STOCK MARKET LIQUIDITY: COMPARATIVE ANALYSIS OF CROATIAN AND REGIONAL MARKETS

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Abstract

On the Croatian stock market liquidity has never been in the focus of academic research. thus we find it necessary to observe liquidity at the aggregate level. This paper observes multi-dimensional liquidity through the impact of turnover on price change together with several one-dimensional measures. In our empirical research we applythe illiquidity measureto seven different stock markets. We focus on the Croatian stock market as compared to other markets in the Central and Eastern Europe and German market. The results of the research indicate a substantial level of illiquidity in the Croatian and other developing markets.

Key words: liquidity, stock market, Croatia, developing stock markets, Amihud's illiquidity ratio, liquidity measures.

1 Introduction

Liquidity has always been in at the focus of interest of financial market participants; however it has become the subject of academic research only in the past few years. One of the reasons firs such a lack of interest in this matter can be explained by the complexity of liquidity. The authors are faced with a challenge of which measure to use and how

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to use it to measure liquidity. Due to its multi-dimensional characteristics there is no single measure that can capture all aspects of liquidity. Available research papers on liquidity are mainly focused on developed markets, hence we focus on Croatian and Central and Eastern European markets. We try to determine the level of liquidity on the Croatian stock market and compare it with other markets in the region and then compare those results with the German market in order to perceive differences between developing and developed markets.

Price volatility together with low levels of turnover on stock marketsindicates illiquidity, and is a problem that we can perceive merely on the basis of the statistics of stock market trading. There is no research on stock market liquidity in Croatia or comparison with regional markets. This paper contributes to this field of research in terms of determining market liquidity with the introduction of a more complex liquidity measure together with other selected measures. The main advantage of this measure of liquidity is that it makes a comparison among markets possible; this measure is in correlation with more complex spread-related[1] measures; it is very precise due to the calculation being based on daily price and daily turnover changes and weighting of stocks in order to eliminate the influence of different number of shares that we use in our sample. With respect to these liquidity measures we will try to determine the levels of liquidity, analyse the results obtained from different measures and observe eventual discrepancy in results.

The Croatian stock market has been facing significant changes in the last two years. The merger of the Zagreb and Varaždin stock exchanges, technology improvements in terms of a new trading system, a more influential role for the regulatory agency and 7 successful IPOs[2] in 2007 indicate important and noteworthy improvements in the stock market development of one small and transitional economy. Despite such improvements, an obstacle to further development is still the relatively considerable market illiquidity. This is evident from the lack of stabile and high daily turnover, the presence of numerous illiquid stocks and the possibility of influencing the prices when executing large volume transactions. On the other hand, developed markets are characterised with high levels of liquidity that enables large transactions to occur with minimum price impact.

The paper is structured as follows. In the second part we define stock market liquidity. dimensions of liquidity and introduce liquidity measures which are suitable to address liquidity measurement. Part three, empirical research and results, introduces the methodology and measures of liquidity we use in this paper. We analyze results applied to the Croatian, Slovenian, Serbian, Bulgarian, Hungarian and Polish and to the German stock market, which latter in our comparison stands for a developed and liquid market. We apply Amihud's measure of illiquidity (*ILLIQ*) on a sample of stocks on each market. Even though this measure is in centre of our empirical research, we also apply additional measures of liquidity such as market index price change, turnover rate, and ratio of market index price change and turnover rate. Part four concludes.

[1] Spread is defined as the difference between the bid and the ask price of a security or asset.
[2] Initial public offer.

2 Definition of liquidity and its role on the market

It is very hard to measure and capture liquidity since there is no unique and widely accepted definition of liquidity.[3] It is noted in papers that encompass liquidity that liquidity represents the possibility of any form of asset to be transformed into an other form of asset in a short period without losing its value, i.e. change in price. Schmukler, Yeyati and Van Horen (2007) define a liquid market "as one where market participants can promptly execute large volume transaction without significant price impact".

Liquidity is a very significant issue for market participants when deciding which investments to take. Liquidity provides them with safety and diminishes the risk of losses if they want to execute large volume transactions as Schmukler et al. (2007) argue. Stahel (2004) argues that due to stock market integration, investors would tend to move their capital where they expect higher returns on their investments. The presence of stock market liberalisation and integration can be seen through the large increase in capital movements in the last 30 years. From a liquidity perspective, a less liquid market enables higher returns due to high price volatility, which also implies higher risk.

Market liquidity significantly varies over time, so unpredictability of liquidity is also important source of risk. Pastor and Stambaugh (2003) measure U.S. stock market liquidity by following the impact of volume traded and price change. In one of their earlier studies, Amihud and Mendelson (1986) measure the link between market liquidity and stock market returns. Chordia, Sarbar and Subrahmanyam (2002) find that volatility of aggregate liquidity in the U.S. affects bonds and stocks and that it is correlated with monetary policy. Bortolotti et al. (2004) argue that liquidity is the fundamental aspect of stock market development.

2.1 Characteristics of liquidity on financial markets

Fundamental assumptions of a liquid market are the existence of significant number of buyers and sellers at all times, the ability to execute the next transaction at the same price as the previous one and market capability to absorbe large transactions without significant price impacts. With respect to the fact that liquidity is a multi-dimensional phenomenon it is impossible to measure it with respect to only one dimension.

Von Wyss (2004) defines 4 aspects or dimensions of financial market liquidity:

- *Trading time:* defined as the ability to execute the transaction immediately at the prevailing price. The waiting time between trades is the measure for trading time.
- *Tightness:* the ability to buy and to sell an asset at about the same price at the same time. Hasbrouck (2003) argues that tightness shows the cost associated with transacting or the cost of immediacy. Measures for tightness are the different versions of spread.
- *Depth:* the ability to buy or to sell a certain amount of an asset without influence on the quoted price. A sign of illiquidity would be an adverse market impact on price

[3] See discussion Amihud and Mendelson (1991b).

when trading occurs. Depth is characterised with existence of large number of buy and sell orders with little changes in prices.

- *Resiliency:* the ability to buy or to sell a certain amount of an asset with little influence on the quoted price. While the aspect of market depth regards only the volume of best bid and best ask prices, resiliency takes the elasticity of supply and demand into account. Dong, Kempf and Yadav (2007) argue that resiliency measures how fast the prices will return to previous levels after have been changed under large volume transaction.

These dimensions of liquidity may be presented with five different levels of liquidity:

- *The ability to trade at all.* This first level of liquidity assumes if there is no liquidity, no trading can take place. In a liquid market there is at least one bid and one ask quote that makes a trade possible.
- *The ability to buy or to sell a certain amount of an asset with an influence on the quoted price.* If a trade is possible, the next issue concerns the price impact of trading. If the market is liquid, it is possible to trade with little impact on the quoted price.
- *The ability to buy or to sell a certain amount of an asset without any influence on the quoted price.* The more liquid a market becomes, the smaller is the impact on the prices. As liquidity increases the impact gets smaller. Eventually, a point will be reached where there is no more price impact for a certain amount of shares.
- *The ability to buy and to sell an asset at about the same price* at the same time.
- *The ability to execute a transaction from points 2 to 4 immediately.*

The following part of this paper introduces different liquidity measures that can be found in the literature on market liquidity. It should be pointed out that not all existing measures of liquidity are included in this overview, which nevertheless provides a good insight on how to approach the problem of measuring liquidity.

2.2 Liquidity measures

Von Wyss (2004) separates liquidity measures into one-dimensional and multi-dimensional measures. One-dimensional liquidity measures take only one variable into account, whereas multi-dimensional measures try to take into account different variables in one measure.

2.2.1 One-dimensional liquidity measures

One-dimensional measures may be divided into four groups: those that capture the size of the firm, the volume traded, the time between trades and the spread. Spread and measures related to spread will not be explained in detail due to the unavailability of the intraday data such measures require to be calculated, thus these measures are not included in this paper.

1) Size of the firm related liquidity measures

One of these measures is market capitalisation which represents the value of the firm with respect to current market price.

$$Mktcap_i = S_i \times P_i \tag{1}$$

Where $Mktcap_i$ is market capitalisation of the stock *i*, S_i is the number of outstanding shares minus treasury shares and P_i is the price of the stock *i*.

Furthermore, the total number of outstanding shares which we use to calculate market capitalisation is not equal to the number of shares that are in fact available to trade. Therefore, to measure the liquidity more precisely, the number of outstanding shares should be corrected for *free float*[4] rate, the number of shares actually available for trade.

2) Volume related liquidity measures

These measures may be calculated as a certain volume, or quantity of shares, per time unit. They are used to capture the depth dimension of liquidity. There is also a relation to the time dimension since higher volume leads to a shorter time needed for a certain amount of shares to be traded. The values of volume-related measures should be higher in order to indicate high liquidity.

- Trading volume (V) represents the number of shares traded in a certain time interval. It can be calculated on a daily, weekly, yearly or any other time interval which is thought to be appropriate for analysis.
- Turnover (*Tn*)[5]

$$Tn_t = \sum_{i=1}^{N_t} p_i \times q_i \tag{2}$$

Where Tn_t represents turnover in time *t*, p_i is the price in transaction *i*, q_i is the number of shares traded in transaction *i*, N_t is the number of transactions in time *t*.

Turnover is calculated for a specific time interval and represents the product of the volume and the price in the same transaction. Turnover is more adequate than trading volume as a measure of liquidity, because it makes possible a comparison between different stocks. Sometimes the relative turnover is used in order to measure liquidity more precisely. Relative turnover is turnover corrected for the free float number of shares. Turnover as a liquidity measure is more meaningful when it is in conjunction with market capitalisation. This turnover rate, as in Sarr and Lybek (2002), explains how many times stocks change owners. The equation is:

$$turnover\ rate = \frac{Tn}{Mktcap} \tag{3}$$

[4] Free float represents the number of shares that are available for trade. A certain amount of shares, owned by the strategic investor in the company or the State, is not available for trade on the market.

[5] Some authors use the term dollar volume.

Turnover *Tn* as defined in (2), *Mktcap* as defined in (1).

As in Sarr and Lybek (2002), in empirical research we combine and calculate additional 2 measures of liquidity, market index average daily price change and the ratio of market index daily price change and turnover rate:

• $|\%\Delta P|$

Market index average daily price change indicates market volatility. A lower value for this measure would indicate a more liquid market. The logic is simple, with a higher price change pointing to lower liquidity.

• $|\%\Delta P| / (Tn/Mktcap)$

Ratio of market index average daily price change and turnover rate represents the impact of turnover and market capitalisation on index volatility, i.e. price volatility. Higher values of this ratio indicate a lower efficiency and a lower liquidity and represent a decrease of *depth* as dimension of liquidity due to the larger impact of large volume transactions on price change and the lack of large and numerous orders with small spreads.

3) Time related liquidity measures

These measures indicate how often transactions occur. High values for these measures indicate high liquidity. Number of transactions per time unit is a widely used liquidity measure because it measures the frequency of trading between two trades. A shorter time interval between transactions indicates higher liquidity in the market. The number of orders per time unit is similar to the number of transactions per time unit and is also used as liquidity measure. The number of transactions may be used in a comparison between different markets at an aggregate level and when a longer time period is analysed.

4) Spread related liquidity measures

Spread is defined as the difference between the bid and the ask price. Spread and spread related measures give an approximation of the costs incurred when trading. In fact, beside fees payed to the stock market and brokers which are calculated in each transaction, there is also the cost directly related to liquidity. That is the cost of simultaniously executing buy and sell orders. The lower values of spread related liquidity measures indicate higher liquidity. The measure related to spread is the absolute or quoted spread, calculated as the difference between the lowest ask price and highest bid price. This measure is always positive and its lower limit is the minimum thick size.[6]

There are many versions of spread measures such as log absolute spread, relative spread, effective spread, as in Roll (1984).[7]

[6] Tick size on Zagreb Stock Exchange is 1 lipa (1/100 of kuna).

[7] Measures mentioned in this paragraph are not included in our empirical research thus are not explained in more details.

2.2.2 Multi-dimensional liquidity measures

Multi-dimensional liquidity measures[8] embody combinations and properties of different one-dimensional measures.

1) Liquidity ratio 1:

$$LR1_t = \frac{Tn_t}{|r_t|} = \frac{\sum_{i=1}^{N} p_i \times q_i}{|r_t|}. \tag{4}$$

where $LR1_t$ denotes liquidity ratio in time t, r_t is the return, i.e. the percentage price change expressed as the absolute value.[9] Liquidity ratio, also called Amivest ratio, compares the turnover to the absolute price change in a certain time period. The higher the turnover, the more price change can be absorbed. High liquidity ratios denote high liquidity. If the return on a stock in a certain time interval is zero, the measure is set to zero.

2) Amihud's illiquidity ratio (ILLIQ):

$$ILLIQ_t = \frac{1}{LR1_t} = \frac{|r_t|}{Tn_t} \tag{5}$$

ILLIQ or *Amihud's illiquidity ratio* is used in Amihud (2002), and it represents reverse liquidity ratio 1, comparing absolute price change with respect to turnover. This is the central measure which is with some adjustments used in the empirical part of this paper thus presented there in more details.

3 Empirical research and results

Firstly we introduce markets that are included in our research. In second part we compare markets with respect to results obtained from our liquidity measures: market index average daily price change |%ΔP|, turnover rate *Tn/Mktcap*, ratio of market index price change and turnover rate |%ΔP|/(*Tn/Mktcap*), and *ILLIQ* as the multi-dimensional indicator that measures the impact of turnover to price change.

3.1 Markets overview

In this research we focus on the Croatian stock market and the developing markets that are part of Central and Eastern Europe. They have similar characteristics, such as economic and financial integration with the EU, similar development path of transitional countries and the challenges of establishing an effective stock market. Poland, Hungary and Slovenia have been members of the EU since 2004, while Bulgaria entered in

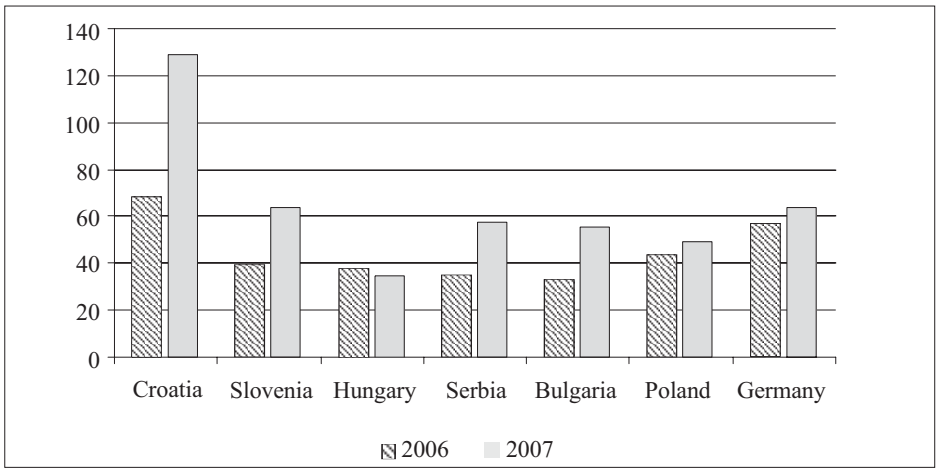
[8] For more on multi-dimensional measures see von Wyss (2006).
[9] All values as positive numbers.

the year 2007. Croatia is currently conducting negotiations and Serbia needs to ratify the SSP agreement, the first step to joining the EU.

In order to show the differences in liquidity measures between developing and developed markets, we have chosen the German market for comparison, as one of the most developed stock markets (Vizek and Dadić, 2006.).

The growth and development of Croatian market resulted in its increasing role among regional markets, as we can se from values of turnover and market capitalisation. With respect to turnover and market capitalisation, the German and Polish markets significantly differ from the observed markets, while compared by turnover to BDP ratio we see different results. The Croatian market shows the highest values of this ratio, mostly due to significant stock prices growth in 2006 and 2007. While GDP has not generated such a high growth rate (GDP growth rate was 5.6% in 2007), the Croatian stock market doubled its market capitalisation in 2007 with respect to 2006 (Figure 1). Together with high price growth this is also the result of 7 IPOs that marked the year 2007 in Croatia.

Figure 1 Market capitalisation and BDP ratio of observed markets in 2006 and 2007 (%)



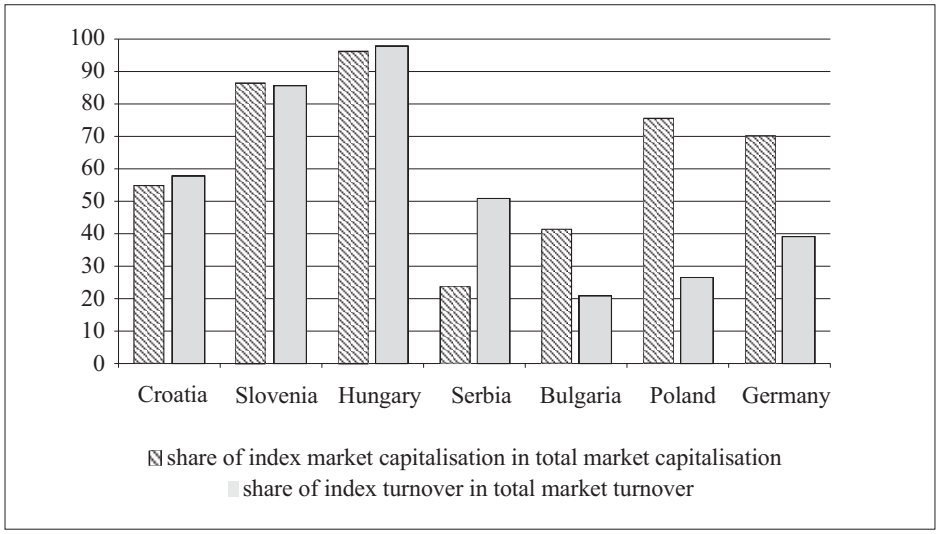
Source: Bloomberg, Eurostat, Federation of European Securities Exchanges (FESE).

As we can see, with the exception of the Hungarian market, markets increased their market capitalisation to BDP ratio in 2007. Given the fact that this ratio represents market size relative to the economy, the Croatian market is significantly larger than other compared markets. Total market turnover is often used as market liquidity indicator, but it does not reveal much when used in comparison to other markets. However, it describes the size of the market. In Germany total turnover was 3,144.2 EURbn, in Poland 126,7 EURbn, Hungary 34,6 EURbn, Bulgaria 4,6 EURbn, Croatia 3,0 EURbn, Slovenia 2,0 ERUbn and Serbia 1,9 EURbn in 2007 respectively.

In order to compare liquidity among different markets we need to define the sample of stocks by certain criteria. The calculation of liquidity measure for every listed stock would lead to inaccurate results. Amihud (2002) in calculation of market liquidity measure for the U.S. market eliminates illiquid stocks to make the results more precise. In the U.S. market he set certain criteria based on stocks' minimum days of trading, minimum price, and he eliminated foreign stocks in order to have representative sample. This issue is much more important in less developed markets such as those in our research. These markets are characterised by a relatively large number of illiquid stocks and in order to avoid assignment of large number of criteria, we decided to use stock market indices as samples for comparison. The impact of the different number of stocks in each index is eliminated by weighting stocks with respect to their market capitalisation. Liquidity is the main criteria for stocks to be included in the index; therefore we find that comparison of the most liquid stocks of each market would lead to more accurate results of liquidity.

Figure 2 graphically presents shares of indices in their markets in terms of market capitalisation and turnover. Measures calculated on the basis of stocks included in the market indices as a sample are to that amount representative for the market.

Figure 2 Share of index market capitalisation in total market capitalisation and share of index turnover in total market turnover for observed markets in 2007 (%)



Source: Bloomberg, www.zse.hr, www.ljse.si, www.bse.hu, www.belex.co.yu, www.bse-sofia.bg, www.gpw.pl, www.deutsche-boerse.com, FESE.

3.2 Calculation of liquidity measures

3.2.1 Amihud's measure of illiquidity

This measure, as multi-dimensional, takes into account several dimensions of liquidity. First, there is price change, for as indicator of liquidity a smaller price change indicates higher liquidity. Second, we have turnover, which multiplies the volume and price of each transaction and represents a one-dimensional measure of trading activity. As indicator of liquidity, a higher volume represents a more liquid market. The most important aspect is the impact of turnover on price change, hence a market is more liquid as the impact of turnover on price is smaller.

In order to calculate liquidity from the aspect of transaction on price impact, data on intraday transactions are demanded and these are mostly not available. An obstacle to comparison is also the market microstructure which varies between countries and thus makes comparison of these intraday data more difficult. These barriers to research can be eliminated by using a measure of liquidity defined as the ratio of absolute return (percentage price change taken as absolute or always positive number) and trading turnover, which is Amihud's liquidity measure. This measure makes a comparison possible through different markets because it uses percentage price change of a stock. If we only use volume, turnover or only price change, we can not determine what the differences in market liquidity in different countries are. Such indicators, if not related to some other indicator, can not reveal to us market liquidity due to different conditions and size of each market.

Amihud (2002) calculates the impact of turnover on price change, a measure that has shown reliable results applied to daily data, particularly when compared to other, conventional, measures mentioned by Hasbrouck (2003). Important aspects for this research and this measure we see from research made by Amihud (2002) and Hasbrouck (2005) which show that Amihud's measure of illiquidity is highly correlated with *TAQ* measures on price impact.[10]

For each stock each day in the observed period, this measure is expressed as the ratio of absolute percentage price change and daily turnover in the currency in which trading is realised.

The equation for the daily *ILLIQ* measure is

$$ILLIQ_{idt} = \frac{|r_{idt}|}{Tn_{idt}} \times 10^5 . \tag{6}$$

where $ILLIQ_{idt}$ denotes illiquidity measure for stock i on day *d* of month *t*, r_{idt} denotes return of stock *i* on day *d* of month *t* and T_{nidt} is daily turnover for the same stock. *ILLIQ* represents the impact of 1 kuna (or other currency depending on the country) on the percentage price change, that is by how much the percentage price will change with a 1 kuna

[10] TAQ – transaction and quotes. intraday liquidity measures.

turnover. In order to get meaningful results we multiply the calculated *ILLIQ* by 10^5 and then we can determine the percentage price change for 100.000 euros of turnover.[11]

After that we calculate the monthly level of illiquidity for each stock in our sample by averaging daily measure for each month with respect to the number of trading days for stocks.

The equation for monthly level of illiquidity is:

$$AMILLIQ_{idt} = \frac{\sum ILLIQ_{idt}}{D_i}, \tag{7}$$

where $AMILLIQ_{idt}$ denotes average monthly measure of illiquidity for stock i of day d in month t. D is number of days traded for stock i in month t.

Market measure of illiquidity is defined as the sum of average *ILLIQ* of each stock weighted by the stock market capitalisation. Due to the relatively low free-float rate on these markets and in order to get more accurate results we adjusted stock market capitalisation for each stock.[12]

The equation for weighted market measure of illiquidity is

$$MKTILLIQ_{Nt} = \sum_{i=1}^{N} \left[AMILLIQ_{it} \left(\frac{Mktcap_{it}}{\sum_{i=1}^{N} Mktcap_{it}} \times ff_i \right) \right], \tag{8}$$

where $MKTILLIQ_{Nt}$ denotes measure of illiquidity for all stocks in our sample (representing market), $Mktcap_{it}$ is market capitalisation of stock i in month t, $\sum_{i=1}^{N} Mktcap_{it}$ is total market capitalisation of all stocks in the sample, ff_i is *free-float* factor of stock i, N is total number of stocks.

In our research we include six developing markets and one developed market. Measure of illiquidity is applied on Croatian market, i.e. 30 stocks from market the index CROBEX, 15 stocks from the Slovenian SBI20 index, 15 stocks from the Serbian BELEX15 index, 20 stocks from the Bulgarian SOFIX index, 15 stocks from the Hungarian BUX index, 20 stocks from the Polish WIG20 index and 30 stocks from the German DAX

[11] On stock markets where turnover is not expressed in euros, we adjusted the calculation with respect to average exchange rate of euro and the currency in which the turnover occured, depending on the country observed. Then we multily this indicator by 100.000.

[12] *Free float* market capitalisation is also used in the calculation of market indices. It is more accurate as a weight factor than total market capitalisation of a stock, especailly on developing markets due to lower free float rates.

index.[13] Due to the short time period observed, the measure of illiquidity is not corrected for inflation as it is in Amihud (2002).

Data are obtained from Bloomberg and publicly available sources from the Internet in period from January 1st 2006 till April 30th 2008 (March 30th 2008 for CROBEX).

Table 1 shows monthly *ILLI*Q measure of illiquidity for observed markets in period January 1st 2006 – April 30th 2008.

A lower value of the *ILLIQ* measure indicates a more liquid market and vice versa. Significant daily price changes and low levels of turnover lead to high values of the measure of illiquidity. Constant turnover levels but greater price changes cause higher values of *ILLIQ*, while low levels of price change and higher values of turnover will lead to lower values of this measure.

The Croatian, Bulgarian, Serbian, Hungarian and Slovenian markets are significantly more illiquid than German market, while the Polish market shows somewhat better level of liquidity. We should take into consideration that the calculated measure represents the impact of 100.000 euros of turnover on percentage price change, while the usual levels of turnover on Polish market are much higher.[14] However, Polish market is more liquid than the other 5 developing markets measured by *ILLIQ*.

If we examine the basic statistical indicators, the most volatile liquidity measure is found on the Bulgarian market and Serbian market, while average deviations from the mean are less expressed in Croatia and Slovenia, which also indicates the level of liquidity. It is important to state that even though almost all of the observed markets indicate liquidity improvements, very high values of *ILLIQ* suggest a substantial level of illiquidity. Thus, the results of our research confirm the assumption that high illiquidity is present on these markets, especially when compared to the German market, with the exception of the Polish market, SOFIX has the highest level of *ILLIQ* in 10 periods observed out of 19. BELEX has the highest value of *ILLIQ* in the 9 out of 20 periods, CROBEX stands somewhere between more liquid DAX, BUX and WIG and the less liquid BELEX and SOFIX.

Figure 3 graphically presents *ILLIQ* of the Croatian market in comparison with other observed markets where we clearly see levels of liquidity. This measure of illiquidity indicates that the Croatian market is more liquid than Bulgarian and the Serbian market, significantly more illiquid than Hungarian, Polish and German market and at a similar level of liquidity as the Slovenian market. The graphically presented measure reveals significant volatility in liquidity which also implies a certain risk associated with unpredictability and variability of liquidity, with the exception of German market where we do not see any such volatility. Liquidity decreased on all the observed markets in the last 4 observed months, which presumably can be associated with the global financial crisis.

[13] We included stocks that are included in the indices in that time of our research. Even though there were minor changes in the indices structure in period under analysis, we did not change our sample due to the fact we only use stocks from the indices as basis for our sample.

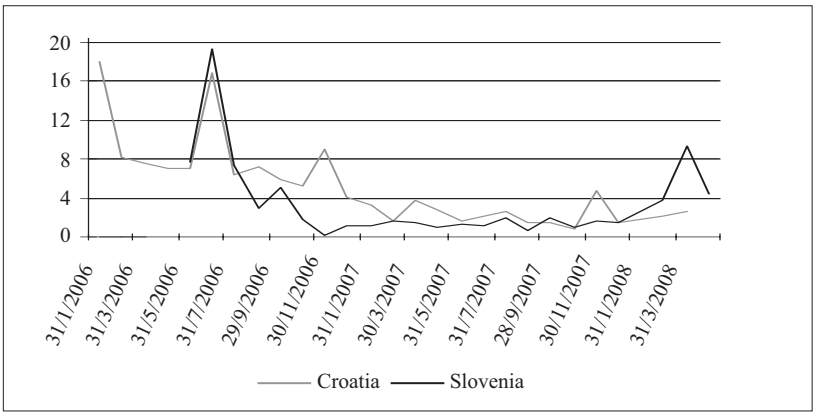
[14] 100,000 euros turnover is used in order to make the comparison more consistent and so that we can interpret and apply this measure on all markets. This adjustment has no impact on the accuracy of the calculated measure. *ILLIQ* would result in somewhat higher value if we calculated it as the impact of 1,000.000 euros on price change.

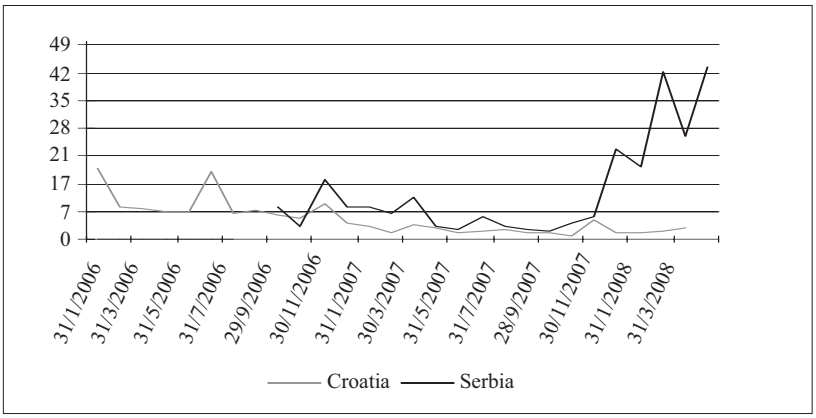
Table 1 Illiquidity measure (ILLIQ) for the analysed markets (January 1st, 2006-April 30th, 2008)

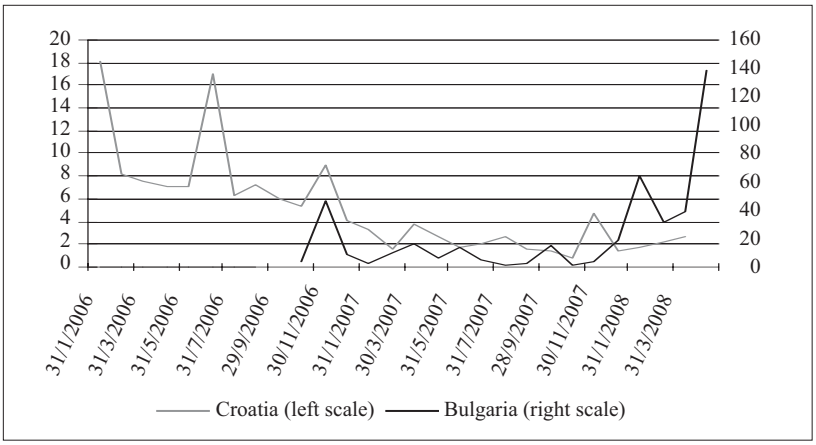
Date	Croatia	Slovenia	Serbia	Bulgaria	Hungary	Poland	Germany
31/1/2006	18.0517					0.1193	0.0007
28/2/2006	8.2256				0.2405	0.1180	0.0005
31/3/2006	7.5919				0.5003	0.1146	0.0005
28/4/2006	7.0393				0.1669	0.1538	0.0005
31/5/2006	7.0901	7.6732			0.2215	0.0919	0.0007
30/6/2006	16.9579	19.3107			0.6015	0.1617	0.0006
31/7/2006	6.3641	7.3997			0.6875	0.1492	0.0007
31/8/2006	7.2119	3.0036			3.0963	0.1380	0.0006
29/9/2006	5.9278	5.0794	8.1879		1.4952	0.1257	0.0005
31/10/2006	5.3276	1.8841	3.4278	4.2650	3.4001	0.0814	0.0004
30/11/2006	9.0465	0.1087	15.0864	46.6417	0.3772	0.0618	0.0004
29/12/2006	4.0858	1.0825	8.1716	8.2722	0.4589	0.0654	0.0004
31/1/2007	3.3039	1.2207	8.1088	2.8852	0.1237	0.0566	0.0004
28/2/2007	1.6034	1.5686	6.3415	9.9410	0.1362	0.0592	0.0003
30/3/2007	3.7164	1.5247	10.6824	16.9639	0.1417	0.0580	0.0003
30/4/2007	2.7347	1.0172	3.0975	5.9346	0.1262	0.0427	0.0003
31/5/2007	1.6599	1.3837	2.5964	14.2548	0.0825	0.0474	0.0003
29/6/2007	2.1191	1.1023	5.7467	5.4879	0.1166	0.0372	0.0003
31/7/2007	2.6192	2.0126	3.4031	1.5684	0.1009	0.0457	0.0004
31/8/2007	1.5095	0.7272	2.3819	2.1146	0.0921	0.0614	0.0004
28/9/2007	1.4936	1.9294	2.2323	14.6136	0.2025	0.0611	0.0004
31/10/2007	0.8102	0.9321	4.0741	1.0039	0.1382	0.0432	0.0003
30/11/2007	4.7553	1.7167	5.8521	3.5988	0.2259	0.0441	0.0004
28/12/2007	1.4335	1.4848	22.9132	18.6174	0.0838	0.0437	0.0004
31/1/2008	1.7500	2.5608	18.1575	63.9120	0.1849	0.0434	0.0004
29/2/2008	2.1574	3.7451	42.0937	31.8933	0.6729	0.0542	0.0005
31/3/2008	2.6502	9.2896	25.9727	39.4668	0.5037	0.0476	0.0005
30/4/2008		4.3661	43.6114	138.0000	0.7182	0.0425	0.0005
no. of months	27	24	20	19	27	28	28
max.	18.0517	19.3107	43.6114	142.6740	3.4001	0.1617	0.0007
min.	0.8102	0.1087	2.2323	1.0039	0.0825	0.0372	0.0003
mean	5.0828	3.4218	12.1069	22.8479	0.5517	0.0775	0.0005
st. devation	4.3369	4.1483	12.5389	33.8326	0.8372	0.0399	0.0001

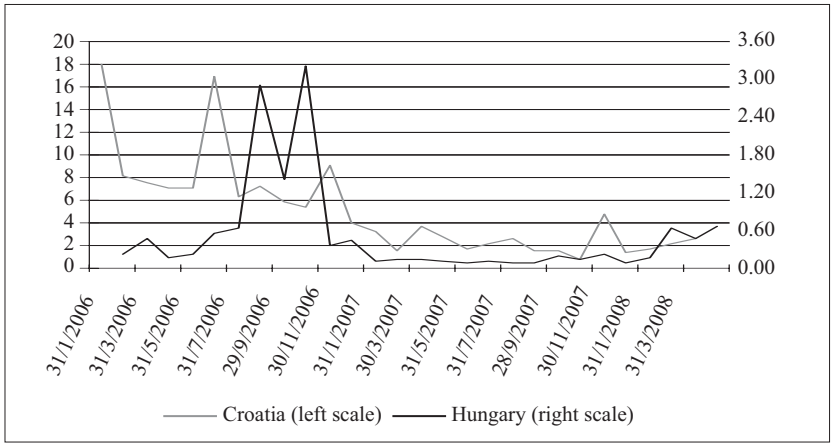
Source: Bloomberg, www.zse.hr, www.belex.co.yu, authors calculation.

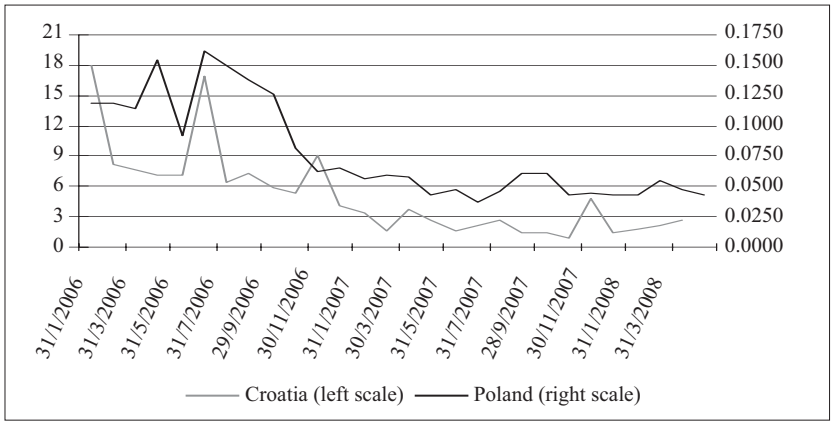
Figure 3 Illiquidity measure of Croatian stock market in comparison with illiquidity measure of other observed markets

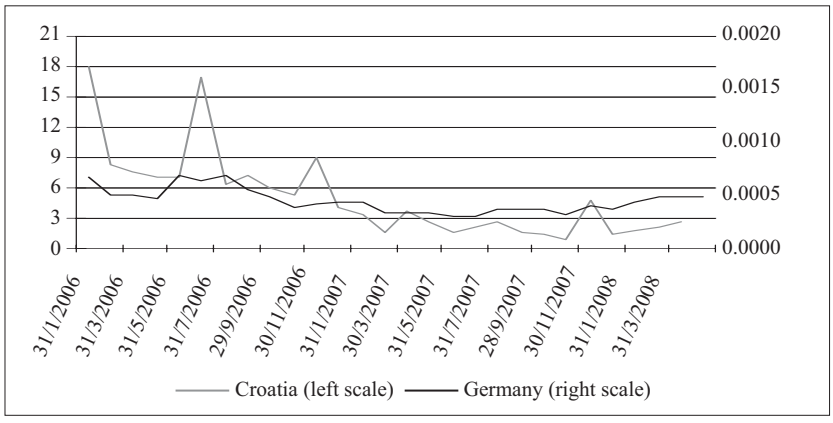












Source: Bloomberg, www.zse.hr, www.belex.co.yu, authors calculation.

Due to the complexity and multi-dimensionality of liquidity, different measures can lead to different conclusions. Since there is no single measure capable of capturing all aspects of liquidity, we focused on the measure that describes the impact of turnover on price change. Together with that liquidity measure we introduce three other measures in order to determine any possible discrepancy in measures and results in our research.

3.2.2 Market index average daily price change, $|\%\Delta P|$

This measure of liquidity reflects market volatility and a lower value of this measure indicates a more liquid market, because higher price change indicates lower liquidity.

Liquidity measured by this indicator improved on the German and Hungarian markets, while other observed markets had increased volatility in 2007. Larger changes in price indicate higher volatility and lower liquidity.

3.2.3 Turnover rate, Tn/Mktcap[15]

Ratio of total turnover and average market capitalisation is a measure of market efficiency and indicator of liquidity. A higher value of turnover rate means more liquidity. The German market, together with the Hungarian and Polish markets have had an increase in turnover rate signalling an increase in liquidity. Turnover has increased (as individual liquidity indicator this signals better liquidity) more than market capitalisation (function of price increase-high change in price, lower liquidity). The Croatian, Slovenian and Bulgarian markets have had a reverse trend due to a larger increase in market capitalisation than turnover, which indicates lower liquidity. For the Croatian market it is important to note 7 IPOs in 2007 which generated higher market capitalisation and thus had significant impact on turnover rate.

3.2.4 Index average daily price change and turnover rate ratio, $|\%\Delta P|/(Tn/Mktcap)$

This measure displays the impact of turnover and market capitalisation on index volatility. A low value of this ratio denotes high liquidity and efficiency. Again we have similar conditions, where the Hungarian, German and Polish markets have had an increase of liquidity measured by this ratio. Impact of turnover and market capitalisation on index volatility is evident as turnover rate increases with an increase in turnover higher than the increase in market capitalisation. Then, a higher turnover rate decreases this ratio and a greater price change can be absorbed, thus indicating higher liquidity. This ratio has a reverse trend on the Croatian, Slovenian and Bulgarian markets where he measure increased in 2007 thus indicating a decrease in liquidity. This measure suggests a decrease in depth as a dimension of liquidity because it denotes that large volume transactions have significant impact on price changes due to lack of large and numerous orders with low spread.

In table 2 we see summary overview of all the measures applied on the observed markets.

[15] Also called turnover ratio or turnover velocity.

Table 2 Liquidity measures for observed markets in 2006 and 2007

	Year	|% ΔP|	Tn/Mktcap (%)	|% ΔP|/ (Tn/Mktcap)	ILLIQ
Croatia	2006	0.63	7.08	0.0890	8.5767
	2007	0.80	6.25	0.1280	2.3132
Slovenia	2006	0.19	17.58	0.0108	5.6792
	2007	0.32	9.91	0.0323	1.3850
Serbia	2006	0.66	n/a	n/a	8.7184
	2007	1.03	10.20	0.1010	6.4525
Bulgaria	2006	0.41	25.56	0.0154	19.7263
	2007	0.84	4.40	0.1909	8.0820
Hungary	2006	1.21	88.32	0.0137	1.0223
	2007	0.91	109.74	0.0083	0.1309
Poland	2006	1.23	45.39	0.0271	0.1151
	2007	1.15	87.81	0.0131	0.0500
Germany	2006	0.73	173.73	0.0042	0.0005
	2007	0.76	218.35	0.0035	0.0004

Source: Bloomberg, www.zse.hr, www.belex.co.yu, FESE, authors calculation.

4 Conclusion

In this paper we tried to measure the levels of liquidity on the Croatian market in comparison to other regional markets and one developed market which can be taken as highly liquid. Based on the results of our research and the calculations we can divide the countries observed in two groups with respect to liquidity levels. In the first group we include countries that based on our liquidity measure have a high level of liquidity. These are Germany, as expected, but also Poland and Hungary. A price change in the index and its volatility do not presume such a qualification, while more complex measures like turnover rate, ratio of market index price change and turnover rate and *ILLIQ* suggest that these markets are more liquid than the others observed. For the German market such results are surely not surprising, however it is interesting to notice that Poland and Hungary are significantly more liquid than the regional average.

The second group of countries includes Croatia, Slovenia, Serbia and Bulgaria. Even though we have certain variations within liquidity measures for these countries, they undoubtedly imply higher levels of illiquidity compared to the first group of countries.

In the observed period, on the determined sample for every market, we apply illiquidity measure (*ILLIQ*) which describes the impact of turnover (or volume traded) on price change of stocks. The significance of this measure is in the dimension of liquidity it ob-

serves. That is, the depth and the cost of transactions, i.e. breadth, dimensions we can not capture with plain measures.

Results have shown that Croatian market is more liquid than Serbian and Bulgarian market, significantly more illiquid than German, Polish and Hungarian, and at the same level of liquidity as Slovenian market.

With respect to the dimensions of the liquidity we observe, a higher level of illiquidity directly leads to a higher risk on investments where investors face the possibility of higher losses, but also higher gains, when compared to more developed and liquid markets due to price volatility. In more illiquid markets investors can not be certain they would be able to execute large volume transactions at any time without significant price change, thus resulting in higher losses. Therefore, the presence of illiquidity represents an obstacle to further stock market development due to lower inflows of capital, which confirms that market liquidity is a fundamental aspect of market development.

Market liquidity is impossible to capture with only one measure due to its multidimensional features. The results from our research confirm that certain measures can point to different conclusions. For example, the Croatian market was more liquid in 2007 than in 2006 measured by *ILLIQ*, but stock market index price change, turnover rate, and ratio of turnover and index change imply that the market was more liquid in 2006 than in 2007. Similar results are found in other developing markets, while in more liquid markets. Polish, Hungarian and German, all measures calculated point to increased liquidity levels in 2007 compared to 2006 (the only exception is the measure of index price change on German market). This might lead to conclusion that *ILLIQ* as a measure is not suitable for developing markets. But, *ILLIQ* is much more precise as a measure of liquidity than other measures calculated, given that it is calculated for every stock on a daily basis and the impact of each stock is weighted by its market capitalisation and free float rate. Additionally, *ILLIQ* provides consistency in results on all observed markets, while other used measures can lead to wrong conclusions regarding liquidity. Indicators like total market turnover, which is often used as proxy for liquidity, turnover rate or market index price change, especially when used in a comparison of different markets, are not able to denote such a precise picture of liquidity.

A good example to show that interpretation of liquidity indicators should be taken with caution is Bulgarian market where total market turnover in 2007 exceeds the turnover on Croatian market, but all other indicators show that Bulgarian market is less liquid than Croatian.

Appendix

Table 3 List of stocks included in the research

	Croatia	Slovenia	Serbia	Bulgaria	Hungary	Poland	Germany
1	ADRS-P-A	PETG	AIKB	ALB	ANY	AGO	ADS
2	ATGR-R-A	KRKG	ENHL	BACB	DANUBIUS	ACP	ALV
3	ATPL-R-A	SAVA	KMBN	CCB	ECONET	BIO	BAS
4	BLSC-R-A	TLSG	CORP	EGIS	EGIS	BRE	BAY
5	CROS-R-A	MELR	UNBN	FIB	EMASZ	BZW	BMW
6	DLKV-R-A	KBMR	SJPT	CHIM	FHB	CST	CBK
7	ERNT-R-A	GRVG	MTBN	ELARG	FOTEX	CEZ	CON
8	HDEL-R-A	PILR	IMLK	HOPAT	MOL	GTN	DAI
9	HT-R-A	LKPG	PRBN	IHLBL	MTELEKOM	GTC	DB1
10	HUPZ-R-A	EIKG	JMBN	EURINS	OTP	KGH	DBK
11	IGH-R-A	HDOG	TGAS	KAO	PANNERGY	LTS	DPB
12	INA-R-A	AELG	TIGR	OTZK	PHYLAXIA	PBG	DPW
13	INGR-RA	ITBG	MTLC	MCH	RABA	PEO	DTE
14	JDPL-R-A	MILG	TLFN	MONBAT	RICHTER	PGN	EOA
15	KOEI-R-A	ZTOG	BMBI	NEOH	SYNERGON	PKN	FME
16	KORF-R-A			ORGH	TVK	PKO	HEN3
17	LEDO-R-A			SFARM		PXM	HRX
18	LKPC-R-A			ELTOS		PND	IFX
19	LKRI-R-A			TOPL		TPS	LHA
20	MGMA-R-A					TVN	MAN
21	PODR-R-A						LIN
22	PKTM-R-A						MEO
23	THNK-R-A						MRK
24	TNPL-R-A						MUV2
25	ULPL-R-A						RWE
26	VDKT-R-A						SAP
27	VIRO-R-A						SIE
28	PBZ-R-A						TKA
29	SNBA-R-A						TUI1
30	ZABA-R-A						VOW

Table 4 Index market capitalisation and index turnover in total market capitalisation and total market turnover ratios (%)

Country	Index market capitalisation / total market capitalisation	Index turnover / total market turnover
Croatia	54.81	58.04
Slovenia	86.40	85.47
Hungary	96.08	97.92
Serbia	23.35	50.73
Bulgaria	41.29	20.90
Poland	75.28	26.72
Germany	69.87	38.95

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