impact of the volatility on the SVI is shorter-lived and greater in magnitude than that of the SVI on the volatility. Swing movements in the market better catch attention. Dimpfl and Jank (2015) support our findings by showing the co-movement of the DJIA search keyword and its realized volatility during July 2006 to December 2011. They find that the search query is higher than average during the turbulence period. Thus, searching behavior is time-varying. The attention-abnormal trading volume relationship has the strongest results with relatively higher numbers of statistically significant coefficient for all samples in our analysis. However, the impact of the trading volume is mixed as the sign shows both negative and positive relations.That is, we find the relationship between SVI and abnormal trading volume is negative in the previous two-weeks but reverses to positive in the past one week. The intuition of the positive relationship is straightforward - when investors pay attention to stocks, then they are likely to trade them. The higher the investor attention, the larger the trading volume, and vice versa. Our findings seem to make intuitive sense in that information in further in the past (e.g., previous two week) is already priced as such investors do not search for any information.

However, information asymmetry in a more recent past (e.g., previous one week) is relatively high, leading to an increase in search volume.

All orthogonalized impulse responses functions depict a similar pattern to the panel VAR results. A comparison of the attention effect between the developing and developed markets indicates significant difference between the two groups. We conclude that the investor attention is common in equity markets, albeit the impact (both number of statistical significance and magnitude of coefficient) is larger in the developed markets. A possible explanation of these differences is that the equity markets in the developed countries are more over-reacted to the level of investor attention than are those in the developing countries. The under-reaction in the developing markets is explained by the frog-in-the-pan hypothesis (Da et al., 2014), stating that investors underreact when small amounts of information arrive to the market relative to large amounts of information arrival. These findings reconfirm arguments proposed in Tantaopas, Padungsaksawasdi, and Treepongkaruna (2016) that the level of investor attention could be affected by the shareholder base, cultural, ownership structure, legal protection, law enforcement, and financial education, respectively.

2. Pertinent literature

The efficient market hypothesis shows when information arrives the market, investors can receive, analyze, and decide to trade securities without limited time, limited processing resources, and limited attention. Thus, asset prices change immediately and appropriately, driving to a rational trading. However, psychological research suggests that investors have limited attention that they can utilize information grabbing their interests within a given period of time. Investor attention and stock markets then co-move over time (Peng, Xiong, and Bollerslev (2007)). Traditionally, investor attention is proxied by news and headline, trading volume, advertising expense, and ceiling price, which each of them has a drawback. Recently,

research on the impact of investor attention in financial markets[3] has gained interests from scholars and the Google SVI is widely used as a reliable and direct proxy of retail investor attention.

Merton (1987) shows that investors will trade a stock as far as they recognize it. Consequently, Huberman and Regev (2001) and Barber and Odean (2007) suggest when information arrival in the market, only attention from investors causes changes in prices, implying that investor attention is a necessary condition of stock trading. Thus, investor attention is the key of investors' decision-making.This is consistent with Da et al. (2011), documenting that investor attention influences stock movement and is not constant over time. High and low levels of investor attention affect the reaction of the stock market differently. A high level of investor attention causes a pressure to stock prices and drives the prices to be efficient, while investors underreact when they pay less attention. In fact, researchers provide evidence of the relationship of investor attention and financial market activities in terms of individual security and aggregate market level. In general, the results of the firm-level data are not qualitatively different from those of the market-wide level that there exists the relationship between investor attention and stock market activities. For example, Bijl, Kringhaug, Molnar, and Sandvik (2016) document the negative return predictability of the Google SVI the companies in the S&P500, which contradicts to Da et al. (2011) and Joseph et al. (2011), who suggest a positive predictive power of the Google SVI on stock returns.

However, Vozlyublennaia (2014) and Tantaopas et al. (2016) document that the Google SVI should be tested with a country-wide investment. We thus limit our discussion in this section only on existing evidence of the aggregate level, which is consistent with the aim and the scope of this study.Importantly, not many studies conduct research on the aggregate level

[3] The study of the attention effect is not limited only in stock markets and the results in other markets largely confirm the findings in stock markets. See, for example, Goddard et al. (2015) for foreign exchange markets, Li et al. (2015) for energy markets, and Rochdi and Dietzel (2015) and Braun (2016) for real estate markets.

of stock performance, stock volatility, and stock trading volume in the single study. Our research thus provides such additional evidence.

Evidence of the investor attention has remained mixed whether it strengthens or worsen the market efficiency. On the supporting side, Vozlyublennaia (2014) shows the dynamic interrelationship of investor attention and aggregate market activities in several asset classes in the U.S. markets.Moreover, the presence of investor attention helps improve return efficiency. An increase in attention reveals information to asset prices.[4] This is confirmed by Hamid and Heiden (2015) in terms of volatility predictability, who document that investor attention drives the Dow Jones equity index to be more efficient both in- and out-of-sample studies and especially in the high volatile state. Moreover, Tantaopas, Padungsaksawasdi, and Treepongkaruna (2016) extend prior studies by examining the investor attention effect both in developing and developed countries. The attention diminishes return and volatility predictability, which is explained by the information discovery hypothesis. However, they do find the effect on trading volume predictability.

On the opposing side, Dimpfl and Jank (2015) find the contemporaneous co-movement between Dow Jones' search volume intensity and it realized volatility. Moreover, search volume increases the volatility predictability, which is explained by the noise trader hypothesis. Keyword search by retail investors as considered as uninformed noise traders causes market more volatile.

To sum up, existing literature is largely based on evidence on individual country in advanced economies, especially in the U.S. markets and the results are still inconclusive. This paper fills a considerable gap in this field providing new evidence on the cross-country analysis on international perspective, developing countries, and developed countries, respectively.

[4] Storms, Kapraun, and Rudolf (2015) also document the efficiency-improving role of investor attention in individual stocks in the European and the U.S. markets. The efficiency improvement is more pronounced during bullish markets. Aouadi, Arouri, and Teulon (2013) find the same evidence in the French stock market.

3. Data

3.1 Google search intensity

The selected search keywords obtained by Google Trends in this study follow Tantaopas et al. (2016), consisting of ten countries and categorizing into two subsamples, developing (China, India, Malaysia, and Thailand) and developed markets (Australia, Hong Kong, Japan, Korea, New Zealand, and Singapore). Other stock markets data are from DataStream. Our sample covers from January 2004 to December 2014.

3.2 Stock market return, volatility, and abnormal trading volume

In this study, weekly Google's SVI starts on Sundays and is shown in terms of natural logarithm. Weekly stock index returns (R) in each country are calculated as natural logarithm of closing stock market index price changes on Mondays and Fridays during the same week.Weekly realized stock index return volatility (σ^2) in each country is the weekly squared return from Mondays to Fridays. We follow Takeda and Wakao (2014) to define abnormal trading volume (ATV) as below.

$$ATV_{i,t} = \frac{TV_{i,t} - \overline{TV_i}}{\overline{TV_i}} \quad (1)$$

where $TV_{i,t}$ is natural logarithm of trading volume of the stock market *i* during week. $\overline{TV_i}$ is the average trading volume of stock market *i* over the entire sample period.

4. Panel Vector Autoregression

Prior literature shows that SVI and other markets variables possess the dynamic interrelationships. In a reduced form, the VAR for panel data is presented as:

$$\begin{bmatrix} SVI_{i,t} \\ Y_{i,t} \end{bmatrix} = \begin{bmatrix} a_{11} & b_{11} \\ a_{21} & b_{21} \end{bmatrix} \begin{bmatrix} SVI_{i,t-1} \\ Y_{i,t-1} \end{bmatrix} + \begin{bmatrix} a_{12} & b_{12} \\ a_{22} & b_{22} \end{bmatrix} \begin{bmatrix} SVI_{i,t-2} \\ Y_{i,t-2} \end{bmatrix} + \cdots + \begin{bmatrix} a_{1p} & b_{1p} \\ a_{2p} & b_{2p} \end{bmatrix} \begin{bmatrix} SVI_{i,t-p} \\ Y_{i,t-p} \end{bmatrix} \quad (3)$$

$$+ \begin{bmatrix} f_{1i} \\ f_{2i} \end{bmatrix} + \begin{bmatrix} e_{1i,t} \\ e_{2i,t} \end{bmatrix}$$

$SVI_{i,t}$ is the appropriate selected keyword of the country *i* in week *t*. *Y* is the stock market variables; namely stock market index return, stock market return volatility, and stock market abnormal trading volume. *i* represents ten countries, which is divided into two groups, developing (China, India, Malaysia, and Thailand) and developed markets (Australia, Hong Kong, Japan, Korea, New Zealand, and Singapore). *p* is the optimal lag length suggested by Andrews and Lu (2001), which is equal to one in the SVI-return relationship and two in the SVI-volatility and the SVI-abnormal trading volume relationships. Andrews and Lu (2001) develop a new methodology for the model selection procedures known as the consistent model and moment selection criteria (MMSC), which is based on GMM estimation. Their proposed technique is similar, but superior, to maximum likelihood estimation used in the Akaike information criteria (AIC), the Bayesian information (BIC), and Hannan-Quinn information criteria (HQIC). A consensus of the minimum lag length of MMSC-AIC, MMSC-BIC, and MMSC-HQIC is the criteria for the model selection in this study.

In panel data, we might encounter with some individual heterogeneity. f_i represents a fixed effect in the model, which unobservable factors in each country are not time-variant. It is common and essential to control for country's fixed effect in a panel analysis. However, incorporating unobservable country's fixed effect variables in the model induces a correlation among the independent variables because of the lagged values of the dependent variables. A common use of first-differencing procedure for solving this problem yields biased and inconsistent estimated coefficients. This might cause more missing data in an unbalanced panel. We alleviate this potential problem by taking a forward mean-differencing procedure known as the Helmert transformation procedure or forward orthogonal deviation (Arellano and

Bover, 1995). This procedure eliminates the fixed effect of the model by transforming all variables in terms of differences from forward means, subsequently reducing missing data. Hayakawa (2009) addresses the choice of transformation is of concern in GMM estimation of a finite sample for empirics and shows that the first difference transformation method is inferior to the forward orthogonal deviation transformation method. Thus, a new panel VAR model after Helmert transformation (H) is

$$\begin{bmatrix} SVI_{i,t}^{H} \\ Y_{i,t}^{H} \end{bmatrix} = \begin{bmatrix} a_{11} & b_{11} \\ a_{21} & b_{21} \end{bmatrix} \begin{bmatrix} SVI_{i,t-1}^{H} \\ Y_{i,t-1}^{H} \end{bmatrix} + \begin{bmatrix} a_{12} & b_{12} \\ a_{22} & b_{22} \end{bmatrix} \begin{bmatrix} SVI_{i,t-2}^{H} \\ Y_{i,t-2}^{H} \end{bmatrix} + \cdots + \begin{bmatrix} a_{1p} & b_{1p} \\ a_{2p} & b_{2p} \end{bmatrix} \begin{bmatrix} SVI_{i,t-p}^{H} \\ Y_{i,t-p}^{H} \end{bmatrix} + \begin{bmatrix} \upsilon_{1i,t} \\ \upsilon_{2i,t} \end{bmatrix} \quad (4)$$

Because of dynamic interrelationships among the SVI, stock market variables, and the fixed effect, the estimation of the least squares dummy variable procedure (LSDV) yields biased estimated coefficients (Rousseau and Wachtel, 2000). A new panel VAR model using GMM estimation is more appropriate in this study for the causality relationships (see for example, Love and Zicchino, 2006 and Grossmann, Love, and Orlov, 2014). We follow the GMM estimation proposed by Holtz-Eakin, Newey, and Rosen (1988).

For our panel VAR analyses, we run pairwise relationships between the SVI and stock market index return, the SVI and stock market volatility, and the SVI and stock market abnormal trading volume, respectively.

5. Empirical results

The stationarity for all variables for panel data is confirmed by using Fisher-type unit root test based on Augmented Dickey Fuller (ADF) and Philips-Perron (PP) statistics as suggested by Choi (2001).[5] For the entire analyses, we present our results into three panels, i.e.

[5] The null hypothesis is that panels are unit roots. The Z statistics is presented as $Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i)$, where p_i is the i^{th} panel and Φ^{-1} is the inverse of the standard normal cumulative distribution function. Z is normally distributed with zero mean and unity variance. The results are available upon request.

Panel A for the relationship between the SVI and stock market index return (SVI-Return), Panel B for the relationship between the SVI and stock market volatility (SVI-Volatility), and Panel C for the relationship between the SVI and stock market abnormal trading volume (SVI-Volume), respectively. The minimum consenting MMSC-AIC, MMSC-BIC, and MMSC-HQIC optimal lag length is one for the SVI-Return analyses and two for both SVI-Volatility and SVI-Volume analyses. Moreover, we separate our sample into three categories for in-depth analyses: i) full sample, ii) developed markets (Australia, Hong Kong, Japan, Korea, New Zealand, and Singapore), and iii) developing markets (China, India, Malaysia, and Thailand), respectively. Overall, we present, compare, and discuss our results both in terms of types of the relationships and those of market developments.

5.1 Panel Granger causality

Table 1 show the panel Granger causality tests for the SVI-return, the SVI-volatility, and the SVI-abnormal trading volume, respectively. Overall, two-way relationships exist in most cases.[6] This is consistent with the information discovery hypothesis, indicating that the SVI and each market activity hold interdependence relationships. However, evidence in the developing markets is weakest such that we do not find any causality relationship of the SVI-return and the SVI-volatility. Our findings on a broad market activity contradict to the results of the experimental design by Boduroglu et al. (2009) that Westerners allocate their attention narrower than East Asians. Interestingly, the evidence of two-way interdependence relationships is very strong – there exists significant SVI-Volume relationship in all cases. This finding is consistent with Miller (1977) and Gervais et al. (2001), who document that trading

[6] It is interesting to note that one-way relationships are detected in the SVI-volatility relationship of the developed markets and the SVI-volume relationship of the full sample. SVI Granger causes stock market volatility and abnormal trading volume, but not the other way round. When people search more, making the market more volatile or executing more trade orders. Thus, Google search intensity is good proxy of retail investor attention.

volume attracts investor attention and encourage markets participants to buy stocks. Thus, the larger the trading volume, the higher the investor attention. In general, our results are consistent with Tantaopas et al. (2016), who investigate the attention effect in individual country. However, our evidence in the developing countries appears to be weaker than those reported in Tantaopas et al. (2016).

5.2 Panel vector autoregression

In this section, we assess the causal relationships through panel VAR using GMM estimation as presented in Table 2.We confirm our model identification by employing Hansen J- statistics test.The null hypothesis of the test is not rejected, hence the model estimation is valid. Overall, the results are consistent with our findings from the panel Granger causality analyses.Panel A of Table 2 shows the two-way and one-way SVI-Return relationships for the full sample and developed markets, respectively. In general, the relationship is negative and the effect of the return on the SVI is greater than that of the SVI on the return. For full sample, the magnitude of negative lagged returns on the current SVI (1.8397) is larger than the impact of the negative lagged SVI on the current returns (0.0035). However, only negative lagged returns influence the current SVI for the developed markets. We argue that people search more for information after a crash in equity markets in those countries. Interestingly, we do not observe the relationship for the developing markets. We propose possible explanations as follows. First, investors in the developing markets do not search information via search engines. A number of non-users internet relative to the country' population in developing countries is much greater than that of in developed countries.[7] Alternatively, technological advance in developing countries is less than that of developed countries. Second, Nisbett, Peng, Choi, and Norenzayan (2001) show that Asians are less analytic, less rational, and more holistic

[7] http://www.internetlivestats.com/internet-users-by-country/

than Westerners, which considerable social differences affect people's belief and cognitive processes. Last, Chang et al. (2000) show that herd behavior is strongly apparent in developing markets, but not in developed markets. Moreover, herd behavior in developing markets is more asymmetric than in developed markets, especially in up markets (Chiang and Zheng, 2010).

Panel B of Table 2 presents the results of the full sample for the SVI-volatility relationship. As in the SVI-return relationship, we find lagged volatilities have impacts on the current SVI and vice versa. Again, the impact of the volatility is larger than that of SVI, but the relationship between the SVI and volatility is positive. The search intensity is one of key determinants of market volatility. Interestingly, volatilities of market in the past call for market-wide attention in the developed markets, but not vice versa. This confirms that investors concern more on the large price movements due to heightened uncertainty. Surprisingly, the volatility effect does not play a role in the developing markets, but the search intensities do. The higher the search intensity in the past, the more volatile the market. Searching information by retail investors causes noises to the market. Again, we do not observe the strong SVI-volatility relationships in the developing markets. The different results of the relationships between the developed and developing markets could be explained as follows. First, similar to argument put forward in the SVI-return relationship, we argue that Asians are less analytic, less rational, and more holistic than Westerners. Second, Easterners do not fully understand the risk-return concept that both the stock market returns and their volatilities do not catch the market-wide attention.

For developing countries, investing in stock markets are more likely to be a gamble than investment. Thus, they do not care on the variability in the stock markets. Kumar (2009) studying the tendency to gamble and trading decision supports this statement. Low-income investors (i.e. retail investors in developing markets) prefer trading in lottery-type stocks and the level of investing in lottery-type stock is higher in markets that traders like to trade them.

Third, that developing markets have different market microstructures as in developed markets (Madhavan, 2000). .

Comparing with the other relationships, Panel C of Table 2 indicates somewhat different results for the SVI-Volume analyses. A weak relationship is noted for the full sample, which only abnormal trading volumes in the past influence the current SVI. On contrary, strong evidence is observed in both developed and developing countries, which abnormal trading volumes have impacts on the current SVI and vice versa. Moreover, the effects of abnormal trading volume dominate those of SVI in all cases. It seems that trading volume shows a strong connection with the SVI. This is consistent with the prior literature (Barber and Odean, 2008 and Gervais et al., 2001) that use the trading volumes as a good proxy of investor attention. A logical explanation is that investors pay more attention on their interesting stocks and have a large tendency to trade them. Thus, the trading volume is more closely related to attention. In another word, without attention, trading volumes cannot emerge.

In sum, the dynamic interrelationships between investor attention and stock market activities are more prominent in the developed countries than in the developing countries. Our findings are attributed to behavioral biases, in which Hou, Peng, and Xiong (2009) document that overreaction is the result of the attention. Without attention, investors cannot process and overreact to available information. Weak evidence on the developing countries shows that people do not search for information before they decide to trade, which falsifies the suggestion of Merton (1987).

Additionally, we present the impulse responses function for the three models employed in this study in Figure 1. As usual, Panels A to C depict the impulse responses of the SVI-Return, the SVI-Volatility, and the SVI-Volume relationships, respectively. The impulse response function is estimated by employing the Cholesky decomposition (Sim, 1980). The 5% error bands are created by using 500 repetitions Monte Carlo simulation. In general, the

impulse responses are consistent with the panel VAR estimated coefficients and most of them show pulse-like lines, which tend to reverse within 5 weeks for the return relationship and within 10 weeks for the volatility and trading volume. Shocks in returns seem to have lower effect than the other two cases. Thus, stock markets are more efficient in terms of return than volatility and trading volumes. . The responses of the SVI to return and the return to SVI are negative for all cases as depicted in Panel A. This is consistent with the prior literature that show a dynamic interdependence relationship between the SVI and stock market index returns. However, a different pattern is present in the relationship between the SVI and stock index volatility as depicted in Panel B and the SVI and abnormal trading volume as depicted in Panel C. The impulse responses of the SVI to volatility and the volatility to SVI are positive, hence a shock in the SVI (volatility) increases the stock market index volatility (SVI). This pattern is similar to the SVI-abnormal trading volume relationship. Thus, a shock in SVI increases trading volumes and vice versa, which support prior studies (Barber and Odean, 2008 and Gervais et al., 2001) using trading volume a proxy of investor attention.

5.3 Variance decomposition

A variance decomposition shows the accumulated impact of the shock on one variable to the proportion of variation in a given variable.Table 3 presents the forecast-error variance decomposition for all relationships in three cases. Panel A reports the variance decomposition of the SVI-Return relationship. We find that returns explain the variation in SVI approximately 1.33% for full sample and 2.00% for developed countries of total variations for 10 periods ahead. The effect in the developing countries is very small, which is consistent to with our finding on the non-existent SVI-Return relationship. Moreover, the effects of the SVI on the return variation is so small for all cases. Different findings are found in the SVI-Volatility relationship as presented in Panel B and the SVI-Volume relationship in Panel C. The effect of

the volatility on the shock in the SVI is more pronounced than that in the SVI-return relationship as shown in Panel A. This is true for the cases of the developed and developing countries. The effect of the abnormal trading volume on the shock in the SVI are the largest, accounting for almost 50% variation. Again, the trading volume is a good proxy of investor attention and show interdependence relationship.

5.4 Developing and developed countries

In order to investigate the difference in the SVI-Return, the SVI-Volatility, and the SVI-Volume relations between developed and developing countries, we follow Love and Zicchino (2006) and Grossmann et al. (2014) by taking the difference in impulse responses of these two groups. Figure 2 depicts the impulse responses of the difference between developed and developing markets of all relationships. The significance of the difference in impulse responses is greater than 5%. These findings confirm differences detected in developed and developing countries reported from our panel VAR analyses.

6. Conclusions

In this study, we examine the role of investor attention in stock markets. Google SVI is chosen as a proxy of retail investor attention with stock market activities, i.e. market return, market volatility, and market abnormal trading volume. We apply a new methodology, the Panel Vector Autoregressive model, to investigate these relationships. This technique is superior to other techniques commonly employed in the existing literature as it takes into account of both the fixed and the time-varying effects. Employing Panel VAR addresses concerns raised in Tantaopas et al. (2016) that attention behavior might be different in each country due to differences in shareholder base, cultural, ownership structure, legal protection, law enforcement, and financial education.

After controlling for both fixed and time-varying effects, we find general support to prior evidence that investor attention is related to the returns, volatility, and trading volume, respectively. However, our results shed a new light on multi-country analyses as follows. We observe mostly two-way panel Granger causality in all relationships, though weakest relationship is detected in the developing countries. These findings are reconfirmed by the panel VARs analyses, indicatingdynamic and interdependent relationships. However, for both SVI-Return and SVI-volatility, we find the negative impact on the SVI is greater than that of the SVI on return or volatility. The investor attention-abnormal trading volume relationship is mixed butstatistically in all cases. To investigate the different level of investor attention between developing and developed markets, we employ and take the difference of the impulse responses functions between these two groups and find that the attention is statistically significantly different. Thus, we conclude that investor attention is necessary for equity markets, but the effect is different between developed and developing countries.

References

Andrei, Daniel and Michael Hasler, 2015. Investor attention and stock market volatility. The Review of Financial Studies, 28 (1), 33-72.

Andrew, Donald W.K. and Biao Lu, 2001. Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models. Journal of Econometrics, 101 (1), 123-164.

Ang, Andrew, Joseph Chen, and Yuhang Xing, 2006. Downside risk. Review of Financial Studies, 19, 1191-1239.

Aouadi, Amal, Mohamed Arouri, and Frederic Teulon, 2013. Investor attention and stock market activity: Evidence from France. Economic Modelling, 35, 674-681.

Arellano, Manuel and Olympia Bover, 1995. Another look at the instrumental variable estimation of error-components models. Journal of Econometrics, 68 (1), 29-51.

Bank Matthias, Martin Larch, and Georg Perter, 2011. Google search volume and its influence on liquidity and returns of German stocks. Financial Market Portfolio Management, 25, 239-264.

Barber, Brad M. and Terrance Odean, 2008. All that glitters: The effect of attention of attention and news on the buying behavior of individual and institutional investors. The Review of Financial Studies, 21 (2), 785-818.

Bijl, Laurens, Glenn Kringhaug, Peter Molnar, and Eirik Sandvik, 2016. Google searches and stock returns. International Review of Financial Analysis, 45, 150-156.

Boduroglu, Aysecan, Priti, Shah, and Richard E. Nisbett, 2009. Cultural differences in allocation of attention in visual information processing. Journal of Cross Cultural Psychology, 40 (3), 349-360.

Braun, Nicole, 2016. Google search volume sentiment and its impact on REIT market movements. Journal of Property Investment & Finance, 34 (3), 249-262.

Chang, Eric C., Joseph W Cheng, and Ajay Khorana, 2000. An examination of herd behavior in equity markets: An international perspective. Journal of Banking and Finance, 24 (10), 1651–1679.

Chaing, Chiang C. and Dazhi Zheng, 2010. An empirical analysis of herd behavior in global stock markets. Journal of Banking and Finance, 34, 1911-1921.

Choi, In. 2001. Unit root tests for panel data. Journal of International Money and Finance, 20, 249–272.

Da, Zhi, Joseph Engelberg, and Pengjie Gao, 2011. In search of attention. The Journal of Finance, 66, 1461-1499.

Da, Zhi, Umit G. Gurun, Mitch Warachka, 2014. Frog in the pan: Continuous information and momentum. Review of Financial Studies, 27 (7), 2171-2218.

Dellaavigna, Stefano and Joshua M. Pollet, 2009. Investor inattention and Friday earnings announcements. Journal of Finance, 64 (2), 709-749.

Dimpfl, Thomas andStephan Jank, 2016. Can Internet Search Queries Help to Predict Stock Market Volatility? European Financial Management, 22 (2), 171-192.

Ding, Rong and Wenxuan Hou, 2015. Retail investor attention and stock liquidity. Journal of International Financial Markets, Institutions & Money, 37, 12-26.

Gervais, Simon, Ron Kaniel, and Dan H. Mingelgrin, 2001. The high-volume return premium. Journal of Finance, 61 (3), 877-919.

Goddard, John, Arben Kita, and Qingwei Wang, 2015. Investor attention and FX market volatility. Journal of International Financial Markets & Institutions & Money, 38, 79-96.

Grossmann, Axel, Inessa Love, and Alexei G. Orlov, 2014. The dynamics of exchange rate volatility: A panel VAR approach. Journal of International Financial Markets, Institutions & Money, 33, 1-27.

Hamid, Alain and Moritz Heiden, 2015. Forecasting volatility with empirical similarity and Google trends. Journal of Economic Behavior & Organization, 117, 62-81.

Hayakawa, Kazuhiko, 2009. First difference or forward orthogonal deviation-which transformation should be used in dynamic panel data models?: A simulation study. Economics Bulletin, 29(3), 2008-2017.

Holtz-Eakin, Douglas, Whitney Newey, and Harvey S. Rosen, 1988. Estimated vector autoregressions with panel data. Econometrica, 56 (6), 1371-1395.

Hou, Kewei, Lin Peng, Wei, and Wei Xiong, 2009. A tale of two anomalies: The implications of investor attention for price and earnings momentum, working paper.

Huberman, Gur and Tomer Regev, 2001. Contagious speculation and a cure for cancer: A nonevent that made stock prices soar. Journal of Finance, 56 (1), 387-396.

Jacobs, Heiko, 2015. The role of attention constraints for investor behavior and economic aggregates: What have we learnt so far? Management Review Quarterly, 65, 217-237.

Joseph, Kissan, M. Babajide Wintoki, and Zelin Zhang, 2011. Forecasting abnormal stock returns and trading volume using investor sentiment: Evidence from online search. International Journal of Forecasting, 27 (4), 1116-1127.

Kahneman, Daniel, 1973. Attention and effort. Priceton Hall, Englewood Cliffs, NJ.

Kumar, Alok, 2014. Who Gambles in the Stock Market? Journal of Finance, 64 (4), 1889-1933.

Li, Xin, Jian Ma, Shouyang Wang, and Xun Zhang, 2015. How does Google search affect trader positions and crude oil prices? Economic Modelling, 49, 162-171.

Love, Inessa and Lea Zicchino, 2006. Financial development and dynamic investment behavior: Evidence from panel VAR. The Quarterly Review of Economics and Finance, 46, 190-210.

Madhavan, Ananth, 2000. Market microstructure: A survey. Journal of Financial Markets, 3, 205-258.

Merton, Robert C., 1987. A simple model of capital market equilibrium with incomplete information. The Journal of Finance, 42, 483-510.

Miller, Edward M., 1977. Risk, uncertainty, and divergence of opinion. Journal of Finance, 32,1151-1168.

Nisbett, Richard E., Kaiping Peng, Incheol Choi, and Ara Norenzayan, 2001. Culture and systems of thought: Holistic versus analytic cognition. Psychological Review, 108, 291-310.

Peng, Lin, Wei Xiong, and Tim Bollerslev, 2007. Investor attention and time-varying comovements. European Financial Management, 13 (3), 394-422.

Rochdi, Karim and Marian Dietzel, 2015. Outperforming the benchmark: Online information demand and REIT market performance. Journal of Property Investment & Finance, 33 (2), 169-195.

Rousseau, P.L. and P. Wachtel, 2000. Equity markets and growth: Cross-country evidence on timing and outcomes, 1980-1995. Journal of Banking and Finance, 24, 1933-1957.

Sim, Christopher A., 1980. Macroeconomics and reality. Econometrica, 48 (1), 1-48.

Storms, Konstantin, Julia Kapraun, and Markus Rudolf, 2015. Can retail investor attention enhance market efficiency? Insights from search engine data. Working paper.

Takeda, Fumiko and Takumi Wakao, 2014. Google search intensity and its relationship with returns and trading volume of Japanese stocks. Pacific-Basin Finance Journal, 27, 1-18.

Tantaopas, Parkpoom, Chaiyuth Padungsaksawasdi, and Sirimon Treepongkaruna, 2016. Attention effect via internet search intensity in Asia-Pacific stock markets. Pacific-Basin Finance Journal, 38, 107-124.

Vozlyublennaia, Nadia, 2014. Investor attention, index performance, and return predictability. Journal of Banking and Finance, 41, 17-35.

Ying, Qianwei, Dongmin Kong, and Danglun Luo, 2015. Investor attention, institutional ownership, and stock return: Empirical evidence from China. Emerging Markets Finance and Trade, 51, 672-685.

Table 1 Panel Granger causality

This table shows the results of the panel Granger causality test for three relationships. Panels A to C show the results for the SVI-return, the SVI-volatility, and the SVI-abnormal trading volume, respectively. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	Chi-square	*p*-value
Panel A: SVI and Return		
Full Sample		
SVI does not Granger cause return	3.847**	0.050
Return does not Granger cause SVI	6.312**	0.012
Developed markets		
SVI does not Granger cause return	3.092*	0.079
Return does not Granger cause SVI	5.35**	0.021
Developing markets		
SVI does not Granger cause return	0.004	0.947
Return does not Granger cause SVI	0.992	0.319
Panel B: SVI and Volatility		
Full Sample		
SVI does not Granger cause volatility	7.674**	0.022
Volatility does not Granger cause SVI	4.901*	0.086
Developed markets		
SVI does not Granger cause volatility	15.695***	0.000
Volatility does not Granger cause SVI	1.249	0.536
Developing markets		
SVI does not Granger cause volatility	2.201	0.333
Volatility does not Granger cause SVI	2.954	0.228
Panel C: SVI and Abnormal Trading Volume		
Full Sample		
SVI does not Granger cause volume	414.089***	0.000
Volume does not Granger cause SVI	1.362	0.506
Developed markets		
SVI does not Granger cause volume	28.301***	0.000
Volume does not Granger cause SVI	5.222*	0.073
Developing markets		
SVI does not Granger cause volume	268.509***	0.000
Volume does not Granger cause SVI	4.648*	0.098

Table 2 Panel VAR estimations

Panels A to C shows the Panel VAR estimations of relationships between the SVI and stock market indices, the SVI and stock market volatilities, and the SVI and market abnormal trading volumes, respectively. The minimum consenting MMSC-AIC, MMSC-BIC, and MMSC-HQIC optimal lag length, which is equal to one for the SVI-return relationship and two for the SVI-volatility and the SVI-abnormal volume relationships. Hansen J test tells about over-identification restrictions of the GMM estimation. Standard errors are shown in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

Panel A: SVI and Return

	Full Sample		Developed Markets		Developing Markets	
	SVI_t	R_t	SVI_t	R_t	SVI_t	R_t
SVI_{t-1}	0.7512***	-0.0035***	0.8790***	-0.0041	0.6753***	-0.0026
	(0.0588)	(0.0014)	(0.0583)	(0.0018)	(0.0872)	(0.0026)
R_{t-1}	-1.8397***	-0.0534**	-2.0877*	-0.0411	-0.0701	-0.0493
	(0.9379)	(0.0224)	(1.1872)	(0.0352)	(1.0598)	(0.0496)
Hansen J Test	0.168		0.127		0.990	

Panel B: SVI and Volatility

	Full Sample		Developed Markets		Developing Markets	
	SVI_t	σ_t^2	SVI_t	σ_t^2	SVI_t	σ_t^2
SVI_{t-1}	0.5861***	0.0000	0.7683***	0.0000	0.5299***	-0.0000
	(0.0624)	(0.0001)	(0.0769)	(0.0001)	(0.0817)	(0.0001)
SVI_{t-2}	0.2436***	0.0002**	0.1643**	0.0001	0.1726**	0.0002*
	(0.0610)	(0.0001)	(0.0693)	(0.0001)	(0.0797)	(0.0001)
σ_{t-1}^2	28.6188*	0.4334***	49.8386***	0.5011***	-9.2805	0.3144***
	(17.0147)	(0.0817)	(17.1577)	(0.0852)	(6.6255)	(0.1016)
σ_{t-2}^2	8.7659	0.2885***	9.4705	0.1961***	3.5395	0.1244**
	(9.3922)	(0.0548)	(9.2032)	(0.0535)	(16.8600)	(0.0494)
Hansen J Test	0.888		0.584		0.998	

Panel C: SVI and Abnormal Trading Volume

	Full Sample		Developed Markets		Developing Markets	
	SVI_t	ATV_t	SVI_t	ATV_t	SVI_t	ATV_t
SVI_{t-1}	0.5687***	0.0022	0.5632***	-0.0023	0.5938***	0.0001
	(0.0419)	(0.0021)	(0.0580)	(0.0019)	(0.0529)	(0.0020)
SVI_{t-2}	0.2178***	0.0001	0.2887***	0.0037**	0.1695***	0.0034**
	(0.0392)	(0.0017)	(0.0558)	(0.0016)	(0.0503)	(0.0016)
ATV_{t-1}	2.5403***	0.7262***	4.4586***	1.2674***	0.5779***	0.5282***
	(0.2191)	(0.0514)	(0.8500)	(0.0784)	(0.1134)	(0.0660)
ATV_{t-2}	-0.5859***	0.2207***	-3.9262***	-0.2962***	1.1878***	0.4054***
	(0.0845)	(0.0449)	(0.7693)	(0.0694)	(0.1898)	(0.0636)
Hansen J Test	0.631		0.931		0.637	

Table 3A Variance decomposition

This table shows the variance decompositions of the relationships. Panels A to C shows the proportion of the response variable explained by the shock of the impulse variable of the relationships between the SVI and stock market indices, the SVI and stock market volatilities, and the SVI and market abnormal trading volumes, respectively, in next 10 periods.

Panel A: SVI and return

Response Variable	Forecast Horizon	Impulse Variable					
		Full Sample		Developed Countries		Developing Countries	
		SVI	Return	SVI	Return	SVI	Return
SVI	1	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000
	2	0.9901	0.0099	0.9848	0.0152	1.0000	0.0000
	3	0.9878	0.0122	0.9809	0.0191	1.0000	0.0000
	4	0.9868	0.0132	0.9789	0.0211	1.0000	0.0000
	5	0.9863	0.0137	0.9778	0.0222	1.0000	0.0000
	6	0.9860	0.0140	0.9771	0.0229	1.0000	0.0000
	7	0.9859	0.0141	0.9766	0.0234	1.0000	0.0000
	8	0.9858	0.0142	0.9762	0.0238	1.0000	0.0000
	9	0.9857	0.0143	0.9760	0.0240	1.0000	0.0000
	10	0.9857	0.0143	0.9758	0.0242	0.9758	0.0242
Return	1	0.0002	0.9998	0.0006	0.9994	0.0004	0.9996
	2	0.0029	0.9971	0.0031	0.9969	0.0022	0.9978
	3	0.0041	0.9959	0.0049	0.9951	0.0028	0.9972
	4	0.0049	0.9951	0.0064	0.9936	0.0031	0.9969
	5	0.0053	0.9947	0.0075	0.9925	0.0033	0.9967
	6	0.0056	0.9944	0.0084	0.9916	0.0033	0.9967
	7	0.0057	0.9943	0.0091	0.9909	0.0034	0.9966
	8	0.0058	0.9942	0.0097	0.9903	0.0034	0.9966
	9	0.0058	0.9942	0.0101	0.9899	0.0034	0.9966
	10	0.0059	0.9941	0.0105	0.9895	0.0034	0.9966

Panel B: SVI and volatility

Response Variable	Forecast Horizon	Impulse Variable: Full Sample		Developed Countries		Developing Countries	
		SVI	Volatility	SVI	Volatility	SVI	Volatility
SVI	1	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000
	2	0.9785	0.0215	0.9350	0.0650	0.9987	0.0013
	3	0.9546	0.0454	0.8669	0.1331	0.9987	0.0013
	4	0.9252	0.0748	0.8009	0.1991	0.9985	0.0015
	5	0.8972	0.1028	0.7458	0.2542	0.9984	0.0016
	6	0.8713	0.1287	0.7010	0.2990	0.9984	0.0016
	7	0.8485	0.1516	0.6650	0.3350	0.9983	0.0017
	8	0.8288	0.1712	0.6360	0.3640	0.9983	0.0017
	9	0.8120	0.1880	0.6125	0.3875	0.9983	0.0017
	10	0.7980	0.2020	0.5934	0.4066	0.9983	0.0017
Volatility	1	0.0101	0.9899	0.0252	0.9748	0.0023	0.9977
	2	0.0103	0.9897	0.0259	0.9741	0.0021	0.9979
	3	0.0128	0.9872	0.0275	0.9725	0.0033	0.9967
	4	0.0145	0.9855	0.0290	0.9710	0.0039	0.9961
	5	0.0165	0.9835	0.0305	0.9695	0.0045	0.9955
	6	0.0182	0.9818	0.0318	0.9682	0.0048	0.9952
	7	0.0199	0.9801	0.0330	0.9670	0.0051	0.9949
	8	0.0213	0.9787	0.0341	0.9659	0.0052	0.9948
	9	0.0226	0.9774	0.0352	0.9649	0.0053	0.9947
	10	0.0237	0.9763	0.0361	0.9639	0.0054	0.9946

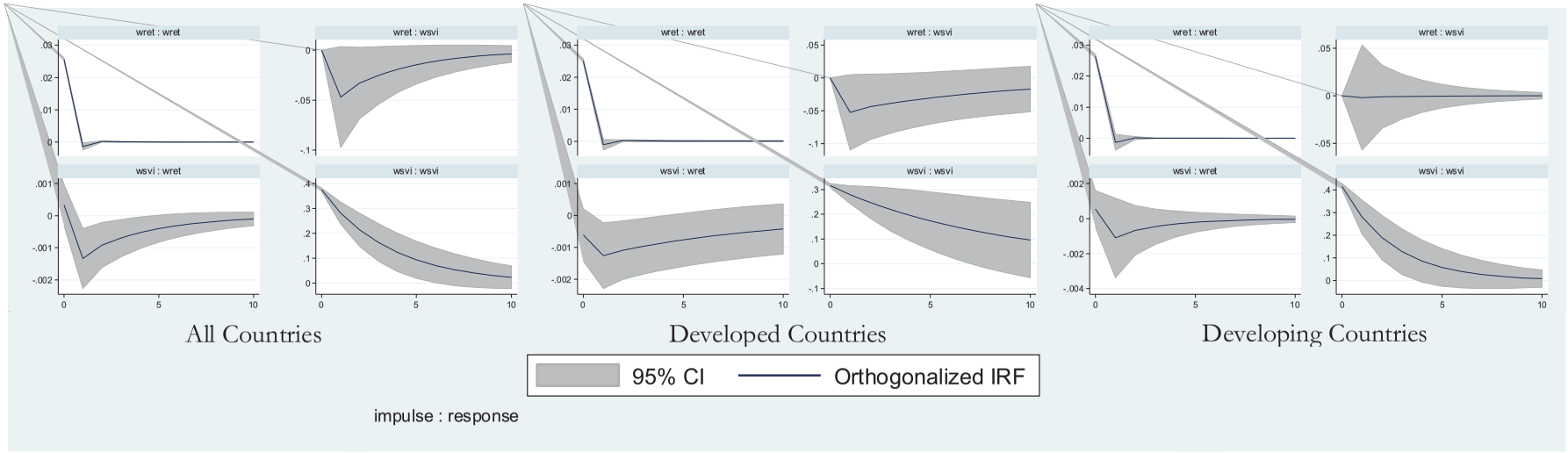
Panel C: SVI and abnormal trading volume

Response Variable	Forecast Horizon	Impulse Variable					
		Full Sample		Developed Countries		Developing Countries	
		SVI	Volume	SVI	Volume	SVI	Volume
SVI	1	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000
	2	0.8716	0.1284	0.9288	0.0712	0.9834	0.0166
	3	0.8054	0.1946	0.8994	0.1006	0.8719	0.1281
	4	0.7175	0.2825	0.8726	0.1274	0.7728	0.2272
	5	0.6427	0.3573	0.8532	0.1468	0.6672	0.3328
	6	0.5766	0.4234	0.8368	0.1632	0.5809	0.4191
	7	0.5210	0.4790	0.8228	0.1772	0.5094	0.4906
	8	0.4744	0.5256	0.8104	0.1896	0.4524	0.5476
	9	0.4355	0.5645	0.7992	0.2008	0.4067	0.5933
	10	0.4029	0.5971	0.7890	0.2110	0.3700	0.6300
Volume	1	0.0515	0.9485	0.0298	0.9702	0.0396	0.9604
	2	0.0539	0.9461	0.0252	0.9748	0.0397	0.9604
	3	0.0558	0.9442	0.0264	0.9736	0.0417	0.9583
	4	0.0575	0.9425	0.0282	0.9718	0.0430	0.9570
	5	0.0589	0.9411	0.0304	0.9696	0.0446	0.9554
	6	0.0603	0.9397	0.0326	0.9674	0.0459	0.9541
	7	0.0615	0.9385	0.0349	0.9651	0.0471	0.9529
	8	0.0626	0.9374	0.0371	0.9629	0.0482	0.9518
	9	0.0636	0.9364	0.0392	0.9608	0.0491	0.9509
	10	0.0644	0.9356	0.0412	0.9588	0.0500	0.9500

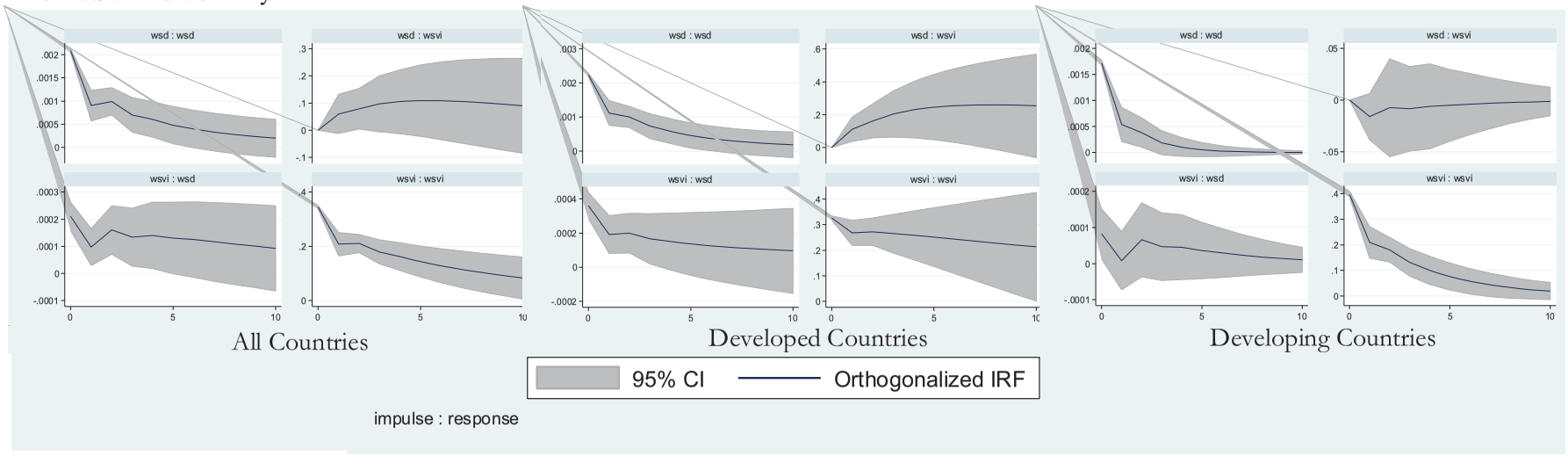
Figure 1 Orthogonalized impulse responses for the SVI relationships

The figures depict the impulse responses for the SVI-return (Panel A), the SVI-volatility (Panel B), and the SVI-abnormal trading volumes (Panel C), respectively. From the left to right, each figure represents the impulse responses of the full sample, developed countries, and developing countries, respectively. The 95% confidence interval (CI) is created by the Monte Carlo simulation with 500 repetitions.

Panel A: SVI and Return



Panel B: SVI and Volatility



Panel C: SVI and Abnormal Volume

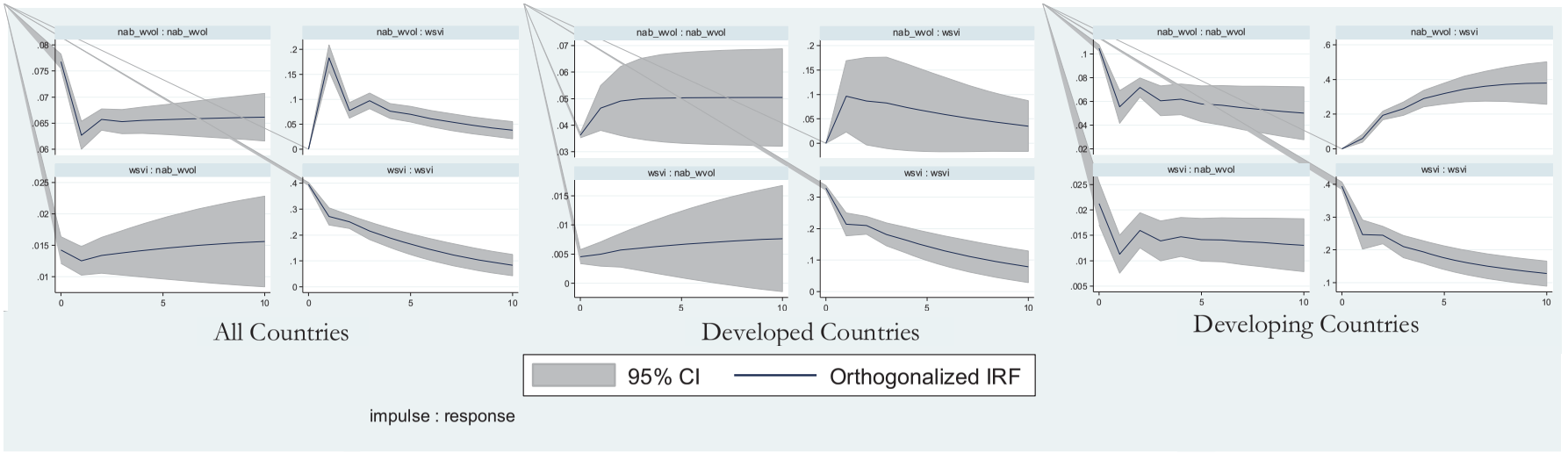


Figure 2 Orthogonalized impulse response for the difference between developed and developing markets

This figure depicts the impulse response function of the difference between the developed and developing markets in three relationships.