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Ranking the Trading Symbols of the Largest Companies Listed in the Tehran Stock Exchange Based on the Probability of Informed Trade Criteria

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Abstract

In this paper, trading symbols of the 30 largest companies in the Tehran Stock Exchange (TSE) were ranked based on the asymmetry information risk. Using the Ersan and Alici (2016) modified clustering algorithm (EA), we estimated the probability of informed trading (PIN) to measure the asymmetry information among traders for each trading symbol and trading day through a two-year horizon from 20th March 2015 to 19th March 2017. Furthermore, we used the analysis of variance (ANOVA) method to determine the source of variation in the estimated PIN. The results showed that the estimated PIN is less than 0.1 for 88.2% of the firms-trading days, which equals zero for 60% of the firms-trading days. Symbol trade "MAPN" is traded with the status of complete asymmetric information in about 75% of its trading days. Factor weekdays have no significant effect on changing the PIN index. The annual average of the estimated PIN index for the first year is significantly less than the second year. The impact of firm specification on the PIN value will be disappeared after one year.

Keywords: Analysis of Variance (ANOVA), Measure of Asymmetry Information, Probability of Informed Trading (PIN), Ranking of Trading Symbols, Tehran Stock Exchange.

JEL Classification: G14, C12, C49, C55.

1. Introduction

The concept of information asymmetry firstly introduced by Akerlof (1978) in the automobiles market and later expanded by Spence

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(1978) and Rothschild and Stiglitz (1978). It generally defined as the information advantage of some market participants compared to others in the market. The stock market is being one of the markets that heavily influenced by the asymmetry of information. Information asymmetry of the shareholders has been making uninformed traders lose the amount of additional return that the informed traders receive. As a result, the risk of information asymmetry will reduce the attractiveness of the stock markets.

Asymmetry of information between traders can be reduced in several ways: One way was designing mechanisms and optimizing the arrangement of contracts between the participants. For instance, in the commodity market warranty mechanism, allows purchasers to access the level of information that sellers have at the time of sale (Auronen, 2003). Ranking the trading symbols postulated that had a considerable ex-post effect in reducing the asymmetry information at the level of shareholders. Sankaraguruswamy, Shen, and Yamada (2013) show that the degree of information asymmetry is lower for firms with more frequent news releases. Besides, the quality of disclosure of financial and the quality of reporting information had an effective role in the reduction of information asymmetry between shareholders (Brown and Hillegeist, 2007).

Lack of adequate supervision, weakness of corporate governance structures, and variation of the information content related to each trading symbol due to the economic instability of the country and increase the number of trading symbols at the Tehran Stock Exchange (TSE) market accelerates the asymmetry of information between Iranian shareholders. In this study, trading symbols of the 30 largest companies listed at the TSE were ranked based on the asymmetry information risk. Ranking the trading symbols of the stock exchange market based on the information asymmetry provides shareholders to make appropriate investment decisions. Hence, ranking the trading symbols of the stock market will have reduced the suffering of shareholders from information asymmetry. Moreover, the results of the ranking are useful in controlling and regulating the market.

There are two open issues in ranking the trading symbols of the stock market based on the asymmetry of information: Using proper proxy measure for the information asymmetry and carry out the

correct estimation of the employed measure with actual data. The basis for measuring the information asymmetries depend on the level of measuring. At the level of shareholders, the probability of informed trade (PIN) is being the most common index to measure the information asymmetry between shareholders. That formed based on the microeconomic behavior of shareholders in the stock market and identifies the number of informed trades among the trades that occur during each fixed time interval (Yan and Zhang, 2012). Gilson et al. (1998) and Krishnaswami and Subramaniam (1999) employ the accuracy of analysts' forecasts of earnings per share (EPS) and the dispersion among analysts' forecasts as proxies for measure the information asymmetry at the financial analysts level. However, the information asymmetry at the level of firms' managers based on the advantage information of firms' manager about the investment opportunities and future cash flows of a firm and that is measured by indicators such as the ratio of market value to equity, the ratio of market value to the book value of assets and the ratio of profit to stock price (see Clarke and Shastri, 2001). Duarte and Young (2009) decomposed PIN into two components and showed that the component related to private information did not price in the market, while the PIN component related to illiquidity is being priced. Lof and Bommel (2018) proposed the volume coefficient of variation[1] (VCV) index computed from daily trading volumes as an easily computable measure of information asymmetry in security markets; they show that the VCV index is correlated with the estimated PIN index.

Several versions of the PIN measure added to the literature. Easley, López de Prado, and O'Hara (2012) introduced the VPIN index (Volume-synchronized probability of informed trading) as a real-time measurement of the PIN to capture the risk variations at an intraday level. Also, Abad and Yagüe (2012) suggested that certain VPIN specifications could be used as proxies for adverse selection risk. DPIN is a dynamic intraday measure of the probability of informed trading developed by Chang, Chang, and Wang (2014). Paparizos et al. (2016) construct a transaction-signed version of VPIN (TR-VPIN) based on tick-by-tick data on securities traded. This measure is a real-

1. Ratio of the standard deviation to the mean of trading volume

time informative indicator of PIN in the high-frequency domain.

Regardless of whether the PIN index is a suitable measure of asymmetry information, estimating the PIN index with actual data remained as an empirical problem. Ersan and Alici (2016) categorized the computational problems in the maximum likelihood estimation of PIN into three: over/under-flow problem that also known as the floating-point exception (FPE), frequent occurrence of boundary solutions, and accurate determination of initial value sets. They show that there does not exist a methodology that provides unbiased estimates. The likelihood factorization of Easley, Hvidkjaer, and O'Hara, 2010 (EHO), and the likelihood factorization of William Lin and Ke, 2011 (LK), introduced as two likelihood specifications to avoid the problem of FPE in optimizing the likelihood function of the PIN model. Furthermore, three different algorithms proposed to overcome the estimation bias arise from boundary solutions: The grid-search based PIN estimates of Yan and Zhang, 2012 (YZ), the clustering-based PIN estimates of Gan, Wei, and Johnstone, 2015 (GAN) and the cluster analysis with the altered steps of Ersan and Alici, 2016 (EA). These estimation approaches based on data clustering algorithm and is more flexible in working with big data sets. Celik and Tiniç (2017) compared YZ, GAN, and EA estimation algorithm along with each likelihood specification and show that EA provides powerful estimates of the PIN model. Nyholm (2002), Boehmer, Grammig, and Theissen (2007), Chang et al. (2014), Petchey, Wee, and Yang (2016) have also considered the issue of estimating the asymmetric information index based on the PIN model.

Numerous studies focused on the applied aspect of asymmetry information instead of focus on the measurement aspect and estimation methods and examined the interaction effects between a variable which measure the asymmetry of information and other variables such as returns, the volatility of returns, volume of transactions and liquidity of capital in the market are a notable object of applied studies. For instance, the impact of informed trade in determining price momentum examined by Chen and Zhao (2012) and in the idiosyncratic return variation explored by Kang and Nam (2015). Hwang et al. (2013) proposed the effect of information asymmetry on the cost of equity capital. Despite foreign studies,

domestic research is few and only concentrated on the applied aspect of asymmetry information. Kordi Tamandani (2016) used intraday data of bid and ask price quotes to measure the daily asymmetric information of active trading symbols listed in TSE over the year 2015. For the most days of sample errors in optimizing the PIN's model's likelihood function have occurred due to the existence of large and small items quotes. Further, Kordi Tamandani's (2017) research depicted the positive effects of asymmetric information risk on the volatility of stock returns in the TSE market.

The purpose of this paper is to estimate the index of asymmetry information related to each trading symbol among stockholders and rank the trading symbols based on the level of information asymmetry. We focused on the active symbols of the 30 largest companies in the Tehran Stock Exchange market and estimated the PIN index of each trading symbol for each trading day from 20th March 2015 to 19th March by using the EA modified clustering algorithm (Ersan & Alici, 2016). The parameters of the PIN model are estimated by using the statistical computing software R. Another aim was to test whether the calendar factors and firm's factor has significant effects on the variation of estimated PIN index. To test that hypothesis the analysis of variance (ANOVA) method used to determine the source of variation of estimated PIN. The empirical results of estimation and ranking contribute to the literature of asymmetric information.

The rest of this paper is as follows: Section 2 describes our data and analytical methods. Section3 explains the estimation results and discussion. The final section concludes the article.

2. Data and Analytical Methods

2.1 Data

The raw data used in the research include best's quotes for the purchase and sale of shares in the Tehran Stock Exchange, which is recorded instantly (millisecond). The database files of intraday trade and quote data are obtained from the Tehran Stock Exchange Technology Management Company. Due to the large size of file data, (that is about 11.3 gigabytes), we used the database software of SQL Server to extract the data sample. Furthermore, the computational

package of "InfoTrad" is used in software R to estimate the parameter of the PIN model.

The database file of quotes contains 22 numbers of columns[1]. Columns 1- 4 respectively indicate the date, the name of a trading symbol, the time (hours-minutes-seconds), and milliseconds of quotes. Columns 5-7 are referred to the volume of the shares that buyers are willing to buy (QB1), the bid price (PB1), and the number of buyers (NB1) of the first best quotes. The offered ask volume of shares (QS1), the asking price (PS1), and the number of sellers (NS1) of the first best quotes is showed in columns 8 to 10 respectively. Columns 11-22 also refer to the second and third superior quotes. Based on the purpose of the research, data from variables of columns 1-4 and fifth columns (QB1) and eighth (QS1) are used to estimate the PIN model indices.

2.2 Probability of Informed Trades (PIN)

As presented in figure (1), each of the three following events could occur in a trading day: 1) there is no news about stock (ø); 2) There is good news (g), and 3) There is bad news (b). Unconditional probabilities of these events are shown through the following formulas:

$$Pr(b)=\alpha\delta,\ Pr(g)=\alpha(1-\delta),\ \text{and}\ Pr(ø)=(1-\alpha).$$

Where, α is the probability of an informative event on a trading day, and δ is the probability that the informative event is bad news. Informed traders are those who consciously buy and sell stocks, as soon as they achieve private information from the market. It is assumed that ask and bid price (volume) of informed traders has Poison distribution and its average is equal to $\boldsymbol{\mu}$ during the period in which informative event has been available. The value of this rate is fixed during the period (day) and does not depend on the type of news (bad or good). In case of no informative event in the market, only uninformed traders make buy and sell in the market; and, it is assumed that ask and bid prices of uninformed traders also has Poison distribution with their average being respectively equal to ε_b and ε_s

1. The database file of trade includes 10 columns.

with fixed values during the period, and notwithstanding the existence of an informative event in the market.

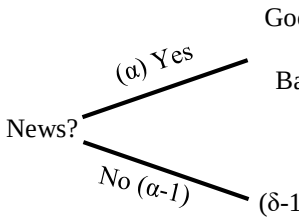

Figure 1: Probability of Informed Trading Model
Source: Gan et al., 2015

The unconditional probability of informed trading during a trading day (PIN) which is defined as the ratio of informed trades to a total number of trades will be obtained through the following relationship:

$$PIN = \frac{\alpha\mu}{\alpha\mu+\varepsilon_b+\varepsilon_s} \quad (1)$$

The above equation shows when there is an increased probability of occurrence of an informative event (α) or an increase in the number of informed trades performed (μ) during the period; then, information asymmetry level among traders would be increased. However, with an increase of tendency towards uninformed trading (ε_b and ε_s), information asymmetry level will be reduced. When the PIN index (probability of informed trading) is equal to zero, there would be no fresh news (α=0), or traders are not informed of fresh news (μ=0). If traders receive new information, then α>0; and, if the information provided leads to asymmetry, the PIN would be positive.

The unknown parameter in the equation (1) and parameter δ in combination with each other will result in $\theta\{\delta, \alpha, \mu, \varepsilon_b, \varepsilon_s\}$; and, elements of the set could be estimated through the following stages, with maximization of likelihood function resulted from the joint distribution of buys (B) and sales (S) performed during one period (Gan et al., 2017).

- Each period is divided into ***N*** time interval and joint distribution of trades performed will be written in each of the time intervals

(e.g. one day) as follows:

$$f(B,S|\theta) = [\alpha\delta e^{\varepsilon_b}\varepsilon_b^B e^{-(\varepsilon_b+\mu)}(\varepsilon_s+\mu)^S + \alpha(1-\delta)e^{-(\varepsilon_b+\mu)}(\varepsilon_b+\mu)^B e^{-\varepsilon_s}\varepsilon_s^S + (1-\alpha)e^{-\varepsilon_b}\varepsilon_b^B e^{-\varepsilon_s}\varepsilon_s^S]/[B!\,S!] \quad (2)$$

- Considering the independence of informative events in each of various time intervals, the likelihood function algorithm of trades during the period is equal to the sum of the likelihood function logarithm of each of intervals.
- Unknown parameters of the set θ will be obtained through maximization of the likelihood function of trades during the period, that is: $\hat{\theta} = \arg Max \sum_{t=1}^{N} \log[f(B_t, S_t|\theta)]$
- After the estimation of unknown parameters of θ, the PIN index value will be obtained from equation (1).

3. Estimation Results and Discussion

3.1 Estimate Parameters of the PIN Model

The PIN model indicators for each trading day are calculated from 20th March 2015 to 19th March 2017 and the results are summarized as the following tables. The estimated value of PIN is variable from zero to one. When it takes value zero, the trading occurred only by uninformed traders. Table 1 shows the frequency distribution of the estimated PIN. The last column of this table contains the "Total trading days" defined to be the sum of trading days for each symbol trade. For the 5347 trading-symbols-days, the estimated PIN value is zero. That is about 60.5 percentage of trading-symbols-days in total. Relative frequency distribution of the estimated PIN value in Table 2 provides a valid comparison of asymmetry information related to each symbol trade. For instance, the Symbol trade “MAPN” has the largest relative distribution if the estimated PIN value is conditioned by zero. That is traded by the uninformed trader in 197 days form 262 days of trading days. In other words, “MAPN” is traded with the status of full asymmetric information in about 75% of its trading days. However, approximately 10% of trading of the symbol trade “PTEH” has done with full asymmetric information. As the final row of Table 2

indicates, the asymmetry information index in the one percent of trading in greater than 0.9.

Table 1: Frequency Distribution of the Estimated PIN

Symbol Trade		Estimated PIN value: Decreasing asymmetry information index →											Total trading days
		0	0.0 - 0.1	0.1 - 0.2	0.2 - 0.3	0.3 - 0.4	0.4 - 0.5	0.5 - 0.6	0.6 - 0.7	0.7 - 0.8	0.8 - 0.9	0.9 - 1	
1	MKBT	209	68	9	9	3	6	2	1	2	0	2	311
2	BFJR	41	79	11	4	8	3	4	3	1	4	6	164
3	PASN	216	96	8	2	3	2	2	2	1	0	2	334
4	IPTR	26	90	7	8	3	3	1	1	0	2	2	143
5	PTAP	227	66	7	3	4	0	1	0	0	2	2	312
6	PJMZ	164	48	31	21	15	5	7	3	1	3	5	303
7	KSHJ	226	113	13	11	6	1	2	1	0	2	1	376
8	SIPA	211	81	1	5	2	1	1	0	3	0	1	306
9	IKCO	218	100	5	5	1	4	0	5	3	0	2	343
10	INFO	231	79	20	19	6	5	5	3	2	1	2	373
11	MAPN	197	46	4	2	4	1	2	2	0	2	2	262
12	PNBA	189	87	5	4	5	1	1	3	3	1	0	299
13	PRDZ	216	79	17	13	4	1	1	4	1	3	3	342
14	PNES	218	102	9	6	5	1	2	2	0	1	3	349
15	PTEH	5	34	4	3	1	1	2	0	1	0	0	51
16	PKLJ	217	92	22	9	6	7	3	3	4	1	6	370
17	FKAS	59	35	11	5	6	3	3	4	4	4	3	137
18	FKHZ	150	98	4	9	2	2	2	3	1	3	0	274
19	MSMI	209	93	8	5	4	1	1	2	1	1	3	328
20	FOLD	193	114	8	3	1	1	0	0	0	3	2	325
21	CHML	123	106	3	8	2	1	0	2	0	2	5	252
22	GOLG	150	75	7	1	4	1	1	1	5	2	3	250
23	MOBN	200	91	11	9	4	2	4	4	2	2	8	337
24	HMRZ	218	78	15	10	9	6	2	3	0	1	3	345
25	OIMC	180	94	14	10	5	2	0	1	0	1	4	311
26	BANK	216	99	18	3	1	1	5	2	1	1	6	353
27	BMLT	206	49	3	2	7	0	2	2	0	1	2	274
28	SAND	211	67	25	10	7	4	2	2	3	4	2	337
29	GDIR	232	108	11	5	3	3	1	2	0	2	6	373
30	MADN	189	88	12	3	3	2	2	4	0	1	4	308

	Sum	5347	2455	323	207	134	71	61	65	39	50	90	8842

Table 2: Relative Frequency Distribution of the Estimated PIN

	Symbol Trade	Estimated PIN value: Decreasing asymmetry information index →											Sum
		0	0.0 - 0.1	0.1 - 0.2	0.2 - 0.3	0.3 - 0.4	0.4 - 0.5	0.5 - 0.6	0.6 - 0.7	0.7 - 0.8	0.8 - 0.9	0.9 - 1	
1	MKBT	0.672	0.219	0.029	0.029	0.010	0.019	0.006	0.003	0.006	0.000	0.006	1
2	BFJR	0.250	0.482	0.067	0.024	0.049	0.018	0.024	0.018	0.006	0.024	0.037	1
3	PASN	0.647	0.287	0.024	0.006	0.009	0.006	0.006	0.006	0.003	0.000	0.006	1
4	IPTR	0.182	0.629	0.049	0.056	0.021	0.021	0.007	0.007	0.000	0.014	0.014	1
5	PTAP	0.728	0.212	0.022	0.010	0.013	0.000	0.003	0.000	0.000	0.006	0.006	1
6	PJMZ	0.541	0.158	0.102	0.069	0.050	0.017	0.023	0.010	0.003	0.010	0.017	1
7	KSHJ	0.601	0.301	0.035	0.029	0.016	0.003	0.005	0.003	0.000	0.005	0.003	1
8	SIPA	0.690	0.265	0.003	0.016	0.007	0.003	0.003	0.000	0.010	0.000	0.003	1
9	IKCO	0.636	0.292	0.015	0.015	0.003	0.012	0.000	0.015	0.009	0.000	0.006	1
10	INFO	0.619	0.212	0.054	0.051	0.016	0.013	0.013	0.008	0.005	0.003	0.005	1
11	MAPN	0.752	0.176	0.015	0.008	0.015	0.004	0.008	0.008	0.000	0.008	0.008	1
12	PNBA	0.632	0.291	0.017	0.013	0.017	0.003	0.003	0.010	0.010	0.003	0.000	1
13	PRDZ	0.632	0.231	0.050	0.038	0.012	0.003	0.003	0.012	0.003	0.009	0.009	1
14	PNES	0.625	0.292	0.026	0.017	0.014	0.003	0.006	0.006	0.000	0.003	0.009	1
15	PTEH	0.098	0.667	0.078	0.059	0.020	0.020	0.039	0.000	0.020	0.000	0.000	1
16	PKLJ	0.586	0.249	0.059	0.024	0.016	0.019	0.008	0.008	0.011	0.003	0.016	1
17	FKAS	0.431	0.255	0.080	0.036	0.044	0.022	0.022	0.029	0.029	0.029	0.022	1
18	FKHZ	0.547	0.358	0.015	0.033	0.007	0.007	0.007	0.011	0.004	0.011	0.000	1
19	MSMI	0.637	0.284	0.024	0.015	0.012	0.003	0.003	0.006	0.003	0.003	0.009	1
20	FOLD	0.594	0.351	0.025	0.009	0.003	0.003	0.000	0.000	0.000	0.009	0.006	1
21	CHML	0.488	0.421	0.012	0.032	0.008	0.004	0.000	0.008	0.000	0.008	0.020	1
22	GOLG	0.600	0.300	0.028	0.004	0.016	0.004	0.004	0.004	0.020	0.008	0.012	1
23	MOBN	0.593	0.270	0.033	0.027	0.012	0.006	0.012	0.012	0.006	0.006	0.024	1
24	HMRZ	0.632	0.226	0.043	0.029	0.026	0.017	0.006	0.009	0.000	0.003	0.009	1
25	OIMC	0.579	0.302	0.045	0.032	0.016	0.006	0.000	0.003	0.000	0.003	0.013	1
26	BANK	0.612	0.280	0.051	0.008	0.003	0.003	0.014	0.006	0.003	0.003	0.017	1
27	BMLT	0.752	0.179	0.011	0.007	0.026	0.000	0.007	0.007	0.000	0.004	0.007	1
28	SAND	0.626	0.199	0.074	0.030	0.021	0.012	0.006	0.006	0.009	0.012	0.006	1
29	GDIR	0.622	0.290	0.029	0.013	0.008	0.008	0.003	0.005	0.000	0.005	0.016	1

30	MADN	0.614	0.286	0.039	0.010	0.010	0.006	0.006	0.013	0.000	0.003	0.013	1
	Sum	0.605	0.278	0.037	0.023	0.015	0.008	0.007	0.007	0.004	0.006	0.010	1

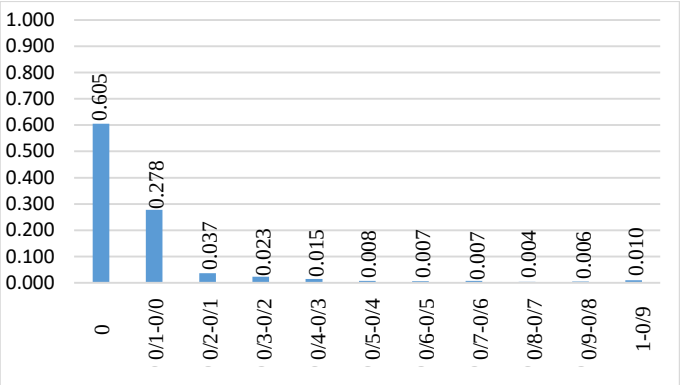

Figure 2: Relative Distribution of Estimated PIN for All Symbols

Figure 2 represents a schematic illustration of the status of asymmetry information between shareholders at the Tehran Stock Exchange. As the density of asymmetry information on the horizontal axis is increasing from right to left, the relative frequency of symbol-trading-days is increasing on the vertical axis.

Average of estimated PIN index on weekdays and at each month and season and year has represented in Tables 3, 4, 5, and 6 respectively. Furthermore, the annual average of the estimated PIN of each year is compared in Figure 3. It seems that the annual average of the estimated PIN index for the first year is significantly less than the second year. In other word asymmetry information were considerably reduced.

Table 3: Average PIN Index on Weekdays

	Symbol Trade	Sunday	Monday	Tuesday	Wednesday	Saturday	Grand Total
1	MKBT	0.027	0.031	0.074	0.046	0.049	0.046
2	BFJR	0.155	0.107	0.153	0.123	0.171	0.142
3	PASN	0.048	0.028	0.030	0.017	0.034	0.031
4	IPTR	0.090	0.085	0.102	0.096	0.069	0.088
5	PTAP	0.051	0.029	0.020	0.034	0.009	0.029
6	PJMZ	0.081	0.101	0.144	0.094	0.115	0.107
7	KSHJ	0.045	0.037	0.038	0.036	0.042	0.040
8	SIPA	0.057	0.017	0.011	0.010	0.026	0.024

	Symbol Trade	Sunday	Monday	Tuesday	Wednesday	Saturday	Grand Total
9	IKCO	0.036	0.060	0.031	0.035	0.036	0.039
10	INFO	0.070	0.063	0.048	0.051	0.093	0.065
11	MAPN	0.028	0.035	0.042	0.024	0.063	0.038
12	PNBA	0.022	0.033	0.013	0.073	0.045	0.037
13	PRDZ	0.080	0.023	0.058	0.063	0.057	0.057
14	PNES	0.040	0.039	0.040	0.017	0.051	0.037
15	PTEH	0.123	0.158	0.101	0.052	0.012	0.088
16	PKLJ	0.067	0.062	0.099	0.074	0.059	0.072
17	FKAS	0.149	0.196	0.179	0.114	0.114	0.150
18	FKHZ	0.034	0.066	0.059	0.049	0.029	0.048
19	MSMI	0.033	0.021	0.026	0.031	0.072	0.037
20	FOLD	0.027	0.041	0.025	0.030	0.019	0.028
21	CHML	0.066	0.038	0.088	0.065	0.019	0.055
22	GOLG	0.030	0.082	0.048	0.034	0.090	0.057
23	MOBN	0.101	0.049	0.076	0.060	0.067	0.071
24	HMRZ	0.033	0.029	0.070	0.043	0.112	0.058
25	OIMC	0.020	0.070	0.035	0.068	0.055	0.050
26	BANK	0.060	0.066	0.027	0.067	0.038	0.051
27	BMLT	0.032	0.045	0.040	0.022	0.034	0.035
28	SAND	0.068	0.050	0.045	0.085	0.076	0.065
29	GDIR	0.045	0.020	0.073	0.048	0.043	0.046
30	MADN	0.036	0.024	0.035	0.064	0.078	0.047

Table 4: Average PIN Index for Each Month during the Sample Period

	Symbol Trade	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	Grand Total
1	MKBT	0.013	0.050	0.029	0.030	0.032	0.143	0.002	0.044	0.007	0.046	0.079	0.054	0.046
2	BFJR	0.055	0.195	0.043	0.126	0.079	0.234	0.259	0.049	0.211	0.152	0.149	0.157	0.142
3	PASN	0.027	0.011	0.032	0.007	0.056	0.000	0.032	0.058	0.020	0.046	0.034	0.033	0.031
4	IPTR		0.061	0.064	0.063	0.122	0.138	0.176	0.141	0.060	0.080	0.054	0.047	0.088
5	PTAP	0.042	0.071	0.001	0.026	0.052	0.009	0.000	0.035	0.035	0.012	0.019	0.017	0.029
6	PJMZ	0.184	0.252	0.193	0.181	0.135	0.076	0.073	0.100	0.072	0.107	0.103	0.044	0.107
7	KSHJ	0.035	0.020	0.033	0.025	0.032	0.030	0.086	0.014	0.044	0.035	0.066	0.058	0.040
8	SIPA	0.056	0.037	0.009	0.064	0.014	0.025	0.003	0.015	0.000	0.015	0.004	0.052	0.024
9	IKCO	0.127	0.055	0.039	0.043	0.004	0.002	0.068	0.023	0.013	0.049	0.034	0.009	0.039
10	INFO	0.103	0.094	0.053	0.068	0.071	0.052	0.048	0.057	0.050	0.102	0.048	0.034	0.065
11	MAPN	0.025	0.022	0.058	0.194	0.015	0.000	0.000	0.000	0.000	0.015	0.016	0.067	0.038
12	PNBA	0.039	0.072	0.009	0.039	0.078	0.090	0.058	0.028	0.028	0.030	0.010	0.004	0.037
13	PRDZ	0.065	0.084	0.049	0.114	0.061	0.000	0.062	0.063	0.039	0.054	0.023	0.047	0.057
14	PNES	0.032	0.009	0.036	0.053	0.065	0.045	0.055	0.006	0.044	0.036	0.036	0.042	0.037

	Symbol Trade	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	Grand Total
15	PTEH								0.071	0.121	0.040	0.079	0.160	0.088
16	PKLJ	0.031	0.086	0.068	0.091	0.048	0.091	0.104	0.061	0.083	0.068	0.030	0.089	0.072
17	FKAS	0.283	0.193	0.082	0.064	0.251	0.163	0.265	0.057	0.223	0.117	0.198	0.021	0.150
18	FKHZ	0.008	0.038	0.097	0.040	0.147	0.075	0.014	0.100	0.029	0.029	0.012	0.032	0.048
19	MSMI	0.013	0.105	0.020	0.050	0.070	0.017	0.008	0.110	0.006	0.007	0.038	0.022	0.037
20	FOLD	0.004	0.010	0.008	0.047	0.220	0.044	0.009	0.008	0.015	0.006	0.048	0.026	0.028
21	CHML	0.138	0.039	0.038	0.111	0.104	0.069	0.031	0.044	0.058	0.014	0.025	0.045	0.055
22	GOLG	0.099	0.061	0.044	0.104	0.185	0.016	0.086	0.061	0.006	0.085	0.009	0.004	0.057
23	MOBN	0.192	0.042	0.080	0.031	0.075	0.140	0.049	0.066	0.051	0.051	0.085	0.062	0.071
24	HMRZ	0.028	0.037	0.066	0.069	0.110	0.040	0.031	0.054	0.103	0.085	0.040	0.036	0.058
25	OIMC	0.083	0.113	0.012	0.021	0.052	0.121	0.022	0.071	0.069	0.017	0.035	0.049	0.050
26	BANK	0.068	0.048	0.113	0.023	0.066	0.019	0.019	0.037	0.088	0.053	0.038	0.035	0.051
27	BMLT	0.077	0.003	0.082	0.029	0.000	0.000	0.013	0.022	0.036	0.000	0.022	0.069	0.035
28	SAND	0.033	0.050	0.013	0.072	0.075	0.074	0.088	0.091	0.062	0.025	0.083	0.110	0.065
29	GDIR	0.055	0.043	0.088	0.031	0.075	0.049	0.012	0.078	0.018	0.034	0.014	0.055	0.046
30	MADN	0.087	0.097	0.067	0.055	0.097	0.024	0.008	0.067	0.038	0.012	0.034	0.034	0.047

Table 5: Average PIN Index at Different Seasons during 2015-2017

	Symbol Trade	Spring	Summer	Autumn	Winter	Grand Total
1	MKBT	0.032	0.061	0.020	0.060	0.046
2	BFJR	0.094	0.147	0.164	0.155	0.142
3	PASN	0.023	0.025	0.038	0.038	0.031
4	IPTR	0.063	0.106	0.129	0.060	0.088
5	PTAP	0.041	0.032	0.026	0.016	0.029
6	PJMZ	0.209	0.110	0.082	0.089	0.107
7	KSHJ	0.030	0.029	0.050	0.054	0.040
8	SIPA	0.033	0.034	0.005	0.021	0.024
9	IKCO	0.070	0.014	0.037	0.034	0.039
10	INFO	0.080	0.064	0.052	0.063	0.065
11	MAPN	0.037	0.082	0.000	0.035	0.038
12	PNBA	0.041	0.063	0.036	0.016	0.037
13	PRDZ	0.066	0.065	0.056	0.040	0.057
14	PNES	0.026	0.053	0.035	0.037	0.037
15	PTEH			0.097	0.080	0.088
16	PKLJ	0.063	0.078	0.085	0.062	0.072
17	FKAS	0.152	0.133	0.188	0.149	0.150
18	FKHZ	0.049	0.083	0.044	0.025	0.048

	Symbol Trade	Spring	Summer	Autumn	Winter	Grand Total
19	MSMI	0.046	0.044	0.037	0.023	0.037
20	FOLD	0.007	0.084	0.011	0.026	0.028
21	CHML	0.066	0.093	0.044	0.030	0.055
22	GOLG	0.066	0.101	0.056	0.027	0.057
23	MOBN	0.088	0.083	0.056	0.064	0.071
24	HMRZ	0.044	0.070	0.062	0.056	0.058
25	OIMC	0.057	0.053	0.058	0.034	0.050
26	BANK	0.079	0.035	0.047	0.042	0.051
27	BMLT	0.053	0.014	0.021	0.035	0.035
28	SAND	0.033	0.074	0.080	0.071	0.065
29	GDIR	0.063	0.051	0.033	0.034	0.046
30	MADN	0.082	0.050	0.037	0.026	0.047

Table 6: Average PIN Index at Each Year

	Symbol Trade	20th March 2015 to 19th march 2016	20th March 2016 to 19th march 2017	Grand Total
1	MKBT	0.005	0.121	0.046
2	BFJR	0.017	0.157	0.142
3	PASN	0.006	0.067	0.031
4	IPTR		0.088	0.088
5	PTAP	0.020	0.050	0.029
6	PJMZ	0.005	0.187	0.107
7	KSHJ	0.010	0.083	0.040
8	SIPA	0.003	0.066	0.024
9	IKCO	0.007	0.089	0.039
10	INFO	0.007	0.145	0.065
11	MAPN	0.013	0.132	0.038
12	PNBA	0.009	0.081	0.037
13	PRDZ	0.004	0.135	0.057
14	PNES	0.013	0.074	0.037
15	PTEH		0.088	0.088
16	PKLJ	0.008	0.152	0.072
17	FKAS	0.000	0.214	0.150
18	FKHZ	0.004	0.088	0.048
19	MSMI	0.007	0.078	0.037
20	FOLD	0.008	0.053	0.028

	Symbol Trade	20th March 2015 to 19th march 2016	20th March 2016 to 19th march 2017	Grand Total
21	CHML	0.003	0.089	0.055
22	GOLG	0.000	0.113	0.057
23	MOBN	0.018	0.138	0.071
24	HMRZ	0.013	0.129	0.058
25	OIMC	0.000	0.103	0.050
26	BANK	0.006	0.107	0.051
27	BMLT	0.012	0.102	0.035
28	SAND	0.001	0.160	0.065
29	GDIR	0.013	0.093	0.046
30	MADN	0.006	0.101	0.047

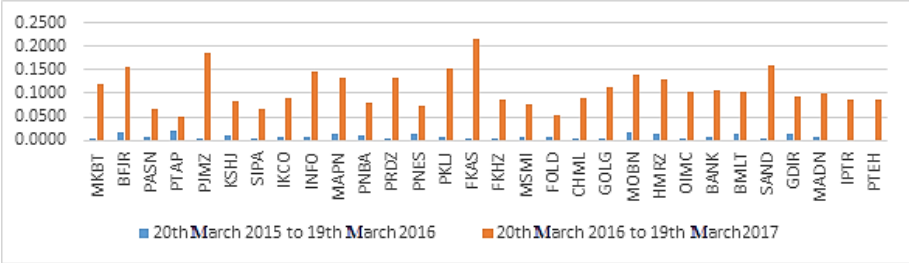

Figure 3: Yearly Comparison of Annual Average of Estimated PIN

3.2 Identify the Source of Variation in the Estimated PIN Index

There are several reasons for varying the estimated PIN index. Here, we classify them into two groups: Calendar effects and firm effects. The two-factor analysis of variance (ANOVA) method used to test the significance of these two factors effects on the variation of estimated PIN index. Calendar effects occur due to changes in weekdays, changes at months and seasons, and years. Therefore, two-factor ANOVA test results are shown in Tables 7 to 10 for each calendar factor with firm factor separately. Under the null hypothesis, it assumed that the factor has significant effects on the variation of estimated PIN index. The null hypothesis will be accepted whenever the associated p-value is less than 5 percent. In this case, the F-test value is greater than the critical values of the test statistic (F critical) and the alternative hypothesis is rejected with a confidence level above 95 percent.

Table 7: The ANOVA Test for the Day's Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Days factor	0.0008	4	0.0002	0.3810	0.8219	2.4499
Firms factor	0.1377	29	0.0047	9.2429	0.0000	1.5653
Error	0.0596	116	0.0005			
Total	0.1981	149				

Table 8: The ANOVA Test for the Month's Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Months factor	0.0391	11	0.0036	2.1815	0.0154	1.8210
Firms factor	0.3583	27	0.0133	8.1494	0.0000	1.5234
Error	0.4836	297	0.0016			
Total	0.8810	335				

Table 9: The ANOVA Test for the Season's Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Seasons factor	0.0052	3	0.0017	3.4412	0.0204	2.7132
Firm factor	0.1159	28	0.0041	8.2803	0.0000	1.6104
Error	0.0420	84	0.0005			
Total	0.1630	115				

Table 10: The ANOVA Test for the Year's Factor

Source of Variation	SS	df	MS	F	P-value	F crit
Years factor	0.1491	1	0.1491	173.8818	0.0000	4.2100
Firms factor	0.0208	27	0.0008	0.8982	0.6088	1.9048
Error	0.0232	27	0.0009			
Total	0.1931	55				

Results of the ANOVA test in Table 7 indicate that changing the weekdays has no significant effect on changing the PIN index. Firms' factor, by contrast, has a significant effect on the variation of

estimated PIN. These results may be due to the status of asymmetry information lasting more than one day; hence, the day's factor is not a significant source of variation. Moreover, firms' factor for a weekday is a source of variation because the arrival of private information and its content may differ across the firms.

Both firm's factor and calendar's factors are significant sources of variation in the monthly and seasonal average of the estimated PIN index (see Tables 8 and 9). Statistical significance of p-value related to year factor in Table 10 leads us to conclude that only year factor is the source of variation in the estimation of the PIN index. Figure 2 and Table 6 confirm the obtained results here intuitively. As Table 10 shows, the Firm factor is not a significant source of variation in the annual average of estimated PIN. In other words, the effect of firm specification on the PIN value will disappear after one year.

3.3 Rank the Trading Symbols Based on the Estimated PIN Index

Here, the trading symbols of the 30 largest companies listed at TSE are ranked in ascending order of level of asymmetry of information, and the results are shown in Table 11. The probability of informed trade (PIN) takes value from zero to one. Based on the PIN value we defined 11 levels for information asymmetry. In the first level PIN, value is zero. In the second level, PIN takes a value between 0-0.1, and in the same way, it takes a value between 0.9-1 in the 11^{th} level of information asymmetry. By increasing the value of PIN, the level of information asymmetry is decreasing. The rank of trading symbol formed by the relative frequency of estimated PIN trading days and that is conditioned by the level of information asymmetry. Symbol trade "MAPN" has rank one at the first level of information asymmetry. Because it is conditional, the relative frequency distribution is greater than the conditional relative frequency distribution of other symbols. THE estimated PIN value for "MAPN" is equal to zero in the 75.2% of its trading days. Symbol trade "PTEH" takes rank one at the second level of information asymmetry. Symbol trade "FKAS" takes rank one at 6^{th}, 8^{th}, 9^{th} and 10^{th} levels of information asymmetry.

Table 11: Rank Symbol Trade Based on Asymmetry Information Index

Symbol Rank	Increasing the Probability of informed trade (the PIN value) → ← Increasing asymmetry information index (1-PIN)										
	0	**0.0 - 0.1**	**0.1 - 0.2**	**0.2 - 0.3**	**0.3 - 0.4**	**0.4 - 0.5**	**0.5 - 0.6**	**0.6 - 0.7**	**0.7 - 0.8**	**0.8 - 0.9**	**0.9 - 1**
1	MAPN	PTEH	PJMZ	PJMZ	PJMZ	FKAS	PTEH	FKAS	FKAS	FKAS	BFJR
2	BMLT	IPTR	FKAS	PTEH	BFJR	IPTR	BFJR	BFJR	GOLG	BFJR	MOBN
3	PTAP	BFJR	PTEH	IPTR	FKAS	PTEH	PJMZ	IKCO	PTEH	IPTR	FKAS
4	SIPA	CHML	SAND	INFO	HMRZ	MKBT	FKAS	MADN	PKLJ	SAND	CHML
5	MKBT	FKHZ	BFJR	PRDZ	BMLT	PKLJ	BANK	MOBN	PNBA	FKHZ	BANK
6	PASN	FOLD	PKLJ	FKAS	IPTR	BFJR	INFO	PRDZ	SIPA	PJMZ	PJMZ
7	MSMI	OIMC	INFO	FKHZ	SAND	HMRZ	MOBN	FKHZ	SAND	FOLD	PKLJ
8	IKCO	KSHJ	BANK	OIMC	PTEH	PJMZ	PKLJ	PNBA	IKCO	PRDZ	GDIR
9	PNBA	GOLG	PRDZ	CHML	PNBA	INFO	MAPN	PJMZ	MKBT	GOLG	IPTR
10	HMRZ	PNES	IPTR	SAND	PKLJ	SAND	BMLT	HMRZ	BFJR	CHML	MADN
11	PRDZ	IKCO	OIMC	KSHJ	INFO	IKCO		PKLJ	MOBN	MAPN	OIMC
12	SAND	PNBA	HMRZ	HMRZ	OIMC	GDIR	IPTR	INFO	INFO	PTAP	GOLG
13	PNES	GDIR	MADN	MKBT	GOLG	FKHZ	MADN	CHML	FKHZ	MOBN	MSMI
14	GDIR	PASN	KSHJ	MOBN	KSHJ	MADN	MKBT	MAPN	PJMZ	GDIR	PRDZ
15	INFO	MADN	MOBN	BFJR	MAPN	OIMC	PASN	BMLT	MSMI	KSHJ	HMRZ
16	MADN	MSMI	GDIR	PKLJ	PNES	PASN	SAND	IPTR	PASN	BMLT	PNES
17	BANK	BANK	MKBT	PNES	PTAP	MOBN	HMRZ	MSMI	PRDZ	PNBA	MAPN
18	KSHJ	MOBN	GOLG	SIPA	MSMI	GOLG	PNES	PASN	BANK	MADN	BMLT
19	GOLG	SIPA	PNES	MSMI	MOBN	CHML	KSHJ	SAND	MADN	OIMC	MKBT
20	FOLD	FKAS	FOLD	IKCO	PRDZ	MAPN	GOLG	PNES		MSMI	PTAP
21	MOBN	PKLJ	MSMI	GDIR	MADN	PNBA	PNBA	BANK		HMRZ	FOLD
22	PKLJ	PRDZ	PASN	PNBA	MKBT	SIPA	SIPA	GDIR		PNES	PASN
23	OIMC	HMRZ	PTAP	MADN	PASN	FOLD	PTAP	GOLG		BANK	SAND
24	FKHZ	MKBT	PNBA	PTAP	GDIR	MSMI	MSMI	OIMC		PKLJ	IKCO
25	PJMZ	INFO	MAPN	FOLD	CHML	PRDZ	PRDZ			INFO	INFO
26	CHML	PTAP	FKHZ	BANK	FKHZ	PNES	GDIR	KSHJ		PTEH	SIPA
27	FKAS	SAND	IKCO	MAPN	SIPA	BANK	OIMC	FOLD			KSHJ

28	BFJR	BMLT	CHML	BMLT	FOLD	KSHJ	FKHZ
29	IPTR	MAPN	BMLT	PASN	IKCO	BMLT	
30	PTEH	PJMZ	SIPA	GOLG	BANK		

4. Conclusion

The main aim of this research is to rank the trading symbols of the 30 largest companies listed in the Tehran Stock Exchange market based on the asymmetry of information of shareholders. We estimate the probability of informed trade (PIN) index for each trading symbol for each trading day from 20th March 2015 to 19th March 2017 by using the Ersan and Alici (2016) modified clustering algorithm (EA) method. PIN index takes value from zero to one. If it takes value zero that means trading symbol has been traded with the status of full asymmetric information. Based on the PIN value we defined eleven different levels for information asymmetry. At the first level of information asymmetry, the PIN value is zero and at the 11th level, the PIN index takes a value between 0.9-1. Conditional relative frequency distribution of each trading symbol represented in Table 2 defined by dividing the number of trading days that have traded with a certain level of asymmetric information by the total number of trading days of a symbol. Trading symbols have ranked based on conditional frequency distribution in ascending order of level of asymmetric information. Results show that for the 60 percent of total firms-trading days accrued with the status of full asymmetric information. Status of symbol trade "MAPN" is worse than others and that is traded with the status of full asymmetric information in about 75% of its trading days.

The analysis of variance (ANOVA) method is used to test the significance of a fixed firm's effect and calendar effects on the estimated PIN index. The ANOVA test has done for each sub-calendar factor such as weekdays, months, seasons, and years separately. Form the results of the ANOVA test someone conclude that status of asymmetry information lasting more than one day, hence day's factor is not a significant source of variation. Yearly comparison of an annual average of estimated PIN index shows significant improvement in the status of asymmetry information at the level of

shareholders. The study provides some empirical evidence supporting the status of asymmetric information of Iranian shareholders.

Accessible limitation to data constrained us to determine the effect of each sub-firm factors such as firm size, the ratio between real and legal shareholders, liquidity of stock on the estimated PIN index separately. Furthermore, the variables of other factors such as the advancement of information technology and the extension of social networks do not include in the model. However, that postulate to have a significant effect on the variation of estimated PIN.

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