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Trading costs, short sale constraints, and the performance of stock market anomalies in Emerging Europe

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ABSTRACT

The study has investigated the impact of trading costs and short-sale constraints on the performance of 70 stock market anomalies in Emerging Europe. While over 30 of the replicated strategies – mostly related to value, momentum, technical analysis, profitability, and issuance effects – delivered significant abnormal returns, the impact of trading costs and short-sale constraints proved truly lethal to most strategies. Once we accounted for commissions, bid-ask spreads, company size, weighting method, and short-sale unavailability, only a handful of anomalies remain significantly profitable. Our research relied on sorting procedures and cross-sectional tests applied to a sample of over 1,800 stocks from the Czech Republic, Hungary, Poland, Russia and Turkey in the years 2000 to 2015.

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1. Introduction

Recent decades have brought plenty of evidence of cross-sectional patterns arising in both developed and emerging stock markets. Recent academic papers have reviewed dozens (Green, Hand, and Zhang, 2014; Hou, Xue, and Zhang, 2013; Jacobs, 2015) or even hundreds (Harvey, Liu, and Zhu, 2015) of return predictive signals (RPS) and other factors determining equity performance. Searching for new anomalies not only enhances understanding of asset pricing patterns in various financial markets but it can also be translated into better investment performance and higher bonuses for asset managers. Consequently, it should come as no surprise that a continuous search for new anomalies has recently became one of the hottest topics in academia.

Still, the implementation of quantitative strategies based on stock market anomalies may encounter an important obstacle: trading costs. Synthetic portfolios used to demonstrate the effects of the stock market anomalies frequently assume high portfolio

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turnover, allocation of capital to illiquid stocks and assumption of short positions even if this might not be entirely feasible. In fact, as shown by Novy-Marx and Velikov (2015) the profitability of stock market anomalies can be seriously impacted by the imposition of trading costs.

The issue of the transaction costs is also important for academic purposes. The behavioural finance view on the stock market anomalies explains their existence pointing to investors irrationality and behavioural biases which cannot be easily arbitraged away (Jacobs, 2015). The acknowledgement of the detrimental impact of trading costs on the profitability of cross-sectional strategies would additionally support the behavioural explanation of the equity anomalies.

The aim of this study was to examine the influence of trading costs and short sale constraints on the performance of stock market anomalies in Emerging Europe. The article aims to contribute in two ways. First, we examined a broad set of 70 anomalies in emerging European markets: the Czech Republic, Hungary, Poland, Russia and Turkey. As most of the anomalies had never been examined in this region, and many had never been explored in any emerging markets, we intended to provide additional insights on asset pricing in emerging markets and simultaneously conduct an out-of-sample test of a substantial number of anomalies. Second, we examined the influence of trading costs and short sale constraints on the performance of stock market anomalies. We tested how the bid-ask spreads, unavailability of short sale opportunities, recognition of market capitalisation of companies, and the rebalancing frequency could impact the returns of the anomaly based strategies. This is the first study to examine these issues comprehensively on a broad set of anomalies across the emerging markets.

The choice of emerging markets, particularly Emerging Europe, is not accidental. A number of characteristics make this region particularly interesting: (1) Emerging markets are characterised by significantly higher transaction costs (Silva and Chaves, 2004; Schoenfeld and Cubeles, 2007; Pittman, Kirk, and Dillon, 2009). As reported by Investment Technology Group, the total trading costs and investment shortfalls across the Emerging Europe in 2014 were nearly three times as high as in the U.S.; (2) Emerging markets are less liquid (Lesmond, 2005; Bekaert, Harvey, and Lundblad, 2007), which not only elevates transaction costs but also hinders implementation of certain strategies; (3) While anomalies appear particularly strong on the short side (Stambaugh, Yu, and Yuan, 2012; Hirshleifer, Teoh, and Yu, 2011), the short sale in emerging markets is frequently unavailable; (4) Emerging European markets are particularly densely populated with small companies, which might lead to elevated trading costs. As noted by Zaremba, Okoń, Nowak, and Konieczka (2016), according to standard U.S. definitions, over 90% of companies in Eastern European markets end up classified as 'microcaps'; and (5) The stock markets in emerging markets have been rapidly growing in the recent years, both in terms of market capitalisation and absolute number of stocks. An excellent example is the NewConnect trading venue in Poland. Launched in 2007, NewConnect was originally intended for small companies, yet it became the second largest market for small- and medium-sized companies in Europe only five years later. The rapid growth of the equity markets in Emerging Europe matters for two reasons. On the one hand, it reflects the increasing importance for the international investors. Emerging markets increase portfolio

diversification despite the ongoing integration of both emerging and developed markets in the post-liberalisation period (Bekaert and Harvey, 2002). On the other hand, a dynamic growth of the number of companies may require more frequent portfolio reviews to reflect the increasing equity universe. This may, in turn, additionally contribute to portfolio turnover and hinder the profitability of return anomalies.

In order to examine the impact of trading costs on the stock market anomalies, we formed equal-weighted and capitalisation-weighted portfolios of stocks and examined their performance with an asset pricing model. We included a control on small and penny stocks within the samples and adjusted the returns for the commissions and bid-ask spreads, based on real market data. Furthermore, we tested both long-only and zero-investment portfolios to account for the short sale constraints. We additionally investigated various rebalancing frequencies on the returns of the anomalies conducting tests within a sample of over 1,800 firms listed on the stock markets of Emerging Europe in the years 2000 to 2015.

Our findings evidence that, out of 70 tested anomalies, 33 proved significant in our most basic approach, i.e., monthly rebalanced equal-weighted zero-investment portfolios with no trading costs adjustment. The strategies performed well also in the long-only portfolios where 28 continued to deliver significant abnormal returns. Nonetheless, the application of the weighting method and trading costs based on real data left hardly any anomaly economically viable. Having adopted the capitalisation-weighting method and adjusted for the bid-ask spreads and commissions, we saw virtually none of the tested anomalies to remain significantly profitable. The findings stayed fundamentally unchanged also after the reduction of rebalancing frequency. Portfolio rotation decreased; however, in the same time the pre-cost performance proved weaker, and thus most of the anomalies failed to display the abnormal returns. Our results support the behaviour finance approach to the equity market anomalies.

The article has the following structure: the next section contains the review of the related literature; in Section 3 we describe the data and methods employed; in Section 4 we present our findings, and in the last section we detail the conclusions from our research.

2. Related literature

This study is cognate with the literature on the impact of market frictions (which primarily include trading costs and short sale constraints) on equity returns anomalies. Transaction costs have been thoroughly discussed in the finance literature. A number of authors, including Seyhun (1985), Amihud and Mendelson (1986) and Perold (1988), concentrated on identifying expected impact on stock portfolio performance. This resulted in the creation of methodology (implementation shortfall) and optimisation models of return-spread relation (Keim and Madhavan,1998; Bertsimas and Lo, 1998). Current observations, however, have revealed a dynamic nature of the transaction costs structure. Trading costs in both emerging and developed markets have been decreasing dramatically over time, which is particularly true for stock markets in Emerging Europe.[1]

In 2002 Chen and Stanzl concluded that price-impact costs successfully deterred agents from exploiting the anomalies. The researchers found that the inclusion of the price impact costs negatively influenced the size, book-to-market, or momentum abnormal returns, so maximum profitable fund sizes are too small to prove profitable. Subsequently, Lesmond, Schill, and Zhou (2004) found the incorporation of trading costs to deplete momentum (based on Relative Strength Index) anomalies. The draining effect of the transaction costs on the momentum strategies led Korajczyk and Sadka (2004) to propose a minimum fund size on the U.S. equities to amount to U.S.$5 billion. Frazzini, Israel, and Moskowitz (2012) calculated the implementation shortfall on live trading data from institutional investors, as well as the impact of trading costs on performance of anomalies. They found that return premia associated with size, value, and momentum appear robust net of costs. Momentum strategies proved most sensitive to the change in cost management, and short-term reversal anomalies did not survive net of costs. The next seminal study carried out on a broad range of return patterns by Novy-Marx and Velikov (2015) also revealed the abnormal returns to diminish with the increase of turnover frequency due to the costs related drag.

The second strain researched in this article concentrates on the attempts to identify the existence of return anomalies in Central and Eastern Europe (CEE). Until recently, studies related to this sub-group of emerging markets have been undertaken on a relatively modest scale and in many cases as a part of tests exploring the weak-worm of efficient market hypothesis (EMH). In 2010, Guidi et al. recognised that calendar anomalies in the returns of the CEE stock markets in the period 1999–2009. The regional markets were then positively tested on the existence of calendar anomalies by Gilmore and McManus (2003). Also, Cakici, Fabozzi, and Tan (2013) and Hanauer and Linhart (2015) included Eastern Europe in their international samples. Finally, Waszczuk (2013) found returns anomalies (value vs growth, size, momentum) in Poland at the same degree as in developed markets, pointing out to a regional character of both the size and value factors. In our view, this is the first study to comprehensively examine such a broad set of anomalies in the markets of Emerging Europe.

Regarding the short sale constraint, a remarkable view was presented by Stambaugh et al. in 2012, who proposed that impediments to shorting the stock in itself created return anomalies such as momentum and quality. As a result, the overpriced securities pushed the long-leg returns higher, and interestingly from the behavioural finance perspective, it created a market-wide sentiment that supported the momentum strategies. The asymmetry between the long and short side of the accrual anomaly was also observed by Hirshleifer et al. (2011), who linked the size of asymmetry to the percentage of institutional ownership, which, in our view, may be regarded as another return predictive signal. Further important links between institutional ownership and profitability of anomalies on the short-leg of strategies were also made by Nagel (2004).

3. Methods and data

As the study aims to examine the impact of trading costs and short-sale constraints on the performance of stock-market anomalies, we formed equal-weighted and

capitalisation-weighted zero-investment and long-only portfolios, and subsequently evaluated their performance having adjusted for trading costs with an asset pricing model. Our null hypothesis assumed no abnormal returns on the anomalies, and the alternative hypothesis to the contrary.

3.1. Data source and sample preparation

Our sample covers the five most important stock markets in Eastern Europe: the Czech Republic, Hungary, Poland, Russia and Turkey. The country choice stems from the composition of the MSCI Emerging Europe index, and follows Eastern European samples in other studies e.g., Cakici et al. (2013).[2]

We used international stock returns and accounting data sourced from Bloomberg, having considered both listed and delisted companies in order to avoid any form of survivorship bias.[3] The computations are based on monthly time-series as providing a sufficient number of observations (188) to ensure the power of the tests and avoid an excessive exposure to the micro-structure issues. The returns are adjusted for both corporate actions (splits, reverse splits, issuance rights, etc.) and cash distributions to investors (dividends). While the sample period of returns runs from February 2000 to September 2015, where necessary, we also facilitated earlier data dating back to 1995 to calculate certain anomalies (e.g., long-term reversal). The late start date – the first month when the sample includes 100 active companies – was chosen deliberately to avoid a small sample bias (after filtering – see below).

A company was included in the sample only when its return could be determined in month *t,* and its total capitalisation and bid-ask spread at the end of moth *t*-1. To ensure the quality of data and align our sample with market practice, we applied a number of static and dynamic filters. As the sample comprises only common stocks, we excluded closed-end funds, exchange traded funds, global depository receipts, and similar investment vehicles, allowing only these securities for which the Czech Republic, Hungary, Russia, or Turkey were primary markets. We also addresses the practical problems of the so-called 'penny stocks' by eliminating a company from the sample in month *t* when at the end of month *t*-1 either its nominal share price dropped below €0.10 or the total stock market capitalisation sank below €5 million.[4] Finally, following e.g., Rouwenhorst (1999), we manually screened the data for suspicious returns using all the companies available in the Bloomberg database. Our final sample consisted of 1,818 companies. The precise number of stock varied in particular months from 125 to 936, and the time-series average reached 566.[5] The basic portfolio composition is presented in Figure A1 in the supplementary material.[6]

All the data was initially collected in local currencies to be subsequently converted to a single currency – the euro. Where a given strategy relied on the accounting data, we used lagged values from month *t*-4 in order to avoid a look-ahead bias.

3.2. Examined portfolios and anomalies

Our study examines the performance of portfolios based on stock-market cross-sectional patterns. Here, we provide a short review of the investigated anomalies.

While the selection of anomalies predominately follows previous research on cross-sectional return patterns (Jacobs, 2015), we added a number of additional screens of the anomalies. First, the anomaly was to be computed using accounting and market data derived from standard databases, e.g., the Bloomberg database. Second, the anomaly should appear on a monthly basis, and be observable in the monthly data. Third, the returns on the anomaly had to be attainable in long-short portfolios based on the cross-sectional rankings of securities. Finally, the anomaly had to be computable using the data available in Emerging Europe. Unfortunately, a number of stock market anomalies were impossible to replicate in the region due to its 'emerging' character. The lack of broad credit rating coverage, which underlies the credit risk-enhanced momentum described by Avramov, Chordia, Jostova, and Philipov (2007), may serve as one example.

A detailed description of the anomalies and the related portfolio formation procedures are presented in Table A1 of the supplementary material. The 70 anomalies were grouped into 12 categories based on the underlying economic intuition as summarised in Table 1.

We formed the portfolios based on the 70 anomalies applying a uniformed procedure across all the strategies. To this end, all the stock securities were ranked against the current value of one of the metrics related to the anomalies at the end of each month t-1. All of the metrics are detailed in Table A1 in the supplementary material.

Subsequently, the stocks included in both the top and the bottom quintile of the rankings were used to form equal-weighted portfolios. Finally, we constructed the differential portfolios – in other words, the zero-investment portfolios or dollar-neutral portfolios – which effectively are long-short portfolios. We consistently assumed a long (short) position in the portfolio that was expected to provide higher (lower) returns based on existing empirical evidence. As a result, we expected all zero-investment portfolios to display positive returns.

3.3. Impact of trading costs, short-sale constraints, and robustness checks

In this study we were particularly interested whether the abnormal returns on the anomaly-based strategies survive the impact of trading costs and short-sale constraints. Therefore, we performed a battery of robustness tests, which examine the influence of these issues.

3.3.1. Equal-weighting vs capitalisation-weighting

We examine both equal-weighted and capitalization-weighted portfolios.

3.3.2. Adjusting for transaction costs

The impact of trading costs on stock market anomalies may vary. The replicated strategies are vulnerable to various portfolio rotation levels and different allocations across the stock market liquidity. Moreover, the profits from stock-market anomalies vary in time and might be correlated with the time-varying transaction costs. Therefore, we examined the influence of trading costs in a direct way, considering two separate 'cost-layers': bid-ask spreads and commissions. To describe the cost

Table 1. Anomalies in the cross-section of returns examined in this study.

No.	Abbr.	Name	No.	Abbr.	Name
Group 1: Value vs growth			*Group 6: Accruals (continued)*		
1	EP	Earnings-to-price	37	AcIvol	Idiosyncratic volatility-enhanced accruals
2	BM	Book-to-market	*Group 7: Liquidity*		
3	CFP	Cash flow-to-price	38	Turn	Turnover
4	SP	Sales-to-price	39	TR	Turnover ratio
5	EBEV	EBITDA-to-EV	40	TRV	Turnover ratio variability
6	SEV	Sales-to-EV	41	TurnV	Turnover variability
7	EBP	EBITDA-to-price	*Group 8: Low volatility*		
8	DY	Dividend yield	42	Beta	Beta
9	SG	Sales growth	43	SD	Volatilty
10	DYCh	Change in dividend yield	44	Ivol	Idiosyncratic volatility
11	BMCap	Size-enhanced book-to-market ratio	*Group 9: Extreme and downside risk*		
12	BMGPA	Gross profitability-enhanced book-to-market ratio	45	DownVol	Downside volatility
			46	VaR	Value at risk
Group 2: Profitability			47	Skew	Skewness
13	ROA	Return on assets	48	Kurt	Kurtosis
14	ROE	Return on equity	*Group 10: Long-term reversal*		
15	GM	Gross margin	49	LtRev	Long-term reversal
16	AT	Asset turnover	50	LtRevIvol	Idiosyncratic volatility-enhanced long-term reversal
17	GPA	Gross profitability			
18	SGIG	Sales growth-to-inventory growth	*Group 11: Momentum*		
19	GMCh	Change in gross margin	51	StMom	Short-term momentum
			52	LtMom	Long-term momentum
Group 3: Credit risk			53	IntMom	Intermediate momentum
20	DM	Leverage	54	MomAge	Age-enhanced momentum
21	LevCh	Change in leverage	55	MomIvol	Idiosyncratic volatility-enhanced momentum
22	CH	Cash holdings	56	MomSmall	Size-enhanced momentum
Group 4: Investment			57	MomBM	Book-to-market ratio-enhanced momentum
23	AG	Asset growth	58	MomTR	Liquidity-enhanced momentum
24	IG	Investment growth	59	Mom52H	52-week high-enhanced momentum
25	InG	Inventory growth	60	MomNeg	Analyst coverage-enhanced momentum
26	InC	Inventory change	*Group 12: Technical analysis*		
27	HR	Hiring rate	61	MA200	200-day moving average
28	OL	Operating leverage	62	MA250	250-day moving average
29	NOAg	Net operating assets growth	63	52H	52-week high
30	NOAc	Net operating assets change	*Group 13: Seasonalities*		
31	CIA	Capital investments	64	SeasMom	Seasonality momentum
			65	OtherJan	The other January effect
Group 5: Issuance			*Group 14: Market frictions*		
32	CEI	Composite equity issuance	66	Cap	Total market Capitalisation
33	NSI	Net stock issuance	67	LP	Price
34	Age	Age	68	StRev	Short-term reversal
Group 6: Accruals			69	Spread	Bid-ask spread
35	OA	Operating accruals	70	Neg	Analyst coverage
36	TA	Total accruals			

The table details the anomalies examined in this study. *No.* is the running number used to identify each anomaly in the text. *Abbr.* is the symbol of an anomaly used in the study. A detailed description of the anomalies along with the reference literature is provided in Table A1 in the supplementary material.

function we employed a simple proportional cost model proposed by Korajczyk and Sadka (2004):

$$\mathrm{f}(P_{\mathrm{j,t}}) = P_{\mathrm{j,t}} \times \mathrm{k}_{\mathrm{j,t}}, \tag{1}$$

where $P_{j,t}$ is the price of stock j at the time t, and $k_{j,t}$ is the constant cost component specific for a security j at time t. We use two approaches to consider $k_{j,t}$. In the first approach, we closely follow Zaremba and Konieczka (2015) and assess it as a half of the quoted spread:

$$\mathrm{k}_{\mathrm{j,t}} = \frac{1}{2} \times \frac{\mathrm{P}^{\mathrm{ask}}_{\mathrm{j,t}} - \mathrm{P}^{\mathrm{bid}}_{\mathrm{j,t}}}{\mathrm{P}^{\mathrm{mid}}_{\mathrm{j,t}}}, \tag{2}$$

where $P^{ask}_{j,t}$, $P^{bid}_{j,t}$, and $\mathrm{P}^{\mathrm{mid}}_{\mathrm{j,t}}$ are, respectively, offer, bid and mid prices of stock j at time t. Under the second approach, we increased $k_{j,t}$ by a fixed component reflecting trading commissions. We assumed a constant value of 0.18%, which represent a typical level of commissions on equities typically applied by institutional investors in the Eastern European region. To sum up, we calculated the returns on the anomalies in three variants: raw, adjusted for bid-ask spread, and for both bid-ask spreads and commissions. As a result, our approach reflects not only the commissions associated with different portfolio rotation on various strategies, but also cross-sectional and time-varying bid-ask spreads on various securities.

3.3.3. Monthly vs annual sorting

Following the standard approach, to form portfolios we ranked securities according to a given variable at the end of every month. However, as the high frequency of rebalancing might result in elevated transaction costs, we supplemented the analysis with an annual approach, which could be regarded a simple cost mitigation strategy. Within this method, we performed sorting only once a year (at the end of June). As the disadvantage of this approach is that the predictive ability of many signals tends to fade rapidly, the raw pre-cost profitability of the anomalies implemented in this way might prove substantially lower.

3.3.4. Long-short vs long-only portfolios

The sets of anomalies are typically examined based on zero-investment portfolios (e.g., Hou et al., 2013; Green et al., 2014; or Jacobs, 2015). This method, however, has two weaknesses from the standpoint of this study. First, short sale opportunities are still hardly available in Emerging Europe, and a decade ago, were virtually nonexistent. Second, this method results in elevated transaction costs relative to long-only portfolios, because it assumes trading both in the long- and short-leg. Therefore, we re-examined our zero-investment strategies in the more realistic long-only approach. This exercise is particularly interesting as Nagel (2004) and Stambaugh et al. (2012) argued that the stock market anomalies stemmed largely from short sale constraints, and that the abnormal returns were predominately driven by the short-leg of the strategies.

3.4. Performance evaluation

We evaluated the performance with the traditional Capital Asset Pricing Model (Sharpe, 1964, abbreviated to CAPM), according to which asset returns depend solely on the market portfolio. It is based on the following regression equation:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{rm,i} \cdot (R_{m,t} - R_{f,t}) + \varepsilon_{i,t}, \quad (3)$$

where $R_{i,t,}$ $R_{m,t}$ and $R_{f,t}$ are returns on the analysed asset i, market portfolio, and risk-free asset at time t; α_i and $\beta_{rm,i}$ are regression parameters. The intercept α_i (Jensen-alpha) measures the average abnormal return. We do not employ any other cross-sectional asset-pricing models, because one of the aims of this study is to verify whether the cross-sectional patterns underlying these models arise within the sample. All regression parameters were estimated using the ordinary least squares (OLS) method. All statistical interferences were based on logarithmic excess returns, and t-statistics were estimated using bootstrap standard errors to avoid any distributional assumption.[7] According to our null hypothesis, the intercept from the CAPM model equaled zero whereas the alternative hypothesis assumed the opposite.[8]

In order to be consistent with the euro convention, we used 1-month Euribor as a proxy for the risk-free rate to compute the excess returns.[9] The return on the market portfolio is represented by the value-weighted portfolio including all companies in the sample. Furthermore, we consistently calculated the return on the market portfolio in the rebalancing and cost-adjustment approach in line with the formation procedures of the examined anomalies. In other words, we rebalanced the market portfolio and adjusted it for the bid-ask spreads and commissions in the same way as in the tested strategies. Table 2 presents the summary statistics for the excess returns on market portfolios calculated under various approaches.

Although the market portfolio was relatively stable in time, it was also the effect of transaction costs, mainly due to new companies constantly entering the market. In consequence, the consideration of both bid-ask spreads and commissions could lead to a return decrease of 0.11 (0.07) percentage points per month in the monthly (yearly) rebalancing approaches. Interestingly, the pre-cost returns on annually rebalanced portfolio proved to be historically slightly lower than the returns on the monthly-rebalances portfolios. Furthermore, the equity risk premium was positive but insignificant within the examined period.

Table 2. Excess returns on the market portfolio.

	Monthly rebalancing			Annual rebalancing		
	Raw	Spread-adjusted return	Spread and commissions-adjusted return	Raw	Spread-adjusted return	Spread and commissions-adjusted return
Mean	0.32 *(0.57)*	0.23 *(0.42)*	0.21 *(0.39)*	0.23 *(0.42)*	0.17 *(0.32)*	0.16 *(0.29)*
Standard deviation	7.51	7.52	7.52	7.54	7.55	7.55
Sharpe ratio	0.15	0.11	0.10	0.11	0.08	0.07

The table reports monthly log excess returns on the market portfolio, i.e., the capitalisation-weighted portfolio of all the companies within the sample. The numbers in brackets are t-statistics. Returns and standard deviations are expressed as percentage. The Sharpe ratios are calculated on annual basis.

4. Results

In this section, we first present the performance of the zero-investment portfolios and continue to discuss the long-only portfolios.

4.1. Performance of the zero-investment portfolios

Table A2 in the supplementary material reports our most basic approach, i.e., the excess returns on the monthly-rebalanced zero-investment portfolios formed on the anomalies, prior to the adjustment for any trading costs. In total, out of 70 anomalies tested in the equal-weighted approach with monthly portfolio reforming, only 33 delivered positive returns, either raw or risk-adjusted, which would significantly depart from 0. In our further investigations, we focused solely on those 33 anomalies, excluding all insignificant groups. The successful batch encompassed nine anomalies from Group 1: Value vs Growth (EP, BM, SP, BEV, SEV, EBP, DY, SG, BMGPA), six anomalies from Group 2: Profitability (ROA, ROE, GM, AT, GPA, GMCh), three anomalies from Group 5: Issuance (C.E.I., N.S.I., Age), one anomaly from Group 7: Liquidity), one anomaly from Group 9: Extreme and downside risk (Skew), 10 anomalies from Group 11: Momentum (StMom, LtMom, IntMom, MomYoung, MomIvol, MomSmall, MomBM, MomTR, Mom52H, MomNeg), and three anomalies from Group 12: Technical analysis (MA200, MA250, 52H).

Understandably, the anomalies within the batch are interrelated. The sample included enhanced versions of other anomalies as well as strategies closely related to each other. Nonetheless, the average pair-wise correlation among the 33 significant strategies represented by the equal-weighted monthly-reformed portfolios amounted to 0.11, which indicates the capture of a broad and diversified set of anomalies. This finding resembles the conclusions of Green et al. (2014) and Jacobs (2015) who indicated that the cross-section of expected returns is remarkably multidimensional. The pair-wise correlation coefficient among the groups of strategies tested in this study is presented in Table A3 in the supplementary material.[10]

The performance of the monthly-reformed portfolios based on anomalies clearly deteriorated when the weighing method progressed to value weighting (see Table A2 in the supplementary material). We observed a huge difference in profitability of the equal-weighted and value-weighted portfolios. When a more realistic approach of capitalisation weighting was implemented, many of the anomalies lost their significance. This may result from the fact that many anomalies appear stronger among small companies. Within our sample, from 33 successful strategies in the equal-weighting approach only 14 continued to deliver significant risk-adjusted returns when the portfolios were weighted by the company capitalisation.

In respect of the impact of the trading costs, Table 3 details the average portfolio turnover (summed in both long- and short-legs of the traded) within the various groups of the strategies.[11] The turnover levels of the monthly-rebalanced portfolios range between 31.2% and 90.2%. The rotation of the capitalisation-weighted approximates the level in the equal-weighted portfolios. Interestingly, the turnover does not markedly differ from the experience of the developed markets. For example, Novy-Marx and Velikov (2015) concluding their research of the U.S. market reported the

Table 3. Monthly turnover of zero-investment portfolios formed on stock market anomalies.

	Monthly rebalancing		Annual rebalancing	
Category	Equal-weighted portfolios	Capitalisation-weighted portfolios	Equal-weighted portfolios	Capitalisation-weighted portfolios
Group 1: Value vs growth	41.1	42.9	22.3	18.0
Group 2: Profitability	33.6	31.2	21.0	17.3
Group 5: Issuance	36.1	36.0	20.0	17.5
Group 7: Liquidity	25.6	25.2	18.7	16.4
Group 9: Extreme and downside risk	40.9	51.5	21.9	19.6
Group 11: Momentum	70.1	86.4	30.0	27.6
Group 12: Technical analysis	67.5	90.2	25.4	23.8

The table reports the mean monthly portfolio turnover, i.e., the average percentage share of stocks replaced every month. The values represent the turnover of the strategies listed in Table A3 averaged within the respective categories. The values are expressed as percentage. The data are sourced from Bloomberg.

turnover on the strategy based on return on equity at 44.6% while in our case the mean rotation of the profitability strategies reached 33.6% (31.2%) in the equal-weighted (capitalisation-weighted) approach, only slightly below that standard.[12] Furthermore, the momentum strategy in the U.S. displayed a turnover of 69% while we found the turnover ranging from 70.1% to 86.4%. Finally, Table 3 presents also the turnover of the annually rebalanced portfolios. In general, this approach allowed nearly to half the portfolio rotation.

Table 4 uncovers the influence of trading costs on the performance of portfolios formed on anomalies. Panel A presents the case of monthly rebalancing. It is clear that in this approach the high rotation annihilates any post-cost profitability of the examined strategies. Regardless of the method of weighting the portfolio components, the trading costs proved lethal for the strategies. Even if considering only the bid-ask spreads, the positive returns transform to losses of approximately 0.5% per month, and none of the strategies remained significantly profitable. The further consideration of the commissions only make the situation worse. The precise post-cost profitability of the individual strategies is displayed in Tables A5 and A6, supplementary material.

Panel B of Table 4 depicts the case of the annually rebalanced portfolios. This approach results in a lower portfolio turnover and possible lower pre-cost profitability of the anomalies. Panel B of Table 4 summarises the details on the annually rebalanced strategies reported in Tables A4 and A6 in the supplementary material. In short, 19 of the 33 strategies deliver significant abnormal pre-cost returns in the annual rebalancing equal-weighted approach. Unfortunately, only one of them remains significantly profitable after trading costs are considered; this sole exception is EBITDA-to-price ratio. For the capitalisation-weighted portfolios, the pre-cost performance of the strategies is visibly poorer and only four anomalies deliver positive abnormal returns. In the end, only two anomalies survive the impact of the trading costs: sales to price and asset turnover.

To sum up, trading costs appear to have highly negative impact on the performance of the examined strategies. While on the pre-cost basis many of the strategies proved profitable, only a handful remained successful after the bid-ask spreads and commissions were considered. In fact, given the large number of the

Table 4. Summary statistics of the impact of trading costs on monthly-rebalanced zero-investment portfolios formed on stock market anomalies.

	Mean return			Intercept		
	Value	*t*-stat	N	Value	*t*-stat	N
Panel A: Monthly rebalancing						
Equal-weighted portfolios						
Raw	1.26	3.09	33	1.28	3.17	33
Spread-adjusted	−0.50	−1.16	0	−0.49	−1.15	0
Spread & commissions-adjusted	−0.69	−1.59	0	−0.67	−1.60	0
Capitalisation-weighted portfolios						
Raw	0.60	1.07	13	0.62	1.13	14
Spread-adjusted	−0.53	−0.62	0	−0.51	−0.65	0
Spread & commissions-adjusted	−0.74	−0.93	0	−0.72	−0.97	0
Panel B: Annual rebalancing						
Equal-weighted portfolios						
Raw	0.59	1.64	20	0.60	1.63	19
Spread-adjusted	−0.08	−0.17	2	−0.07	−0.07	2
Spread & commissions-adjusted	−0.17	−0.41	1	−0.16	−0.31	1
Capitalisation-weighted portfolios						
Raw	0.08	0.27	5	0.10	0.29	4
Spread-adjusted	−0.31	−0.46	2	−0.30	−0.43	2
Spread & commissions-adjusted	−0.39	−0.61	2	−0.38	−0.57	2

The table reports the summary statistics of the monthly log returns on monthly-rebalanced and annually-rebalanced zero-investment portfolios formed on stock market anomalies. 'Intercept' is the intercept from the CAPM; '*t*-stat' is *t*-statistics, and '*N*' is the number of values significantly higher than 0 at the 5% level. Mean returns and intercepts are expressed as percentage.

tested anomalies, the seeming profitability of these very few strategies could be a result of pure chance.

Table 5 displays the intercepts on the 33 trading averaged across the categories of the anomalies. Looking at the monthly-rebalancing approach within the equal-weighted portfolios the most profitable on the pre-cost basis proved to be the momentum and technical analysis strategies, followed by the value and profitability categories. The momentum and the technical analysis, however, were most affected by the trading costs, thus on the-post cost basis they appeared the biggest losers. Furthermore, these pair of categories visibly lost their efficiency under the capitalisation-weighting approach. In this case, the most profitable group was Group 2: Profitability, with the average alpha exceeding 1%. It was also the only group of strategies whose intercepts remained on average positive (although insignificantly) after the trading costs were incurred.

The picture of the annually rebalanced portfolios (Panel B) is quite different. The momentum approach clearly lost its profitability while the technical trading strategies continued to perform well. In this case the most profitable on the pre-cost basis were the value strategies, which due to their low turnover and resilience kept their alphas historically on average positive even after accounting for the trading costs.[13]

4.2. Performance of the long-only portfolio

Table A7 in the supplementary material presents excess returns on monthly rebalanced long-only portfolios formed on the 33 anomalies which proved significant in the approach presented in Table A2 in the supplementary material, and which were

Table 5. Mean intercepts of zero-investment portfolios within the various categories of anomalies.

	Group 1: Value vs growth	Group 2: Profitability	Group 5: Issuance	Group 7: Liquidity	Group 9: Extreme and downside risk	Group 11: Momentum	Group 12: Technical analysis
Panel A: Monthly rebalancing							
Equal-weighted portfolios							
Raw	1.26	1.21	1.08	0.97	0.51	1.40	1.58
Spread-adj.	−0.12	−0.12	−0.11	−0.45	−0.83	−1.06	−0.72
Spread&com.-adj.	−0.27	−0.25	−0.24	−0.55	−0.97	−1.32	−0.97
Capitalisation-weighted portfolios							
Raw	0.78	1.08	0.68	1.03	0.00	0.53	−0.41
Spread-adj.	−0.06	0.36	0.02	−0.46	−0.83	−1.17	−1.85
Spread&com.-adj.	−0.22	0.24	−0.11	−0.56	−1.02	−1.49	−2.19
Panel B: Annual rebalancing							
Equal-weighted portfolios							
Raw	0.90	0.71	0.89	0.67	0.31	0.07	1.07
Spread-adj.	0.32	0.11	0.36	−0.16	−0.35	−0.74	0.30
Spread&com.-adj.	0.24	0.03	0.29	−0.23	−0.43	−0.85	0.21
Capitalisation-weighted portfolios							
Raw	0.55	0.09	0.35	0.57	0.03	−0.48	0.27
Spread-adj.	0.24	−0.27	0.05	−0.20	−0.22	−0.99	−0.11
Spread&com.-adj.	0.17	−0.33	−0.02	−0.27	−0.29	−1.09	−0.20

The table reports the mean intercepts from the CAPM model of the zero-investment portfolios formed on asset-pricing anomalies averaged within various categories. The intercepts are expressed as a percentage.

indicated earlier in this section. While the returns on the long-only portfolios can be expected to be less 'anomalous', as the abnormal returns are largely concentrated on the short side, the long-only portfolios provide a large number of strategies with abnormal returns. Putting it in different words, the abnormal returns on the long-only portfolios were almost as frequent as in the case of the zero-cost portfolios. Among the equal-weighted portfolios, 28 displayed significant alphas. Nonetheless, the value weighting, which better reflects the stock market reality, exerted largely a negative impact. Only 12 anomalies continued to show significant alphas, mostly originating from the profitability strategies.

Unsurprisingly, the turnover of the long-only strategies was about 50% lower than of the zero-investment portfolios (Table 6). The lowest turnover we recorded on the profitability based strategies while the highest, on the technical analysis and momentum strategies. The switch from the annual to monthly rebalancing led to a substantial decrease of the portfolio rotation. Interestingly, the decline was the largest for the most active strategies. While the turnover reduction for the profitability strategy slightly exceeded 40%, in the case of technical analysis the turnover actually deteriorated by about 70%.

The outcomes presented in Tables 7 and 8 led to conclude that the impact of trading costs on the long-only portfolios was only slightly less detrimental than in the case of the long-short portfolios. Starting with the monthly rebalancing portfolios (Panel A, Table 7), in the equal-weighting-approach only two anomalies survived the cumulative impact of transaction costs and commissions. The results of the

Table 6. Monthly turnover of long-only portfolios formed on stock market anomalies.

	Monthly rebalancing		Annual rebalancing	
Category	Equal-weighted portfolios	Capitalisation-weighted portfolios	Equal-weighted portfolios	Capitalisation-weighted portfolios
Group 1: Value vs growth	22.1	21.8	11.4	8.9
Group 2: Profitability	16.5	15.3	10.0	8.1
Group 5: Issuance	20.1	21.0	9.7	8.7
Group 7: Liquidity	18.2	20.5	12.7	12.2
Group 9: Extreme and downside risk	20.5	26.0	10.2	8.8
Group 11: Momentum	33.4	38.1	14.4	13.8
Group 12: Technical analysis	35.9	44.1	12.1	11.5

The table reports mean monthly portfolio turnover, i.e., the average percentage share of stocks replaced every month. The values represent the turnover of the strategies listed in Table A3 averaged within the respective categories. The values are expressed as percentage. The data are sourced from Bloomberg.

Table 7. Summary statistics of the impact of trading costs on monthly-rebalanced long-only portfolios formed on stock market anomalies.

	Mean excess return			Intercept		
	Value	*t*-stat	*N*	Value	*t*-stat	*N*
Panel A: Monthly rebalancing						
Equal-weighted portfolios						
Raw	1.31	2.42	28	1.09	3.02	28
Spread-adjusted	0.44	0.81	1	0.27	0.79	7
Spread & commisions-adjusted	0.34	0.64	1	0.19	0.57	2
Capitalisation-weighted portfolios						
Raw	0.88	1.42	11	0.62	1.50	12
Spread-adjusted	0.32	0.49	5	0.13	0.27	6
Spread & commisions-adjusted	0.22	0.33	2	0.04	0.05	6
Panel B: Annual rebalancing						
Equal-weighted portfolios						
Raw	0.87	1.57	17	0.70	1.95	19
Spread-adjusted	0.53	0.96	5	0.40	1.13	12
Spread & commisions-adjusted	0.49	0.88	2	0.37	1.05	11
Capitalisation-weighted portfolios						
Raw	0.48	0.82	3	0.29	0.74	3
Spread-adjusted	0.28	0.49	0	0.13	0.34	2
Spread & commisions-adjusted	0.24	0.41	0	0.11	0.27	2

The table reports the summary statistics of monthly log returns on monthly-rebalanced and annually-rebalanced long-only portfolios formed on stock market anomalies. 'Intercept' is the intercept from the CAPM; '*t*-stat' is *t*-statistics, and '*N*' is the number of values significantly higher than 0 at the 5% level. Mean returns and intercepts are expressed as percentage.

investigations of capitalisation-weighted portfolios were slightly more promising, especially that this approach reflects the investor's standpoint better. Half of the 12 significant alphas remained statistically significant. Nonetheless, the mean value of the intercept among the testes strategies dropped markedly. When ignoring the transaction costs, the mean intercept equaled 0.62%, yet once adjusted for trading costs it fell down to only 0.04%.

Table 8. Mean intercepts of long-only portfolios within the various categories of anomalies.

	Group 1: Value vs growth	Group 2: Profitability	Group 5: Issuance	Group 7: Liquidity	Group 9: Extreme and downside risk	Group 11: Momentum	Group 12: Technical analysis
Panel A: Monthly rebalancing							
Equal-weighted portfolios							
Raw	1.07	1.07	0.95	0.98	0.48	1.12	1.45
Spread-adj.	0.27	0.52	0.39	−0.22	0.04	0.10	0.47
Spread&com.-adj.	0.20	0.47	0.33	−0.28	−0.02	−0.01	0.35
Capitalisation-weighted portfolios							
Raw	0.57	1.08	0.88	1.04	0.05	0.44	0.25
Spread-adj.	0.10	0.83	0.54	−0.35	−0.14	−0.18	−0.30
Spread&com.-adj.	0.04	0.79	0.48	−0.41	−0.22	−0.31	−0.45
Panel B: Annual rebalancing							
Equal-weighted portfolios							
Raw	0.82	0.80	0.66	0.90	0.53	0.49	0.87
Spread-adj.	0.52	0.54	0.46	0.23	0.34	0.16	0.61
Spread&com.-adj.	0.49	0.51	0.43	0.19	0.32	0.13	0.58
Capitalisation-weighted portfolios							
Raw	0.35	0.30	0.65	0.77	0.12	0.15	0.11
Spread-adj.	0.21	0.20	0.55	0.08	0.08	−0.04	−0.01
Spread&com.-adj.	0.19	0.18	0.53	0.04	0.07	−0.08	−0.03

The table reports mean intercepts from the CAPM model of the long-only portfolios formed on asset-pricing anomalies averaged within various categories. The intercepts are expressed as percentage.

Panel A of Table 8 synthesises which strategies performed best and which were the most resilient to the trading costs. The detailed outcomes of the individual anomalies are set out in Tables A7–A10 in the supplementary material. Analysing the most realistic and conservative approach, i.e., the trading costs-adjusted returns on the capitalisation-weighted portfolios, we clearly see that the best performance was delivered by the long-only portfolios from sorts on profitability. The average post-cost intercept within this category amounted to 0.79%. Additionally, Table A9 in the supplementary material reports four profitability strategies which remained successful: ROA, ROE, GPA, and GMCh The remaining two significant anomalies were profitability-enhanced book-to-market ratio (BMGPA) and net stock issuance (NSI).

Coming back to Panel B of Table 7, displaying the performance of annually rebalanced portfolios, we see that this simple cost mitigation strategy proved relatively successful, particularly for the equal-weighted portfolios. On the cost-unadjusted basis the performance was naturally poorer than in the case of the monthly rebalanced portfolios. In the equal-weighting approach, the mean intercept equaled 0.70% and 19 were both economically and statistically significant, compared both to the mean intercept of 1.09% for the monthly-rebalanced portfolios and the 28 significant alphas (the detailed statistics on the annually rebalanced long-only portfolios are reported in Table A8 in the supplementary material). However, on the post-cost basis, only the annually rebalanced anomalies prevailed. Eleven anomalies remained both economically and statistically

significant, and the mean intercept equaled 0.37%, nearly doubling the monthly-rebalancing approach (for details on the cost-adjusted performance of the individual long-only annually rebalanced strategies see Table A10 in the supplementary material). The abnormal returns once again concentrated within the portfolios formed on profitability. This time, however, the value-based strategy also performed well (Table 8, Panel A): the average CAPM intercept amounted to 0.49% and 0.51% for the value and profitability categories.

Interestingly, most of these abnormal returns surfaced when weighting the portfolios by capitalization, i.e., in a much more realistic approach (Table 7, Panel B). Even on the pre-cost basis merely 3 anomalies displayed significant abnormal returns. After application of the trading costs, the mean monthly intercept fell to 0.11%, and the significant intercepts included only 2 lucky strategies: book-to-market ratio and asset turnover (see Table A10 in the supplementary material). The relatively high risk-adjusted and cost-adjusted returns were also provided by the issuance based strategies. Although Panel B of Table 8 shows their monthly excess of 0.5%, none of them is statistically significant.

Summing up the considerations of the long-only portfolios, we found that on the pre-cost basis many of the strategies still delivered abnormal returns, especially within the equal-weighted portfolios. Yet once adjusted for trading costs and appropriated their liquidity with capitalizations, the significance of the abnormal returns vanished almost entirely.

5. Conclusions

In our study we rigorously examined a broad set of 70 anomalies in Emerging Europe Most of these strategies had never been examined before. We found that in the most basic approach 33 anomalies delivered significant abnormal returns in the 2000–2015 period. Later, however, the more realistic approach we adopted, the less anomalous the portfolios appeared. When using capitalisation-weighting for long-only portfolios, the number of return-wise significant anomalies was visibly decreasing, leaving only a small number of strategies significantly profitable after accounting for trading costs, i.e., spreads and commissions. For the prevailing majority of the anomalies the transaction costs proved truly lethal. The results remained consistent even after decreasing the rebalancing frequency from monthly to annual. Although the portfolio turnover visibly diminished, it failed to compensate for the lower effectiveness of the anomalies. Consequently, nearly none of the anomalies delivered any noteworthy abnormal returns.

The outcomes are particularly important for individual investors and portfolio managers focused on Emerging Europe who in practice may, however, encounter serious obstacles to profit from them as once trading costs are recognised, most anomalies prove unprofitable. This observation bears some implications for the theory of asset pricing in financial markets. It supports the behavioural finance view of capital market anomalies, which explains their existence as a phenomenon which cannot be easily arbitraged away. We have documented here such arbitrage to be too costly to be economically justifiable for the arbitrageur.

The study may have an important limitation: its relatively short sample period of a mere 15 years. One may argue this time-span to be too short to form serious inferences regarding asset pricing. Yet given, the young age of the stock markets in Eastern Europe, hardly any longer time-series are available. As a result of the short time-span, our outcomes can also be, to some extent, period specific. For example, the sample period included the global financial crisis 2008–2009, which was followed by the exceptionally poor momentum returns (Daniel and Moskowitz, 2014). Unfortunately, given a large variability of the abnormal returns, splitting the full sample into sub-periods would yield no additional insights.

The further research on the issues presented in this article can be pursued in a number of directions. First, one of the shortcomings of this research is the use of a relatively simple cost function. We considered a small number of components of the implementation shortfall, particularly related to the market impact. Considering, for example, the trade size, would provide further insights and would better reflect the standpoint of the institutional investor. Further research could incorporate more sophisticated cost functions, as, for example, by Glosten and Harris (1988), Breen, Hodrick, and Korajczyk (2002), or Almgreen, Thun, Hauptmann, and Li (2005), or rely on real transaction data as performed by Frazzini et al. (2012).

Moreover, further research can concentrate on the cost-mitigation techniques and their applications in emerging markets following, for example, the tests carried out by Novy-Marx and Velikov (2015) in the U.S. market, who limited trading to low expected transaction costs stocks, reduced rebalancing frequencies, and introduced the buy/hold spread. Another interesting perspective is presented by Engle et al., who stated that many strategies to reduce execution costs (e.g., delaying trades to search for higher liquidity environments, breaking up trades to reduce spreads and price impact or using more out-of-the-money limit orders) require taking more time to trade, which in turn worsens the risk/return trade-off.

Finally, many of the cross-sectional patterns tested in this study have their parallel phenomena across other asset classes (see, e.g., Asness, Moskowitz, and Pedersen, 2013), and to date the impact of the trading costs on the cross-sectional strategies across many asset classes (e.g., corporate and sovereign bonds) has been modestly explored.

Notes

1. For example: ITG reports, Griffin, Kelly, and Nardari (2010).
2. The markets are well integrated, which is confirmed by a number of studies thereon (Cakici et al., 2013), as well as by the stock market indices covering the region, and numerous investment products focused on this geographic area.
3. The company list was compiled from quarterly downloads using the equity screening function (EQS). We selected listed, delisted, liquidated, withdrawn and acquired companies.
4. de Groot et al. (2011) showed that the impact of trading costs on the strategies' profitability can largely be attributed to excessively trading in small cap stocks. A review of methods used to eliminate the penny stocks is provided in Waszczuk (2014).
5. Importantly, due to the limitations of the Bloomberg database, there are no Turkish companies that meet our selection criteria in the period prior to year 2005.

6. The supplementary material is available and upon request.
7. We compute the bootstrap *t*-statistics based on 10,000 random draws.
8. The calculations were conducted in Microsoft Excel and R.
9. The risk-free rate is subtracted only from the long-only and market portfolios to obtain an excess return. Naturally, in the case of zero-investment portfolios we do diminish them by the risk-free return.
10. Interestingly, our results concerning the correlation across the strategies is consistent with previous evidence from developed countries. For example, we found that the momentum and value strategies displayed negative correlation, which was also found by Asness et al. (2013).
11. As we have noted already, we consider only the 33 anomalies which proved significant in the monthly-reformed equal-weighting approach.
12. To be precise, Novy-Marx and Velikov (2015) reported the average turnover on the long and short side, so for comparison purposes we have reported the doubled values.
13. The values are significantly different from zero only in a few cases. For details, see Table A6 in the supplementary material.

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