

A Market-Microstructural Comparison of a Well Established Capital Market with a Transition Economy Competitor: Euronext (France) vs. the Warsaw Stock Exchange[#]

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Draft March 2006

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Abstract

This study provides a quantifiable comparison of the quality of the capital markets of a fully developed and a transition economy. In particular, Euronext France and the Warsaw Stock Exchange [WSE] are compared. The two markets were chosen as they are representative of broader classes of capital markets. Their market structure is very similar however, providing the basis for a clean natural experiment. Using intraday data for up to 178 stocks at both the Paris Euronext market and the WSE we show that while overall liquidity is certainly much greater in Paris, range based intra-day volatility is significantly lower in the WSE. For stocks with the highest market capitalisation the WSE has lower transaction costs in the first [largest] decile than Euronext France. These results indicate that while the established market is significantly more liquid in terms of average trade size and trade numbers it does not always offer lower transaction costs or volatility. Policy makers at the WSE should seriously consider whether to go ahead and mimic more established markets as the results indicate that an optimal market structure for a transition economy such as Poland is different to the optimal structure of an established market.

JEL Classification: G12, G14, G15, G18, E44

Key Words: Transition Economy, Market Microstructure, Emerging Markets

The authors would like to thank SIRCA and Reuters for their provision of data.

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1 Introduction

To provide a method for comparing the capital market of a fully developed economy to the capital market of a transition economy we investigate the differences in four measures of market quality for two representative markets, Euronext France [Euronext] and the Warsaw Stock Exchange [WSE]. It is generally accepted that an economy in transition from being centrally planned to a market economy requires an efficient set of capital markets as documented in Demirgüç,-Kunt and Levine (1996) and others; in particular, a liquid stock market that not only facilitates the movement of capital to existing firms but also promotes the development of new industries with both domestic and foreign capital. Capital markets also diminish information asymmetries that may be present in markets; particularly transition economies. The collapse of communism last century led most of the former centrally planned economies to artificially introduce one of the strongest symbols of capitalism into their economies; namely stock-markets¹. Poland was no exception and with the financial aid of the French government, the expertise of the French Bourse (SBF), SICOVAM, and the French central depository the WSE was formed on October 16th 1990. The WSE was privatised with the owners being the Polish state, several banks, and the brokerages houses.

This paper analyses quantitatively the difference between the market qualities a fully developed capital-market in a first world industrial nation with a stock market functioning in a transition economy. The results from this paper are robust as they are based upon a natural and clean experiment due to the fact that the underlying structures of both markets are effectively the same. The WSE is actually replicated from the Euronext Paris market structure. This therefore, allows the researcher to accurately determine the statistically significant differences of market qualities present in both markets. The paper goes on to follow up some of the questions framed by Kairys (1999 and 2000) concerning the development of the WSE and the progress it has made since the publication of those works. As this research measures the liquidity of the WSE and compares it with Euronext France, a normative statement about the maturity of the WSE is possible. This paper also allows the reader to place the WSE in an historical context by making comparisons with what are now well regarded and fully developed capital markets and their history. By analysing the development of a capital market and comparing it with a fully developed market using the same platforms it is possible to determine the point-in-time stage of development for the WSE.

1.1 Institutional detail

This paper analyses data from March 2000 to the end of October 2001 and thus requires a description of the institutional details of the markets being scrutinised for that period. The following information has been taken from the World Stock Exchange Handbook (2001).

The Paris stock exchange (Euronext) segments stocks into three categories relating to size known as *Marché* with varying listing requirements that diminish in regulatory requirements through the first through third *Marché* respectively. Companies across the spectrum must report their financial statements in the newspaper within six

months of the end of the financial year and within four months for their half-yearly reports. The Bourse must be notified of any news that may affect share prices while the public must be notified of any general meetings or information that directly affects the share price such as dividend announcements etc. Investors are obliged to make a takeover bid when their holding reach 33.3% of the outstanding shares while there are caveats to company activity during such a bid such as the prohibition of the release of further shares during that same period.

Investors are protected through several measures that the Bourse can implement. The market for a stock may be temporarily suspended should the Bourse think it in the best interest of the share holders (this may be for 15 or 30 minutes if there is a fluctuation of 5% or 10% from the previous days closing price) while the Commission de Opérations (modelled on the United States SEC) may invoke other broad measures to ensure fair trading. Circuit breakers are applied and based on the liquidity of a security if outside the measures stipulated by the metric named “Fixing A” or “Fixing B” groups that are determined by the relative liquidity of a stock. To protect investors from broker defaulting, member firms must maintain minimum capital bases, risk spread, liquidity, and a division of member and client accounts. The Bourse also maintains a guarantee fund. If an investor increases share holdings beyond certain discrete boundaries then they are compelled to inform both the company whose stock is being traded and the Bourse itself. If an investor is a non-European Union resident then they are barred from holding more than 20% of a company’s stocks without receiving authorisation from the Finance Ministry.

Due to the size of the French economy the stock market has many well defined index composites that reflect the diversification present in the French economy. These range from industrial (energy, intermediate goods automotive etc) and services (merchandising) to financials (real estate and investment companies etc). Commission and fees for trading are negotiable while the clearing method is book-entry. Settlement is T+5 where T is the day of the trade. Monthly settlement is also available. Trading on Paris is organised as an electronic limit order book with no market makers with affirmative obligations in the largest stocks. Outside of the top stocks, market makers are given affirmative obligations and privileges to guarantee a fair and orderly market in the assigned stocks. The least liquid stocks are called once or twice a day when an auction price is determined.

In comparison, the Polish economy where the Warsaw Stock Exchange functions, is a developing economy in transition from communist reign in 1989. As a result of this, the WSE is much smaller in size and relative diversification than that of the Paris Euronext market. In order to list at the WSE, a company must have been worth at least 24 million Zloty, as should its book value. The listed capital must have had a minimum value of 7 million Zloty spread over a minimum of 500 shareholders whose total holdings do not exceed 5% of total value. In order to list at the WSE company pre-tax profits must have exceeded 5 million Zlotys for three consecutive years prior to listing. To seek listing a company must disclose information pertinent to the ability of an investor when evaluating asset values, financing sources, profits/losses, and development prospects. To list on the main market a company must release three years of financials and are required to continually disclose quarterly and semi-annual reports, and annual reports for auditing purposes. Relevant information held by the

company has to be shared with the Polish Securities Commission, the WSE, and the Polish Press Agency.

Physical delivery is the clearing method for the market and settlement is T+3 where T is the day of the trade. Commission range from 0.75 to 2% but are negotiable on trades over 500 million Zlotys. There was also a 0.2% stamp duty payable by the seller. Trading on the WSE is organised as a continuous order driven market with market makers in some stocks. A daily fixed price call auction is conducted when all current marketable orders are matched to arrive at a single clearing price.

1.2 Theoretical Background: Market Microstructure

A liquid and efficient stock market is generally accepted to be a key feature a developed economy. As the centrally planned communist nations of Central Europe lacked such infrastructure, financial systems architecture was instrumental to their transition into market economies. Now, after almost 17 years of operations, it is time to take a snapshot of one of these economies and compare it to a well developed and regarded capital market. The symbiotic nature of capital markets and economic growth has been well documented and analysed by such authors as Demirgüç,-Kunt and Levine (1996) but there is a gap in the literature where the analysis of the dynamics and qualities of these newly developed markets should be. Without such analysis it is difficult to determine the nature of investment within a transition economy. In the absence of a liquid and efficient stock market, economic agents cannot invest with the knowledge that adequate liquidity is present to reduce many risks. In this situation, an investor would have to place their capital in investments that can be readily converted in a medium of exchange. Due to these liquidity constraints foreign direct investment is stifled, as is economic growth itself. Stock markets may be superior to commercial bank lending when considering raising funds as they are not subject to bank runs and may in fact offer other positive externalities such as the conveyance of more timely information flows. Hermes and Lensink (2000). This possible reduction in moral hazard and adverse selection costs is one of many reasons why the newly established Polish government introduced and fostered the development WSE in 1990 and its subsequent growth and development.

The analysis of emerging economies' capital markets has been investigated several times by authors such as Glen (1994), but rarely has there been attention granted to the 'recently' transitioned economies of Central and Eastern Europe. Kairys (1999) compares the stock exchanges of Poland, Latvia, and Lithuania and finds that while the three exchanges had similar market microstructures they exhibited varying degrees of success when measured in market quality metrics. Warsaw was shown to facilitate greater liquidity over the continuous order driven market while a fixed call auction market provided a framework more appropriate for facilitating exchange in the lower liquidity markets. This supported the theoretical work of Easley, Keifer, O'Hara, and Paperman (1986) who strongly argued that screen trading in low liquidity environments hinders the development of an emerging market.

Rather than seeking an optimal market structure, this paper seeks to document the quantitative differences in market quality between a fully developed and transition economy operating off the same basic platform. The WSE after all, has already

determined that the continuous trading mechanism coupled with a daily fixed price call auction is their optimal structure. Effectively, this research gives a metric to the state of the transition economy measured by its capital market qualities rather than the usual macroeconomic metrics such as GDP.

Scholtens (2000) discusses the relative merits of transition economies by focusing on developing capital markets as opposed to a focus on fostering banking finance. In theory an economy with borrowers who possess strong credit reputations will lean towards a capital market like a stock market where information asymmetries can be nullified through the regular updating of market prices [Boot and Thakor (1997)]. Therefore, this paper may also claim to be able to normatively place Poland at a certain stage of its economic development. Empirical analysis however, states that financial system architecture is also based on the progress of its financial institution and the regulations used to keep them in order. We do not address the regulation of financial institutions in this paper. Evidence suggests that there is a strong relationship between finance and growth. Scholtens (2000) presents the work of Goldsmith (1969), by suggesting that financial development largely occurs during the early stages of economic development when incomes are relatively low and therefore, there is a strong correlation between growth and market development. By investigating the WSE at a relatively advanced state, (where continuous trading was the norm) the authors can make a stronger case for pinpointing the WSE's true state of development.

As financial markets depend on liquidity which is in turn based upon information flows we see that they are effectively a tool for good corporate governance. The WSE has strong disclosure rules for such events as mergers and acquisition which implies that corporate governance is maintained well and the market is informed of most events.

Scholtens (2000) compares western economy macro economic indicators with Central European figures for the year 1995. In it he shows that there were large differences when stock market capitalisation in the transition economies was 10% compared to 5% in the western economies. The actual quality of these markets, when measured using the market microstructure approach is basically ignored with the reader having no idea of the true costs of liquidity. The Polish economy and the WSE are given sparse treatment as only basic descriptive statistics are reported. While the number of firms listed at the WSE grew from 9 to 83 from 1991 to 1996 we are not informed of the costs of trading nor of the volatility inherent in the market. In particular, we are not told of the comparisons that investors would face if having to choose between trading through Euronext Paris and the WSE. Indeed, many managers of foreign companies may be wary of cross listing at the WSE as is done at Uronext Paris. This means that Polish domestic investors may be investing in a limited universe. This means that foreign investors are at an information disadvantage when choosing the location of their future investments. While Frydman (1998) shows that privatisation improves the investment performance of formally state owned enterprises there has been little to no work carried out on the performance of the markets themselves. Scholtens (2000) also reports on turnover ratios (ratio of equity trade value to market capitalisation) for several transition economies but fails to determine the statistical significance of these differences. He states that these markets are extremely illiquid but does not define liquidity. Finding that the economic role of the stock market in

Poland is limited as at 1996 due to limited direct foreign investment and liquidity Scholtens (2000) may be limited in his perspective.

Hermes and Lensink (2000) suggest that due to the thin liquidity of many transition economies markets many may experience excessive volatility. Studies of the Asian financial markets conducted by Singh (1997) appear to confirm this while Cho (1986), as presented in Hermes *et al* argues that stock markets foster ‘short-termism.’ Banks on the other hand foster long-term growth and develop long-term relationships with the firms they are financing. Of course, this fails to critically analyse the moral hazard and adverse selections costs associated with this closed form of financing.

Liquidity has been a main-stay of the economics literature for some time and neither the market-microstructure or transition economy literature has been immune to its significance. The extant literature assumes varying definitions of liquidity. The standard definition is of immediacy of trade. An asset is deemed liquid if an investor can trade the asset quickly in large volumes without their being too great an impact on the price (Black 1971, and Glosten and Harris 1988). Therefore, in order facilitate the three influential factors; being time, volume and price must be analysed. The liquidity of a stock market is partially dependent upon its microstructure. Hermes *et al* recognise this and suggest that the organisation of trading is of fundamental importance to policy makers in transition economies. Kairys (2000) analyses the WSE in conjunction with the Latvian and Lithuanian stock markets and finds that when continuous trading replaced a closed call auction market there both positive and negative repercussions. Firstly, the more liquid stocks improved in terms of liquidity and secondly the less-liquid stocks suffered. This paper furthers this work by applying a market-microstructure perspective and tool set to the WSE and more recent data.

2 Empirical Framework and Data

Several aspects of market quality are analysed both independently and cross sectionally across the two markets. As the primary transaction cost measure the effective spread, which measures how far from the mid-point of the spread trade execution occurs is used. The effective spread is weighted by the trade volume of each trade to give greater emphasis to the feature that this measure estimates both actual paid transaction costs and market impact costs (how costly it is to execute larger trades). The trade volume weighted relative effective spreadⁱⁱ is:

$$2 \sum_{t_0}^{t_c} \left\{ \frac{ABS \left[Trade Price - \left\{ \frac{Ask_t + Bid_t}{2} \right\} \right] [TradeVol_t]}{\left\{ \frac{Ask_t + Bid_t}{2} \right\} TotalTradeVol} \right\} \quad Eq.1$$

Where, t_0 is the time when regular trading commences during a trading day following an opening algorithm, t is time when a trade is executed, t_c is the time when trading ceases for the day, and trade volume refers to the number of shares traded. Six components of transaction costs can be identified: brokerage, bid-ask spread, market impact, exchange fees and taxes (stamp duty) and the opportunity cost of an inability

to make a desired trade due to transactions costs. Brokerage fees are excluded from the transaction cost measure as they may vary between customer and trade and are largely determined by competition and are not directly related to the quality of the market structure. The transaction cost measure, the trade volume weighted relative effective spread, includes the bid-ask spread, exchange fees and taxes and to some extent market impact costs.

As the price volatility measure the range-based intraday volatility, calculated as the log of the daily high price minus log of the daily low price is utilised, see Alizadeh *et al.* (2002):

$$\text{High - Low Intraday Volatility} = \ln(\text{high price}) - \ln(\text{low price}) \quad \text{Eq.2}$$

The range based volatility is well suited for measuring quality of market structure as it measures the intra-day price volatility only, which is expected to be more affected by the market structure than measures including overnight volatility.

Trade size (the average dollar value of all trades during one day) is studied as a measure of the ability of the market structure to cope with large trades and the number of trades (total number of trades per day) as a measure of resistance of the trading system to bursts of high activity. The product of trade size and number of trades conveniently provides the traded value which, according to Swan and Westerholm (2005), is the ultimate source of income for the exchange and hence an important determinant of policy for a profit-driven exchange such as Euronext and WSE.

The original data provided by *Reuters* to SIRCA contains intra-day trade, quote, and volume information for all securities listed on the two exchanges. Consistent exchange specific information was obtained from the International Federation of Stock Exchanges, *Annual Year Books*, the official internet home pages of the exchanges, and exchange rulebooks published by the stock exchanges. Brokerage fees for institutional investors on an exchange-by-exchange basis were obtained from Chakravarty *et al.* (2004b). *Reuter's* intra-day trading and bid-ask spread data supplied by SIRCA is extracted for the period between start of March 2000 to end of October 2001. The period chosen for the study is one of high volatility in world markets. It includes the last month of the 1990s technology driven bull market. 178 common stocks for Euronext and 79 for the WSE are analysed as they exhibit the highest security value traded during the period at both the WSE and Euronext. Also obtained were Thomson Financial *Datastream* data on share numbers and stock splits for as many stocks for which the data is available.

Intra-day trade-by-trade prices, numbers of trades and average trade size expressed in dollars, and best bid-ask quotes or orders (whichever is applicable, for all included stocks), calculated comparable exchange rate adjusted measures using intra-day data, were obtained and presented as daily time series for each company. The series for the average value of each stock is expressed daily in USD. Transaction taxes and exchange fees, expressed as relative measures on a round-trip basis were added to the effective spread calculations based on equation (1) above. Exchange fees and taxes for the WSE and Euronext are sourced from an industry participant.

Each selection of stocks from the respective markets broken into ten deciles in order to facilitate comparison. The stocks were initially ranked according to market capitalisation (in USD) with the foreign stocks listed on each exchange removed from the sample to leave only domestic stocks.

Like most high frequency data, the samples tend to be non-normal in their distributional properties and thus require non-parametric econometric techniques when conducting tests of statistical significance. In particular, a Wilcoxon signed rank test is used to determine the statistical significance of the differences between the variables taken from each market. This is conducted using both two-tailed and one-tailed hypothesis testing at the 1% level. This means that the significance tests are not skewed by the choice of the normal distribution. Both the Euronext and WSE sample were then split into deciles from which comparisons were drawn. These results can be found in the following section. The data is effectively broken into daily results for the sample period and compared over time.

3. Results

The hypothesis posed in this work actually relates to the degree to which the WSE lags Euronext Paris in its development rather than whether or not one market or the other is actually in a more developed state. This means that a two-tailed significance test is used to determine the depth of each market by statistically comparing each of the deciles of each market. This allows the researcher to gauge market quality in the form of volumes, spreads, and volatility at ten different market depths. Descriptive statistics for each of the variables and across all ten deciles for both markets are presented in the Appendix.

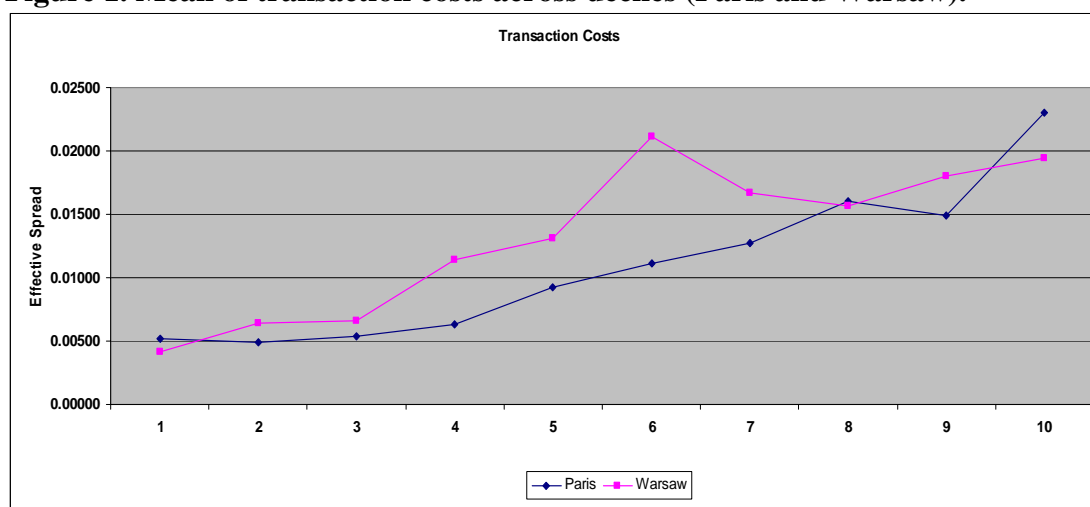
Overall, the Euronext Paris market clearly outperforms the WSE in virtually all of the variables tested. In particular, it can be seen in Table 1 that Paris has across all deciles much lower transaction costs and higher trade numbers; both in amount and trade size. On the other hand, the WSE appears to attract lower market-wide volatility than the fully developed Euronext Paris. The focus here is on four variables that should describe the merits of the liquidity of each market and allow for quick comparison. Transaction costs, as measured by the effective spread and augmented with institutional brokerage fees, tax, and stamp duties, is considered the best measure of the costs facing an investor making a deal. Trade size and the 'number of trades' data indicate the depth and frequency of trading and thus provide insights into another aspect of the liquidity of the market. Finally, the range based volatility measure, as opposed to the standard deviation of variance of the market makes sense of the possible risks of return facing an investor. Both the mean and the median are presented to give some indication of the distributions for each variable. This lends further credence to the use of non-parametric statistics due the skewness and Kurtotic nature present in most of the data. For more detailed descriptions of a wider range of data please see Tables A1 and A2 in the appendix relating to Paris and Warsaw respectivelyⁱⁱⁱ.

Table 1. Paris Euronext v WSE market quality descriptive statistics.

	Warsaw		Paris	
	Mean	Median	Mean	Median
Transaction Costs	0.020439	0.011392	0.007184	0.004507
Range Based Volatility	0.019345	0.012371	0.049418	0.035091
Trade Size	1554.26	777.1549	26697.44	8577.06
Number of Trades	86.15897	28.0002	643.2954	190.0002

Figure 1 shows the effective spread of each decile for both the WSE and Euronext Paris. The expected outcome would be that the effective bid-ask spread would in all cases be lower for the French market than the ‘newly’ formed WSE. However, it is evident that the WSE outperforms the Paris market in the first and tenth deciles, (although it must be admitted that this is only a minor advantage) and compares favourably in the eighth. In all other deciles the WSE exhibits higher transaction costs. In particular, Euronext is particularly ‘cheap’ in the second marche, or alternatively from decile 4 through to 7. This is consistent with much of the literature which suggests that in a transition market such as the WSE there will be concentration in trading for only a few companies at the expense of less liquid assets.

Figure 1. Mean of transaction costs across deciles (Paris and Warsaw).



The Wilcoxon signed rank test in Table A7 shows how many times the Euronext metric (in this case transaction costs as documented by the effective spread) are either greater than, less than, or equal to the WSE. All deciles show that the WSE has higher effective spreads in the vast majority of cases.

The significance of these differences is depicted by the results presented in Table A7. This shows at the 1% level the difference between the WSE and Euronext is strongly significant for all deciles. Using both a one-tailed and two tailed test it is apparent that Euronext is a much cheaper market to trade in. Therefore, transaction costs are significantly lower for all deciles using the non-parametric tests. These tests use the median as a measurement rather than the mean due to the skewed and Kurtotic nature of the data. That is why, even though the mean transaction costs are lower for the WSE at deciles one and ten they are significantly higher using the median.

However, given that the mean is lower at certain points it is worth investigating the reasons behind this. Kairys et al (2000) suggested that the introduction of continuous trading in 1999 led to enhanced market quality for the most liquid stocks at all of the Poland, Latvia and Lithuania stock exchanges. The data presented here confirms these results as the mean of transaction costs for the WSE is lower than the fully developed economy's effective spread.

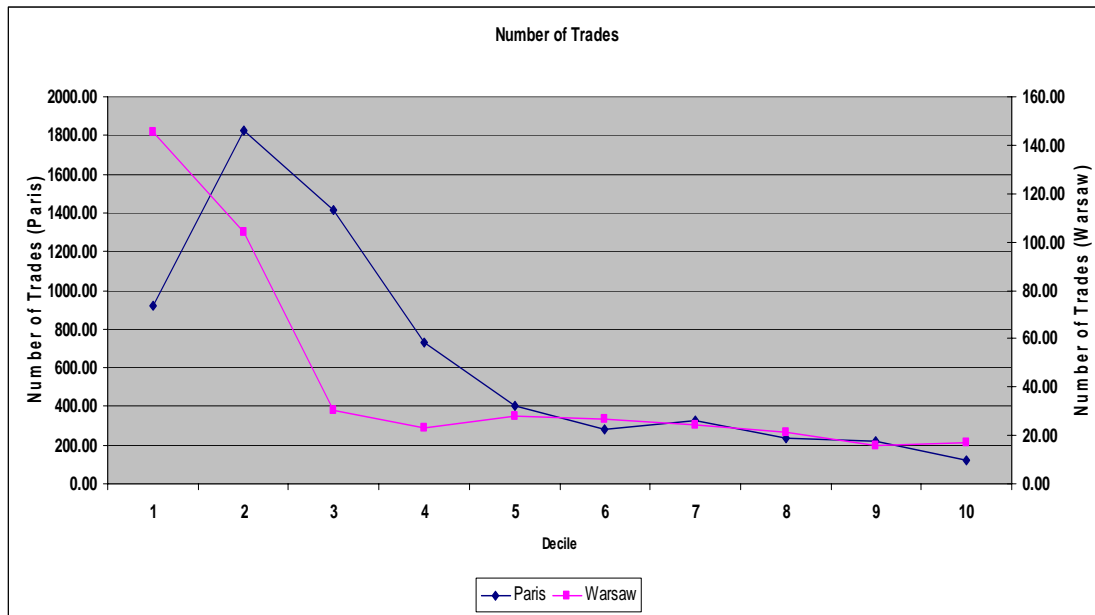
Table 2. Difference between transaction costs deciles.

Transaction Costs	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE
	v	v	v	v	v	v	v	v	v	v
	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX
Z	-12.49	-12.75	-12.72	-12.72	-12.71	-12.72	-12.72	-11.89	-12.30	-10.55
Asymp. Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (1-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Poland, being a transition economy and at a much earlier stage of its economic development (at least chronologically), has much lower trade volumes than Euronext Paris. While the average number of trades is not the best measure of liquidity it does provide an insight into the machinations of a market. As the relevant Y-axis show, the WSE clearly trades far more infrequently than Euronext Paris. Even at the lowest deciles the number of trades in Paris exceeds the WSE by a factor of 10. Interestingly, this ratio remains constant across the decile range indicating that the relative liquidity/depth of each market is similar. This supports the Wilcoxon signed rank tests that were conducted at both 99% and 95% significance levels.

The WSE exhibited its highest turnover in decile one and then falls by around 28% in the second decile and an even greater 49% in the third. From then on trade numbers tend to stagnate and thus reveal the fact that the first two deciles only account for the majority of trading at the WSE. Paris follows the orthodox in at least one way as a developed western market. At least three deciles, or even four, make up relatively large trade numbers in comparison to the total. This indicates much greater depth than that of the WSE. Interestingly though, we see that the unorthodox also prevails in Paris. The first decile is 97% smaller than the second indicating that the trade numbers are small. Pursuant to this, in order to be consistent with the market capitalisation rankings would necessitate that the average price of the shares would have to be very high. Again, from decile five though, similar relative trading is obvious.

Figure 2. Paris Euronext v WSE average number of trades.



The magnitude of the two scales of trading at each market is reinforced through the signed rank test. In only four trading days did the WSE have higher average trading amounts and these were only in four deciles. The Paris Euronext market clearly dominates in the average trade size metric over the WSE.

All of this data indicates that the WSE must increase its liquidity in order to enhance its chances of competing with developed economies stock markets in attracting direct foreign investment. Levine (1991) and Bencivenga (1995) argue that long term growth prospects are dependent upon liquidity in a stock market and the minimisation of certain risks that this feature provides. Also, the minimisation of asymmetric information will be induced by increasing liquidity flows through the number of trades. As mentioned earlier, and as Kairys (2000) suggested, the use of continuous trading facility at the WSE has increased liquidity at the top of the trading scale but may be detrimental to the lower end. As the WSE has only a few of the former, it may wish to increase lower decile trading liquidity, as expressed by the amount of trades, by either lowering transaction costs in the lower deciles (reducing either brokerage fees or stamp duties) or re-introducing the single call auction as suggested by Kairys (2000).

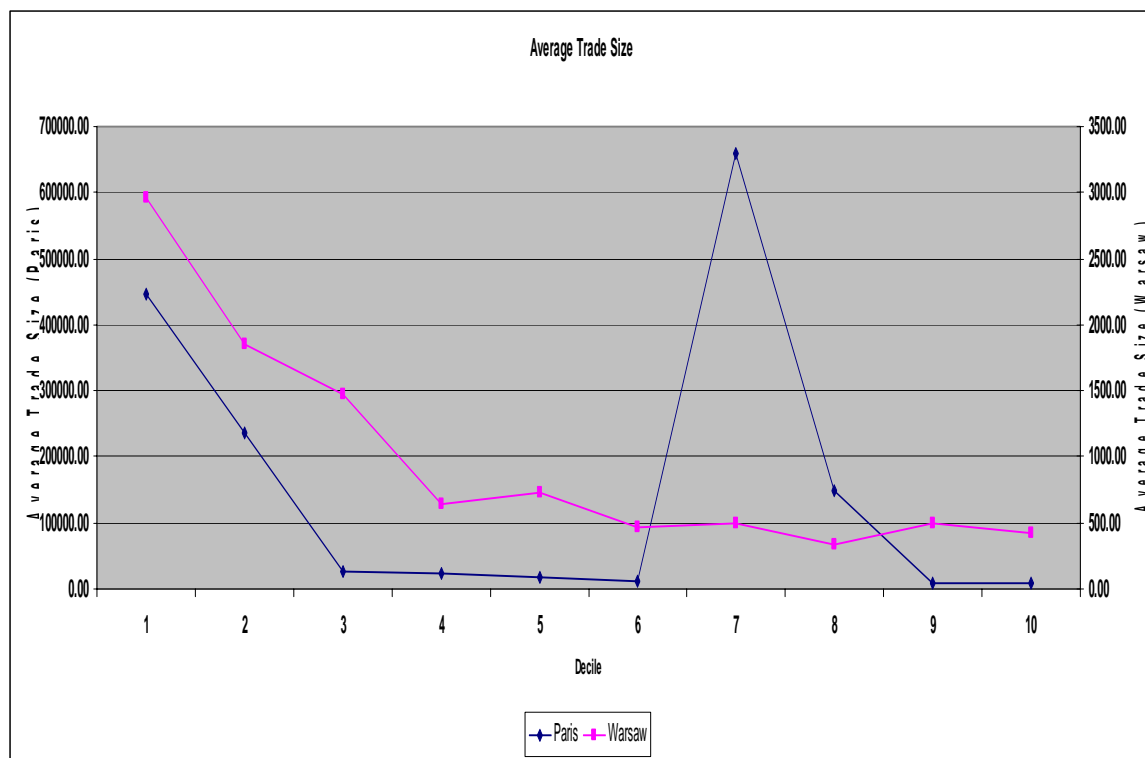
The signed rank test is supported strongly by the Wilcoxon significance test where in every case we see significance at the 1% level using both one and two-tailed testing. Not only is this significant, but the z-score of nearly 13 indicates that there is no question of this significance, as does the asymptotic significance levels much lower than either .01 or .05.

Table 3. Paris Euronext v WSE average number of trades statistical differences.

Number of Trades	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE
	v	v	v	v	v	v	v	v	v	v
Z	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX
Z	-12.97	-12.97	-12.95	-12.95	-12.95	-12.95	-12.97	-12.97	-12.95	-12.95
Asymp. Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (1-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2 presented the interesting case where the average trade number for decile one at the WSE was less than the same relative decile in Paris. It was then suggested that the average trade value would therefore have to be very high in decile one in Paris. This is the case as Figure 3 reports average trade size. Being 49% larger than the second decile shows that average trade value for decile one is in fact orthodox. This also indicates that large block trades exist in Paris while the WSE supports (at least in decile 1) relatively more frequent smaller trading lots^{iv}. Again, the shape of each curve indicates this.

Figure 3. Paris Euronext v WSE average trade size.



In this diagram it is evident that Paris' decile 7 may be anomalous. Again, as in Figure 2, the depth in the Paris market exceeds Warsaw by a ratio of around 28 to 1 in all deciles excluding 7. A relative magnitude of this strength obviously means that the WSE will always rank below the Paris Euronext market in average trade size. Liquidity under this guise allows the researcher to both positively and normatively

state that the WSE is a far smaller market. Applicable to the liquidity results presented thus far is the work of Amihud, Mendelson and Lauterbach (1997) who showed that when the Te Aviv stock exchange introduced continuous trading (as the WSE had done prior to the sample date reported here), liquidity increased but only in the top-end stocks.

In statistical significance terms the same story is true for average trade size as it was for the average number of trades. At the 1% level the WSE is significantly smaller than Paris. This is true for all deciles (See Table A9).

Interestingly in this case, the WSE exhibits stronger relative depth across the first five deciles in comparison to Paris. The percentage fall from decile one to five is much smaller than the Paris decline. This is contrary to the number of trades data where Paris showed greater signs of depth than the WSE.

Table 4. Paris Euronext v WSE average trade size statistical differences.

Average Trade Size	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE
	v	v	v	v	v	v	v	v	v	v
Z	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX
Z	-12.98	-12.98	-12.95	-12.95	-12.95	-12.95	-12.98	-12.98	-12.95	-12.95
Asymp. Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (1-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

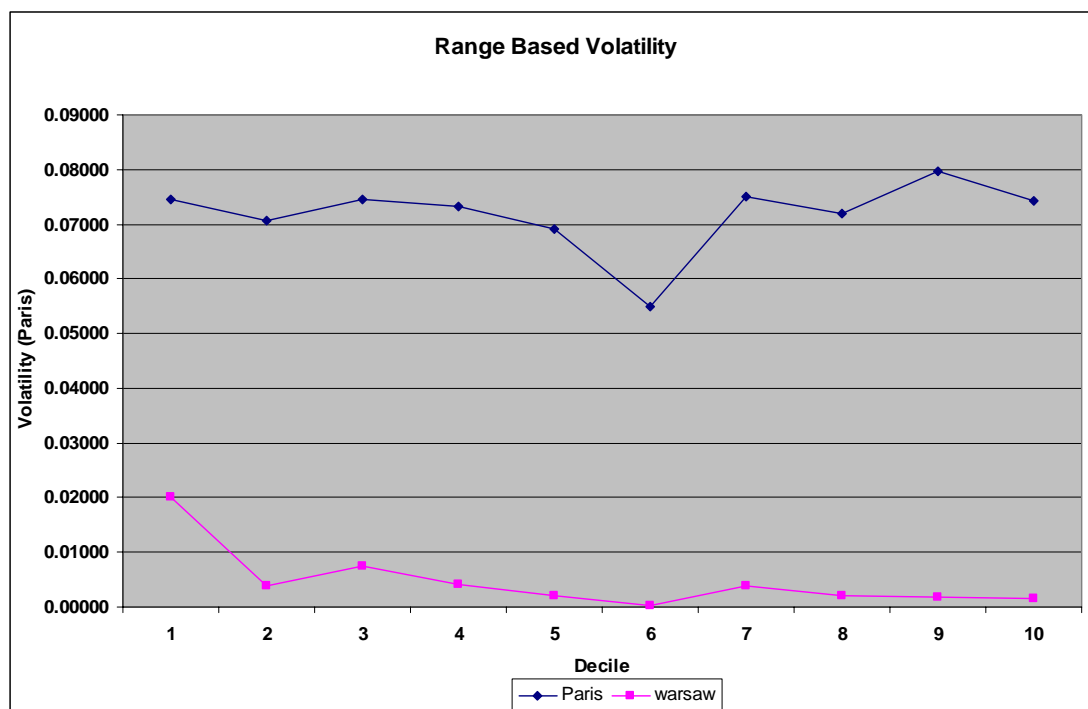
While liquidity is a major determinant of market quality so to is the volatility that an investor faces. This paper uses a range based volatility measure which is in accordance with such authors Alizadeh, Brandt and Diebold (2002).

Volatility is often associated with limited liquidity as the price will only be impacted upon by information infrequently. Volatility may also be subject to information flows in a liquid stock but will have less dramatic and discrete effects. Kairys (2000) asserted that the introduction of continuous trading at the WSE and two other transition economy stock exchanges led to greater liquidity in the lost liquid stocks at the possible expense of the less liquid stocks. He therefore, suggested that a transition economy's stock market should have a tiered system where the lower liquid stocks are actually priced off a daily single call auction. His treatment of volatility though was limited.

Figure 4, a representation of the volatility for each market across all deciles is quite clear. Each market can be compared against the other and to itself among each of the deciles. Paris is reasonably static across the decile range except for decile 6. Typically, range-based volatility varies between 7% and 8%. The WSE on the other hand shows much smaller absolute variance in daily price changes. This is more than likely due to the smaller nature of both average trading numbers and the size of the trades when they are executed. This is due to the use of continuous trading at the WSE as opposed to the single call auctions used in other emerging stock markets in the former communist nations of Central Europe. Also evident, is the fact that the

more liquid decile 1 experiences almost twice the volatility as the less liquid deciles. This is contrary to the theoretical literature and requires further analysis in the future.

Figure 4. Paris Euronext v WSE range based volatility.



Hermes and Lensink (2000) suggest that due to the thin markets typically associated with the transition economies of Central Europe excessive volatility may be a problem. This is clearly not the case here and is evident when looking at both tables 8 and 9. Table A10 shows that the WSE is statically less volatile in all deciles than Euronext Paris.

In terms of policy changes, the WSE may want to reintroduce the single call auction for stock inhabiting the lower deciles of market capitalisation. While much of the theoretical literature, including such authorities as Easley, Keifer, O'Hara, and Paperman (1996), suggest that the continuous trading mechanism results in lower transaction costs, they may want to follow the recommendation of Kairys (2000). This is particularly evident given the low volatility being exhibited at the WSE across all deciles when compared to the Euronext in Paris. Even though the discretisation of the trading mechanism may increase volatilities, as information may only be impounded occasionally, the evidence suggests that liquidities may be increased with the single call auction market-microstructure. This may come at the expense of volatility but increase trading and therefore, the development of the exchange itself. However, it must be noted that an endogenous issue may be present due to the unknown nature of the exact relationship between volumes and range based volatility.

Table 5. Paris Euronext v WSE range based volatility statistical differences.

Range Based Volatility	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE	WSE
	v	v	v	v	v	v	v	v	v	v
	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX	ENX
Z	12.29	12.97	12.95	12.95	12.95	12.95	12.98	12.98	12.73	12.95
Asymp. Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (2-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monte Carlo Sig. (1-tailed)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4. Conclusion

This study shows that in most areas of market quality, the stock exchange in a representative transition economy WSE is inferior to the stock market in a developed economy, the Euronext. Liquidity is significantly higher in trading volumes, average trade size and trade value. An interesting result is that WSE exhibits much smaller volatility than the Euronext. The low volatility is clearly a side effect of lower trading activity on the WSE than in Euronext Paris. However, since some of the highest capitalisation stocks on the WSE exhibit lower transaction costs than similarly sized companies on Euronext Paris, the WSE is an interesting alternative for foreign investors that seek to add liquid low risk stocks to their portfolios.

To provide a method for comparing the capital market of a fully developed economy to the capital market of a transition economy the differences in four measures of market quality for two representative markets are investigated. This has allowed a normative statement to be made that the emerging market of the Polish Transition economy is at a stage equal to that of many other emerging markets. Even though the Polish economy has grown strongly since ‘independence’ in 1989 it still requires further development. Statements of this nature are often made but not substantiated. Both markets have used the same trading platform yet produce different investment universes where investors face different outcomes in the form of return levels and variance. Even if the same systematic information were to flow simultaneously between these markets an investor at the WSE may suffer from lack of liquidity. Also, as transaction costs are nearly always higher in Poland than France, investors may simply be shunning the market. This is apparent when analysing the amount of trading going on in both markets. Policy makers in Poland need to analyse these data to attempt to attract not only domestic investment but also foreign investments and listings. Indeed, on Euronext Paris, some of the largest and most active companies are large European and US companies that trade on the Euronext as simultaneously^v. The WSE may be able to attract companies from other neighbouring emerging markets. A strong argument for the potential competitiveness of the WSE is the observation that a few of the highest capitalisation stocks on the WSE exhibit lower transaction costs and volatility than similarly sized companies on Euronext Paris.

To further the work completed in this study it would be interesting to investigate similar data covering a longer time period and to test for changes in market quality as a result of market-microstructure reforms. Also, of particular interest would be the

measurement due to the liquidity and volatility impacts of the introduction of equity derivatives on the WSE.

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Description of costs

Appendix : Descriptive Statistics

Table A1. Paris descriptive statistics

DECILE 1							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	66,468,339,287	59,546,105,623	39,739,044,094	99,990,363,903	20,572,791,000	0.3183067	-1.3122403
Market to Book	1.7194	0.0000	-12.0700	32.6800	9.2758	1.3926	3.2638
Traded Volume	1829492.3600	664239.0000	1.0000	61071172.0000	3172430.9600	4.0774	33.1244
Closing Price	175.0141	75.0000	3.3400	2525.5000	458.2687	4.3413	17.2281
Effective Spread	0.0041	0.0020	0.0004	0.0702	0.0048	3.4477	21.6241
Range Based Vol	0.0412	0.0350	0.0000	1.4258	0.0304	15.8360	653.3305
Avg Trade Size	51851.9300	23671.2300	20.0970	72481203.5300	1165728.5000	51.7838	2830.9900
Number of Trades	1553.0300	893.0002	1.0000	25166.0000	2025.8800	2.5455	12.5722
DECILE 2							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	23,126,820,603	19,354,844,325	12,851,648,844	39,379,075,390	9,298,646,112	0.6048354	-1.1446575
Market to Book	-2.2633	0.0000	-47.1800	33.0300	16.2596	-0.8156	2.5714
Traded Volume	943085.6200	481599.0000	1.0000	49149336.0000	2018537.9700	9.3221	142.6853
Closing Price	106.3126	81.3000	6.4000	476.0000	71.6126	1.4767	3.9722
Effective Spread	0.0032	0.0022	0.0002	0.0723	0.0031	6.7632	99.3145
Range Based Vol	0.0415	0.0314	0.0000	2.3336	0.0553	16.4552	538.0613
Avg Trade Size	84011.4000	24289.8800	0.0011	81398558.0300	1626732.5600	34.4179	1376.4100
Number of Trades	1372.9600	1229.0000	1.0000	23673.0000	1220.4900	2.8808	27.8992
DECILE 3							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	9,912,765,903	10,187,572,161	7,154,366,454	12,201,414,629	1,534,420,473	-0.4417224	-0.8704859
Market to Book	-14.3729	3.9000	-371.8500	68.5600	92.9356	-3.4438	10.5047
Traded Volume	522209.9200	328491.0000	536.0000	13133191.0000	667378.4400	5.7870	64.3978
Closing Price	87.3923	56.0000	3.1000	846.0000	93.9194	3.5615	19.7393
Effective Spread	0.0038	0.0023	0.0003	0.3783	0.0070	27.9058	1345.7200
Range Based Vol	0.0410	0.0346	0.0044	0.4364	0.0252	2.6907	16.8405
Avg Trade Size	19840.4400	16281.4200	165.7277	371949.6200	18437.7900	5.9133	74.0297
Number of Trades	947.4031	796.0002	1.0002	24419.0000	869.8210	6.5441	111.3152
DECILE 4							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	4,446,593,039	4,319,753,468	3,425,354,826	6,136,443,970	814,726,974	0.5429187	-0.9042974
Market to Book	15.0009	1.2600	-81.0600	286.8100	71.2886	3.1123	9.6488
Traded Volume	337353.0000	135285.0000	23.0000	53932576.0000	970083.6900	30.1591	1463.5500
Closing Price	102.5607	49.6000	5.6400	1550.0000	167.7729	4.9615	30.7464
Effective Spread	0.0041	0.0030	0.0002	0.2816	0.0059	21.0322	786.8290
Range Based Vol	0.0440	0.0345	0.0000	11.4624	0.1819	57.0794	3355.7600
Avg Trade Size	16587.9500	12069.3200	476.5691	765581.6000	23553.0400	11.9451	256.0761
Number of Trades	488.0187	392.0002	1.0002	8774.0000	437.5231	4.9116	61.6749

DECILE 5

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	2,571,633,615	2,407,236,300	2,044,163,536	3,366,323,483	390,082,050	0.4937253	-0.9404266
Market to Book	18.7202	2.7200	-8.5900	248.4000	60.6864	3.4974	10.3325
Traded Volume	353703.5200	43305.0000	23.0000	35645126.0000	1162720.0700	9.7028	178.9043
Closing Price	89.9814	75.9000	0.6300	348.5000	78.4070	1.4084	1.8818
Effective Spread	0.0058	0.0042	0.0003	0.1217	0.0053	4.6427	50.5075
Range Based Vol	0.0415	0.0325	0.0000	12.7434	0.1649	74.8055	5763.7100
Avg Trade Size	13587.2400	9014.3600	783.6521	567117.3000	20520.4800	10.2699	170.9150
Number of Trades	323.2853	171.0002	1.0000	6203.0000	457.8917	4.2412	27.0501

DECILE 6

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	1,477,904,395	1,551,126,259	1,099,793,146	1,810,079,152	250,899,666	-0.1836424	-1.5634432
Market to Book	-7.4587	0.0000	-102.2200	9.8500	25.9766	-3.0082	8.0292
Traded Volume	77147.0100	22602.5000	30.0000	2777782.0000	165981.4800	5.7052	49.4118
Closing Price	79.5585	55.4000	1.8000	320.2000	63.7578	1.7222	2.9691
Effective Spread	0.0077	0.0052	0.0004	0.7741	0.0128	35.2639	2012.2800
Range Based Vol	0.0395	0.0284	0.0000	8.8192	0.1144	70.2412	5387.4900
Avg Trade Size	9839.8300	5878.4200	40.4387	860197.4300	23030.7000	17.4961	456.2008
Number of Trades	321.0425	124.0002	1.0000	29917.0000	946.3556	17.0152	422.8690

DECILE 7

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	983,572,129	958,972,399	889,560,523	1,099,598,789	73,157,258	0.2915005	-1.360433
Market to Book	7.2800	3.0000	-30.7000	67.8000	21.4909	1.1372	2.2208
Traded Volume	641182.7800	35829.0000	10.0000	35524745.0000	2513790.3700	5.6025	37.0491
Closing Price	69.3686	42.8350	0.5300	723.5000	101.6326	3.9425	18.0138
Effective Spread	0.0085	0.0062	0.0002	0.1907	0.0088	6.4351	83.7903
Range Based Vol	0.0594	0.0442	0.0000	11.3145	0.2315	42.4570	1891.4900
Avg Trade Size	37926.2400	5236.8700	33.9866	72409247.8700	999358.1400	67.6721	4804.6200
Number of Trades	763.8176	130.0002	1.0000	33958.0000	2755.5200	5.5686	35.2763

DECILE 8

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	748,117,148	756,249,769	599,216,371	861,573,834	75,391,609	-0.3845134	-0.8826003
Market to Book	21.2559	4.7600	-16.4500	219.8300	55.4109	3.1528	8.4980
Traded Volume	231486.0500	23169.5000	60.0000	17449623.0000	696116.0100	8.6110	129.0857
Closing Price	56.7602	37.5000	0.5100	298.7000	55.6158	1.6356	2.4914
Effective Spread	0.0107	0.0089	0.0003	0.2524	0.0095	8.1163	157.7402
Range Based Vol	0.0495	0.0335	0.0000	10.4850	0.2388	39.5541	1654.4900
Avg Trade Size	15049.8000	4314.4300	239.3486	21456038.0700	349550.8700	55.2777	3131.1300
Number of Trades	210.2521	98.0002	1.0000	3741.0000	315.4526	3.5136	15.5612

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DECILE 9

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	507,618,493	516,698,362	437,899,307	596,196,889	50,609,709	0.0524102	-1.3840775
Market to Book	1.8760	0.0000	-11.2000	16.9500	7.0542	0.4158	-0.0863
Traded Volume	99435.1800	22274.0000	34.0000	3650456.0000	224862.5900	5.6767	52.1333
Closing Price	57.4191	49.5500	0.3800	425.0000	53.2154	2.9973	16.4241
Effective Spread	0.0094	0.0075	0.0006	0.1896	0.0074	5.9744	110.2461
Range Based Vol	0.0616	0.0382	0.0000	11.8663	0.3384	28.8934	873.5678
Avg Trade Size	13005.0300	4226.3300	149.2261	1144547.6000	34886.7400	12.5267	283.0011
Number of Trades	261.7206	92.0002	1.0002	6834.0000	509.8178	4.6902	31.9109

DECILE 10

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	294,980,681	335,161,037	119,184,795	410,576,977	82,010,368	-0.7817271	-0.5958222
Market to Book	15.8662	0.0000	-60.2000	309.9900	76.6263	3.3460	10.2176
Traded Volume	35886.2200	13733.0000	1.0000	1341949.0000	69959.0500	6.9827	85.2036
Closing Price	67.8686	45.9000	1.1900	759.0000	90.8395	4.2123	21.6486
Effective Spread	0.0156	0.0109	0.0005	1.2786	0.0326	17.2245	466.5798
Range Based Vol	0.0771	0.0477	0.0000	11.1053	0.4138	22.2221	508.5798
Avg Trade Size	7538.7600	3941.0500	34.6978	586057.3900	16293.6700	17.4390	492.0467
Number of Trades	134.2033	62.0002	1.0000	4969.0000	256.7872	7.0074	74.4475

Table A2. Warsaw descriptive statistics

DECILE 1							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	1,233,728,391	938,678,488	627,053,321	2,680,177,947	697,636,188	1.1009522	-0.2007475
Market to Book	1.5821	0.9300	0.6000	3.5100	1.1393	0.9699	-0.9602
Traded Volume	194202.4800	58901.5000	8.0000	2631377.0000	323558.4100	2.9560	11.4290
Closing Price	19.4251	19.9500	10.0000	27.3000	4.8390	-0.3373	-0.9418
Effective Spread	0.0052	0.0039	0.0002	0.0562	0.0048	4.4662	31.5544
Range Based Vol	0.0268	0.0243	0.0000	0.1272	0.0170	1.2872	3.4040
Avg Trade Size	3827.9700	3284.4200	141.0600	163844.9400	5211.2600	19.4654	552.2657
Number of Trades	286.3102	186.5002	1.0002	2946.0000	327.8883	2.4563	9.4808

DECILE 2							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	312,814,452	276,672,605	158,613,560	619,731,957	145,569,894	0.9268527	-0.1349971
Market to Book	1.5082	1.4600	-2.1700	4.3300	1.8083	-0.4858	-0.0111
Traded Volume	85189.8400	45387.5000	8.0000	2824318.0000	162291.9700	8.1021	100.7898
Closing Price							
Effective Spread	0.0098	0.0048	0.0002	0.2322	0.0133	5.6747	58.8707
Range Based Vol	0.0193	0.0153	0.0000	0.1451	0.0208	1.5407	3.8044
Avg Trade Size	2549.5400	1761.0800	44.4564	66304.7600	3721.1200	8.1509	93.6518
Number of Trades	200.0598	109.0002	1.0000	3481.0000	259.9298	3.5450	23.3130

DECILE 3							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	104,286,939	98,205,729	80,568,245	145,920,493	20,017,505	0.8209199	-0.2235387
Market to Book	5.6630	1.2000	0.0000	37.3100	12.0005	2.2468	3.0921
Traded Volume	14721.5700	7882.0000	3.0000	1179357.0000	33723.8100	23.5332	791.0339
Closing Price	30.2814	30.0000	26.1000	35.3000	1.7020	0.3401	0.5314
Effective Spread	0.0109	0.0052	0.0002	0.2922	0.0186	6.3081	62.1079
Range Based Vol	0.0227	0.0208	0.0000	0.1482	0.0183	1.3721	3.8724
Avg Trade Size	2131.6000	1364.1100	66.0960	54185.9700	3457.9300	7.6393	76.5148
Number of Trades	51.5584	31.0002	1.0000	446.0002	57.8576	2.2639	6.9982

DECILE 4							
Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	64,458,788	65,443,028	52,575,712	79,341,975	7,898,058	0.3545071	-0.5104674
Market to Book	0.5278	0.4700	0.0000	2.4300	0.7747	1.7263	1.7321
Traded Volume	21281.0900	3714.5000	1.0000	1066206.0000	64766.9100	9.0139	110.6823
Closing Price	12.7788	12.9000	10.5000	14.7500	1.0001	-0.2732	-1.0112
Effective Spread	0.0176	0.0122	0.0002	0.3042	0.0219	4.7382	39.6270
Range Based Vol	0.0195	0.0131	0.0000	0.1727	0.0236	2.0873	6.3300
Avg Trade Size	1316.4900	689.4460	3.9264	104007.1400	4103.1800	16.8627	358.4316
Number of Trades	48.6498	18.0002	1.0000	377.0000	60.7604	1.8522	3.5783

DECILE 5

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	42,758,629	41,695,072	38,152,737	49,548,645	4,540,213	0.3581757	-1.6556016
Market to Book	0.6403	0.4500	0.0000	2.4300	0.7574	1.4596	1.1263
Traded Volume	60625.8700	10353.0000	1.0000	5325692.0000	230471.8600	14.1443	257.1407
Closing Price							
Effective Spread	0.0191	0.0122	0.0002	0.1922	0.0202	3.1761	15.5406
Range Based Vol	0.0151	0.0052	0.0000	0.2032	0.0205	2.3648	10.0828
Avg Trade Size	960.2373	709.4528	3.9614	41459.7100	1606.2600	17.1149	383.2831
Number of Trades	52.1536	26.0002	1.0000	2481.0000	115.7893	11.6112	186.4849

DECILE 6

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	31,174,082	29,362,437	27,356,068	36,564,135	3,296,468	0.5027776	-1.4444846
Market to Book	0.3242	0.1900	0.0000	0.8700	0.3499	0.3722	-1.5480
Traded Volume	16917.2000	5030.5000	1.0000	1093162.0000	50711.5700	12.1228	206.2435
Closing Price	19.0836	17.3500	14.0000	29.0000	3.7398	0.8746	-0.8433
Effective Spread	0.0301	0.0202	0.0002	0.7082	0.0357	6.4634	85.1965
Range Based Vol	0.0081	0.0002	0.0000	0.1555	0.0170	2.9706	11.3431
Avg Trade Size	973.8952	561.5671	1.8502	54863.1000	2231.7800	12.6418	246.2423
Number of Trades	46.0551	24.0000	1.0000	406.0002	53.0633	2.1540	5.7120

DECILE 7

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	22,923,966	23,150,509	21,331,684	24,352,386	1,021,774	-0.3546299	-1.1721963
Market to Book	0.3659	0.4200	0.0000	1.2100	0.4218	0.8044	-0.5809
Traded Volume	19963.7800	4311.5000	3.0000	895847.0000	51609.5600	7.2951	81.0390
Closing Price	23.1613	22.6000	16.9000	31.9000	3.7571	0.3390	-0.9786
Effective Spread	0.0283	0.0162	0.0002	0.7562	0.0476	7.7562	93.1003
Range Based Vol	0.0205	0.0132	0.0000	0.2550	0.0265	2.3392	8.6255
Avg Trade Size	966.9492	557.2995	6.1748	84304.1000	2885.5600	18.3541	452.3687
Number of Trades	52.5115	17.0002	1.0000	970.0000	90.2361	3.9723	22.2318

DECILE 8

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	16,125,153	15,263,597	14,024,730	19,720,776	2,022,176	0.6427077	-1.1151182
Market to Book	0.2500	0.0000	0.0000	0.9300	0.3338	0.9660	-0.4260
Traded Volume	18153.7300	5168.0000	1.0000	924252.0000	50327.8400	9.1137	116.4510
Closing Price	49.6948	49.4000	47.0000	52.5000	1.4407	0.1144	-1.0948
Effective Spread	0.0265	0.0151	0.0002	0.8322	0.0410	7.6420	110.6185
Range Based Vol	0.0163	0.0055	0.0000	0.2030	0.0233	2.3120	7.6908
Avg Trade Size	954.0478	412.3993	2.3500	131484.4800	4171.5900	22.2722	628.9350
Number of Trades	46.5852	20.0002	1.0000	645.0002	59.5869	2.3324	9.8799

DECILE 9

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	11,354,363	11,245,593	9,689,545	13,512,986	1,245,722	0.4374624	-0.8631401
Market to Book	0.0615	0.0000	0.0000	0.3800	0.1400	1.8376	1.3786
Traded Volume	20927.7900	7102.0000	1.0000	990025.0000	47230.4700	9.4257	149.5964
Closing Price							
Effective Spread	0.0315	0.0168	0.0002	2.8522	0.0885	24.6780	768.5263
Range Based Vol	0.0233	0.0018	0.0000	6.5196	0.1805	33.6590	1202.1300
Avg Trade Size	1170.9000	504.1408	0.3811	113730.5000	4224.3400	18.3470	433.7918
Number of Trades	34.2629	13.0000	1.0000	474.0002	51.1131	2.7770	10.4407

DECILE 10

Variable	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
Market Capitalisation	5,884,419	6,209,064	1,906,295	9,002,580	2,364,245	-0.2175821	-1.1726229
Market to Book	0.5047	0.0000	0.0000	3.3100	1.0981	2.0822	2.5439
Traded Volume	38097.0800	5119.0000	1.0000	5325692.0000	221913.9900	15.9631	305.0204
Closing Price	4.2026	3.5000	0.9300	10.7500	2.8382	0.4955	-1.1617
Effective Spread	0.0282	0.0202	0.0002	0.4922	0.0296	4.8665	49.8122
Range Based Vol	0.0231	0.0024	0.0000	1.1793	0.0456	10.7481	239.9613
Avg Trade Size	616.0634	389.0500	0.5769	34381.7000	1270.4500	17.5405	406.6556
Number of Trades	35.6149	16.0000	1.0000	2481.0000	111.6019	13.2567	223.6229

Table A3. Transaction costs

Transaction Costs		Descriptive Statistics							
	Decile	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
							25th	50th (Median)	75th
Paris	1	224	0.00519	0.03867	0.00187	0.58133	0.00232	0.00251	0.00279
Warsaw	1	224	0.00418	0.00080	0.00245	0.00763	0.00368	0.00414	0.00460
Paris	2	224	0.00487	0.03632	0.00058	0.54593	0.00220	0.00239	0.00263
Warsaw	2	224	0.00643	0.00119	0.00342	0.01000	0.00560	0.00629	0.00722
Paris	3	223	0.00538	0.03999	0.00192	0.59976	0.00236	0.00259	0.00292
Warsaw	3	224	0.00656	0.00167	0.00307	0.01312	0.00538	0.00633	0.00749
Paris	4	223	0.00628	0.04669	0.00199	0.70034	0.00262	0.00311	0.00347
Warsaw	4	224	0.01137	0.00428	0.00332	0.02695	0.00818	0.01062	0.01366
Paris	5	223	0.00929	0.06903	0.00252	1.03529	0.00394	0.00446	0.00498
Warsaw	5	224	0.01310	0.00366	0.00353	0.02584	0.01067	0.01273	0.01542
Paris	6	223	0.01111	0.08259	0.00331	1.23877	0.00480	0.00543	0.00612
Warsaw	6	224	0.02113	0.00690	0.00590	0.04287	0.01600	0.02015	0.02542
Paris	7	224	0.01278	0.09523	0.00088	1.43153	0.00535	0.00609	0.00724
Warsaw	7	224	0.01674	0.00655	0.00333	0.03929	0.01225	0.01568	0.02001
Paris	8	224	0.01601	0.11929	0.00464	1.79310	0.00661	0.00769	0.00884
Warsaw	8	224	0.01568	0.00636	0.00277	0.04310	0.01114	0.01474	0.01854
Paris	9	223	0.01488	0.11065	0.00469	1.65961	0.00619	0.00710	0.00834
Warsaw	9	224	0.01804	0.00889	0.00386	0.05530	0.01194	0.01658	0.02330
Paris	10	223	0.02298	0.17084	0.00657	2.56242	0.00979	0.01121	0.01287
Warsaw	10	224	0.01945	0.00788	0.00363	0.04138	0.01332	0.01949	0.02461

Table A4. Number of trades

Number of Trades	Descriptive Statistics								
	Decile	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
							25th	50th (Median)	75th
Paris	1	224	923.12	6878.20	2.00	103389.23	382.98	453.54	538.92
Warsaw	1	224	145.65	52.15	58.87	353.27	107.54	136.74	173.16
Paris	2	224	1823.37	13585.77	1.59	204217.54	767.55	886.56	1058.33
Warsaw	2	224	103.98	38.67	13.74	287.50	77.18	97.17	122.72
Paris	3	223	1414.52	10515.27	137.30	157718.90	603.50	690.06	802.15
Warsaw	3	224	30.54	13.39	7.88	81.15	20.09	27.36	37.39
Paris	4	223	727.46	5407.75	64.56	81111.58	322.87	365.75	419.22
Warsaw	4	224	23.02	8.97	8.18	55.13	15.26	22.42	28.82
Paris	5	223	401.92	2987.84	36.91	44814.32	176.91	202.30	230.87
Warsaw	5	224	27.83	13.54	8.77	74.36	16.46	25.39	35.35
Paris	6	223	283.61	2108.39	30.05	31621.96	119.81	142.86	168.30
Warsaw	6	224	27.03	10.38	9.34	73.35	19.59	26.93	33.28
Paris	7	224	325.47	2425.21	2.00	36453.11	128.61	159.68	192.58
Warsaw	7	224	24.28	14.79	5.92	81.76	14.08	20.13	30.40
Paris	8	224	237.65	1770.71	2.00	26616.69	99.92	117.63	135.43
Warsaw	8	224	20.99	9.99	5.69	52.65	12.43	19.04	28.46
Paris	9	223	221.57	1647.13	21.38	24705.07	94.78	108.20	126.01
Warsaw	9	224	15.76	6.48	4.38	37.58	10.72	15.07	19.87
Paris	10	223	122.06	907.42	12.09	13609.59	49.72	58.65	71.09
Warsaw	10	224	16.97	7.07	2.88	73.31	12.74	15.72	20.03

Table A5. Average trade size

Average Trade Size	Descriptive Statistics								
	Decile	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
							25th	50th (Median)	75th
Paris	1	224	447141.84	4534686.95	11657.71	50079885.84	16277.95	17640.74	19527.39
Warsaw	1	224	2954.42	814.54	1320.72	7348.68	2443.57	2872.35	3288.91
Paris	2	224	234836.50	2251186.56	8250.07	26301687.55	19276.76	21892.59	24660.46
Warsaw	2	224	1858.61	543.72	729.47	4013.20	1494.75	1763.08	2136.54
Paris	3	223	27518.13	204558.78	7329.08	3068271.39	12020.42	13644.50	15154.19
Warsaw	3	224	1472.60	450.80	558.63	3139.57	1143.38	1421.22	1730.64
Paris	4	223	24248.41	180265.63	5969.56	2703698.26	10111.08	11714.97	13588.15
Warsaw	4	224	644.71	258.28	228.13	2050.04	470.73	586.03	747.55
Paris	5	223	18813.53	139855.97	5371.81	2097708.68	8247.70	9290.99	10310.11
Warsaw	5	224	723.40	237.73	236.58	1703.77	538.45	723.88	875.28
Paris	6	223	11007.64	81829.70	3240.22	1227352.00	4545.93	5378.04	6374.43
Warsaw	6	224	468.79	175.57	154.86	1103.85	341.74	445.66	558.34
Paris	7	224	658127.82	6887727.89	2271.63	73710316.00	3936.87	5200.84	7620.65
Warsaw	7	224	502.07	216.50	124.11	1469.92	339.45	466.48	633.02
Paris	8	224	147804.26	1505463.29	2546.51	16554077.26	4599.54	5171.17	6003.98
Warsaw	8	224	328.80	124.61	83.36	705.51	233.42	316.17	401.12
Paris	9	223	9346.82	69481.24	2824.13	1042169.97	4049.78	4612.77	5217.05
Warsaw	9	224	494.63	241.06	115.96	1833.40	321.09	458.49	630.94
Paris	10	223	7317.57	54409.20	1501.60	815909.50	2460.73	3486.60	4699.06
Warsaw	10	224	422.24	152.54	135.72	1268.63	316.56	403.05	506.17

Table A6. Range based volatility

Range Based Volatility	Descriptive Statistics								
	Decile	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
							25th	50th (Median)	75th
Paris	1	224	0.07445	0.55479	0.00383	8.33835	0.02970	0.03562	0.04287
Warsaw	1	224	0.02023	0.00855	0.00352	0.04416	0.01456	0.01981	0.02626
Paris	2	224	0.07074	0.52719	0.00000	7.92295	0.02728	0.03212	0.03935
Warsaw	2	224	0.00378	0.00286	0.00027	0.02246	0.00181	0.00314	0.00493
Paris	3	223	0.07444	0.55352	0.01774	8.30054	0.02892	0.03490	0.04106
Warsaw	3	224	0.00739	0.00448	0.00030	0.02463	0.00483	0.00622	0.00937
Paris	4	223	0.07331	0.54513	0.01774	8.17436	0.02930	0.03353	0.03988
Warsaw	4	224	0.00407	0.00339	0.00014	0.01865	0.00178	0.00310	0.00541
Paris	5	223	0.06902	0.51326	0.01712	7.69627	0.02705	0.03132	0.03772
Warsaw	5	224	0.00209	0.00180	0.00013	0.01140	0.00086	0.00156	0.00283
Paris	6	223	0.05481	0.40755	0.00837	6.11159	0.02107	0.02657	0.03200
Warsaw	6	224	0.00031	0.00029	0.00001	0.00169	0.00012	0.00023	0.00039
Paris	7	224	0.07504	0.55926	0.00034	8.40395	0.02443	0.03673	0.04478
Warsaw	7	224	0.00378	0.00336	0.00005	0.02309	0.00142	0.00277	0.00488
Paris	8	224	0.07202	0.53681	0.00819	8.06579	0.02723	0.03305	0.03890
Warsaw	8	224	0.00204	0.00217	0.00008	0.01678	0.00063	0.00133	0.00276
Paris	9	223	0.07959	0.59189	0.01537	8.87463	0.03103	0.03631	0.04498
Warsaw	9	224	0.00173	0.00729	0.00001	0.10689	0.00023	0.00058	0.00147
Paris	10	223	0.07423	0.55200	0.01293	8.27696	0.02708	0.03492	0.04430
Warsaw	10	224	0.00148	0.00180	0.00002	0.01148	0.00038	0.00086	0.00190

Table A7. Wilcoxon signed rank test of transaction costs across deciles; Paris Euronext v WSE

Transaction Costs					
Ranks		N	Mean Rank	Sum of Ranks	
Decile 1 WSE v Euronext	Negative Ranks	5	95	475	WSE<Euronext
	Positive Ranks	219	112.90	24725	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 2 WSE v Euronext	Negative Ranks	1	224	224	WSE<Euronext
	Positive Ranks	223	112	24976	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 3 WSE v Euronext	Negative Ranks	1	223	223	WSE<Euronext
	Positive Ranks	222	111.5	24753	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 4 WSE v Euronext	Negative Ranks	1	223	223	WSE<Euronext
	Positive Ranks	222	111.5	24753	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 5 WSE v Euronext	Negative Ranks	4	57.75	231	WSE<Euronext
	Positive Ranks	219	112.99	24745	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 6 WSE v Euronext	Negative Ranks	1	223	223	WSE<Euronext
	Positive Ranks	222	111.5	24753	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 7 WSE v Euronext	Negative Ranks	5	50.4	252	WSE<Euronext
	Positive Ranks	219	113.92	24948	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 8 WSE v Euronext	Negative Ranks	16	66	1056	WSE<Euronext
	Positive Ranks	208	116.08	24144	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 9 WSE v Euronext	Negative Ranks	22	28.32	623	WSE<Euronext
	Positive Ranks	201	121.16	24353	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 10 WSE v Euronext	Negative Ranks	42	55	2310	WSE<Euronext
	Positive Ranks	181	125.23	22666	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			

**Table A8. Wilcoxon signed rank test of average trade numbers across deciles;
Paris Euronext v WSE**

Number of Trades					
Ranks		N	Mean Rank	Sum of Ranks	
Decile 1 WSE v Euronext	Negative Ranks	223	112.99	25196	WSE<Euronext
	Positive Ranks	1	4	4	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 2 WSE v Euronext	Negative Ranks	223	113	25199	WSE<Euronext
	Positive Ranks	1	1	1	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 3 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 4 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 5 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 6 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 7 WSE v Euronext	Negative Ranks	223	113	25199	WSE<Euronext
	Positive Ranks	1	1	1	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 8 WSE v Euronext	Negative Ranks	223	113.00	25198	WSE<Euronext
	Positive Ranks	1	2	2	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 9 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 10 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			

Table A9. Wilcoxon signed rank test of average trade size across deciles; Paris Euronext v WSE

Average Trade Size					
Ranks		N	Mean Rank	Sum of Ranks	
Decile 1 WSE v Euronext	Negative Ranks	224	112.50	25200	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 2 WSE v Euronext	Negative Ranks	224	112.50	25200	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 3 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 4 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 5 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 6 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 7 WSE v Euronext	Negative Ranks	224	112.5	25200	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 8 WSE v Euronext	Negative Ranks	224	112.5	25200	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 9 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 10 WSE v Euronext	Negative Ranks	223	112	24976	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			

Table A10. Wilcoxon signed rank test of range based volatility across deciles; Paris Euronext v WSE

Range Based Volatility					
Ranks		N	Mean Rank	Sum of Ranks	
Decile 1 WSE v Euronext	Negative Ranks	207	118.51	24532.00	WSE<Euronext
	Positive Ranks	17	39.29	668.00	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 2 WSE v Euronext	Negative Ranks	223	113.00	25199.00	WSE<Euronext
	Positive Ranks	1	1	1	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 3 WSE v Euronext	Negative Ranks	223	112.00	24976.00	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 4 WSE v Euronext	Negative Ranks	223	112.00	24976.00	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 5 WSE v Euronext	Negative Ranks	223	112.00	24976.00	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 6 WSE v Euronext	Negative Ranks	223	112.00	24976.00	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 7 WSE v Euronext	Negative Ranks	224	112.50	25200.00	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 8 WSE v Euronext	Negative Ranks	224	112.50	25200.00	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	224			
Decile 9 WSE v Euronext	Negative Ranks	222	111.54	24762.00	WSE<Euronext
	Positive Ranks	1	214	214	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			
Decile 10 WSE v Euronext	Negative Ranks	223	112.00	24976.00	WSE<Euronext
	Positive Ranks	0	0	0	WSE>Euronext
	Ties	0			WSE=Euronext
	Total	223			

ⁱ Transition economy capital markets are an interesting case study as they have not ‘naturally’ formed through economic evolution as in the western economies but rather been superimposed on to the planned economies that they service.

ⁱⁱ The effective spread is doubled to account for the round-trip cost of transacting. A smaller spread indicates lower transaction costs.

ⁱⁱⁱ Other data measured but explicitly used in the study include for each decile and across markets the following: market to book ratio, closing price, and log relative minimum tick size,

^{iv} The data used in this paper only includes on market trades reported through the Reuters database. It therefore, excludes off-market trades and indeed upstairs market trades.

^{v v} We exclude these foreign companies from our analysis since even if their market capitalization is great, only a fraction of the interest in these stocks are in France.