High Frequency Trading Readiness in Central Europe

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***Abstract*—This paper addresses the microstructure of Central European public financial markets. The aim of the paper is to justify the development and potential of high frequency trading (HFT) on transition economies regulated markets. The regression analysis is applied over neighborhood economies. The data consists of 642 firm-year observation over years 2010-2012. The evidences show that there is lack of responsiveness of the return on equity towards the stock exchanges co-location.**

Keywords - algorithmic trading; geocoding; home bias; panel

I. INTRODUCTION

High Frequency Trading (HFT) is trading based on rapid and massive order in time and quantity in order to yield on the short term price variation.

The use of HFT is widely used in developed economies [1]–[3], however there is little research thereon on transition economies.

The purpose of this paper is challenging the selected Central European markets for its broker-dealers responsiveness to the HFT opportunities.

The financial entities located in Poland, Slovak Republic, Czech Republic, Hungary, Slovenia and Latvia were sampled. The geographical structure was tested based on a random unbalance panel of the 642 firm-year observation for the period 2010–2012 was applied. The paper follows prior research of H. Hau on the German market and of the Staszkiewiczs' on the Polish market [4], [5], Slovakia [6], [7] and Czech Republic [8] The findings demonstrate that HFT's development is constrained by the entities' origin.

This paper contributes to the prior research by:

- Providing further that co-location of investment companies with exchanges is not profit driven (Section IV).

II. LITERATURE REVIEW

A. High frequency trading

Evidence was found, on developed markets, for an information advantage for high frequency trading due to the proximity of corporate headquarters [4]. This research broadly follows H. Hau's concept. The discussion on HFT is spread over different areas. General discussion focuses on HFT's impact on the market. T. Hendershott et al. confirmed that HFT improves liquidity and enhances access to information on quotes [9]. The improvements resulting from HFT to overall market quality, including bid-ask spreads, liquidity, and transitory price impacts were observed by R. Litzenberger and others [10]. The relation between HFT and LFT (Low frequency trading) is contrasted against each other. In terms of trading, Easley et al. state that HFT will evolve to continue exploiting the structural weaknesses of low-frequency trading [11]. HFT impacts the econometrics in a number of fields like variance/covariance estimations. F. Bandi et al. indicate that the profits yielded by optimal sampling are economically large, statistically significant and robust to realistic transaction costs [12]. This issue resulted in discussion on the autoregressive conditional duration (ACD) models [13], [14]. There was also research conducted on return variance structure [15], stochastic variability for return and time [16] or interpolation of the inequity in the non-synchronized time series [17]. Some researchers indicate that HFT opens new ways for business misconduct. M. Davis et al. showed that automation of the processes leads to cross-disciplinary ethics arbitrage, therefore the organization should assume "wide responsibilities to external market

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participants and society" [18]. Imposed market regulation and supervisory gaps allowed fast traders to earn substantial revenue at the expense of slow traders [19]. J. Hasbrouck and G. Saal claimed that increased low-latency activity did not always lead to the detriment of long-term investors [20]. Both HFT and LFT have an impact on the operational risk measurement [21]. Application of a machine learning method for HFT outperforms technical analysis indicators' parameters typically recommended by practitioners. Overconfident investors tend to perceive themselves to be more competent and are thus more willing to act on their beliefs, leading to higher trading frequency [22].

From the geographical point of view the researcher focused their attention on the German market [4], [23], USA [24], Norway [25], Australia [26], [27], India [28]. For enhanced literature discussion reader might refer to the priory papers [5], [8], [29].

B. Factors influencing return

This paper follows the same factors as stated in previous research on the Polish and Slovak market [6]. The relationship between leverage and profitability, size, market-to-book ratios and stock returns extends to banks was tested by Barber and Lyon [30] and Gropp and Heider [31] and Teixeira, João C. et al. [32]. The home biasness might be attributed to different aspects like. like market liberalization [33], market size [34], and investors' perceptions [35]. The auditor size and brand name and audit obligation is the proxy for the data quality [36]–[38]. For the data robustness the synthetic index relative distance to the closes stock exchange is calculates (as shown IV.B).

Expected sings of the variables and the definitions are summarized in Table 1.

TABLE I. SUMMARY OF VARIABLES DEFINITIONS AND EXPECTED DIRECTIONS

Name of the variable	Symbol	Definitions	Expected sign
Return on Equity (RoE)	Y	Return on equity, being the net profit divided by the equity (a response variable).	Dependent variable
Country	$\boldsymbol{X}_1$	Country of origin of entity a binary vector of variables for Poland, Slovakia, Slovenia, Hungary[1], Czech, Latvia	NA*
License	X_2	A binary variable, a value of 1 indicates the licensed entity otherwise 0.	(-)
Min	X_3	Distance to the closest stock exchange being the minimum distance between the Warsaw and Bratislava Stock Exchanges expressed in km.	?
Distance1	X_4	A binary variable indicated 1 for the entity within a range up to one km from the stock exchange, otherwise 0.	Tested variable
Distance3	X_5	A binary variable indicated 1 for the entity within a range of one to three km from the stock exchange, otherwise 0.	Tested variable
Requirements	X_6	Requirements defined as the ratio of the total equity over total assets.	(+)
Auditor	X_7	A binary variable, takes the value of 1 for the following internationally active companies: EY, KPMG, PWC, Deloitte,BDO, PKF, Mazar, Moore Stephens, otherwise 0.	(+)
Assets(log)	X_8	Logarithm of total assets	(-)
Audited	X_9	A binary variable indicated 1 entity's financial statements were audited otherwise 0.	(+)
Consolidated	X_{10}	A binary variable indicated 1 group financial statements otherwise 0.	(+)

* The effect should be significant however sing is not controlled. NA - not applicable. Source: own study.

The HFT is not directly observed market data. There is not a widely accepted proxy for HFT performance or ability. Thus it is proposed in this research to measure the HFT ability of an entity by application of the physical distance[2] from the main office of the entity to the seat of the stock exchange.

[1] Estimated through intercept.

[2] The proxy might rise concern due to the different perception of distance for the economic processes, istead of the linear distance, the time distance and number of orders per time span can be applied. The selction of phiscal distance is due to the resistance of the electronic signal transmission of the oder and homogienity of the broker-dearers in term of the technical solution access..

Hence the research was conducted based on the following hypothesis:

H_0: *Central European investment companies' RoE is affected by last mile to the stock exchange*

The last mile proxy is the distance up to 1 kilometer from the stock exchange and distance between 1 and 3 kilometer separately. The time lag of the orders delivery and confirmation is not linear function of the distance and the IT environment. Due to the competitiveness, technical requirements and relative small cost of the IT, it was assumed that IT has little discrimination power in contrast to the physical distance.

III. DATA AND METHODOLOGY

A. Methodology

The approximation of distance between any two different locations A (Long1, Lat1) and B (Long2, Lat2) where Long1 and Long2 are longitudes, Lat1 and Lat2 - latitudes was calculated based on the following formula:

$$d = 2 * \pi * q * R /360$$

Where:

$\pi = 3.1415...$,

R = 6371km (average radius of the Earth).

q is the solid angle between the points A i B.

Because:

$$\cos (q) = \sin(Lat1)*\sin(Lat2) + \cos(Lat1)*\cos(Lat2)* \cos(Long1 - Long2)$$

Thus:

$$d = 2*\pi*\arccos(\sin(Lat1)*\sin(Lat2) + \cos(Lat1)* \cos(Lat2)*\cos(Long1 - Long2)) *R/360$$

A uniform Earth radius was used due to its changeability within 0–90 degrees, while the latitude changes with the sample from around 40–60 degrees, thus potential corrections are insignificant to conclusions.

The local market of both licensed and non-licensed financial entities was examined against the relation of return and distance.

Analytical form of the model of the panel data (fixed effects):

$$y_{it} = \beta x'_{i,j} + \alpha_i + u_{it}$$

where:

y_{it}- response variable - return on equity (RoE)

x_{it}- vector of dependent variables as shown in table I.

α_i - individual effect of i

β - vector of parameters

u_{it} - error term

Actually the de-mean procedure was applied thus the intercept represents the average individual effect.

B. Data Set

The entities' data were collected from the official website of ESMA register for investment firms in the European Union during the period April to June 2015 All geocoding data, if necessary, were retranslated from the degree, minutes and seconds into a decimal degree. The geocoding of the addresses was done using the application of batch transferring at www.findlatitudeandlongitude.com. The output data were reviewed for consistency and manual corrections were made for the missing coding. The calculation was performed using the application of the R environment and Statistica and Gretl [39]–[41].

Financial statements data were collected from the EMIS database randomly based on the following search criteria: financial companies for region, all operating activities include those under reconstruction and under insolvency, time scope 2010 till 2012. The cut-off of 2010 was taken to avoid the impact of the liquidity crisis 2007–2009 and the capital requirements were as discussed earlier. The sample consists of the 642 company year observation, the panel is imbalanced among others due to entities entering and exiting the market during the period.

IV. RESULTS AND DISCUSSION

A. Results

Figure 2 summarizes the priory research finding on the Central European broker dealers licensed entities geographical distribution (both local and notified entities) as well the priory sample allocation.

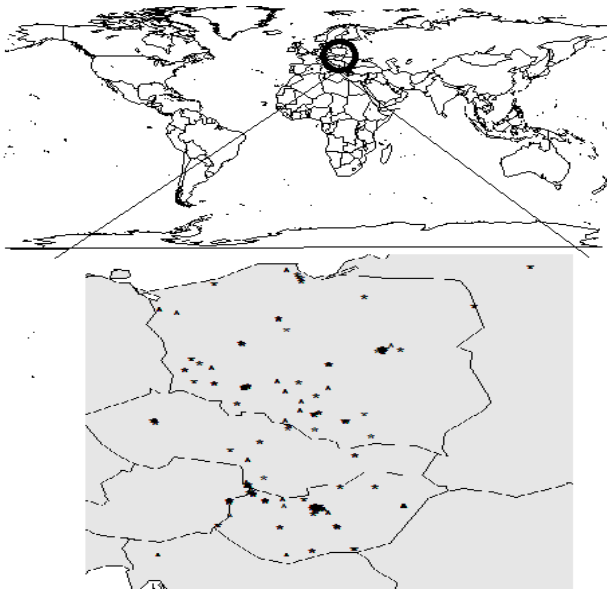
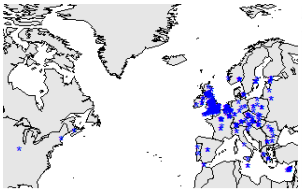
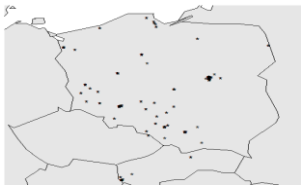


Figure 1. Sample and population geographical allocation of entities (both licensed and non-licensed)

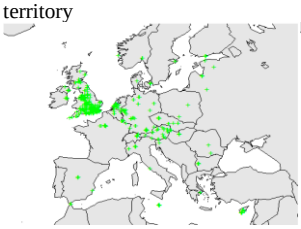
Source: own presentation.



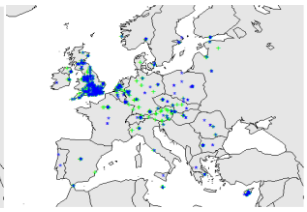
1 Geographical allocation of the entities notified on Polish territory



2 Geographical allocation of sample against the Slovak and Polish territory



3. Slovak territory notifications (+)



4. Slovak (+) and Polish (*) notifications rescaled to Slovak range

Figure 2. Licensed entities concentration aspects

Source: 1 - resized based on Staszkiewicz, L., & Staszkiewicz, P. HFT's potential of investment companies. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, forthcoming, 2- own presentation based on data for Staszkiewicz, P. (2015), How far is enough for financial markets? In 5th Annual Interantiaonal Conference on Accounting and Finance. Singapore: GSTF, pp. 21–26 [6]. 3, 4- Staszkiewicz, P. (2014), *Do Bratislava and Warsaw Stock Exchanges go high frequency trading?* In M. Niniaj & M. Zahumenska, eds. *Proceedings of the 16th International Scientific Conference Bratislava: Finance and Risk 2014 vol. 1*. Bratislava: Publishing House EKONÓM, pp. 240–249., [29]..

Table II shows the definition and basic characteristics of the variables.

TABLE II. DESCRITPIVE STATISTICS OF VARIABLES

Varialbe	Mean	Min	Max	σ	Skew.	Kurt.
Poland	0.43	0.0	1.00	0.50	0.26	-1.93
Slovakia	0.06	0.0	1.00	0.24	3.57	10.73
Slovenia	0.01	0.0	1.00	0.11	8.79	75.26
Hungaria	0.41	0.0	1.00	0.49	0.35	-1.87
Czech	0.07	0.0	1.00	0.25	3.42	9.66
Litva	0.01	0.0	1.00	0.09	11.20	123
Licence	0.22	0.0	1.00	0.41	1.38	-0.10
Min	170	0.0	471	169	0.33	-1.61
MinN*	0.36	0.0	1.00	0.36	0.33	-1.61
Dist 1	0.02	0.0	1.00	0.14	6.81	44.41
Dist 3	0.03	0.0	1.00	0.18	5.25	25.61
Auditor	0.23	0.0	1.00	0.42	1.28	-0.36
RoE	6.29	-3923	689	166	-20.5	485
Audited	0.94	0.0	1.00	0.24	-3.74	11.96
Con.	0.05	0.0	1.00	0.22	4.06	14.51
Requ	0.35	-18.5	1.00	1.41	-11.4	140
Log(Ass)	2.25	0.0	7.93	1.84	0.71	-0.12

*Varialbe used for the robustness of results test

Source: own calculation.

Following priory research [6] the panel model and heteroscasticity corrected model were estimated. The results of the models estimations are shown in the table III:

TABLE III. THE PARAMETERS AND BASIC DIAGNOSTIC FOR PANEL FIXED EFFECT MODEL (M1)HETEROSCEDASTICIY CORRECTED (M2). DEPENDEND VARIABLE ROE.

	M1	M2
	Panel	HSK
const	-30,31	7,303
	(36,16)	(6,465)
Min	0,05713	0,06515**
	(0,08963)	(0,02272)
Audited	5,466	2,729
	(14,69)	(6,092)
Consolidated	3,733	-5,226
	(26,32)	(7,485)
Requirements	23,40	-18,86**
	(17,60)	(1,654)
Log(Assets)	5,695	-0,2654
	(12,49)	(0,9902)
RoE (-1)	0,8210**	0,3384**
	(0,2738)	(0,1060)

Licence		0,5361
		(3,336)
Distance 1		5,293
		(6,792)
Distance 3		4,631
		(6,645)
Auditor		3,456
		(3,550)
Poland		-19,51
		(9,301)
Slovakia		-8,559
		(6,739)
Slovenia		0,9730
		(10,07)
Czech		-0,1076
		(6,158)
Litva		8,311
		(24,47)
Adj R^2	0,1720	0,6205
lnL	-685,7	-297,7

at * p < 10%,** p < 5%, *** p < 1%,
Source: own calculations.

The general weaknesses of the panel analysis might be addressed by the limitation of the dataset. There was a substantial number of unbalanced panel due to unavailability of the financial statements and incoming and outgoing entities from the markets.

Irrespective which the model will be the chosen the both distance, and the subsets of the 1 and 1 to 3 km from the stock exchange turned out to not be significant or excluded which confirms the priory results on Polish and Slovak markets toward the backbone of the Central Europe. The findings do not confirm the Boasson et al. results that firm value responds positively to geographic factors [42].

B. Robustness of results

For the testing of the robustness of results the tobit regression was applied. The dependent variable is the development of the distances to the closed stock exchange defined as follows:

$$\text{MinN}_i = \frac{Min_i}{\text{Max}(Min_k)}$$

Where:

MinN_i - development of distance for the i company

Min_i - the closest stock exchange distance for the i company

k = 1...n, where n - is the number of companies in sample.

TABLE IV. TABIT REGRESSION OF MINN RESULTS

	Coeff	*St Error*	*z*	*p-value*
Const**	0.109	0.045	2.44	0.01
Poland***	0.695	0.024	29.43	<0.0001
Slovakia	−0.009	0.024	-0.40	0.69
Slovenia**	-0.084	0.036	-2.32	0.02
Czech	0.013	0.032	0.40	0.69
Litva	0.143	0.147	0.98	0.33
Licence	0.011	0.017	0.63	0.53
Auditor	0.026	0.016	1.64	0.10
Audited	-0.048	0.040	-1.18	0.24
Consol.	0.021	0.030	0.69	0.49
Requr.**	0.008	0.003	2.57	0.01
Log(Assets)**	-0.012	0.005	-2.39	0.02

at * p < 10%,** p < 5%, *** p < 1%,
Source: own calculations

The tests reveals that the dependence of distance is Poland, Slovenia and Hungary, these tests indicate the geographical aspect as Poland and Hungary are the largest in terms of the surface counties from the sample. The results of Slovenia is not expected, probably due to small representation in the sample. The robustness test explains the significant of the overall distance in the HSK model.

Due to the potential number of entities with HFT competitive advantage, it is rejected the null hypothesis that:

H_0: *Central European investment companies' RoE is affected by last mile to the stock exchange*

This is rejected in favor of the statement that there is no evidence found that Central European investment companies' RoE is affected by last mile to the stock exchange.

V. CONCLUSIONS

The purpose of this paper was to examine the maturity of the Central European stock exchange markets in respect of their potential high frequency trading abilities.

The distance to exchanges was not a decision-taker parameter for broker-dealer return. Thus markets are not mature enough for high frequency trading.

This research actually opens more question that it closes, however indicate the future research avenues for example to justify on the horizontal HFTs differences across Europe.

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