Muhammad Munir Ahmad[*], Ahmed Imran Hunjra[**]
Muhammad Umer Quddoos[***]

Development of Asymmetric Information Index Using Principal Component Method

ABSTRACT

The objective of this study is to develop an index of asymmetric information that not only captures the information environment but also determines the level of asymmetric information around the firms. The index is constructed through the Principal Component Method (PCM) by incorporating trading volume, price impact measures, relative bid-ask spread, volume coefficient of variation, discretionary accruals, and abnormal returns. Equity data of 280 firms, which comprises 155 firms from agriculture allied sectors and 125 firms from other non-financial sectors of Pakistan is extracted from DataStream and Worldscop for the period of 19 years from 2000 to 2018. Descriptive statistics, correlation analysis, and PCM are used for data analysis. Year by year statistics is calculated to check the level of asymmetric information over the sample period for the full sample, agriculture allied firms, and other non-financial firms. Mean values of the asymmetric information show no specific pattern; however, it increases from 2007 to 2008, the period of financial crises. The pattern of asymmetric information index in agriculture allied firms' data set is different from the two data set. There is less variation in the mean of the data and shows an increase over the time-period with less decrease in

[*] University Institute of Management Sciences-PMAS- Arid Agriculture University, Rawalpindi, Pakistan.
[**] University Institute of Management Sciences-PMAS- Arid Agriculture University, Rawalpindi, Pakistan.
[***] Department of Commerce, Bahauddin Zakariya University, Multan, Pakistan.

some years. The results of the study describe that asymmetric information prevails around the firms and there may be technological advancement as well as the improvement in disclosure policies, to minimize the level of asymmetric information.

Keywords: Asymmetric information, asymmetric information index, capital structure, investment, feedback effect, speed of adjustment, agriculture allied firms, non-financial firms.

JEL Classification: G01, G12, G14

Introduction

Market participants hold different information that affects their decisions in many situations. These decisions are taken based on information that is possessed by the decision-maker. Owing to having better information, few market participants avail a better position at negotiating the deal with others or could be better positioned compared with the competitors(Brunnermeier, 2001). Having different levels of information by every market participant is known as asymmetric information(Stiglitz, 2002). Under this situation, decisions may be affected by the risk associated with the lack of information. Theoretically, the decisions can be predicted easily in the perfect information scenario but in the real world, it is not the case.

Like other markets, financial markets also work based on news and information. According to Modigliani and Miller (1958)all the stakeholders of financial markets possess equal information. However, in reality, each participant holds different levels of information. Some participants may have better information about any specific event, while others hold different information about the same event. Even if all the market participants listen to the same information about any public proclamation, it may be possible that they interpret it differently. Announcements by corporations seldom provide a direct statement of security's value. Market participants must possess further information to know the impact of this announcement on the value of assets. Markets participants with different experiences, information might draw various interpretations from the same news. Hence, it is difficult to get a better understanding of the financial market unless one also analyses the asymmetries in the information variations and assimilation process (Brunnermeier, 2001).

The problem of measuring the information environment around the firm, from the investor to investor or firm to investor, has been substantially discussed in the literature. Finance and accounting literature has developed various proxies and measures to capture the asymmetric information that prevails around the firm. The proxies and measures of asymmetric information discussed in the finance literature can be categorized into three groups. In the first group, intangible fixed assets of firms, market to book value of equity, growth opportunities, size of a firm, and other firm's characteristics are used as proxies of asymmetric information (Baker & Wurgler, 2002; Frank & Goyal, 2003; Lemmon &

Zender, 2010). Large size firms are considered as low information asymmetry firms due to multiple financing resources and having various investment opportunities, whereas firms with high market to book value are considered to have high growth opportunities. Intangible assets are linked with the information opaqueness. These proxies of a firm's characteristics are also widely used for systematic risk and mispricing (Fama & French, 1993; Lakonishok & Vermaelen, 1990). Hence, these proxies are considered noisy measures of information asymmetry. Bharath et al. (2009) described that these measures are inherently persistent.

Analysts consider the second group as adynamic measure, which includes a dispersion of earnings forecasts and level of coverage. There are various interpretations and intangible assets, growth opportunities, and high book to market firms that generate conflicting results in the literature regarding these proxies such as higher dispersion of earning forecast. In the same way, large firms are inclined to be covered by many analysts (Chang et al., 2006; Gomes & Phillips, 2012).The third group comprises of proxies described by market microstructure literature and based on adverse selection measures. Bagehot (1971) originated the idea that traders having better information in a financial market may impact the price formation process resulting in the adverse selection problem. Relative bid-ask spread, effective bid-ask spread, Price Impact Measures (PIM), Volume Coefficient of Variation (VCV) and Probability of Informed Trading (PIN) are common measures or proxies discussed in the market microstructure literature (Amihud, 2002; George et al., 1991; Lof & Bommel, 2018). The last group measures have been widely used in the finance literature because these are less sensitive to the measurement of asymmetric information. Besides, these measures have not directly associated with the firm's characteristics and analyst interpretations. Even these proxies are improved in estimating the asymmetric information, they are considered less direct measures, having complicated interpretations of liquidity and the problem of data availability (Bharath et al., 2009; Frank & Goyal, 2003; Hasbrouck, 2009).

Most of the studies in accounting literature provide the same proxies of asymmetric information as described in the finance literature. These include characteristics of firms, market microstructure framework, and analyst coverage (Ecker et al., 2006; Piotroski & Roulstone, 2005). Francis et al. (2005) described the listing of a firm in the stock exchange as a proxy of asymmetric information. The public listed companies are bound

to publish financial statements and provide a broader set of reliable information. Accounting literature discusses the information revealed from published financial statements. Different associations in different countries provide investor relation measures. These measures provide timeliness information across the industry and are considered complete and clear. Apart from these proxies' discretionary accruals and abnormal returns are also used as a proxy of asymmetric information in the accounting literature (Bhattacharya et al., 2013).

The main purpose of this study is to develop an asymmetric information index by utilizing accounting and finance-based measures in Pakistani non-financial and agriculture allied firms. The remainder of the paper comprises the literature in section 2 followed by the method in the 3rd section. Results and discussion are made in part four and the study is concluded in section 5.

Literature Review

Asymmetric information refers to a situation in which one party in a transaction possesses more information while others involved have less or no information(Philip & Paul, 2015). The concept of asymmetric information was first coined by Akerlof (1970). He was of the view that buyers do not possess complete information as compared to the seller. The buyer only considers the average of the whole market, while the seller has better information on a specific item. This theory is also referred to as the theory of imperfect information. Since its inception, it has become an important area in economics and finance to explain different phenomena. In financial markets, asymmetric information can be (i) Adverse selections, (ii) moral hazard, and (iii) monitoring cost. The funds' provider may face adverse selection when he is unable to access the risk level associated with each project at the time of fund allocation. If two projects are having equal predicted value, preferences of lender and borrower differ. The lender chooses the less risky whereas the borrower prefers the higher risky projects. Risky projects are preferred by the borrower because they feel convenient to veil the accurate nature of the project and help them to exploit the low level of information possessed by lenders. Moral hazard describes the ability of fund borrowers in deploying funds to various projects instead of those projects, which are agreed with the lenders. Due to lack of information, lenders are unable to know the exact uses of the loan and have not to control over borrowers.

Due to higher monitoring cost borrower take advantage of this and hide their actions and disclose the fewer earnings instead of actual(Bebczuk, 2003).

Signaling theory is fundamentally concerned with reducing information asymmetry between two parties. The signaling model by Ross (1977) holds that actions taken by the managers serve as the information for the outsiders of the firm in deciding the investment and financing strategies. It describes asymmetric information between external and firms' managers and changes in capital structure provide a signal in the market about the future performance of the firm. Whenever a firm makes changes in capital structure or announces dividends it reduces the level of asymmetric information and investor make decisions of investment based on signals in the market and shares prices vary because of these signals(Andres et al., 2014).Taj (2016) narrated three important elements of signaling theory, i.e., Signaler, signal, and the receiver. Insiders (firm's management) are the signaler, who possess better information than outsider about the firm. According to Connelly et al.(2011), private information gives advantage to insiders to develop the good perception about underlying qualities of some aspects. Signals are the clues or information either positive or negative that is sent by the insiders to investors or other stakeholders of the firms. Receivers are the outsiders of the firms which interpret the signals differently.

Information plays a significant role at the time of each type of decision-making made by the state, households, or businesspersons. Individuals make decisions based on publicly available information that is available in the market freely and some of them make decisions based on private information that is only possessed by very few individuals. Stiglitz (2002) narrated that situation of asymmetric information creates when different individuals have different information about the same thing due to holding some private information. Decisions of individuals having more information are better than possess less information. It is important to study information asymmetry because it can harm economic efficiency and investment decisions. Researchers are working on big data and they are of the view that, where more and more information is available for the market players, they can base their decision sustained by real evidence. It can be concluded that accurate and timely information to market participants is key to economic growth and financial stability.

Measuring the asymmetric information between investor to firm and investor-to-investor has gained much importance in the literature. Some

proxies and direct or indirect measures have been discussed and criticized in the finance and accounting literature. Therefore, capturing the level of asymmetric information in the market and around the firm for the valuation of the firm's market value has become a difficult task. To address the issue, a composite index is needed which not only captures the information environment but also determined the level of asymmetric information around the firms. Bharath et al. (2009), Andres et al. (2014),Gao and Zhu (2015) and Aflatooni and Khazaei (2020)focused on the development of a composite index of information asymmetry which captures the effect of maximum direct and indirect proxies used in the literature for measuring the asymmetric information in the market.

Methodology

Andres et al. (2014) narrated that market participants (like managers, suppliers, analysts, and traders) closely related to firms, possess better information about the respective firm and traded securities. Upon this notion, the theory of market microstructure tries to know the extent of asymmetric information from the market data. Researchers used different proxies for measuring the asymmetric information that is described in the literature. Corwin and Schultz (2012) used bid-ask spread and Ravi and Hong (2014) employed accruals quality and return volatility. Zagaglia (2013) used Probability of Informed trader (PIN Package) whereas Lopatta et al. (2014) taken abnormal returns. Philip and Paul (2015) developed a questionnaire. Cui et al. (2018) used dispersion of analysts' forecasts (DISP), price impact measure, and bid-ask spread. Danso et al.(2019) and Huynh et al.(2020)utilized the analysts' forecasts properties to capture the effect of asymmetric information. The novelty of the study is the construction of the asymmetric information index, which is used to test whether asymmetric information drives the capital structure decisions. The asymmetrical information index is constructed by using the principal component method. The details of measuring the index of information asymmetries are discussed in the microstructure literature which is based on the adverse selection and stated that the existence of well-informed traders in a financial market has an impact on the process of price formation (Bharath et al., 2009).

The asymmetric information index is constructed by applying PCM by incorporating the following (06) six variables, which cover each aspect of information flow.

Trading Volume (TV_{it})

Llorente et al. (2015) narrated that intenseness of trading volume has gained importance for measuring and identifying the speculation and hedging explaining share price fluctuations. They confirm the existence of a correlation between trading volume and stock price movements. Based on the argument trading volume is used as the proxy of asymmetric information. For this purpose Lof and Bommel (2018) describe the following measure of the trading volume:

$$TV_{it} = ln(VOL_{it} * P_{it})$$

Price Impact Measures (PIM_{it})

The illiquidity measure is used in this study, which is known as the Price Impact Measure (PIM). It is the absolute daily returns on shares to its volume of trade and is utilized to check the response of price against one rupee of the trading volume. Its positive impacts expected returns (Amihud, 2002). To account for the price changes implied by order size, the daily ratio of the absolute value of observed returns to trading volume is calculated as follows:

$$PIM_{it} = \frac{|R_{it}|}{VOL_{it}}$$

Volume Coefficient of Variations (VCV_{it})

Uninformed traders place dissimilar orders whereas the informed traders place similar nature or correlated orders in the market. Orders placed by uninformed traders are usually matched with each other, whereas the orders placed by informed traders create imbalances in orders that are adjusted by market makers. It leads to the connection of two moments that the distribution of trading volume is a function of informed trading proportionally as argued by Kyle (1985). Based on the notion described above, Lof and Bommel (2018) developed the new proxy of the asymmetric information named Volume Coefficient of Variations (VCV). Chordia, Subrahmanyam, and Anshuman (2001) also used VCV of trading volume for examining the stock returns and dispersion in trading volume but didn't relate to the asymmetric information. VCV is estimated based on aggregate volume data of trade.

$$VCV_{it} = \frac{\sigma_{V\ (i,t\in T)}}{\mu_{V\ (i,t\in T)}}$$

VCV_{it} is defined as the volume coefficient of variation of firm *i* in year *t*, $\sigma_{V\ (i,t\in T)}$ is the sample standard deviation of all daily trading volumes of firm *i*, $\mu_{V\ (i,t\in T)}$is the sample average of all daily trading volumes of firm *i* in year *t*.

Bid-Ask Spread (S_{it})

Ample literature is available to use bid-ask spread as the component of the adverse selection of asymmetric information (Hasbrouck, 2009; Huang & Stoll, 1998). Some scholars emphasized that the bid-ask spread should reflect the cost of holding inventory by liquidity suppliers (Amihud & Mendelson, 1980; Demsetz, 1968; Glosten & Milgrom, 1985). Roll (1984) model is one of the pioneer models, which measures the spread from the serial covariance of observed prices. Hasbrouck (2009) and Andres et al. (2014) stated that relative bid-ask spread captures the ignore book orders due to deviation from bid and ask prices. For this purpose, the relative bid-ask spread in this study is measured as follows:

$$S_{it} = \frac{(Ask_{it} - Bid_{it})}{P_{it}}$$

Discretionary Accruals (ACC_{it})

Ravi and Hong (2014) categorized the measures of asymmetric information between firms to investors in two broad categories; market information-based measures as indirect measures and firm's characteristics disclosure measures as direct measures. Bhattacharya et al. (2013) worked on the relationship of asymmetric information with poor earning quality by using the proxy of accruals. They further explored that the highest positive and negative value of accruals leads to the investor to firm information asymmetry.

Discretionary accruals are used in this study as a measure of a firm to investor information asymmetry, which is already used by Bhattacharya et al. (2013); Kothari, Leone, & Wasley (2005); Ravi & Hong(2014).The following equation is used to calculate:

$$\frac{ACC_{it}}{ASSETS_{it}} = \beta_o + \beta_1 \frac{1}{Assets_{it}} + \beta_2 \frac{\Delta SALES_{it}}{Assets_{it}} + \beta_3 \frac{PPE_{it}}{Assets_{it}} + \varepsilon_{it} \quad \text{..... (1)}$$

ACC_{it} means the total accruals of year *t* and firm *i*, which is measured by taking the difference between earnings and cash flows.PPE is property plant and equipment. Δ Sales is a change in sales relative to the previous year. The residual ε_{it} is taken as discretionary accrual.

Abnormal Returns (AbR_{it})

The literature on information economics narrates abnormal returns on the stock as a proxy of asymmetric information around the firm. Beyer, Cohen, Lys, and Walther (2010) argue that stock returns provide a detailed measure of the flow of information and allow the assessments of information flow apart from financial narratives and quantitative information revealed from corporate disclosures. At the time of trading based on private information inside traders concurrently reduce the level of asymmetric information and earn abnormal returns. The abnormal returns as the proxy of asymmetric information are used in previous studies (Acharya, DeMarzo, & Kremer, 2011; Kalev, Liu, Pham, & Jarnecic, 2004; Shin, 2006). Abnormal returns are calculated by standard methodology as developed by Fama et al. (1969) and described by MacKinlay (1997) as follows

$$AR_{it} = R_{it} - E(R_{it})$$

AR_{it} is the Abnormal returns of the i firm and year t

R_{it} is the Returns of an individual stock, which is calculated by taking the difference of current market price at the end of each year *t* and the previous period price of a firm. The formula is as under:

$$R_{it} = \left(\frac{P_t - P_{t-1}}{P_{t-1}}\right)$$

E (R_{it}) is calculated from the CAPM model by taking the daily market prices of the stock of each firm. The average of the year for each firm is taken after applying the CAPM methodology.

$$E(R_{it}) = R_f + \beta_i(R_m - R_f)$$

R_f is the risk-free rate

Rm_t is the market return, which is calculated by taking the daily closing value of the index of Pakistan Stock Exchange (PSX) and using the following formulae:

$$Rm_t = \left(\frac{P_t - P_{t-1}}{P_{t-1}}\right)$$

After calculating the market returns the daily returns of each stock of the individual company are matched with the daily market returns. β_iThe coefficient is calculated by applying the regression analysis.

Principal Component Method (PCM) Equation

The weight of each component is calculated by applying the PCM. The following equation is used to construct the asymmetric information index (AII_{it}).

$$AII_{it} = W_1 TV_{it} + W_2 PIM_{it} + W_3 S_{it} + W_4 VCV_{it} + W_5 ACC_{it} + W_6 AbR_{it} \quad ...(2)$$

Weight (W) is calculated weight of each component and for each firm. The asymmetric information index for each year and each firm is obtained by summing up all the individual indices for a respective year. The weight for each variable is captured and then is multiplied with the respective value of the variable in each year for each firm.

Results

This section describes the results of the study, comprises of the summary and correlation of the variables used to develop the index, then results of the principal component method are mentioned and at the end, descriptive statistics of asymmetric information index of each data set is shown.

A summary of the asymmetric information measures, that are used to develop the index of asymmetric information, is given in the following table 1.

Table 1
Summary Statistics of Asymmetric Information Measures

	Full Sample			Agriculture Allied			Other Non-Financial		
Variable	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
TV	1.693	1.594	2.096	1.052	1.112	2.138	1.025	1.042	1.810
PIM	0.006	0.004	0.040	0.006	0.003	0.044	0.005	0.003	0.033
SP	0.003	0.000	0.551	0.009	0.000	0.554	-0.005	0.000	0.546
VCV	1.170	1.032	0.685	1.155	1.021	0.705	1.140	1.012	0.657
DAcc	0.192	0.159	0.981	0.112	0.164	0.679	0.118	0.152	0.472
AbR	0.266	-0.059	4.319	0.208	-0.034	2.594	0.338	-0.093	5.783

This table shows the cross-sectional data on measures of Asymmetric Information for the full sample, Agriculture Allied and Other Non-Financial firms from 2000 through 2019. The measures include Natural Log of Trading Volume (TV), Amihud (2002) Price Impact Measures (PIM), Spreads (Sp), Volume Coefficient of Variations (VCV), Discretionary Accruals (DAcc), and Abnormal Returns.

Trading volume is considered as a function of asymmetric information on asset value. The mean value of the trading volume of the full sample is 1.693, which shows the average of the whole sample, the median is close to the average and the standard deviation of 2.096 explains the variation in the data. Averages of trading volume of agriculture allied firms and other non-financial firms are 1.052 and 1.025 with 2.138 and 1.810 standard deviations respectively. Variation in the data set of other non-financial firms is also below the agriculture allied firms. To account for the price changes implied by the order size, Price Impact Measures (PIM) is calculated as suggested by Amihud (2002). Higher daily returns are considered as a strong price impact. The average value of PIM is 0.6% with a 4% variation in the data set. Mean and standard deviation are more or less the same in Agriculture Allied Firms and slightly different in the other Non-Financial firms. Average values of PIM describe that there is a 0.5 to 0.6 percent effect of price changes against the one-rupee trading activity. Bid-Ask spread is considered as the most observed measure of asymmetric information, based on the premise that traders having more information take more benefits from their trading activities. The higher the bid-ask spread denotes the higher the information asymmetry around the firm. The average value of the spread is 0.3% with a standard deviation of 0.551 in the full sample data set. It shows the average spread is generated from the trading activity during the sample period. The mean value of Spread in the agriculture allied firms is 0.9% with a standard deviation of 55% in the data set, which is higher than the whole complete sample.

The average spread in other non-financial sectors is -0.5% with a 55% standard deviation in the data set of sub-sample. It shows that the intensity of asymmetric information is high in non-financial firms. The average VCV of full sample data is 1.170 with a standard deviation of 0.685 whereas the mean values of agriculture allied and other non-financial firms' data set are 1.155 and 1.140 with a standard deviation of 0.705 and 0.657 respectively. These values are more related to overall sample data sets. The mean value of discretionary accruals is 19% with a

standard deviation of 0.98 and the mean values are 11.2% and 11.8% in agriculture allied and other non-financial firm's data sets, which are slightly different and positive in all data sets. Higher positive and negative returns are associated with a higher level of asymmetric information around the firms. The mean values of abnormal returns are 26.6%, 20.8%, and 33.8% in the full data set, agriculture allied and other non-financial firms respectively. Non-financial firms show higher abnormal returns with a higher standard deviation.

It is important to check the relationship among the measures of asymmetric information which are used to construct the index. Therefore, Correlation analysis is performed to check the strength of the relationship between asymmetric information measures.

Table 2
Correlation Coefficients of Asymmetric Information Measures

	TV	*PIM*	*SP*	*VCV*	*AbR*	*DAcc*
Pearson Correlation, Pairwise, n= 5320						
TV	1					
PIM	-0.298***	1				
SP	-0.422***	0.193***	1			
VCV	0.560***	0.194***	0.287***	1		
AbR	0.533***	0.316***	0.422***	0.339***	1	
DAcc	0.740***	0.234***	0.329***	0.429***	0.358***	1
Spearman Rank Correlation, Pairwise, n= 5320						
TV	1					
PIM	-0.490***	1				
SP	-0.504***	0.328***	1			
VCV	0.590***	0.302***	0.331***	1		
AbR	0.600***	0.443***	0.498***	0.374***	1	
DAcc	0.754***	0.381***	0.403***	0.455***	0.384***	1

This table indicates the Pearson pairwise correlation and spearman rank correlation for the full sample data set from 2000 through 2018. Variables are Natural Log of Trading Volume (TV), Amihud (2002) Price Impact Measures (PIM), Spreads (Sp), Volume Coefficient of Variations (VCV),

Discretionary Accruals (DAcc), and Abnormal Returns. *** denote statistical significance at 1% level.

Pearson correlation coefficients evaluate the linear relationship between two variables whereas Spearman rank correlation coefficients describe the monotonic relationship between the variables. Results of the Spearman rank correlation are better than Pearson's correlation because some of the measures of asymmetric information have a monotonic relationship. All measures of asymmetric information are positively correlated to each other, having more than a 30% correlation that is necessary for applying the Principal Component Analysis (PCA). Results Spearman rank correlation is in line with the Bharath et al. (2009)and Andres et al. (2014) except trading volume, which shows a negative with all measures of asymmetric information in their studies. However, the trading volume shows a negative relationship with spread and price impact measure (PIM). Whereas it is positively correlated to the other four measures.

Principal Component Analysis is used to reduce a large number of variables into a single index or variable that contains maximum information of the large set of variables. Literature reported various measures/proxies to understand the phenomenon of asymmetric information which prevails in the capital markets. Some proxies are based on accounting measures and some are market-based. Yet, there is no single measure, which can fully capture all aspects of asymmetric information. To account for the maximum facets, a composite time-varying asymmetric information index is constructed by using the PCA by utilizing six measures which are separately used in literature (Andres et al., 2014; Bharath et al., 2009; Gao & Zhu, 2015). These measures are Natural Log of Trading Volume (TV), Price Impact Measures (PIM), Spreads (SP), Volume Coefficient of Variations (VCV), Discretionary Accruals (DAcc), and Abnormal Returns (AbR).

Table 3
Factors Loading of Asymmetric Information Measures

	PC1 Year by Year							
Year	TV	PIM	SP	VCV	AbR	DAcc	Var Exp (%)	Eigen Values
2000	0.946	0.481	0.659	0.819	0.798	0.896	61.20%	3.672
2001	0.948	0.533	0.657	0.794	0.788	0.868	60.34%	3.620
2002	0.974	0.445	0.974	0.804	0.698	0.906	67.51%	4.050
2003	0.945	0.477	0.675	0.815	0.764	0.888	60.21%	3.612
2004	0.954	0.516	0.601	0.796	0.771	0.865	58.58%	3.515
2005	0.949	0.401	0.674	0.787	0.776	0.863	58.17%	3.490
2006	0.940	0.375	0.674	0.782	0.744	0.876	56.85%	3.411
2007	0.989	0.476	0.858	0.790	0.726	0.891	58.09%	3.485
2008	0.979	0.485	0.914	0.809	0.755	0.906	61.48%	3.689
2009	0.955	0.423	0.936	0.795	0.763	0.891	60.01%	3.600
2010	0.945	0.505	0.801	0.726	0.726	0.853	57.02%	3.421
2011	0.929	0.521	0.839	0.723	0.695	0.857	54.68%	3.281
2012	0.933	0.553	0.703	0.721	0.774	0.859	58.78%	3.527
2013	0.933	0.525	0.660	0.775	0.661	0.865	56.12%	3.367
2014	0.932	0.528	0.704	0.800	0.735	0.863	59.50%	3.570
2015	0.943	0.505	0.646	0.836	0.809	0.874	61.30%	3.678
2016	0.940	0.499	0.643	0.785	0.780	0.856	58.41%	3.505
2017	0.956	0.427	0.732	0.824	0.734	0.879	60.38%	3.623
2018	0.937	0.397	0.524	0.785	0.727	0.864	53.36%	3.201
Mean	0.944	0.483	0.679	0.788	0.749	0.875	59.14%	3.543

This table describes the results for the Full Sample from 2000 through 2018, which shows the time series of factor loadings for the first

component derived using year-by-year Principal Component Analysis (PCA) on standardized Asymmetric Information Measures. These include Natural Log of Trading Volume (TV), Amihud (2002) Price Impact Measures (PIM), Spreads (Sp), Volume Coefficient of Variations (VCV), Discretionary Accruals (DAcc), and Abnormal Returns (AbR). In the last column percentage of variance explained (Var Exp) of the first principal component is explained.

All the factor loadings have positive signs and do not change over time for asymmetric information measures. All the measures taken in PCA are included in the construction of the index and not a single measure is excluded by close the zero factor loadings, rather these measures have reasonable factor loadings. On average, the first component analysis accounts for 60% explained variance in the sample and the Eigen Value is 3.50, which is more than the second one that is 0.80 on average. Hence, the first principal component is considered as a good estimator to represent the common variability in the six proxies of asymmetric information. Year by year PCA is performed to check the variability in the factor loadings of the asymmetric information measures. Gao and Zhu (2015) reported that higher loadings of measures are associated with more severe asymmetric information problems. In the same way, Andres et al. (2014)stated that a decrease in the values of factor loadings shows the irrelevance of the factors. Variation in the factor loadings of all measures is found, and no specific pattern is observed. However, the spread tightened gradually after 2008 due to improvements in exchange technology. It is important to mention here, that during 2007 and 2008 many of the measures gained significantly, which provide evidence of higher asymmetric information during the period of global financial crises. Factor loadings of all measures are observed in Figure-1.

Figure-1: Factor loadings of index measures

Figure-1 shows the year wise factor loadings of all measures of asymmetric information for the period of 2000 to 2018, After getting the loading factors, mean values of all loading factors are obtained and inserted into the equation for construction of asymmetric information index.

$$AII_{it} = 0.944TV_{it} + 0.483PIM_{it} + 0.679S_{it} + 0.788VCV_{it} + 0.749ACC_{it} + 0.875AbR_{it}$$

Weights in the equation are multiplied with year-to-year and firm to firm variables to construct the asymmetric information index.

An index is developed by PCM is based on direct and some other informational measures have some properties. The elements of the first eigenvector are used to calculate PCA_{it} having a positive sign. It captures the information contents of four direct measures and two indirect measures and retains the maximum possible available information about market perceptions. By combining the variations of maximum measures,

the asymmetric information index minimizes the likelihood that is related to non-informational liquidity. The following table describes the descriptive statistics of the asymmetric information index.

Table 4
Descriptive Statistics of Asymmetric Information Index

	Full Sample			Agriculture Allied			Other Non-Financial		
Year	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
2000	1.258	1.069	4.232	1.16	1.072	2.772	1.334	1.065	5.103
2001	1.552	1.075	7.909	1.307	1.113	4.749	1.742	1.064	9.69
2002	1.072	1.09	5.445	0.86	1.115	4.832	1.237	1.077	5.889
2003	1.054	1.114	4.615	1.059	1.169	3.718	1.05	1.094	5.231
2004	0.76	1.125	5.681	1.057	1.155	2.317	0.619	1.117	7.359
2005	1.074	1.087	5.512	1.494	1.124	4.482	0.735	1.076	6.217
2006	1.12	1.116	4.981	1.43	1.146	3.08	0.75	1.082	6.084
2007	1.29	1.111	6.341	1.575	1.118	3.133	1.06	1.096	8.056
2008	1.772	1.111	5.567	1.736	1.119	3.01	1.912	1.106	6.981
2009	1.143	1.082	9.22	1.63	1.101	4.478	1.161	1.072	10.04
2010	0.744	1.081	5.358	1.376	1.11	3.833	0.257	1.058	6.256
2011	1.013	1.087	7.761	1.97	1.121	9.087	0.396	0.547	1.049
2012	1.063	1.091	7.113	1.884	0.804	8.43	0.423	1.061	5.837
2013	1.635	1.105	7.221	1.226	1.122	8.436	1.16	1.084	2.538
2014	1.345	1.137	4.186	1.636	1.154	5.223	1.107	1.12	3.089
2015	1.336	1.146	5.065	1.914	1.188	6.98	0.977	1.119	2.665
2016	0.88	1.148	7.916	1.873	1.194	6.133	0.96	1.141	9.036
2017	1.029	1.164	3.01	1.332	1.175	1.769	0.788	1.153	3.703
2018	1.113	1.156	3.073	1.435	1.181	2.121	0.855	1.143	3.647

This table describes year by year descriptive statistics from 2000 through 2018 which contains Mean, Median, and Standard Deviations of Full Sample data, Agriculture Allied Firms and Other non-Financial Firms of Asymmetric Information Index, constructed by applying the Principal Component Analysis based on six measures.

Mean, median, and standard deviation of the asymmetric information index are described year by year from 2000 to 2018 for the full sample,

agriculture allied firms, and other non-financial firms. Gao and Zhu (2015) reported that higher loadings values of measures are associated with more severe asymmetric information problems. Mean values are presented graphically fora better understanding of the level of asymmetric information year by year of each group.

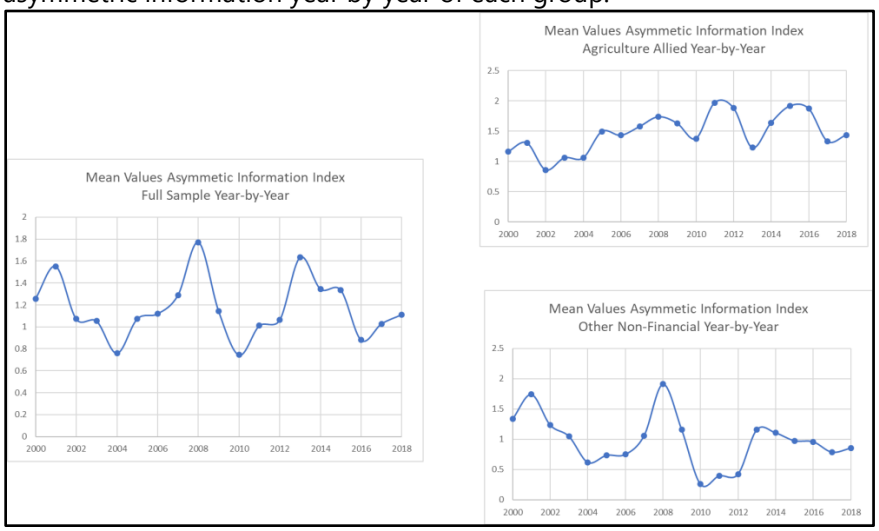

Figure-2: *Mean Values of Asymmetric Information Index*

Mean values in figure-2 show no specific pattern; however, it increases during the financial crises 2007-2008 period. The maximum mean value of symmetric information is 2008 after the global financial crisis. The minimum value of mean is 0.774 in the year 2010 that shows that effective measures are taken to resolve the asymmetric information problem. The pattern of asymmetric information index in agriculture allied firms is different from the non-financial sector and overall sample. There is less variation in the mean of the data and shows an increase over the time-period with less decrease in some years. The maximum average value is 1.97 in 2011 with a standard deviation of 9.087. The minimum average value is 0.86 in the year 2002 with a standard deviation of 4.832. Like the other two data sets, there is an increase in the mean value of the index in 2008 from 1.575 to 1.736 in the period of global financial crises. Other non-financial firms' data set shows approximately the same pattern as shown by the full sample data set. The maximum mean value of agriculture allied firms' data set is 1.912 with a standard deviation of 6.981 that is also the year of higher asymmetric information in 2008 after

the global financial crisis. The minimum value of 0.257 in 2010 shows less asymmetric information and investor confidence in the stock market.

Conclusion

Information plays a significant role in every type of financial decision making. Individuals make decisions based on both publicly available and private information possessed by few individuals. Thus, the level of available information, or otherwise the presence of information asymmetries, does play vital role in making any investment or financing decisions by the individuals as well as firms. The phenomenon of measuring the level of asymmetric information has gained much importance in the finance and accounting literature. The contemporary literature has described various measures and proxies for the level of information asymmetries, but no one represents the phenomenon of asymmetric information in a comprehensive manner. This research attempted to develop and test aforementioned index to measure the asymmetric information using PCM analysis. This index captures the maximum information from both accounting and market perspectives. From the results, it can be argued that information asymmetries prevail in the market, so there must be promoted use of technologically advanced means of information processing as well as the improvement in the information disclosure policies which may lead to the minimization of the level of information asymmetries. More comprehensive asymmetric information index needs to be developed for the best interest of the common investors in the emerging economies like Pakistan. Future research may be conducted by taking the data of the financial sector and investigating and comparing the levels of information asymmetries in both the financial and non-financial sector.

References

Acharya, V. V., DeMarzo, P., & Kremer, I. (2011). Endogenous information flows and the clustering of announcements. *American Economic Review*, *101*(7), 2955–2979.

Aflatooni, A., & Khazaei, M. (2020). Information asymmetry, leverage deviation and leverage adjustment speed. *Asian Journal of Business and Accounting*, *13*(1), 1–34.

Akerlof, G. (1970). The market for 'Lemons': Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, *84*(2), 488–500.

Amihud, Y. (2002). Illiquidity and stock returns: Cross-section and time-series effects. *Journal of Financial Markets*, *5*(1), 31–56.

Amihud, Y., & Mendelson, H. (1980). Dealership market. Market-making with inventory. *Journal of Financial Economics*, *8*(1), 31–53.

Andres, C., Cumming, D., Karabiber, T., & Schweizer, D. (2014). Do markets anticipate capital structure decisions? - Feedback effects in equity liquidity. *Journal of Corporate Finance*, *27*, 133–156.

Bagehot, W. (1971). The Only Game in Town. *Financial Analysts Journal*, *27*(2), 12–14.

Baker, M., & Wurgler, J. (2002). Market timing and capital structure. *Journal of Finance*, *57*(1), 1–32.

Bebczuk, R. N. (2003). Asymmetric information in financial markets: Introduction and applications. In *Cambridge University Press*.

Beyer, A., Cohen, D. A., Lys, T. Z., & Walther, B. R. (2010). The financial reporting environment: Review of the recent literature. *Journal of Accounting and Economics*, *50*(2), 296–343.

Bharath, S. T., Pasquariello, P., & Wu, G. (2009). Does asymmetric information drive capital structure decisions. *Review of Financial Studies*, *22*(8), 3211–3243.

Bhattacharya, N., Desai, H., & Venkataraman, K. (2013). Does earnings quality affect information asymmetry? Evidence from trading costs. *Contemporary Accounting Research*, *30*(2), 482–516.

Brunnermeier, M. K. (2001). *Asset pricing under asymmetric information: Bubbles, crashes, technical analysis, and herding*. Oxford University Press.

Chang, X., Dasgupta, S., & Hilary, G. (2006). Analyst coverage and financing decisions. *Journal of Finance*, *61*(6), 3009–3048.

Chordia, T., Subrahmanyam, A., & Anshuman, V. R. (2001). Trading activity and expected stock returns. *Journal of Financial Economics*, *59*(1), 3–32.

Connelly, B. L., Certo, S. T., Ireland, R. D., & Reutzel, C. R. (2011). Signaling Theory: A Review and Assessment. *Journal of Management*, *37*(1), 39–67.

Corwin, S. A., & Schultz, P. (2012). A simple way to estimate bid-ask spreads from daily high and low prices. *The Journal of Finance*, *67*(2), 719–759.

Cui, J., Jo, H., & Na, H. (2018). Does corporate social responsibility affect information asymmetry? *Journal of Business Ethics*, *148*(3), 549–572.

Danso, A., Lartey, T., Fosu, S., Owusu-Agyei, S., & Uddin, M. (2019). Leverage and firm investment: the role of information asymmetry and growth. *International Journal of Accounting and Information Management*, *27*(1), 56–73.

Demsetz, H. (1968). The cost of transacting. *The Quarterly Journal of Economics*, *82*(1), 33.

Ecker, F., Francis, J., Kim, I., Olsson, P. M., & Schipper, K. (2006). A returns-based representation of earnings quality. *Accounting Review*, *81*(4), 749–780.

Fama, E. F., Fisher, L., Jensen, M. C., & Roll, R. (1969). The adjustment of stock prices to new information. *International Economic Review*, *10*(1), 1–21.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3–56.

Francis, J. R., Khurana, I. K., & Pereira, R. (2005). Disclosure incentives and effects on cost of capital around the world. *Accounting Review*, *80*(4), 1125–1162.

Frank, M. Z., & Goyal, V. K. (2003). Testing the pecking order theory of capital structure. *Journal of Financial Economics*, *67*(2), 217–248.

Gao, W., & Zhu, F. (2015). Information asymmetry and capital structure around the world. *Pacific Basin Finance Journal*, *32*(2), 131–159.

George, T. J., Kaul, G., & Nimalendran, M. (1991). Estimation of the bid–ask spread and its components: A new approach. *The Review of Financial Studies*, *4*(4), 623–656.

Glosten, L. R., & Milgrom, P. R. (1985). Bid, ask and transaction prices in a specialist market with heterogeneously informed traders. *Journal of Financial Economics*, *14*(1), 71–100.

Gomes, A., & Phillips, G. (2012). Why do public firms issue private and public securities? *Journal of Financial Intermediation*, *21*(4), 619–658.

Hasbrouck, J. (2009). Trading costs and returns for U.S. equities: Estimating effective costs from daily data. *Journal of Finance*, *64*(3), 1445–1477.

Huang, R. D., & Stoll, H. R. (1998). *B6 The components of the bid-ask spread-1.pdf*.

Huynh, T. L. D., Wu, J., & Duong, A. T. (2020). Information asymmetry and firm value: Is Vietnam different? *The Journal of Economic Asymmetries*, *21*.

Kalev, P. S., Liu, W. M., Pham, P. K., & Jarnecic, E. (2004). Public information arrival and volatility of intraday stock returns. *Journal of Banking and Finance*, *28*(6), 1441–1467.

Kothari, S. P., Leone, A. J., & Wasley, C. E. (2005). Performance matched discretionary accrual measures. *Journal of Accounting and Economics*, *39*(1), 163–197.

Kyle, A. S. (1985). Continuous auctions and insider trading. *Econometrica*, *53*(6), 1315–1335.

Lakonishok, J., & Vermaelen, T. (1990). Anomalous price behavior around repurchase tender offers. *The Journal of Finance*, *45*(2), 455–477.

Lemmon, M. L., & Zender, J. F. (2010). Debt capacity and tests of capital structure theories. *Journal of Financial and Quantitative Analysis*, *45*(5), 1161–1187.

Llorente, G., Michaely, R., Saar, G., & Wang, J. (2002). Dynamic volume-return relation of individual stocks. *The Review of Financial Studies*, *15*(1), 1005–1047.

Lof, M., & van Bommel, J. (2018). Asymmetric information and the

distribution of trading volume. *SSRN Electronic Journal*.

Lopatta, K., Buchholz, F., & Kaspereit, T. (2016). Asymmetric information and corporate social responsibility. *Business and Society*, *55*(3), 458–488.

MacKinlay, A. C. (1997). Event studies in economics and finance. *Journal of Economic Literature*, *35*(1), 13–39.

Modigliani, F., & Miller, M. H. (1958). The cost of capital, corporation finance and the theory of investment. *The American Economic Review*, *48*(3), 261–297.

Philip, N. A., & Paul, A. A. (2015). An empirical analysis of the effects of asymmetric information in the Kano markets for used phones. *AshEse Journal of Economics*, *1*(3), 30–56.

Piotroski, J. D., & Roulstone, D. T. (2005). Do insider trades reflect both contrarian beliefs and superior knowledge about future cash flow realizations? *Journal of Accounting and Economics*, *39*(1), 55–81.

Ravi, R., & Hong, Y. (2014). Firm opacity and financial market information asymmetry. *Journal of Empirical Finance*, *25*(3), 83–94.

Roll, R. (1984). A simple implicit measure of the effective bid-ask spread in an efficient market. *The Journal of Finance*, *39*(4), 1127–1139.

Ross, S. A. (1977). The Determination of financial structure: The incentive-signalling approach. *The Bell Journal of Economics*, *8*(1), 23–40.

Shin, H. S. (2006). Disclosure risk and price drift. *Journal of Accounting Research*, *44*(2), 351–379.

Stiglitz, J. E. (2002). Information and the change in the paradigm in economics. *American Economic Review*, *92*(3), 460–501.

Taj, S. A. (2016). Application of signaling theory in management research: Addressing major gaps in theory. *European Management Journal*, *34*, 338–348.

Zagaglia, P. (2013). PIN: Measuring asymmetric information in financial markets with R. *R Journal*, *5*(1), 80–86.