EQUILIBRIUM
Quarterly Journal of Economics and Economic Policy
2017 VOLUME 12 ISSUE 2, June
p-ISSN 1689-765X, e-ISSN 2353-3293
www.economic-policy.pl

ORIGINAL PAPER

Citation: Gniadkowska-Szymańska, A. (2017). The Multifactorial Pastor-Stambaugh model: explaining the impact of liquidity on the rate of return based on the example of the Warsaw Stock Exchange. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *12*(2), 211–228. doi: 10.24136/eq.v12i2.11

Contact: agata.gniadkowska@uni.lodz.pl, University of Lodz, Faculty of Economics and Sociology, Department of Economics of Industry and Capital Markets, ul. POW 3/5, 90-255 Łódź, Poland
Received: 13 December 2016; Revised: 14 April 2017; Accepted: 19 May 2017

Agata Gniadkowska-Szymańska
University of Lodz, Poland

The Multifactorial Pastor-Stambaugh model: explaining the impact of liquidity on the rate of return based on the example of the Warsaw Stock Exchange

JEL Classification: *G12; G13; G14*

Keywords: *liquidity; the Pastor-Stambaugh model; illiquidity premium*

Abstract
Research background: The liquidity of assets in the financial market is understood generally as costs, and the easiest way in which different types of assets can be converted into cash, or to put it simply, sold at the currently available price on the market. For a considerable period of time this category had not been duly considered in the framework of modern finance theory. As a result, a number of basic models constructed within the framework of this theory in its classical form did not include problems with liquidity. This applies to a number of aspects related to liquidity, with one of the most important being the relationship between the liquidity of trading in shares and the results obtained from these rates of return.
Purpose of the article: The aim of the article is to determine whether the rate of return on shares increases with the increase in share liquidity and the incremental rate of return on this account decreases with increasing liquidity. The applied research methodology is similar to that described by Pastor and Stambaugh (2003). The model used in the empirical study is the expanded model of Fama and Francha (1993) for the liquidity factor.
Methods: In this paper I present various factors which will affect the liquidity. The paper will also provide the results of research concerning the relations between spread and stock return on the Warsaw Stock Exchange (WSE). The evidence drawn from WSE stock returns

over the period 2004–2012 indicates that Amihuda measure and other variables have a significant effect on stock return using the multifactorial Pastor-Stambaugh model.
Findings & Value added: In the case of the Polish market, it can be stated that in the analysis based on the Pastor-Stambaugh model not all the variables included in this model are statistically significant. However, directional parameters associated with liquidity risk were statistically significant in all analyzed periods, which allows us to confirm the hypothesis that liquidity has a significant influence on the rate of return on shares listed on the Stock Exchange in Warsaw.

Introduction

The liquidity of assets in the capital market is understood by investors as the ease with which a particular type of asset can be converted into cash, or put simply, sold. A high liquidity market is a very desirable feature of any market. On the other hand, low liquidity means that investors will demand a premium for liquidity risk, i.e. taking into account the potential inability to sell large blocks of shares at the price the market may offer for small packages. Managers of investment portfolios offset this inability by diversifying the investments included in a portfolio in terms of the liquidity preference and the time horizon of the client. However, despite the obvious importance of liquidity in investment decision-making, it has not yet found a suitable place in the theory of finance. Even the Capital Asset Pricing Model (CAPM) does not pay sufficient attention to the effects of the liquidity of assets and the time for which the investments are concluded. The situation has changed since the mid-1980s, when formal attempts were made to analyze the issue of liquidity in the financial market. Particularly important in this respect is the work by Amihud and Mendelson (1986b), who in both theoretical and empirical studies demonstrated the relationship between the rate of return on shares and liquidity, measured by the spread on the US market. Subsequent studies confirmed the thesis that liquidity has a significant impact on stock prices and their rate of return (see: Shannon *et al.*, 2000; Chordia, *et al.*, 2000, pp. 3–32; Daters *et al*., 1998, pp. 203–219; Chan & Faff, 2005, pp. 429–458; Acharyal & Pedersen, 2005, pp. 375–410). As a result, the problem of liquidity began to be included in the financial models, such as the Capital Asset Pricing Model (CAPM), for which versions were originated to take into account the effects of liquidity (see: Bodie *et al.*, 2002). There is now sample evidence that liquidity affects the profits of assets, but the liquidity of assets is difficult to define and measure. While the generally accepted definition of liquidity is 'the possibility of trading the assets in large amounts without affecting the price,' a serious debate remains aboutthe precise definition and the role of liquidity. Acharya and Pedersen (2005) described the effect of liquidity both as

a feature (return on investment depends on the level of liquidity) and as a risk factor. Using high-frequency data, Korajczyk and Sadka (2008) confirmed that both the liquidity risk and its level has an impact on the valuation of the shares.

Hence there are many measures of liquidity remaining, but the most popular is turnover. Studies using the effects of prices as a measure of liquidity were presented by, among others, Brennan and Subrahmanyan (1996), Bertsimas and Lo (1998), Amihud (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005) and Sadka (2006). Another measure used is the spread, which was employed in the first study originating from Amihud and Mendelson (1986b). Hasbrouck (2005) demonstrated a new way of estimating effective spreads. However, he found only a weak impact of liquidity on the stock price, and did not confirm the impact of the risk factor on the expected rate of return. The most popular measure of liquidity of assets is the one proposed by Amihud (2002). This measure is used in many of the latest empirical research on markets around the world (see: Acharya & Pedersen 2005, pp. 375–410; Bekaert *et al.*, 2007, pp. 1783–1831; Goyenko *et al*., 2009, pp. 153–181; Lischewski & Voronkova, 2012, pp. 8–25; Lesmond, 2005 pp. 411–452). The Amihud measure is determined from daily data, usually analyzed on a monthly basis, but the design model allows for the calculation of this measure using other intervals as well.

The lack of liquidity is defined as:

$$\mathrm{ILLIQ_{it}} = \frac{1}{\mathrm{D_{it}}} \frac{\sum_{t=1}^{\mathrm{D_{it}}} |\mathrm{R_{itd}}|}{\mathrm{DVOL_{itd}}} \tag{1}$$

where:
D_{it} is the number of days on which trading took place in a given week or month;
R_{itd} is the absolute value of daily returns audited action;
$DVOL_{itd}$ is the daily volume of transactions in zloty.

This indicator shows the daily influence of the size of orders on prices (Amihud, 2002, pp. 31–56). No measure is specified for days of zero turnover. The lack of liquidity factor takes the high (low) values for assets with low (high) liquidity. Unlike other measurements, this is expressed as an average daily rate of return per unit of monetary measure of trading (on the Polish market — at one thousand zlotys of trading) (Olbryś, 2013, pp. 65–77). While this indicator was used in its original form in the work of many researchers, nonetheless there have been frequent modifications, for example using the inverse of the index. However, as emphasized in his

Hasbrouck's works (Hasbrouck, 2005, pp. 3–52), indicator modifications often lead to a number of inaccuracies in the calculations. As can be seen, there are many measures defining the liquidity of trading in shares on the market, but not all of them accurately reflect the severity of the problem. Therefore, I modeled my measure on the research described by Pastor and Stambaugh (2003, pp. 642–685) for the analysis I carried out on the basis of data from the Warsaw Stock Exchange, used as a measure of the liquidity measures presented by Amihud (2002).

Research methodology

The aim of the study is to determine whether there is a statistically significant correlation between liquidity and the evolution of the rate of return. The applied research methodology is similar to the one described by Pastor and Stambaugh (2003, pp. 642–685). The model presented in the article is a development Fama and Franch model (Fama & French, 1993, pp. 3–56) by a factor of liquidity. This model is based on a neoclassical finance theory, but in a very innovative way, as these researchers approached the issue of return and its impact on the development of a variety of factors. In a very synthetic way, they have collected all the factors affecting the rate of return derived from market variables in this model. In this study, subject to market factors such as the size of the company, the P/BV ratio, the beta coefficient, stock liquidity and momentum — these factors are taken into account in the basic form of the model developed by the Pastor and Stambaugh (2003). Pastor and Stambaugh found that the earlier model presented by Fama and Franch (1993) which took into account four factors — i.e. the beta coefficient, the difference between the rates of return on equity portfolios created with companies with small and large capitalization (SML — small minus large); the difference between the rates of return on the equity portfolios of companies created with high and low rates of price to book value ratio (HML — high minus low); and the momentum factor, being the difference between the rate of return with diversified stock portfolios achieving the best and worst performances from the previous year — can better explain the formation of the rate of return on the shares if we consider it as a factor of liquidity.[1] However, this methodology must be modified to take into account the nature of emerging markets, such as the small number of listed

[1] Although the importance of the momentum factor is dependent on the inclusion in the model of variable liquidity. Pastor and Stambaugh leave open the question of the relationship between the two variables.

companies, short time series, occurrence of the problem of "thin trading" and the lack of easy access to information and market data. The original Pastor-Stambaugh model is based on the analysis of equity portfolios constructed according to the methodology proposed by Fama and MacBeth (1973). However, in the study presented in this section I encountered the problem of an insufficiently large number of portfolios and assets listed on the Stock Exchange in Warsaw. For these reasons, this section uses a methodology based on the individual rate of return based on a work critical of the portfolio approach (Litzenburger & Ramaswamy, 1979, pp.163–195; Shanken, 1992, pp. 1–33).

The measure of liquidity of individual shares for the Pastor and Stambaugh is $\gamma_{i,t}$ constructed as follows:

$$r^{e}_{i,d+1,t} = \theta_i + \Phi i * r_{i,d,t} + \gamma_{i,t} * sign(r^{e}_{i,d,t}) * \mathbf{V}_{i,d,t} + e_{i,d+1,v} \qquad (2)$$

where:
$r_{i,d,t}$ is the rate of return on shares and calculated for day *d* in month *t*,
$r^{e}_{i,d,t}$ is equal to the difference between r_{idt}, and r_{mdt} (return on market index for day *d* in month *t*),
$V_{i,d,t}$ is the value of the transaction volume for shares, calculated for day *d* in month *t*.

If the parameter γ_i, than a value less than zero it will represent a rate of return after the transaction. The measure of liquidity for the entire market is formed as an average measure of liquidity of individual stocks in a particular month. Regression cross occurs at this stage of the research in the following way: for a given month/quarter/year, the monthly/quarterly/annual rate of return is calculated for each of the 100 companies. This rate is explained by the following variables (values are also calculated for each month, quarter and year):

- The standard sensitivity (parameter regression-based time series) for the conversion of the WIG of the company — represented in the study by the classical beta factor;
- The size of the company expressed by capitalization;
- Price to book value ratio of the company;
- The measure of liquidity of shares of a company — represented in the study by a factor of lack of liquidity Amihud (2002);
- The momentum indicator for the company.[2]

[2] Momentum is one of the simplest technical analysis indicators for determining the state of the market (whether it is bought or sold out). Momentum is calculated by deducting from the price of the day(closing price) the price of the pre-k periods: $MOM=P_n-P_{n-k}$,

In the case of capitalization, the price to book value ratio, liquidity, and momentum applied logarithm includes, as suggested in the literature (Fama & French ,1993, pp. 3–56; Amihud & Mendelson, 1986b, pp. 43–48) a non-linear relationship between these variables and rates of return. This was done by estimating model parameters according to the following formula:

$$R_{it} = \gamma_{0t} + \gamma_{1t}\,\beta_{it} + \gamma_{2t}\log(ILLIQ)_{it} + \gamma_{3t}\log(CAP)_{it} + \gamma_{4t}\log(P/BV)_{it} + \gamma_{5t}\log(MOM)_{it} + \varepsilon_{it} \quad (3)$$

$$i=1,2,\ldots\ldots, N_t, \quad t=1,2,\ldots\ldots, T$$

where:
R_{it} is the rate of return on stocks in month *t*,
βit is a beta coefficient in month *t*,
$ILLIQ_{it}$ is an indicator of the lack of liquidity of the shares in month *t*,
C_{apit} is the size of the company measured by capitalization in month *t*,
P/BV_{it} is price to book value ratio of the company in month *t*,
MOM_{it} is an indicator of momentum stocks in month *t*,
ε_{it} is the rest of the equation.

Then, the beta coefficient for each share has been calculated according to formula (4).

Due to the use of the least squares method for calculating the beta coefficient, I also analyzed whether there is autocorrelation or heteroskedasticity counted coefficients. The results on the occurrence of heteroskedasticity and the estimated autocorrelation coefficients coincide with the results on the prevalence of these phenomena described in item 4.

Characteristics of the Polish stock market

Capital markets perform two basic functions: they provide an objective measurement of financial instruments and ensure the liquidity of the assets (O'Hara, 2003, pp. 1335–1354). In order to ensure good adherence to these two functions a proper structure and organization of trade on the market are required. These factors are very important in influencing the liquidity of assets in a given market (Harris, 2003, pp. 643–682). Especially important is the organization of trade on the market, because it has an impact on the entire process of transactions concluded by investors. Well-organized asset trading enabling the smooth conclusion of transactions is the basis of a liquid market. The Warsaw Stock Exchange ranks among the markets with autonomous guided orders (Olbryś, 2013, pp. 65–77). In such a market

they are mainly traders, and they mediate the transfer of orders from customers and market makers, whose main task is to improve the liquidity of individual financial instruments. Due to the activities performed, both brokers and animators have the possibility to use information in a superior way compared to other market participants, and information asymmetry is considered to be one of the main reasons causing a decrease in the liquidity of assets (O'Hara, 2003, pp. 1335–1354). Thus the Warsaw Stock Exchange — in order to meet the expectations of investors who wish to quickly settle their transactions and realize profits — introduced in 2013 a new trading system — UTP (Universal Trading Platform), which significantly changed the organization of trading on the Warsaw Stock Exchange. Compared with the previous system, the UTP is much faster, more efficient and has higher bandwidth, which in practice means the ability to support ten times more orders in a given unit of time. Such activities provide the opportunity to significantly increase market liquidity and volumes, lower transaction costs, and reduce the spread between the bid and ask prices of the financial instruments traded on the market. Confirmation of the previously transfused arguments relating to a well-functioning capital market in Poland, and the determinant of its further development, may be seen in Figures 1 and 2, which show statistics on the volume of trading in shares and block trades executed on the WSE.

As one can see, with the development of the Polish capital market there has been an increased volume of trading, both in terms of value of assets and the number of transactions. This is the key to a good and proper organization of the market, because it provides opportunities for investors to facilitate transactions and to achieve the expected return on their investments.

Data source and selection of the research sample

Gathering relevant data is a very important part of any research project. Thus, in order to obtain the most accurate and relevant data I took advantage of a number of databases, concerning both public institutions (e.g. The Warsaw Stock Exchange, NBP, GUS, PAP, Eurostat, World Bank) and private ones (e.g. Bloomberg, Reuters, Amadeus, Notoria). In each case the method used for calculating the selected data was analyzed and its quality carefully checked.

The study was conducted on a group of companies listed on the Warsaw Stock Exchange between the period 31.01.2000–31.12.2012. Companies that meet all of the following conditions were selected for the study:

- were listed on the Warsaw Stock Exchange in the period considered,
- belonged to WIG,
- their listing of shares took place on a continuous basis (until January 2013)
- the database Reuters contained a share price for the analyzed companies at the end of all 156 analyzed months.[3]

I was able to select 100 companies which met all the above-mentioned criteria. Data on spreads came from the official website of the Warsaw Stock Exchange, while price data came from the Reuters platform. Prices have been adjusted for capital changes of types such as changes in subscription rights, dividends, and splits. The study was carried out first based on the monthly data calculated with respect to the prices of the last day of each month, and then on quarterly data calculated based on the prices of the last day of each quarter, and then annual data calculated based on the prices of the last day of each year. As the rate of return on risk-free assets I selected Wibor.

Thus, for each share a beta coefficient has been calculated according to the formula:

$$R_i = \alpha_i + \beta_i * R_M \quad + u_i \tag{4}$$

The calculations of the beta coefficient were made using the method of least squares (OLS): the dependent variable was the surplus average monthly rate of return on the share,[4] and the surplus explanatory variable was the average rate of return on the WIG for 60 months (five years), which period included that year (T-4 to T, and T ε (2004, 2012)). As the rate of return on risk-free assets I selected Wibor (after conversion to the monthly data and annual data).

Due to the use of the least squares method for calculating the beta coefficient I tested whether there is an autocorrelation or heteroskedasticity. In most cases the Durbin-Watson test did not reject the hypothesis of the absence of autocorrelation. This hypothesis could be rejected only for 13% of all models. The nucleus of an estimate of a large number of regression[5]is difficult to correct for each of the equations so as to eliminate the problem

[3] Only eight companies were eliminated as a result of the last criterion.

[4] Surplus return is understood as the difference between the return on a given instrument and the rate of return on risk-free assets.

[5] This was carried out for about 15,300 estimates of the regression line.

of autocorrelation in 13% of all cases. It was therefore decided to leave the results unchanged, with the proviso that it may be a source of potential load test results. The White test (White, 1980, pp. 817–838) on the stability of the variance indicates that the hypothesis of constant variance of the random component can be rejected for 9.11% of the total equation — although they are not. This value is negligible,[6] but these are relatively small fraction of all performed regressions. The high number of constructed regression prevents adjusting each potential loaded equation, and because of the relatively small load on the tested sample estimates I decided to leave the results in the previously obtained form.

Table 1 shows the basic statistics of the data used in this study. Additionally, I checked the correlation between the variables used in the study. These results are shown in Table 2.

The results of the study

Based on the methodology described by Pastor and Stambaugh (2003) I first tested, according to formula (3), the relationship between the rate of return and systematically risk measured beta coefficient, the size of the company measured by capitalization, the price to book value ratio, an indicator of momentum and an indicator of a lack of liquidity (ILLIQ) for the collected data, thus obtaining the results described in Table 3. In the cases of capitalization, price to book value ratio, liquidity and momentum I included the applied logarithm suggested by the literature (Fama & French, 1993, pp. 3–56; Amihud & Mendelson, 1986b, pp. 43–48) for the nonlinear relationship between these variables and rates of return.

As shown in Table 3, the presented calculations performed on quarterly and annual data to estimate a parameter relating to liquidity is positive and statistically significant at the 0.05 level. Based on the calculations, it can be concluded that there is a link between the evolution of the rate of return and liquidity calculated on quarterly and annual data. In contrast, in the parameters described in Parts A and B of Table 3 the coefficient estimated for the beta coefficient and capitalization are not statistically significant. That is,

[6] Due to the large number of successful estimations of the regression line (about 15,300 estimates), the occurrences of which are physically difficult in these cases, potentially loaded estimates the occurrence heteroscedasticity or autocorrelation. However, as evidenced by other studies, for example the analysis carried out by Brzeszczyński *et al.* (2011) of samples potentially loaded estimates by the presence of heteroskedasticity or autocorrelation (sample for one of the year — for the year 2008) shows that these burdens are not a big error (from a few to several percent of the estimate) and may not significantly affect the conclusions of the study. However, they remain a potential source of load results.

the beta coefficient and capitalization do not affect the formation of the rate of return on stocks calculated on a quarterly and annual basis. It is therefore apparent that, at least in respect of analyzed the annual and quarterly periods, contrary to the predictions of basic models in the field of modern finance theory systematic risk measured by the beta coefficient did not play a significantly important role for the formation of the rate of return, a fact that at this point will not yield a detailed considerations since this is not a systematic risk analysis in the context of the capital asset pricing model or the model of Sharpe (1964). However, in the case of the price to book value ratio and an indicator of momentum, based on the calculations on quarterly and annual data, these variables are important in shaping the return on the shares of a company. The fit of the model estimated on quarterly data, the actual data as measured by the coefficient R^2 is 0.12; while the average error of regression (standard error of estimation) is 0.39. While the fit of the model estimated using annual data, the actual data as measured by the coefficient R^2 is 0.34; while the average error of regression (standard error of estimation) is 1.35.

The following sections of Table 3 (parts C to F) present the results of calculations made by applying formula (3) to monthly data, using all the data collected monthly and divided into sub-periods of boom and bust.

As is apparent from Table 3, Part C, the parameter estimation data relating to an indicator of a lack of liquidity (ILLIQ) is positive and statistically significant at the 0.05 level. Therefore there is no reason to reject the hypothesis that there is a relationship between the rate of return and liquidity expressed by an increase in the rate of return with increasing illiquidity. Other variables in the study, which include the beta coefficient, the momentum indicator, and the price to book value ratio do not affect the formation of the rate of return on the stock. Only the variable showing the size of a company measured as the logarithm of the capitalization is in this case statistically significant in influencing the formation rate of return on the stock.

The next stage of the study was to see whether liquidity has a significant impact on the formation of the rate of return in sub-periods of boom and bust. The results of these studies were also presented in Table 3 in sections D to F.

The date adopted as the beginning of the first period of boom on the Warsaw Stock Exchange was January 2004, and as the end of the bull market the date adopted was July 2007, when the WIG index reached its local maximum value and created the first maximum of the formation of a double top, promising to change the trend in share prices from growth to decline. For the given period of the bull market, I tested the relationship be-

tween the rate of return and systematically risk measured as the beta coefficient, size of the company measured by capitalization, the price to book value ratio, and an indicator of momentum and an indicator of a lack of liquidity (ILLIQ) for the data collected monthly, thus obtaining the results presented in Table 3, section D.

For the sub-period of the bull market, i.e. lasting from the beginning of 2004 until July 2007, the estimate of the parameter relating to liquidity is positive and statistically significant at the level of 0.1. Based on these calculations it can be concluded that there is a link between the evolution of the rate of return and liquidity in this sub-period. In contrast, the parameters estimated for the beta coefficient and capitalization are not statistically significant, i.e. the beta coefficient and capitalization did not affect the formation of the rate of return on stocks specified in bull market sub-period. However, in the case of the price to book value ratio and the momentum indicator, these variables are important in shaping the return on the shares of a company. Adapting the model to real data, measured by the coefficient R^2 is 0.14; while the average error of regression (standard error of estimation) is 0.21.

Another sub-period which was chosen for study was the period of a nearly two-year slump, which lasted from August 2007 until February 2009. For a given period at the beginning of a bear market I tested the relationship between the rate of return and systematic risk measured by a beta coefficient, the size of the company measured by market capitalization, the price to book value ratio, and the momentum indicator and an indicator of a lack of liquidity (ILLIQ) for the collected monthly data, as presented in Table 3, section E.

As shown above, for the sub-period of the bear market which began in August 2007 until February 2009 all parameter estimates are statistically significant at the 0.05 level. What is interesting for this period is that the parameter occurring at the variable determining illiquidity is negative, which suggests the growth of illiquidity accompanied by a decreased rate of return. Adapting the model to real data, measured by the coefficient R^2 is 0.079; while the average error of regression (standard error of estimation) is 0.14.

The last sub-period which was chosen for study was the period of the next bull market, lasting from March 2009 to the end of 2012. As demonstrated in Table 3, part F, for the sub-period of the next bull market the parameter estimates of liquidity, capitalization, and momentum indicators are statistically significant at the level of 0.4. The parameters evaluated for other variables, i.e. the beta coefficient and the price to book value ratio,

were not statistically significant, meaning they have no influence on the formation of the rate of return on the stock.

As can be easily seen, both boom sub-periods presented confirmed the hypothesis that there is a relationship between the rate of return and liquidity expressed by an increase in the rate of return with the increase in the illiquidity of shares. Additionally, for all boom sub-periods presented the parameters estimated for the beta coefficient is statistically insignificant, i.e. in these sub-periods analyzed the beta parameter does not affect the formation of the rate of return on the stock.

Conclusions

The study described by Pastor and Stambaugh (2003) first examined the relationship between the rate of return and systematic risk measured by the beta coefficient, the size of the company measured by capitalization, the price to book value ratio, an indicator of momentum and an indicator of a lack of liquidity (ILLIQ). The analysis was based on individual stocks, not on portfolios of shares. In the case of the Polish market, it can be stated that in the analysis based on the Pastor-Stambaugh model not all the variables included in the model are statistically significant. Directional parameters associated with the risk of change in the market index WIG are not statistically significant. It is therefore apparent, at least with respect to the analyzed period, that as foreseen by the basic models in the field of modern finance theory systematic risk measured by the beta coefficient did not play a significant role for the formation of the rate of return, a fact that at this point is not given detailed consideration, since a systematic risk analysis in the context of the capital asset pricing model or model of Sharpe (1964) is not the subject of interest. However, directional parameters associated with liquidity risk were statistically significant in all analyzed periods, which allows us to confirm the hypothesis that liquidity has a significant influence on the rate of return on shares listed on the Stock Exchange in Warsaw. In addition, the momentum indicator was likewise statistically significant in all analyzed periods, which means it affected the formation of the rate of return on shares in the Polish market.

References

Acharyal, V., & Pedersen, L. H. (2005). Asset pricing with liquidity risk. *Journal of Financial Economics, 77*(2). doi: 10.1016/j.jfineco.2004.06.007.

Amihud, Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets, 5*. doi: 10.1016/s1386-4181(01)00024-6.

Amihud, Y., & Mendelson, H. (1986a). Asset pricing and a bid-ask spread. *Journal of Financial Economics*, *17*. doi: 10.1016/0304-405x(86)90065-6.

Amihud, Y., & Mendelson, H. (1986b). Liquidity and stock returns. *Financial Analysts Journal*, *42*(3). doi: 10.2469/faj.v42.n3.43.

Amihud, Y., & Mendelson, H. (1989). The effects of beta, bid-ask spread, residual, risk and size on stock returns. *Journal of Finance, 44*. doi: 10.2307/2328600.

Bekaert, G., Harvey, C. R., & Lundblad, C. (2007). Liquidity and expected returns: lessons from emerging markets. *Review of Financial Studies*, *20*(6). doi: 10.1093/rfs/hhm030.3.

Bertsimas, D., & Lo, A. W. (1998). Optimal control of execution costs. *Journal of Financial Markets*, *1*(1). doi: 10.1016/s1386-4181(97)00012-8.

Bodie, Z., Kane, A., & Marcus, A. (2002). *Investments*. Irwin/McGraw-Hill.

Brennan, M. J., & Subrahmanyam, A. (1996). Market microstructure and asset pricing: on the compensation for illiquidity in stock returns. *Journal of Financial Economics, 41*. doi: 10.1016/0304-405x(95)00870-k.

Brzeszczyński, J., Gajdka, J., & Schabek, T. (2011). The role of stock size and trading intensity in the magnitude of the „interval effect" in beta estimation. Empirical evidence from the Polish capital market. *Emerging Markets Finance and Trade, 47*(1). doi: 10.2753/ree1540-496x470102.

Chan, H., & Faff, R. (2005). Asset pricing and illiquidity premium. *Financial Review*, *40*. doi: 10.1111/j.1540-6288.2005.00118.x.

Chan, L. K. C., & Lakonishok, J. (1995). The behavior of stock prices around institutional trades. *Journal of Finance*, *50*. doi: 10.2307/2329347.

Chang, Y. Y., Faff, R., & Hwang, C.-Y. (2010). Liquidity and stock returns in Japan: new evidence. *Pacific-Basin Finance Journal*, *18*(1). doi: 10.1016/j.pacfin.2009.09.001.

Cheng, L., Fung, H., & Leung, T. (2007). Information effects of dividends: evidence from the Hong Kong market. *Review of Quantitative Finance and Accounting*, *26*(1). doi: 10.1007/s11156-006-0002-y.

Chordia, T., Roll, R., & Subrahmanyam, A. (2000). Commonality and liquidity. *Journal of Financial Economics*, *56*(1). doi: 10.1016/s0304-405x(99)00057-4.

Dater, V., Naik, N., & Radcliffe, R. (1998). Liquidity and stock returns: an alternative test. *Journal of Financial Markets, 1*. doi: 10.1016/s1386-4181(97)00004-9.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*. doi: 10.1016/0304-405x(93)90023-5.

Fama, E. F., & French, K. R. (1996). Multifactor explanations of asset pricing anomalies. *Journal of Finance*, *51*(1). doi: 10.1111/j.1540-6261.1996 .tb05202.x.

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy*, *81*. doi: 10.1086/260061.

Fama, E. F., & French, K. R. (2001). Disappearing dividends: changing firm characteristics or lower propensity to pay?. *Journal of Financial Economics*, *60*. doi: 10.1016/s0304-405x(01)00038-1.

Goyenko, R. Y., Holden, C. W., & Trzcinka, C. A. (2009). Do liquidity measures measure liquidity?. *Journal of Financial Economics*, *92*(2). doi: 10.1016/j.jfineco.2008.06.002.

Hasbrouck, J. (2006). Trading costs and returns for US equities: estimating effective costs from daily data. *Working Paper, Stern School of Business, New York University*.

Korajczyk, R., & Sadka, R. (2008). Pricing the commonality across alternative measures of liquidity. *Journal of Financial Economics*, *87*(1). doi: 10.1016/j.jfineco.2006.12.003.

Lakonishok, J., & Shapiro, A. C. (1986). Systematic risk, total risk and size as determinants of stock market returns. *Journal of Banking & Finance*, *10*(1). doi: 10.1016/0378-4266(86)90023-3.

Lakonishok, J., Shleifer, A., & Vishny, R. (1994). Contrarian investment, extrapolation, and risk. *Journal of Finance*, *49* (5). doi: 10.1111/j.1540-6261.1994.tb04772.x.

Lesmond, D. A. (2005). Liquidity of emerging markets. *Journal of Financial Economics*, *77*(2). doi: 10.1016/j.jfineco.2004.01.005.

Lesmond, D. A., Ogden, J. P., & Trzcinka, C. A. (1999). A new estimate of transaction costs. *Review of Financial Studies, 12*(5). doi: 10.1093/rfs/12.5.1113.

Lischewski, J., & Voronkova, S. (2012). Size, value, and liquidity. Do they really matter on an emerging stock market?. *Emerging Markets Review*, *13*(1). doi: 10.1016/j.ememar.2011.09.002.

Litzenberger, R., & Ramaswamy, K. (1979). The effects of personal taxes and dividends on capital asset prices. *Journal of Financial Economics*, *7*(2). doi: 10.1016/0304-405x(79)90012-6.

Pastor, L., & Stambaugh, R. F. (2003). Liquidity risk and expected stock returns. *Journal of Political Economy*, *111* (3). doi: 10.1086/374184.

Sadka, R. (2006). Momentum and post-earnings announcement drift anomalies: The role of liquidity risk. *Journal of Financial Economics*, *80*, doi: 10.1016/j.jfineco.2005.04.005.

Shanken, J. (1992). On the estimation of beta-pricing models. *Review of Financial Studies*, *5*. doi: 10.1093/rfs/5.1.1.

Shannon, P., Reilly, R., & Schweihs, R. (2000). *Valuing a business: the analysis and appraisal of closely held companies*. McGraw-Hill Library of Investment and Finance.

Sharpe, W. (1964). Capital asset prices: a theory of market equilibrum under condition of risk. *Journal of Finance*, *19*. doi: 10.2307/2977928.

Vayanos, D. (2004). Flight to quality, flight to liquidity and the pricing of risk. *NBER Working Paper*, *10327*. doi: https://doi.org/10.3386/w10327.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, *48*(4). doi: 10.2307/1912934

www.gpw.pl (16.08.2012).

www.gpwinfostrefa.pl (11.12.2014).

www.knf.gov.pl (16.08.2012).

www.money.pl (11.12.2014).

Annex

Table 1. Basic statistics collected monthly data

	Rate of return	P/BV	Capitalization	Beta coefficient	ILLIQ	Momentum
Average	0.366	1.900	1955.638	1.029	0.000	1.349
Mediana	0.0651	1.2600	200.0000	1.0119	0.0000	0.1064
Minimum	-0.88	0.00	0.00	-0.57	0.00	-33.60
Maksimum	25.37	33.49	59444.00	3.78	0.00	173.74
The lowerquartile	-0.27625	0.66500	66.00000	0.70725	0.00000	-0.46367
The upperquartile	0.5135	2.2400	936.0000	1.3030	0.0000	1.0782
Variance	3	6	34315525	0	0	63
Standard deviation	1.662	2.457	5857.946	0.535	0.000	7.935
Coefficient of variation	454.586	129.292	299.541	52.041	314.015	588.347
Kurtosis	123.5926	47.4489	30.0957	2.3373	155.0596	271.8902

Table 2. Correlation between the variables calculated monthly data

	Rate of return	P/BV	Capitalization	Beta coefficient	ILLIQ	Momentum
Rate of return	1.000000	0.497626	-0.005844	-0.124701	0.205349	0.546181
P/BV		1.000000	0.070671	-0.080159	0.052688	0.340323
Capitalization			1.000000	0.022646	-0.068417	-0.015463
Beta coefficient				1.000000	-0.160388	-0.008892
ILLIQ					1.000000	0.093093
Momentum						1.000000

Table 3. Estimate model parameters and corresponding values of p-value and statistics t-student

	Estimators	*Statistics t-student*	*p-value*
	ANNUAL DATA		
	A		
free term	1.239114661	3.579662317	0.00036
beta coefficient	-0.085232326	-0.92841588	0.35344
log(ILLIQ)	0.099538642	2.303295615	0.02149
log(P/BV)	1.161961332	7.342682046	0.00000

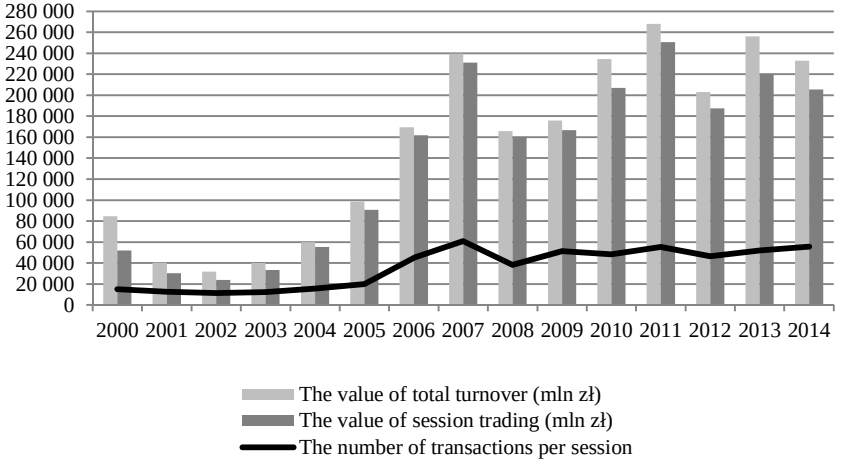
Table 3. Continued

	Estimators	*Statistics t-student*	*p-value*
ANNUAL DATA			
A			
ln(Cap)	-0.016201789	-0.27045905	0.78687
log(MOM)	1.255399334	12.06101242	0.00000
QUARTERLY DATA			
B			
free term	0.191214602	4.351643398	0.00001
beta coefficient	0.02068139	1.586857567	0.11263
log(ILLIQ)	0.023169572	4.468072093	0.00001
log(P/BV)	0.248971842	12.25840459	0.00000
ln(Cap)	-0.00344999	-0.41380989	0.67904
log(MOM)	0.063320108	4.895868264	0.00000
MONTHLY DATA			
C			
free term	3.304635625	3.506133956	0.000457
beta coefficient	-0.050587306	-0.15946699	0.873304
log(ILLIQ)	0.385984196	3.599290134	0.000321
log(P/BV)	0.119087996	0.230207826	0.817935
ln(Cap)	0.351563744	1.696092541	0.089897
log(MOM)	0.29323416	1.028565	0.303707
Bull Market (January 2004 - July 2007)			
D			
free term	0.055054175	2.897693919	0.00378
beta coefficient	0.001164259	0.194202005	0.84603
log(ILLIQ)	0.003516099	1.650855936	0.09884
log(P/BV)	0.062279209	5.731113437	0.00000
ln(Cap)	-0.004351366	-1.05565611	0.29118
log(MOM)	0.113587268	22.50014777	0.00000
Bear Market (August 2007 - February 2009)			
E			
free term	-0.125973316	-5.59659266	0.00000
beta coefficient	-0.021059736	-3.20929529	0.00135
log(ILLIQ)	-0.01322654	-4.27379809	0.00002
log(P/BV)	0.067729621	7.335335177	0.00000

Table 3. Continued

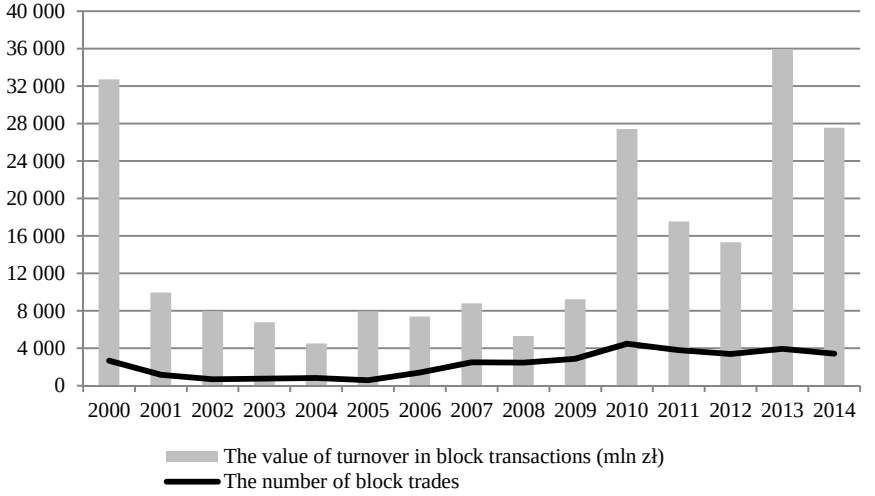
	Estimators	*Statistics t-student*	*p-value*
Bear Market (August 2007 - February 2009)			
	E		
ln(Cap)	-0.010483412	-2.21445653	0.02692
log(MOM)	-0.082046933	-7.01696624	0.00000
Bull Market (March 2009 - December 2012)			
	F		
free term	5.454974429	2.674046563	0.007521
beta coefficient	-0.340238668	-0.39110056	0.695741
log(ILLIQ)	0.838363059	3.500907139	0.000468
log(P/BV)	0.164813056	0.127076387	0.898885
ln(Cap)	0.890083693	1.773724586	0.076175
log(MOM)	0.705277288	1.000587358	0.317079

Figure 1. The value of trading in securities on the Stock Exchange



Source: own study based on statistics retrieved form http://www.gpw.pl/analizy_i_staty styki.

Figure 2. The value of turnover in block transactions on the Warsaw Stock Exchange



Source: own study based on statistics retrieved form http://www.gpw.pl/analizy_i_staty styki.