Pecunia Monográfico 2011, pp. 33-45

A re-examination of the relationship between volatility, liquidity and trading activity

Khine Kyaw[1]
University of Plymouth (UK)
khine.kyawplymouh.ac.uk

David Hillier
University of Plymouth (UK)

Resumen

Este trabajo investiga si la relación entre actividad negociadora en el mercado de acciones, la liquidez del mercado y la volatilidad a nivel de cartera, es similar a dicha relación a nivel de acciones individuales. Para las carteras de empresas de mayor tamaño, la mayor actividad negociadora está relacionada con mayor liquidez y más volatilidad. Sin embargo, a pesar de que la relación volatilidad-liquidez es la misma para las carteras de acciones pequeñas, encontramos que la mayor actividad negociadora está negativamente asociada con la liquidez para esta agrupación. Este contraste en las relaciones está causado por las interrelaciones dinámicas entre las tres variables y una vez que se controla por esas interrelaciones, dicho contraste en los resultados desparece. Estos hallazgos contribuyen al debate sobre el comportamiento del mercado, que ha adquirido un renovado interés en los últimos años.

Palabras clave: Liquidez; Volatilidad; Actividad negociadora; Tamaño de la empresa; Negociación estratégica; Bolsa de Londres.

Abstract

We investigate whether the relationship between equity trading activity, market liquidity and return volatility at the portfolio level is similar to the relationship at the individual security level. For the very largest firm-size portfolio, higher trading activity is positively associated with greater liquidity and more volatile returns. However, despite the volatility-liquidity relationship being the same for smaller equity portfolios, we find that higher trading activity is negatively associated with liquidity for this grouping. These contrasting relationships are shown to be caused by the interdynamics between all three variables and once we control for these interrelationships, the contrasting results

[1] The authors are from the University of Plymouth and the University of Strathclyde, respectively. Corresponding Author: Khine Kyaw, Plymouth Business School, University of Plymouth, Hampton Street, Plymouth PL4 8AA, UK; E-mail address khine.kyaw@plymouth.ac.uk. All errors are our responsibility.

disappear. The findings contribute to the debate on market behaviour that has taken on renewed vigour in recent years.

Keywords: Liquidity, Volatility, Trading activity, Firm size, Strategic trading, LSE.

1. INTRODUCTION

Since the global financial crisis of 2008, a broader understanding of the dynamics of market liquidity has become one of the most urgent priorities facing regulators in developed economies. Market microstructure theories predict a negative relationship between security liquidity and volatility. However, although this relationship is evident for individual securities, at a portfolio level the picture is not so clear (eg. Huberman and Halka, 2001; Pastor and Stambaugh, 2003).

Most theoretical research places asset risk as the main determinant of liquidity in financial markets. In this paper, we empirically explore this linkage at the portfolio level to better understand how general market behaviour is framed by liquidity and volatility. A portfolio-level analysis is important in the context of the proliferation of broad index-based investment portfolios in existence today.

Inventory models of liquidity predict a negative relation between asset volatility and liquidity (Stoll, 1978 a,b; Amihud and Mendelson, 1980; Ho and Stoll, 1981, 1983; Copeland and Galai, 1983; and Foster and Viswanathan, 1990). However, information-based models of liquidity predict that the relationship between liquidity and volatility can be either positive or negative. Admati and Pfleiderer (1988), and Barclay and Warner (1993) show that informed stealth trading amidst a larger group of uninformed liquidity traders can lead to a positive relationship between volatility and liquidity. On the other hand, Foster and Viswanathan (1990) suggest that specialists' knowledge of the presence of informed traders can result in a negative relationship between volatility and liquidity.

Empirical evidence is similarly mixed. Tinic (1972), Stoll (1978b, 2000), and Menyah and Paudyal (1996), all report a positive relationship between volatility and liquidity. Pastor and Stambaugh (2003) find that the empirical correlation between aggregate liquidity and market volatility is negative, and Chordia et al. (2001) document a positive relation between aggregate volatility and liquidity.

This paper makes several new and unique contributions to the literature. First, while most research focuses on the security-level liquidity-volatility relationship, we consider the relationship on a portfolio basis. Second, we look at how market volatility impacts upon liquidity. Third, we acknowledge the limiting issues of multicollinearity among market variables and employ an augmented econometric model with activity-adjusted volatility variables to circumvent this issue.

In addition to exploring the aggregate liquidity-volatility relation, we also investigate the influential factors that may accentuate the role of volatility on market liquidity. Trading volume is one such factor that can influence the volatility-liquidity relation. Barclay and Warner (1993), Jones et al. (1994), Huang and Masulis (2003), and Darrat et al. (2003) show that trading volume covaries with volatility at the firm level. In addition, trading volume is regarded as one of the more influential determinants of a security's bid-ask spread (Stoll, 1978b, 2000; Menyah and Paudyal, 1996; and Wu, 2004).

Subrahmanyam (1991), Foster and Viswanathan (1990), and Nelling and Goldstein (1999) show that competition among market makers, volume of liquidity motivated transactions, and the quality of public information a firm disseminates are also important determinants of spread. Those determinants are proxied to a large extent by the size of the firm. Thus, the study also investigates the role of firm size on the liquidity-volatility relationship.

We find that for large company equities on the London Stock Exchange, an increase in trading activity is closely associated with an improvement in liquidity, as well as an increase in volatility. However, for smaller equities, an increase in trading activity leads to a deterioration in market liquidity with increased volatility. Thus, our results suggest a positive volatility-liquidity relation for large firms and a negative volatility-liquidity relation for small firms. Nevertheless, the volatility-liquidity relation clearly becomes positive for all firm sizes when we control for the level of trading activity.

The data and methodology are explained in the next section and the results are presented in section 3. Section 4 concludes.

2. DATA AND METHODOLOGY

The data employed in the study are the daily proportional bid-ask spread, realized volatility, number of transactions and trading volume of all firms listed on the London Stock Exchange from 21 December, 1993 to 31 July, 2003.

The proportional bid-ask spread (*PBAS*) is used to proxy the market-wide illiquidity/trading cost, while the number of transactions (*NT*) and trading volume (*VO*) are used as measures of trading activity. The aggregate liquidity and trading activity variables are constructed by taking the weighted average of the variables across companies using each company's daily market capitalisation as the weight. The market volatility variable, *STDEV*, is calculated as the standard deviation of daily return index over a 30-calendar-day period (equivalent of the 22 trading days).

This study employs the total risk measure instead of the systematic and/or residual risk. In the literature, there is a debate on which risk measure is a more appropriate measure. Benston and Hagerman (1974) argue that only the residual (unsystematic) risk should be considered. However, Stoll (1978b) argues that the market-making process makes dealers unable to maintain either diversified portfolios or the ones suitable for their risk-return preferences. Therefore, it should be the total (both systematic and residual) risk that matters rather than the residual risk alone. The empirical evidence by Stoll (1978b) and Menyah and Paudyal (1996) from the US and the UK, respectively, strongly supports the importance of total risk in the spread-setting behaviour of dealers.

Our regression model is estimated using Hansen's (1982) Generalized Method of Moments (GMM) technique with the Newy and West (1987) correction for serial correlation. GMM estimates are robust to the presence of autocorrelation and heteroscedasticity, both of which one would expect to find in this type of data. Since the system is just identified, the GMM coefficient estimates are identical to those from OLS, although their standard errors are different.

3. RESULTS

3.1. Preliminary analysis

The analysis consists of four main variables: proportional bid-ask spread (*PBAS*), the daily return standard deviation (*STDEV*), the number of trades (*NT*), and the sterling denominated trading volume (*VO*). From Table 1, the variables take on the expected signs and values. Panel B of Table 1 presents the correlation matrix of the four variables. It is clear that the interrelationships are strong. Liquid securities have lower bid ask spreads and volatility (daily standard deviation) is increasing in the level of liquidity.

Since our econometric methodology utilises Generalised Method of Moments (GMM), we test to see if our variables meet the assumptions required for GMM estimation. The most important assumption is that the variables are stationary. For this purpose, we carry out the Augmented Dickey Fuller unit root test (Table 1, Panel C) and the null hypotheses of a unit root is rejected for all four variables at the conventional 5 percent significance level.

3.2. The relationship between trading activity and liquidity

Table 2 reports the results from regressing *PBAS* on trading activity variables. Panel A shows the results for trading activity as measured by the number of trades, while panel B shows the estimation results for trading volume as a measure of trading activity. The activity-liquidity results are also segregated into four different groups to show the effect of firm size on the relationship. The groups are (1) top-100 companies (with largest market value), (2) the next top-250 companies, (3) companies with market value larger than £30 million, and (4) companies with market value of less than £30 million. The companies are segregated based on their beginning-of-year market capitalisation.

The striking result is that the relationship between liquidity (*PBAS*) and trading activity (*NT* and *VO*) is opposite in sign for large and small firms. For the large market value portfolio, the relationship between trading activity and liquidity is positive (lower proportional bid-ask spread implies greater liquidity), whereas it is negative for the small size portfolio. Furthermore, trading activity, whether it is measured by the number of transactions or by trading volume, exhibits a similar relationship across large and small size equity portfolio.

3.3. The relationship between trading activity and volatility

We now consider the relationship between trading activity (as proxied by the number of trades and trading volume) and volatility (the standard deviation of daily returns). All the coefficients of trading activity variables, both *NT* and *VO* in both tables, exhibit positive signs as expected, and they are statistically significant. The results in Table 3 show that an increase in trading leads to a more volatile market, as expected, and the effect is observed across different firm sizes. Thus, our results suggest that information is released through trading, consistent with information-based theories and Barclay and Warner's (1993) stealth trading hypothesis.

Our results also support Jones et al. (1994) in that both measures of trading activity (i.e., number of transactions and trading volume) have similar information content.

3.4. The relationship between volatility and liquidity

In the empirical literature, it is shown that price, trading activity, and volatility are major factors that affect liquidity (Demsetz, 1968; Tinic, 1972; Stoll, 1978b, 2000; Menyah and Paudyal, 1996). In an attempt to understand whether these relationships apply across different sized companies, the companies are ranked into four size categories as before. For each size grouping, the weighted average *PBAS* and *STDEV* series are constructed, and we carry out the analysis at the portfolio level. Our results are reported alongside whole sample estimation results in Table 4.

The column for all companies shows that volatility tends to have a negative relation to liquidity, as indicated by the statistically insignificant *STDEV* coefficient. However, across groups, although the relation is significantly negative for the largest firm-size portfolio, it is not characteristic of other companies. Moreover, the effect of volatility on spread increases for smaller companies except for smallest size category.

A similar finding for the New York Stock Exchange is documented by Chordia et al. (2001) who find that higher volatility is associated with a lower spread and trading activity. The study also finds that the negative spread-volatility relation is observed for both value-weighted indexes and equal-weighted indexes. Nevertheless, although a similar negative relation is observed for the largest group of companies, it is not a common characteristic of the UK companies, as indicated by the segregated results in Table 4.

3.5. The effect of trading activity on liquidity-volatility relation

We now control for the effect of trading activity on the liquidity-volume relationship. To do this, we standardise volatility by the level of trading activity (number of trades and trading volume), thus removing the impact of this control variable. The results are provided in Table 5.

A comparison of the results in Table 5 with Table 4 shows the relationship to be positive for all firm size portfolios. Thus trading activity has a direct impact on the relationship between liquidity and volatility. The results, therefore, provide strong evidence that once we control for trading activity, liquidity is positively related to volatility. This is consistent with information theories of asset pricing dynamics.

4. CONCLUSIONS

Market microstructure theories predict a negative relation between an asset's liquidity and volatility, and a variety of empirical evidence on individual stock data confirms this relation. However, existing empirical evidence on aggregate data suggests otherwise. This study, therefore, analyses the relationship between liquidity and volatility on at the portfolio level. In addition, the study also attempts to uncover factors that can influence the relation, in particular, trading activity and the firm size.

The study finds that for the largest equities on the London Stock Exchange, an increase in trading activity is highly associated with an improvement in liquidity as well as an increase in volatility. However, for smaller stock portfolios, higher trading activity is associated with lower liquidity as well as an increase in volatility.

Nevertheless, the volatility-liquidity relationship clearly becomes negative for all groups of firms when trading activity is incorporated into the analysis. This suggests that the positive aggregate volatility-liquidity relation, as documented by Chordia et al. (2001), may be due to the confounding effect of trading activity in the analysis.

To conclude, it should be emphasized that this research is exploratory and subject to a number of significant limitations. Future research should consider the liquidity-volatility relationship during a period of market stress such as the recent financial crisis to ascertain whether the dynamics documented in this paper remained constant during a period of stress. In addition, the econometric methodology could be developed further to simultaneously model the relationship between liquidity, volatility and trading activity.

5. REFERENCES

Admati, A.R. and Pfleiderer, P. (1988). "A theory of intraday patterns: Volume and price variability", *The Review of Financial Studies*, 1 (1), pp. 3-40.

Amihud, Y. and Mendelson, H. (1980). "Dealership market: Market-making with inventory", *Journal of Financial Economics*, 8, pp. 31-53.

Barclay, M.J. and Warner, J.B. (1993). “Stealth trading and volatility: Which trades move prices?”, *Journal of Financial Economics*, 34, pp. 281-305.

Benston, G.J. and Hagerman, R.L. (1974). “Determinants of bid-asked spreads in the over-the-counter market”, *Journal of Financial Economics,* 1 (December), pp. 353-364.

Chordia, T.; Roll, R. and Subrahmanyam, A. (2001). “Market liquidity and trading activity”, *Journal of Finance*, LVI (2), pp. 501-530.

Copeland, T.E. and Galai, D. (1983). “Information effects on the bid-ask spread”, *The Journal of Finance*, 38 (5), pp. 1457-1469.

Darrat, A.F.; Rahman, S. and Zhong, M. (2003). “Intraday trading volume and return volatility of the DJIA stocks: A note”, *Journal of Banking and Finance*, 27, pp. 2035-2043.

Demsetz, H.F. (1968). “The cost of transacting”, *Quarterly Journal of Economics*, February, pp. 33-53.

Foster, F.D. and Viswanathan, S. (1990). “A theory of the interday variations in volume, variance and trading costs in securities markets”, *The Review of Financial Studies*, 3 (4), pp. 593-624.

Hansen, L.P. (1982). "Large sample properties of generalised method of moments estimators", *Econometrica*, 50, pp. 1029-1054.

Ho, T. and Stoll, H.R. (1981). “Optimal dealer pricing under transactions and return uncertainty”, *Journal of Financial Economics*, 9, pp. 47-73.

Ho, T. and Stoll, H.R. (1983). “The dynamics of dealer markets under competition”, *Journal of Finance*, 38, pp. 1053-1074.

Huang, R.D. and Masulis, R.W. (2003). “Trading activity and stock price volatility: Evidence from the London stock exchange”, *Journal of Empirical Finance*, 10, pp. 249-269.

Huberman, G. and Halka, D. (2001). “Systematic liquidity”, *Journal of Financial Research*, XXIV (2), pp. 161-178.

Jones, C.M.; Kaul, G. and Lipson, M.L. (1994). “Transactions, volume, and volatility”, *The Review of Financial Studies*, 7 (4), pp. 631-651.

Menyah, K. and Paudyal, K. (1996). “The determinants and dynamics of bid-ask spreads on the London stock exchange”, *Journal of Financial Research*, XIX (3), pp. 377-394.

Menyah, K. and Paudyal, K. (2000). “The components of bid-ask spreads on the London stock exchange”, *Journal of Banking and Finance*, 24, pp. 1767-1785.

Nelling, E.F. and Goldstein, M.A. (1999). “Market making and trading in Nasdaq stocks”, *Financial Review*, 34, pp. 27–44.

Newey, W. and West, K. (1987). "A simple positive definite, heteroscedasticity and autocorrelation consistent covariance matrix", *Econometrica*, 55, pp. 703-705.

Pastor, L. and Stambaugh, R.F. (2003). "Liquidity risk and expected stock returns", *Journal of Political Economy,* 111 (June), pp. 642-685.

Stoll, H.R. (1978a). "The supply of dealer services in securities markets", *Journal of Finance*, XXXIII (4), pp. 1133-1151.

Stoll, H.R. (1978b). "The pricing of security dealer services: An empirical study of NASDAQ stocks", *Journal of Finance*, XXXIII (4), pp. 1153-1172.

Stoll, H.R. (2000). "Friction", *Journal of Finance*, LV (4), pp. 1479-1514.

Subrahmanyam, A.F. (1991). "Risk aversion, market liquidity, and price efficiency", *Review of Financial Studies*, 4 (3), pp. 417-441.

Tinic, S.M. (1972). "The economics of liquidity services", *Quarterly Journal of Economics*, February, pp. 79-93.

Wu, C.F. (2004). "Information flow, volatility and spreads of infrequently traded nasdaq stocks", *The Quarterly Review of Economics and Finance*, 44, pp. 20-43.

Table 1
Descriptions of the sample

PBAS is defined as the value weighted average of proportional spreads of the companies within the sample; *STDEV* is defined as the market volatility calculated as the standard deviation of value weighted average daily returns across companies; *NT* is defined as the value weighted average of the number of transactions across companies; and *VO* is defined as the value weighted average of trading volume of the companies within the sample.

Panel A: Descriptive statistics

	PBAS	STDEV	NT	VO
Mean	0.1745	0.0147	848.64	20707.40
Median	0.1725	0.0041	481.34	9074.57
Maximum	0.5383	0.7651	3691.40	164719.30
Minimum	0.0394	0.0000	2.83	1316.96
Std. Dev.	0.0350	0.0371	783.21	21209.65
Coefficient of variation	0.20	2.53	0.92	1.02
Skewness	2.58	8.87	1.08	1.54
Kurtosis	21.48	125.83	3.09	5.37

Panel B: Correlation between variables

Variable	PBAS	SDVOLA	NT	VO
PBAS	1	-0.0414	-0.3162	-0.2759
STDEV	-0.0414	1	0.6324	0.5399
NT	-0.3162	0.6324	1	0.9179
VO	-0.2759	0.5399	0.9179	1

Panel C: Unit root test results

		Critical value * (5% significance level)		
	ADF test-statistics	With intercept	With no intercept or trend	With intercept and trend
PBAS	-10.40 **	-2.8634	-1.94	-3.41
STDEV	-3.39 **	-2.8634	-1.94	-3.41
NT	-6.73 **	-2.8634	-1.94	-3.41
VO	-4.32 **	-2.8634	-1.94	-3.41

* MacKinnon critical values for rejection of null hypothesis of a unit root
** Statistically significant at 5% level

Table 2
Trading activity–Liquidity relation

The market liquidity variable, as measured by the proportional bid-ask spread (*PBAS*), is regressed on the trading activity variable. The sample consists of the 733 companies listed in the LSE from 22 December, 1993 through 31 July, 2003 for a total of 2142 trading days. Market liquidity variable is measured as a market capitalisation weighted average of individual liquidity across companies, while the trading activity is measured as daily market capitalisation weighted average of either the number of transactions (*NT*) or trading volume (*VO*). The regression takes the following form.

$$PBASt = a0 + a1ACTIVITYt + et$$

where *ACTIVITY* indicates natural logarithm of either the number of transactions (*NT*) or the trading volume (*VO*). The equation is estimated by the GMM estimation method and the standard errors are adjusted according to the Newy and West (1987) adjustments for serial correlation and/or heteroscedasticity. The test-statistics are reported below their respective coefficient values.

Panel A: Trading activity as measured by number of transactions

	All Companies	**Portfolios**			
		Top 100	**Top 250**	**Small-cap**	**Micro**
Constant	0.25041 31.95	0.00835 26.84	0.00930 13.70	0.03305 43.75	0.06690 38.76
NT	-0.01207 -9.16	-0.00050 -9.74	0.00291 13.80	0.00302 7.14	0.00314 2.74
R^2	0.1149	0.1123	0.2122	0.0386	0.0209

Panel B: Trading activity as measured by trading volume

	All Companies	**Portfolios**			
		Top 100	**Top 250**	**Small-cap**	**Micro**
Constant	0.29180 19.55	0.01021 16.65	0.00857 3.14	0.02275 6.73	0.05853 9.14
VO	-0.01239 -7.73	-0.00053 -8.14	0.00415 10.03	0.00313 4.56	0.00285 1.97
R^2	0.1116	0.1169	0.1048	0.0076	0.0095

Table 3
Trading activity-Volatility relation

The market volatility variable, as measured by the daily return standard deviation (*STDEV*), is regressed on the trading activity variable as measured either by the number of transactions (*NT*) or trading volume (*VO*). Market-wide variable is calculated as the market capitalisation weighted average of individual variable across companies. The sample consists of the 733 companies listed in the LSE from 22 December, 1993 through 31 July, 2003 for a total of 2142 trading days. The regression takes the following form.

$$STDEVt = a0 + a1ACTIVITYt + et$$

where *ACTIVITY* indicates either natural logarithm of the number of transactions (*NT*) or natural logarithm of the trading volume (*VO*).The equation is estimated by the GMM estimation method and the standard errors are adjusted according to the Newy and West (1987) adjustments for serial correlation and/or heteroscedasticity. The test-statistics are reported below their respective coefficient values.

Panel A: Trading activity as measured by the number of transactions

	All Companies	Portfolios			
		Top 100	**Top 250**	**Small-cap**	**Micro**
Constant	0.01032 6.77	2.57322 6.72	0.14700 0.71	1.35582 8.57	2.75584 7.06
NT	0.00305 11.61	0.76871 11.82	0.51814 7.21	0.22898 2.29	-0.19282 -0.97
R^2	0.3795	0.3486	0.164	0.0256	0.003

Panel B: Trading activity as measured by the trading volume

	All Companies	Portfolios			
		Top 100	**Top 250**	**Small-cap**	**Micro**
Constant	0.01960 7.34	4.65035 6.82	2.72038 3.51	0.60569 0.89	4.39332 4.46
VO	0.00301 10.18	0.73086 9.81	0.64679 5.38	0.48106 3.34	-0.42266 -2.21
R^2	0.32	0.2746	0.0769	0.0209	0.0075

Table 4
Volatility-Liquidity relation

The market liquidity variable, as measured by the proportional bid-ask spread (*PBAS*), is regressed on the market volatility variable (*STDEV*). The sample consists of the 733 companies listed on the LSE from 22 December, 1993 through 31 July, 2003 for a total of 2142 trading days. Market liquidity is measured as a market capitalisation weighted average of individual liquidity across companies. Market volatility is measured standard deviation of daily weighted return index. The regression takes the following form.

PBASt = a0 + a1STDEVt + et

The equation is estimated by the GMM estimation method and the standard errors are adjusted according to the Newy and West (1987) adjustments for serial correlation and/or heteroscedasticity. The test-statistics are reported below their respective coefficient values.

	All Companies	Portfolios			
		Top 100	Top 250	Small-cap	Micro
Constant	0.1778 56.51	0.0055 46.74	0.0161 55.64	0.0344 41.20	0.0691 61.67
STDEV	-0.3718 -1.03	-0.0002 -3.34	0.0017 8.28	0.0020 4.42	0.0010 2.80
R^2	0.0165	0.1942	0.1251	0.0371	0.0391

Table 5
Volatility-Liquidity relation without trading activity effect

In order to study the relation between risk and liquidity, the influence of trading activity is controlled by standardising the volatility measure with trading activity variable to yield volatility per unit of trading activity. The daily trading volume index is first calculated as the weighted average of individual company trading volume using each company's daily market capitalisation as the respective weights. The volatility as measured by the standard deviation of daily return index (*STDEV*) is then divided by the daily trading volume index. The market liquidity variable as measured by the proportional bid-ask spread (*PBAS*) is then regressed on the *VO*- or *NT*- adjusted market volatility variable (*ADJ-STDEV*). The sample consists of the 733 companies listed in the LSE from 22 December, 1993 through 31 July, 2003 for a total of 2142 trading days.

PBASt = a0 + a1ADJ-STDEVt + et

The equation is estimated by the GMM estimation method and the standard errors are adjusted according to the Newy and West (1987) adjustments for serial correlation and/or heteroscedasticity. The test-statistics are reported below their respective coefficient values

Panel A: Volatility variable adjusted by number of transactions

	All Companies	Portfolios			
		Top 100	Top 250	Mid-cap	Micro
Constant	0.1525 36.39	0.0044 30.01	0.0046 31.71	0.0047 37.99	0.0051 70.12
ADJ-STDEV	1.0882 8.27	1.5078 8.52	1.7591 4.73	1.1406 5.94	0.0955 3.22
R^2	0.0320	0.0378	0.0110	0.0076	0.0081

Panel B: Volatility variable adjusted by trading volume

	All Companies	Portfolios			
		Top 100	Top 250	Mid-cap	Micro
Constant	0.1512 50.55	0.0050 69.41	0.0046 36.52	0.0047 46.70	0.0051 71.51
ADJ-STDEV	2.9445 9.29	2.3192 4.19	4.4232 4.37	2.7828 5.46	0.2813 2.88
R^2	0.0187	0.0852	0.0122	0.0089	0.0149