MEASURING INFORMATION ASYMMETRY IN LARGE ACTIVE FIRMS ON THE TEHRAN STOCK EXCHANGE

Mostafa SHAMSODDINI[*]**, Mohammad N. SHAHIKI TASH**[**]**,**
Farhad KHODADAD-KASHI[***]

Abstract

In financial markets, transparency of financial information is one of the most effective variables of investment strategies. Information asymmetry can seriously affect firm performance on the stock exchange and firms with a poor informational environment can lose the interest of investors. Reducing information asymmetry can have an important effect on firm performance on the stock exchange. Firms may lack a clear informational environment in the market because of the emerging conditions governing the Tehran Stock Exchange. Because larger and more active firms on the Tehran Stock Exchange provide more information, measuring the informational environment of these firms provides an overview of information asymmetry. The present study calculated the information asymmetry in these firms using the PIN and FE indices. The inconsistent results provided by these indices prompted the authors to offer a new index that is a composite of the PIN and FE that can better explain information asymmetry in developing market such as Asian stock markets. The results show that the new composite index, by using the mechanisms of the PIN and FE indices, provides a better outcome. The new composite index shows that the Tosee Melli Inv (TMEL1), Mobarakeh Steel (FOLD1), Iran Mobil Tele (HMRZ1), Saipa (SIPA1) and I.N.C. Ind. (MSMI1) firms have a better informational environment on the Tehran Stock Exchange.

Keywords: Information asymmetry, Tehran Stock Exchange, Composite index, PIN, FE

JEL classification: D82, D83

1. INTRODUCTION

Information asymmetry is a fundamental issue in financial markets. The effect of information asymmetry is undeniable when determining market function and explaining its complexities. Trading stocks creates legal rights and commitments for firms and investors. Basically, firms must commit to repayment of the principal and interest in due time, but beyond all legal regulations, a stock contract is at risk in terms of economic considerations.

---

[*] Faculty of Management and Economics, University of Sistan and Baluchestan, Iran; e-mail: *msi.shine@yahoo.com*.

[**] Faculty of Management and Economics, University of Sistan and Baluchestan, Iran;
e-mail: *mohammad_tash@eco.usb.ac.ir*.

[***] Payame Noor University, Iran; e-mail: *khodadad@pnu.ac.ir*.

The intrinsic uncertainty of each investment project challenges a firm's ability to cover published stock. This obstacle can affect stock value logically and by estimating probability. Another obstacle is breach of commitment in a stock contract by a firm. Firms can hide the nature of a project, deflect inputting capital from its original route, or hide actual results. Uneven distribution of information can cause different results. Before it is considered by individual users, determining the quality of the information distributed is important.

Researchers have developed measures to determine the level of information asymmetry because is not directly observable. These measures fall into three categories (Clarke and Shastri, 2000). The first category uses measures based on growth opportunities and argues that firms with more growth opportunities have a symmetrical information environment. The second category uses measures based on predicted profit and argues that an increase in the level of a firm's information leads to convergence of expectations of that firm's future profits. The third category uses a series of measures based on market microstructure literature that are commonly compared with other categories.

The present study measured information asymmetry in selected firms on the Tehran Stock Exchange using two indexes from the second and third categories. The PIN index (Probability of Informed Trade) falls into the third category; the FE index (Earning Forecast Error) falls into the second category and was used to verify the results. There are many criteria to measuring information asymmetry, but most of them are suitable for developed markets. In most of developing markets they are not able to measuring information asymmetry singly and significantly. Therefore, we tried to investigate this issue. The Tehran Stock Exchange is one of the best examples of developing markets. Differences in the results by the two indices led to the use of a composite measure of these indices that considers both profit forecast and market structure. This new index calculates both general information asymmetry at beginning of a period and detailed information asymmetry over time.

2. LITERATURE REVIEW

In the context of information asymmetry measures based on market microstructure literature, Demsetz (1968) introduced a range of bid-ask prices (spread). The spread has been commonly used as a proxy for information asymmetry in previous studies. Analytical models such as Kyle (1985) and Glosten and Milgrom (1985) predicted that information asymmetry increases the adverse selection risk of market makers (liquidity providers), which increases the spread and decreases market depth and, as a result, decreases liquidity. Higher levels of information asymmetry will combine to form a larger spread. Using the spread to control a firm's informational environment, Healy and Palepu (1995) and Welker (1995) found a negative (positive) relationship between spread and the quality of information disclosure (information asymmetry). Healy et al. (1999) and Leuz and Verrecchia (2000) showed that information asymmetry, the spread, and volatility of stock prices are negatively associated with quality disclosure.

Many measures of the bid-ask spread have been used. Stoll (2000) found that the spread protects market makers against losses from trade with informed investors; thus, they expand the spread in order to limit informed traders and limit the spread to attract liquidity traders. Hasbrouck (2009) found a relatively high correlation between various spread measures (~90%). Richardson (2000), Mohd (2005), Attig et al. (2006), Jayaraman (2008) and Bhattacharya et al. (2009) used different spread indices to measure information asymmetry. Easley and O'Hara (1987 and 1992) offered a model of order flow in the market

that can estimate the probability of random trading by an informed trader (PIN). Also Easley *et al.* (1997b) argued about information content between trades, Easley *et al.* (1997a) about trade size, Easley *et al.* (1998) about analyst coverage, Easley *et al.* (2001) about stock splits, and Easley *et al.* (2002) about asset pricing. Many studies used PIN index as proxy of information asymmetry, such as Heidle and Huang (2002), Vega (2006), Ascioglu *et al.* (2008), Brockman and Yan (2009), Kang (2010), Aslan *et al.* (2011), Abad and Yague (2012), Chen and Zhao (2012), Dey and Radhakrishna (2015), Lin *et al.* (2013), Sankaraguruswamy *et al.* (2013), Chang and Lin (2015), Agudelo *et al.* (2015) and Paparizos *et al.* (2016).

3. METHODOLOGY

Information asymmetry is a feature of many trades. Often, seller information about quality is greater than buyer information. On the stock market, information plays an important role and its acquisition cost is gradual. According to Crawford *et al.* (2015) we assume which $i = 1, \dots, I$ is visible investors of type $k = 1, \dots, K$, and $j = 1, \dots, J$ is firms in stock markets $m = 1, \dots, M$, and $t = 1, \dots, T$ term. Investors gain the utility for stock that is dependent on their demands as follows:

$$U_{ikjmt}^D = \bar{\alpha}_0^D + \alpha_1^D P_{jmt} + X_{jmt}' \beta^D + \xi_{jmt}^D + \sigma^D v_i + Y_i' \eta^D + \gamma_K^D + \varepsilon_{ikjmt}^D \tag{1}$$

Utility for the outside option is normalized to zero. Investors will choose firms that maximize their utility or avoid buying securities. Provided that they invest in stocks, they will choose a share of capital for which their utility is maximized as follows:

$$U_{ikmt}^L = \alpha_0^L + \alpha_1^L P_{jmt} + X_{jmt}' \beta^L + \xi_{jmt}^L + Y_i' \eta^L + \gamma_k^L + \varepsilon_{ikmt}^L \tag{2}$$

And investors will choose to default if the following utility is greater than zero:

$$U_{ikmt}^F = \alpha_0^F + \alpha_1^F P_{jmt} + X_{jmt}' \beta^F + \xi_{jmt}^F + Y_i' \eta^F + \gamma_k^F + \varepsilon_{ikmt}^F \tag{3}$$

In above equations, X_{jmt} are firms visible features, P_{jmt} are prices, ξ_{jmt} are firms invisible features, Y_i are investors visible feature and γ_k^F are type of fixed effects. Also assumed to be ε_{ikmt}^D are is distributed as a type of extreme value (Crawford *et al.*, 2015; Berry *et al.*, 1995). Crawford *et al.* (2015) assumed random coefficient of the demand's constant term $\alpha_{0i}^D = \bar{\alpha}_0^D + \sigma^D v_i$, with $v_i \sim N(0,1)$ that have normally distributed with ε_{ikmt}^L and ε_{ikmt}^F, so that:

$$\begin{pmatrix} \alpha_0^D \\ \varepsilon^L \\ \varepsilon^F \end{pmatrix} \sim N \left(\begin{pmatrix} \bar{\alpha}_0^D \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^{2D} & \rho DL\sigma^D\sigma^L & \rho DF\sigma^D\sigma^F \\ \rho DL\sigma^D\sigma^L & \sigma^{2L} & \rho LF\sigma^L\sigma^F \\ \rho DF\sigma^D\sigma^F & \rho LF\sigma^L\sigma^F & \sigma^{2F} \end{pmatrix} \right) \tag{4}$$

There is a positive correlation between invisible demand by investors and default (ρDF), that is evidence of information asymmetry. If there exists a positive correlation between invisible demand and invisible default, investors with higher risk will create a greater demand for stocks. The argument of correlation between α_0^D and ε^F is that if an investor who the model predicts should not be willing to buy stocks is observed to buy

stocks, then this denotes an investor with high α_0^D. A positive correlation between α_0^D and ε^F is evidence of information asymmetry. The interpretation of a positive correlation between stock size and invisible default (ρDF) is also evidence of information asymmetry.

Easley and O'Hara (1987 and 1992) offered a model of order flow in the market that can be used to estimate the probability of random trading by an informed trader (PIN). A higher the PIN value (0 to 1) indicates more confidential information or higher levels of information asymmetry (Wan, 2009). The basic assumption is that public information is directly reflected in prices without the need for trading activity, while confidential information is reflected in unusual orders (surplus Bid and Ask orders).

Figure no. 1 shows informed trade mechanism. Assuming that α is the probability of an informational event, then δ is the probability of bad news, and 1-δ is the probability of good news on a specific day. If no informational event (with probability 1-α) occurs, only uninformed traders (Liquidity) will trade in the market. On this day, the arrival rate of uninformed traders (what to buy or sell) will have an independent Poisson distribution with probability ε. Informed traders will be willing to trade only in the event of an informational event (with probability μ). If they receive good news, they will buy and, if they receive bad news, they will sell their stocks. For informed traders on a specific day, if the occurrence is a bad informational event (with probability δα), the arrival rate of buy orders (α) will be less than that of sell orders (ε + μ). If the occurrence is a good informational event (with probability α(1-δ)), the arrival rate of buy orders (ε + μ) will be greater than the sell orders (ε). Easley and O'Hara (1992) stated that the probability of trading based on information for a specific stock (PIN$_i$) as defined by the estimated arrival rate of informed trading divided by the estimated arrival rate of all trades in a specific day is as follows (Vega, 2006):

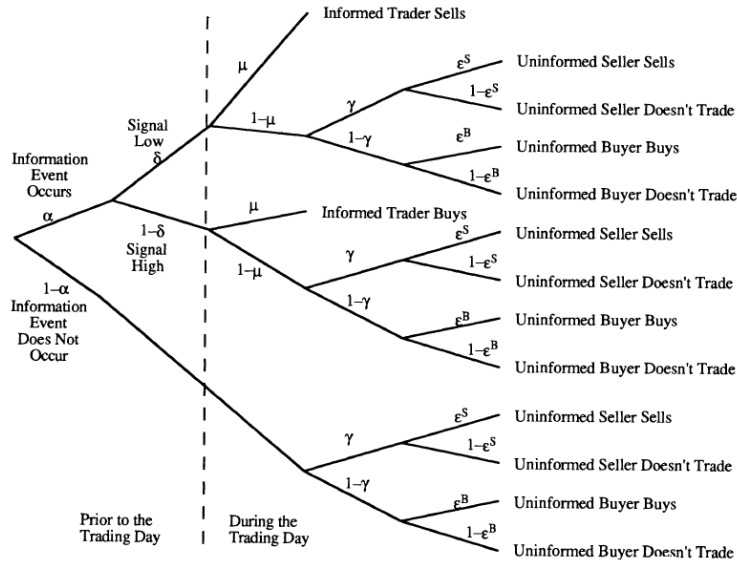$$\text{PIN}_i = \frac{\alpha\mu}{\alpha\delta + 2\varepsilon} \qquad (5)$$

Figure no. 1 – Tree diagram of the trading probability (Easley and O'Hara, 1992)

Easley *et al.* (1996) stated that, under these conditions, a market maker is assumed to be Bayesian if he uses the information to trade and update his expectations about good news, bad news, or no news. At time *t*, before the start of trading, market maker expectation for the probability of no news, good news, or bad news are as follows:

$$P_n(t) = 1 - \alpha, \tag{6}$$

$$P_g(t) = \alpha(1 - \delta), \tag{7}$$

$$P_b(t) = \alpha\delta \tag{8}$$

Therefore if B and S Represent buy and sell orders at time t, $P(t|S_t)$ is Represents the market maker's updated expectation when a sell order arriving, $P_n(t|S_t)$ is expectation about no news when a sell order arriving, $P_b(t|S_t)$ is his updated probability of bad news when a sell order arrives, and $P_g(t|S_t)$ is his updated probability of good news when a sell order arriving at time t. Probabilities when a buy order arriving are represented in a similar way. According to Easley *et al.* (1996), using Bayes's rule, his posterior probability on no news when a sell order arrives at time t is:

$$P_n(t|S_t) = \frac{P_n(S_t|t)P_n(t)}{P(S_t)} = \frac{P_n(S_t|t)P_n(t)}{P_n(S_t|t)P_n(t) + P_g(S_t|t)P_g(t) + P_b(S_t|t)P_b(t)} = \frac{\varepsilon_S P_n(t)}{\varepsilon_S + \mu P_b(t)} \tag{9}$$

The posterior probability on bad news and good news are the as follows respectively:

$$P_b(t|S_t) = \frac{(\varepsilon_S + \mu)P_b(t)}{\varepsilon_S + \mu P_b(t)}, \tag{10}$$

$$P_g(t|S_t) = \frac{(\varepsilon_S)P_g(t)}{\varepsilon_S + \mu P_b(t)} \tag{11}$$

The zero expected profit bid price is the expected value of the stock at time t. So, the bid is:

$$b(t) = \frac{\varepsilon_S P_n(t)V^* + (\varepsilon_S + \mu)P_b(t)\underline{V_i} + (\varepsilon_S)P_g(t)\overline{V}_i}{\varepsilon_S + \mu P_b(t)} \tag{12}$$

and the ask is:

$$a(t) = \frac{\varepsilon_b P_n(t)V^* + \varepsilon_b P_b(t)\underline{V_i} + (\varepsilon_b + \mu)P_g(t)\overline{V}_i}{\varepsilon_b + \mu P_g(t)} \tag{13}$$

Where V^* Represents the value of the stock when no news. So expected value of the stock is:

$$E[V_i] = P_n(t)V^* + P_b(t)\underline{V_i} + P_g(t)\overline{V}_i \tag{14}$$

With substituting equation (14) into equation (12) and (13):

$$b(t) = E[V_i] - \frac{\mu P_b(t)}{\varepsilon_S + \mu P_b(t)}(E[V_i] - \underline{V_i}) \tag{15}$$

$$a(t) = E[V_i] + \frac{\mu P_g(t)}{\varepsilon_b + \mu P_g(t)}(\overline{V}_i - E[V_i]) \tag{16}$$

These equations considering the stock expected value, improve analysis of entering role of informed and uninformed investors in affecting trading prices. Now spread defined by the difference between ask and bid prices:

$$\Sigma(t) = a(t) - b(t), \tag{17}$$

$$\Sigma(t) = \frac{\mu P_g(t)}{\varepsilon_b + \mu P_g(t)}(\overline{V}_i - E[V_i]) + \frac{\mu P_b(t)}{\varepsilon_s + \mu P_b(t)}(E[V_i] - \underline{V_i}) \tag{18}$$

With these explanation, All four parameters that used in PIN formula ($\theta = \{\alpha, \delta, \mu, \varepsilon\}$), estimated by maximizing following likelihood function:

$$L(\theta|(B_i, S_i)) = \alpha(1-\delta)e^{-(\mu+\varepsilon_b)}\frac{(\mu+\varepsilon_b)^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{\varepsilon_s^{S_i}}{S_i!} + \alpha\delta e^{-\varepsilon_b}\frac{\varepsilon_b^{B_i}}{B_i!}e^{-(\mu+\varepsilon_s)}\frac{(\mu+\varepsilon_s)^{S_i}}{S_i!} +$$
$$(1-\alpha)e^{-\varepsilon_b}\frac{\varepsilon_b^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{\varepsilon_s^{S_i}}{S_i!} \tag{19}$$

That for determine the direction of trading, used Lee and Ready (1991) algorithm (Vega, 2006). Also, in order to estimate parameter vector θ, for collection of data related to buy and sell ($\{M = (B_t, S_t)\}_{t=1}^T$), can be used the product of the daily likelihoods, as follow:

$$L(\theta|M) = \prod_{t=1}^T L(\theta|B_t, S_t) \tag{20}$$

As previously mentioned, according to Easley and O'Hara (1987 and 1992) the higher value of PIN (in the range of 0 to 1) shows higher levels of information asymmetry.

4. RESULTS

Several indices have been proposed to measuring information asymmetry. The present study used two indices to calculate information asymmetry on the Tehran Stock Exchange. The Tehran Stock Exchange is one of the best examples of developing markets and results of this market can be generalized to other developing stock markets. The PIN index was first calculated and then the forecast error (FE) was used to verify the PIN results.

4.1 Probability of informed trade (PIN)

Table no. 1 shows PIN results for selected firms on the Tehran Stock Exchange as calculated using R software. Some of the data required was not available, thus, some values were not calculated. The PIN values ranges from 0 to 1. For some years and firms, the PIN values approached zero and for others they approached 1. That means that, in some cases, information asymmetry was minimal and in others there was relatively total information asymmetry. On average, the firms Saipa (SIPA 1), Kharazmy Invest (IKHR1) and Bahman Group (BHMN1) had the lowest information asymmetry and Khorasan Steel Co. (FKAS1), IRI Marine Co. (KSHJ1) and Isf. Oil Ref. Co. (PNES1) highest during the study period.

Table no. 1 – PIN index for selected firms in Tehran Stock Exchange

Symbols	Year					
	2010	**2011**	**2012**	**2013**	**2014**	**2015**
BPAS1	NA	0.166704	0.139762	0.149106	0.271291	0.172495
BPAR1	0.522269	0.180636	1.45E-06	0.113892	0.284433	0.0006
BANS1	NA	4.06E-07	0.219249	0.586407	0.103655	1.19E-06
NOVN1	0.497494	2.62E-05	0.158441	0.104573	0.159042	0.606513
IKCO1	0.893349	0.288327	0.231418	0.119108	0.338615	2.03E-07
HMRZ1	NA	NA	NA	0.198231	0.122192	0.001645
AZAB1	0.106689	0.050791	0.113496	0.545859	0.349026	0.021220
PRDZ1	NA	0.666667	6.56E-08	5.24E-07	0.193120	3.06E-06
PNBA1	NA	NA	0.470499	3.12E-07	0.666667	0.154439
PNES1	0.704277	0.000475	0.666667	0.413642	0.666667	0.031259
BMLT1	0.106280	0.110235	0.705329	0.11969	0.296926	0.729434
KRAF1	0.164573	0.096204	0.495496	0.064234	0.084361	8.29E-06
BSDR1	0.338596	0.120153	0.199741	0.033096	0.078678	0.506873
BTEJ1	0.082507	0.166919	0.136061	0.544487	0.126631	0.017420
IKHR1	NA	NA	1.10E-06	0.133666	0.152341	1.90E-06
TMEL1	1.44E-07	0.004674	0.131624	0.134457	0.119897	0.085609
MADN1	0.096535	0.666667	0.107911	3.37E-07	0.305857	1.08E-07
SIPA1	2.78E-07	0.133732	0.181860	0.0339	3.08E-07	0.034985
INFO1	0.176605	0.179613	0.109613	0.533459	0.354425	0.091472
CHML1	7.21E-06	0.131999	0.666667	0.046018	0.324008	0.230670
PKHA1	0.666667	0.421011	2.06E-06	0.117356	0.089161	3.84E-07
FKAS1	0.537248	0.457724	0.690347	0.848530	0.805267	0.999999
FOLD1	2.20E-06	0.089611	0.222156	1.40E-05	0.223613	0.106802
FKHZ1	0.462570	0.666667	3.47E-07	0.666667	0.273945	0.091927
PKLJ1	NA	NA	NA	0.161692	0.189887	0.350816
GDIR1	0.679264	0.020087	0.123194	0.471598	4.06E-07	0.356946
SAND1	NA	NA	NA	0.666667	8.99E-08	NA
DTIP1	NA	NA	NA	0.666667	0.144601	9.66E-08
MSMI1	0.148367	0.003161	0.082847	0.081209	0.211537	0.070261
MKBT1	0.104182	0.029881	0.182249	0.088111	0.179157	6.83E-06
GOLG1	0.457707	0.244731	0.666667	3.24E-07	0.087778	0.242175
PASN1	NA	0.283843	0.160343	0.135109	0.219111	0.079447
MAPN1	0.411996	0.226090	2.47E-06	0.955160	0.159202	0.087237
BHMN1	0.157715	0.134182	0.056006	0.085225	2.88E-07	1.37E-07
KSHJ1	0.443594	0.813148	0.749914	0.717575	0.607927	8.60E-08

The average PIN value for SIPA was 0.06, which suggests very low information asymmetry in the market. In reality, this firm has a good chance with investors on the Tehran Stock Exchange. Six firms had PIN values of less than 0.1 (SIPA1, IKHR1, BHMN1, TMEL1, MKBT1, MSMI1). The PIN value for Khorasan Steel Co. (FKAS1) was approximately 0.72, which is significant for a large and active firm on the Tehran Stock Exchange; only three firms recorded PIN values greater than 0.40 (FKAS1, KSHJ1 and PNES1).

Table no. 2 – PIN index in the years of study

Year	2010	2011	2012	2013	2014	2015
Average	0.310340	0.219102	0.247341	0.272440	0.233972	0.149125

Table no. 2 shows that the PIN index in 2010 had a maximum coefficient and in 2015 had minimum coefficient. In 2015, information asymmetry dropped considerably, which could have been in response to the increasing informational level of traders and good news in market that improved trader expectations about investing on the Tehran Stock Exchange. Positive political events played a strong role in this case. The PIN value has a direct relationship with instability on the Tehran Stock Exchange.

4.2 Earning forecast error (FE)

The FE index was used to calculate information asymmetry to verify the PIN results. Lang and Lundholm (1996) shows that increasing informational transparency improves forecast accuracy and decreases forecast dispersion and can be used as a measure of earnings forecast error to calculate information asymmetry. Using the method proposed by Christie (1987), the FE was measured as the ratio of absolute difference between forecast earnings (ACT_t) and actual earnings per share (EST_t) to calculate information asymmetry as:

$$FE = \frac{ACT_t - EST_t}{ACT_t} \tag{21}$$

Firms with a larger level of information asymmetry have higher FE (Krishnaswami and Subramaniam, 1999). Table no. 3 shows the FE for selected firms on the Tehran Stock Exchange. The FE value for the earnings for selected firms on the Tehran Stock Exchange were unusual; in 13 cases, the FE were more than 1000%. In 20 cases, the FE was 9% to 20%; these are the lowest FE values. Earnings data was not available for 2015 as the research was completed; therefore, the FE was not calculated for that year.

On average, Khalij Fars Industries (PKLJ1) recorded the maximum FE; however, this was based on published statistics for only two years (2013≅470 and 2014≅1). Tamin Daroo (DTIP1) ranks second at 370 with 1 FE value for two years. Iran Tele. Co. (MKBT1) and Pension Fund (SAND1) rank third and fourth and show high volatility in earnings FE. The average FE values for these four firms show a huge difference with those of other firms. On average, Tosee Melli Inv. (TMEL1) had the lowest FE; this firm has very stable values throughout the study period. Khouz. Steel (FKHZ1), Chadormalu (CHML1) and Khark Petr. (PKHA1) rank second, third and fourth after Tosee Melli Inv. (TMEL1) for the best FE values.

It is notable that the values presented by these indices do not match when the PIN and FE results are used as indicators of information asymmetry. For example, Khalij Fars (PKLJ1) (2013), Tamin Daroo (DTIP1) (2013) and Iran Tele. Co. (MKBT1) (2011) had the highest FE values, respectively, but ranked 84th, 14th and 149th rates for PIN. Conversely, Khark Petr. (PKHA1) (2014), Khouz. Steel (FKHZ1) (2010) and Iran Khodro (IKCO1) (2014) had the lowest FE values, but ranked 62th, 151th and 140th, respectively, with low PIN values.

Table no. 3 – FE index for selected firms in Tehran Stock Exchange

Symbols	Year				
	2010	**2011**	**2012**	**2013**	**2014**
BPAS1	-3.17460	-1.02454	-0.85714	-0.74771	-0.42249
BPAR1	-1.17413	-1.36190	-0.61357	-0.54394	-0.32962
BANS1	-0.36916	-0.36916	-1.16736	-0.92444	-0.46409
NOVN1	-1.15880	-0.57307	-0.63743	-0.61694	-0.54211
IKCO1	-0.89754	-0.28622	-0.63212	-0.33753	-0.11828
HMRZ1	-0.99365	-0.35756	-3.08496	-0.34830	-0.31941
AZAB1	-0.38053	-1.11111	-0.25126	-0.27083	-0.38636
PRDZ1	NA	-0.35786	-0.47113	-0.36284	-0.78516
PNBA1	0.245902	0.245902	-1.22388	-1.08600	-0.50023
PNES1	-3.03448	-0.68269	-0.35051	-2.01127	-0.66791
BMLT1	-0.26180	-0.33043	-1.00000	-1.00000	-0.48889
KRAF1	-0.58867	-0.32558	-0.47737	-0.61472	-0.14085
BSDR1	-0.18072	-0.27841	-0.71622	-0.98182	-0.47857
BTEJ1	-0.41414	-0.71212	-2.43137	-0.91736	-0.64198
IKHR1	NA	-0.65248	-4.20833	-4.20833	-0.80800
TMEL1	-0.18182	-0.18182	-0.18182	-0.18182	-0.15385
MADN1	-2.04473	-1.42045	-3.29255	-2.73377	-0.86141
SIPA1	-2.66851	-1.59434	-0.32292	0.16000	-6.66667
INFO1	-15.0590	-31.5926	-1.89107	-1.68209	-0.65069
CHML1	-0.27061	-0.33645	-0.29078	-0.17532	-0.23200
PKHA1	-0.55014	-0.19357	-0.14468	-0.32991	-0.09555
FKAS1	-0.66953	-0.18956	-0.28514	-0.12220	-0.19789
FOLD1	-0.13043	-0.41608	-0.42125	-0.13521	-0.22441
FKHZ1	-0.10689	-0.33138	-0.25146	-0.20570	-0.19716
PKLJ1	NA	NA	NA	-469.667	-0.99808
GDIR1	-1.79231	-19.4286	-3.24537	-5.89535	-0.39162
SAND1	-0.79245	-152.333	-42.7273	-59.0000	-0.94188
DTIP1	NA	NA	NA	-370.500	-1.00602
MSMI1	-1.07855	-0.30898	-0.46531	-0.61538	-0.22289
MKBT1	-52.1250	-168.500	-58.4286	-15.0909	-1.02804
GOLG1	-0.81166	-0.72078	-0.22617	-0.28709	-0.25086
PASN1	NA	-1.00000	-1.68103	-1.27740	-0.98929
MAPN1	-0.34896	-1.15315	-1.71978	-1.88304	-0.64271
BHMN1	-0.25000	-1.26481	-5.93443	-5.64063	-0.87055
KSHJ1	-27.5000	9.571429	-6.40000	-3.50000	-1.06338

The difference between mechanisms of PIN and FE indicated that the FE index calculates information asymmetry at the beginning of a period and the PIN index calculates information asymmetry over time. If a logical relation between these indices can be found that covers both mechanisms, a new more accurate index can be developed. This would be more suitable for emerging markets such as the Tehran Stock Exchange in which firm performance does not show great stability and political issues and outside influences have a strong effect on stock trends.

4.3 New composite index (C-PIN-FE)

The PIN is used in many financial studies, but cannot solely represent information asymmetry in emerging markets such as the Tehran Stock Exchange. The results found in the previous sections illustrate this; firms with very low PIN values show relatively high FE values. This means the forecasts differed from actual earnings significantly, which denotes high information asymmetry. Also, earnings FE cannot represent information asymmetry in stock markets properly because it does not directly consider information traders. This suggests the need for a composite index of PIN and FE that can better measure information asymmetry in emerging stock markets, especially during turbulent years. This composite index (C-PIN-FE) can be calculated as follows:

$$\text{C–PIN–FE} = \frac{|FE|}{\left(Ln(PIN)\right)^2} = \frac{|ACT_t - EST_t|[Ln\left(\frac{\alpha\mu}{\alpha\delta+2\varepsilon}\right)]^{-2}}{|ACT_t|} \tag{22}$$

Because the PIN value falls between 0 and 1, but FE can be a number of any size, the PIN should be adjusted in the new index. The natural logarithm of PIN is, thus, obtained as a negative number and its value will be weighed as Ln(PIN) (Now larger numbers represent less information asymmetry). Because the goal is to measure information asymmetry and not to show the direction of important information, the absolute value of FE is used. This new composite index modifies the previous indices and offers a better measure of information asymmetry with emphasis on the characteristics of each index. It considers information, initial expectations, and adjusted information over time.

The results of this index for selected firms on the Tehran Stock Exchange are shown in Table no. 4. In the C-PIN-FE index, Tosee Melli Inv (TEMEL1) (2010), Mobarakeh Steel (FOLD1) (2010) and Khark Petr. (PKHA1) (2012) rank lowest; these firms in the low PIN values rank 7th, 25th and 24th, respectively, and in the low FE values rank 15th, 9th and 12th. In the C-PIN-FE, Tamin Daroo (DTIP1) (2013), MAPNA (MAPN1) (2013) and Pension Fund (SAND1) (2013) rank highly; in the high PIN values, they rank 13th, 2th and 14th and in the high FE values rank 2th, 33th and 5th, respectively. These results are more reasonable than the previous comparison between their PIN and FE values.

On average, the Tosee Melli Inv. (TMEL1) had the lowest value in the C-PIN-FE index, but in the previous indices, this firm had low values and showed volatility. The informational environment around this firm has been safer for investors because earnings forecasts and investor performance regarding this firm better match expectations. In the C-PIN-FE, Mobarakeh Steel (FOLD1), Iran Mobil Tele (HMRZ1), Saipa (SIPA1) and I. N. C. Ind. (MSMI1) rank second, third, fourth and fifth after Tosee Melli Inv. (TMEL1). On average, Tamin Daroo (DTIP1), Pension Fund (SAND1), MAPNA (MAPN1), IRI Marine Co. (KSHJ1) and Khalij Fars (PKLJ1) rank highest in this index, meaning there is a high level of information asymmetry about their performance in the market. On average, 2013 showed the highest level of information asymmetry; this was a turbulent year on the Tehran Stock Exchange, which justifies the high C-PIN-FE values for this year. In 2014, C-PIN-FE values decreased dramatically because of stagnation on the Tehran Stock Exchange and there was little good news to encourage investors to trade. The market conditions and PIN index indicates that the C-PIN-FE index for 2015 will have low values, although it was not calculated at the time of the study.

Table no. 4 – C-PIN-FE index for selected firms in Tehran Stock Exchange

Symbols	Year				
	2010	**2011**	**2012**	**2013**	**2014**
BPAS1	NA	0.319211	0.221352	0.206448	0.248250
BPAR1	2.782668	0.465060	0.003395	0.115247	0.208527
BANS1	NA	0.001705	0.506899	3.245037	0.090327
NOVN1	2.377299	0.00515	0.187791	0.121016	0.160367
IKCO1	70.56741	0.185052	0.295121	0.074555	0.100865
HMRZ1	NA	NA	NA	0.132991	0.072279
AZAB1	0.075986	0.125116	0.053064	0.738969	0.348708
PRDZ1	NA	2.176708	0.001722	0.001735	0.290348
PNBA1	NA	NA	2.152979	0.004839	3.042717
PNES1	24.68897	0.011660	2.132030	2.581020	4.062691
BMLT1	0.052099	0.067954	8.205818	0.221902	0.331573
KRAF1	0.180803	0.059395	0.968132	0.081568	0.023037
BSDR1	0.154099	0.062005	0.276055	0.084518	0.074039
BTEJ1	0.066535	0.222192	0.611105	2.482312	0.150333
IKHR1	NA	NA	0.022358	1.039150	0.228214
TMEL1	0.000733	0.006315	0.044217	0.045160	0.034194
MADN1	0.374113	8.640132	0.664215	0.012306	0.613820
SIPA1	0.011712	0.393876	0.111145	0.013969	0.029651
INFO1	5.009322	10.71692	0.386910	4.260027	0.604782
CHML1	0.001930	0.082051	1.768715	0.018496	0.182663
PKHA1	3.346306	0.258647	0.000844	0.071869	0.016353
FKAS1	1.734494	0.310386	2.076537	4.529597	4.218709
FOLD1	0.000769	0.071503	0.186133	0.001083	0.100026
FKHZ1	0.179841	2.015644	0.001137	1.251202	0.117597
PKLJ1	NA	NA	NA	141.4702	0.361620
GDIR1	11.98289	1.272322	0.740137	10.43525	0.001808
SAND1	NA	NA	NA	358.8765	0.003578
DTIP1	NA	NA	NA	2253.623	0.269027
MSMI1	0.296248	0.009323	0.075004	0.097622	0.092374
MKBT1	10.19083	13.67267	20.16099	2.557425	0.347703
GOLG1	1.32888	0.363786	1.375735	0.001286	0.042380
PASN1	NA	0.630546	0.501724	0.318817	0.429217
MAPN1	0.443792	0.521636	0.010320	894.6986	0.190338
BHMN1	0.073286	0.313512	0.714336	0.930229	0.003837
KSHJ1	41.62129	223.7174	77.26977	31.77689	4.292922

A review of the results of this new composite index and comparison with the previous indices show it presents a better measure for information asymmetry in markets such as the Tehran Stock Exchange. Where the PIN or FE are not able to explain and describe information asymmetry in markets on their own, the use of the C-PIN-FE index is recommended.

5. CONCLUSION

One reason for a breach in competition in the stock market is information asymmetry. In emerging stock markets with high volatility, trader information often differs. This holds true for the Tehran Stock Exchange. The present study measured information asymmetry in

large and active firms on the Tehran Stock Exchange because investors have more information about these firms and a review their informational environment can be offered as a good indicator of the informational environment. The PIN and FE indices were initially used and it was shown that the PIN index, on average, showed information asymmetry of more than 20%. The PIN index predicts that information asymmetry will decrease considerably in 2015, because of political changes and improved market expectations.

To verify these results, the FE index was implemented, but presented unusual results. The FE values indicated that earnings forecasts were very different from actual earnings (in some cases more than 1000%). A comparison of the PIN and FE values reveals mismatched results when ranking firms based on information asymmetry. Because the FE index shows information asymmetry at the beginning of a period and the PIN index shows information asymmetry over time, a new composite index (C-PIN-FE) that uses the results and mechanism of both indices was developed. The C-PIN-FE index offers more reasonable results for ranking firms based on information asymmetry and corresponds with both PIN and FE results. It is suggested that the C-PIN-FE index more accurately measures information asymmetry in emerging, turbulent, and highly volatile stock markets showing large differences in earnings forecasts and dual functions.

References

Abad, D., and Yague, J., 2012. From PIN to VPIN: An introduction to order flow toxicity. *10*(2), 74-83. DOI: DOI:10.1016/j.srfe.2012.10.002

Agudelo, D. A., Giraldo, S., and Villarraga, E., 2015. Does PIN measure information? Informed trading effects on returns and liquidity in six emerging markets. *International Review of Economics & Finance, 39*, 149-161. DOI: DOI:10.1016/j.iref.2015.04.002

Ascioglu, A., Hegde, S. P., and McDermott, J. B., 2008. Information asymmetry and investment-cash flow sensitivity. *Journal of Banking & Finance, 32*(6), 1036-1048. DOI: DOI:10.1016/j.jbankfin.2007.09.018

Aslan, H., Easley, D., Hvidkjaer, S., and O'Hara, M., 2011. The characteristics of informed trading: Implications for asset pricing. *Journal of Empirical Finance, 18*(5), 782-801. DOI: DOI:10.1016/j.jempfin.2011.08.001

Attig, N., Fong, W. M., Gadhoum, Y., and Lang, L., 2006. Effects of Large Shareholding on Information Asymmetry and Stock Liquidity. *Journal of Banking & Finance, 30*(10), 2875-2892. DOI: DOI:10.1016/j.jbankfin.2005.12.002

Berry, S., Levinsohn, J., and Pakes, A., 1995. Automobile prices in market equilibrium. *Econometrica, 63*(4), 841-890. DOI: DOI:10.2307/2171802

Bhattacharya, N., Desai, H., and Venkataraman, K., 2009. *Earnings quality and information asymmetry: evidence from trading costs*: Available at SSRN.

Brockman, P., and Yan, X. S., 2009. Block ownership and firm-specific information. *Journal of Banking & Finance, 33*(2), 308-316. DOI: DOI:10.1016/j.jbankfin.2008.08.011

Chang, C., and Lin, E., 2015. Cash-futures basis and the impact of market maturity, informed trading, and expiration effects. *International Review of Economics & Finance, 35*, 197-213. DOI: DOI:10.1016/j.iref.2014.09.003

Chen, Y., and Zhao, H., 2012. Informed trading, information uncertainty, and price momentum. *Journal of Banking & Finance, 36*(7), 2095-2109. DOI: DOI:10.1016/j.jbankfin.2012.03.016

Christie, A., 1987. On cross-sectional analysis in accounting research. *Journal of Accounting and Economics, 9*(3), 231-258. DOI: DOI:10.1016/0165-4101(87)90007-3

Clarke, J., and Shastri, K., 2000. *On information asymmetry metrics*: Available at SSRN.

Crawford, G. S., Pavanini, N., and Schivardi, F., 2015. Asymmetric Information and Imperfect Competition in Lending Markets. *University of Zurich, Department of Economics, Working Paper, 192*. DOI: 10.2139/ssrn.2602751

Demsetz, H., 1968. The cost of transacting. *The Quarterly Journal of Economics, 82*(1), 33-53. DOI: DOI:10.2307/1882244

Dey, M. K., and Radhakrishna, B., 2015. Informed trading, institutional trading, and spread. *Journal of Economics and Finance, 39*(2), 288-307. DOI: DOI:10.1007/s12197-012-9249-4

Easley, D., Hvidkjaer, S., and O'Hara, M., 2002. Is information risk a determinant of asset returns? *The Journal of Finance, 57*(5), 2185-2221. DOI: DOI:10.1111/1540-6261.00493

Easley, D., Kiefer, N., and O'Hara, M., 1997a. The information content of the trading process. *Journal of Empirical Finance, 4*(2-3), 159-186. DOI: DOI:10.1016/S0927-5398(97)00005-4

Easley, D., Kiefer, N., and O'Hara, M., 1997b. One day in the life of a very common stock. *Review of Financial Studies, 10*(3), 805-835. DOI: DOI:10.1093/rfs/10.3.805

Easley, D., Kiefer, N. M., O'Hara, M., and Paperman, J. B., 1996. Liquidity, Information, and Infrequently Traded Stocks. *The Journal of Finance, 51*(4), 1405-1436. DOI: 10.2307/2329399

Easley, D., and O'Hara, M., 1987. Price, trade size, and information in securities markets. *Journal of Financial Economics, 19*(1), 69-90. DOI: DOI:10.1016/0304-405X(87)90029-8

Easley, D., and O'Hara, M., 1992. Time and the process of security price adjustment. *The Journal of Finance, 47*(2), 577-605. DOI: DOI:10.1111/j.1540-6261.1992.tb04402.x

Easley, D., O'Hara, M., and Paperman, J., 1998. Financial analysts and informtion-based trade. *Journal of Financial Markets, 1*(2), 175-201. DOI: DOI:10.1016/S1386-4181(98)00002-0

Easley, D., O'Hara, M., and Saar, G., 2001. How stock splits affect trading: A microstructure approach. *Journal of Financial and Quantitative Analysis, 36*(1), 25-51. DOI: DOI:10.2307/2676196

Glosten, L., and Milgrom, P., 1985. Bid, ask and transaction prices in a specialist market with heterogeneously informed traders. *Journal of Financial Economics, 14*(1), 71-100. DOI: DOI:10.1016/0304-405X(85)90044-3

Hasbrouck, J., 2009. Trading Costs and Returns for U.S. Equities: Estimating Effective Costs from Daily Data. *The Journal of Finance, 64*(3), 1445-1477. DOI: 10.1111/j.1540-6261.2009.01469.x

Healy, P., Hutton, A., and Palepu, K., 1999. Stock performance and intermediation changes surrounding sustained increases in disclosure. *Contemporary Accounting Research, 16*(3), 485-520. DOI: DOI:10.1111/j.1911-3846.1999.tb00592.x

Healy, P., and Palepu, K., 1995. The challenges of investor communications: The case of CUC International, Inc. *Journal of Financial Economics, 38*(2), 111-140. DOI: DOI:10.1016/0304-405X(94)00814-H

Heidle, H., and Huang, R., 2002. Information-based trading in dealer and auction markets: An analysis of exchange listings. *Journal of Financial and Quantitative Analysis, 37*(3), 391-424. DOI: DOI:10.2307/3594986

Jayaraman, S., 2008. Earnings volatility, cash flow volatility and informed trading. *Journal of Accounting Research, 46*(4), 809-851. DOI: DOI:10.1111/j.1475-679X.2008.00293.x

Kang, M., 2010. Probability of information-based trading and the January effect. *Journal of Banking & Finance, 34*(12), 2985-2994. DOI: DOI:10.1016/j.jbankfin.2010.07.007

Krishnaswami, S., and Subramaniam, V., 1999. Information asymmetry, valuation and the corporate spin-off decision. *Journal of Financial Economics, 53*(1), 73-112. DOI: DOI:10.1016/S0304-405X(99)00017-3

Kyle, A., 1985. Continuous auctions and insider trading. *Econometrica, 53*(6), 1315-1335. DOI: DOI:10.2307/1913210

Lang, M., and Lundholm, R., 1996. Corporate disclosure policy and analyst behavior. *The Accounting Review, 71*(4), 467-492. DOI: DOI:10.2307/1913210

Lee, C. M. C., and Ready, M. J., 1991. Inferring Trade Direction from Intraday Data. *The Journal of Finance, 46*(2), 733-746. DOI: 10.1111/j.1540-6261.1991.tb02683.x

Leuz, C., and Verrecchia, R., 2000. Economic consequences of increased disclosure. *Journal of Accounting Research, 38*, 91-124. DOI: DOI:10.2307/2672910

Lin, E., Lee, C. F., and Wang, K., 2013. Futures mispricing, order imbalance, and short-selling constraints. *International Review of Economics & Finance, 25*, 408-423. DOI: DOI:10.1016/j.iref.2012.08.001

Mohd, E., 2005. Accounting for software development costs and information asymmetry. *The Accounting Review, 80*(4), 1211-1231. DOI: DOI:10.2308/accr.2005.80.4.1211

Paparizos, P., Dimitriou, D., Kenourgios, D., and Simos, T., 2016. On high frequency dynamics between information asymmetry and volatility for securities. *Journal of Economic Asymmetries, 13*, 21-34. DOI: DOI:10.1016/j.jeca.2015.10.001

Richardson, V. J., 2000. Information asymmetry and earnings management: Some evidence. *Review of Quantitative Finance and Accounting, 15*(4), 325-347. DOI: DOI:10.1023/A:1012098407706

Sankaraguruswamy, S., Shen, J., and Yamada, T., 2013. The relationship between the frequency of news release and the information asymmetry: The role of uninformed trading. *Journal of Banking & Finance, 37*(11), 4134-4143. DOI: DOI:10.1016/j.jbankfin.2013.07.026

Stoll, H. R., 2000. Presidential Address: Friction. *The Journal of Finance, 55*(4), 1479-1514. DOI: DOI:10.1111/0022-1082.00259

Vega, C., 2006. stock price reaction to public and private information. *Journal of Financial Economics, 82*(1), 103-133. DOI: DOI:10.1016/j.jfineco.2005.07.011

Wan, Y., 2009. Corporate governance, disclosure method and information asymmetry. *Master of Science Thesis*. http://hdl.handle.net/10388/etd-11102009-150016

Welker, M., 1995. Disclosure policy, information asymmetry and liquidity in equity markets. *Contemporary Accounting Research, 11*(2), 801-827. DOI: DOI:10.1111/j.1911-3846.1995.tb00467.x

APPENDIX

Symbols, names and webpages of large active firms on the Tehran Stock Exchange

Symbol	Name	Webpage	Symbol	Name	Webpage
AZAB1	Azarab Ind.	*AZAB0001	INFO1	Inf. Services	*INFO0001
BANS1	Ansar Bank	*BANS0001	KRAF1	Karafarin Bank	*KRAF0001
BHMN1	Bahman Group	*BHMN0001	KSHJ1	IRI Marine Co.	*KSHJ0001
BMLT1	Mellat Bank	*BMLT0001	MADN1	Metals & Min.	*MADN0001
BPAR1	Parsian Bank	*BPAR0001	MAPN1	MAPNA	*MAPN0001
BPAS1	Pasargad Bank	*BPAS0001	MSMI1	I. N. C. Ind.	*MSMI0001
BSDR1	Saderat Bank	*BSDR0001	MKBT1	Iran Tele. Co.	*MKBT0001
BTEJ1	Tejarat Bank	*BTEJ0001	NOVN1	EN Bank	*NOVN0001
CHML1	Chadormalu	*CHML0001	PASN1	Parsian Oil&Gas	*PASN0001
DTIP1	Tamin Daroo	*DTIP0001	PKHA1	Khark Petr.	*PKHA0001
FKAS1	Khorasan Steel Co.	*FKAS0001	PKLJ1	Khalij Fars	*PKLJ0001
FKHZ1	Khouz. Steel	*FKHZ0001	PNBA1	B.A Oil Refinie	*PNBA0001
FOLD1	Mobarakeh Steel	*FOLD0001	PNES1	Isf. Oil Ref. Co.	*PNES0001
GDIR1	Ghadir Inv.	*GDIR0001	PRDZ1	Pardis Petr.	*PRDZ0001
GOLG1	Gol-E-Gohar.	*GOLG0001	SAND1	Pension Fund	*SAND0001
HMRZ1	Iran Mobil Tele	*HMRZ0001	SIPA1	Saipa	*SIPA0001
IKCO1	Iran Khodro	*IKCO0001	TMEL1	Tosee Melli Inv	*TMEL0001
IKHR1	Kharazmy Invest	*IKHR0001			

*Note: * http://new.tse.ir/en/Instrument.html?IRO1 (repeated information)*