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THE IMPACT OF PENNY STOCKS ON THE PRICING OF COMPANIES LISTED ON THE WARSAW STOCK EXCHANGE IN LIGHT OF THE CAPM

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Abstract

Oryginality and objective – Research on the pricing of stocks listed on developed markets shows inexplicable deviation from the pricing that could be observed with CAPM validity. A similar anomaly is found on the Polish market. Reasons for inconsistent pricing with CAPM are unknown, and they are the main objective of this research.

Method – The study is conducted using stocks listed on the Warsaw Stock Exchange in 1995–2012. Quintile stock portfolios are formed on the basis of strategies widely used by investors. The study is carried out in several modes. In the subsequent modes penny stocks with the market values below 0.5, 1.5, 5.0 and 15.0 PLN are eliminated.

Results – It is conjectured that both penny stocks and improper procedures for the test portfolios forming contribute to inconsistent stock pricing in light of the CAPM. The studies show that results are in line with the extended conjectures. Also, study results indicate that speculative stocks are mostly penny stocks, however, it is not possible to explicitly state that penny stock are speculative.

Keywords: stock pricing, penny stocks, stock portfolio, return changes.

JEL classification: G11, G12.

Introduction

The classic CAPM is commonly used to assess the capital cost of companies listed on the stock exchange. In this case, the main condition for a correct estimation of capital cost is the assumption that stock pricing is consistent with the pricing that could be observed with CAPM validity. Fama and MacBeth¹ research shows the compatibility of stock pricing in light of the CAPM. However further works often document deviations from the well-known pricing theory and contradict pricing in light of the CAPM. The examples of returns anomalies include: the size **effect** of **Banz**², the January effect, the reversal of long-term returns documented by DeBondt and Thaler³ or the continuation of short term returns found by Jegadeesh and Titman⁴.

Research works concerning stock pricing on the Polish market were mainly focused on testing the classic CAPM and APT applications. These works are presented, among others, by Adamczak⁵, Jajuga⁶, Bołt and Miłobędzki⁷, Osińska and Stempińska⁸, Byrka-Kita and Rozkrut⁹, Zarzecki et al.¹⁰, Fiszeder¹¹ or Czapkiewicz and Skalna¹². Most of the results contradict the concept that stock pricing is in line with the pricing that could be observed with classic CAPM validity. The results of works on the American market are similar.

The attempt to explain the reasons for the incorrect stock pricing in light of the CAPM is undertaken by Urbański¹³. He analyzed the quarterly returns of stocks listed on the Warsaw Stock Exchange (WSE) in 1995–2012, and notes that many speculative stocks, described by bad financial indicators and penny prices, are characterized by extremely high returns. The author of this work examines the impact of speculative stocks on the pricing and states that they are components of inconsistent stock pricing in light of the CAPM.

It seems commonly understood that investment in penny stock is characterized by high risk arising from simple speculative reasons. Consequently, a large number of listed penny stock makes the market risky and speculative. The most famous stock exchanges introduce restrictions on penny stocks trading¹⁴.

One might ask whether the penny stocks can be identified with speculative ones and vice versa, whether speculative stocks can be equated with the penny stocks. Following this thought further, in the light of Urbański's previous research, the question arises whether inconsistent pricing in light of the CAPM is a component of speculative stocks or penny stocks.

To our knowledge, there are no in-depth studies which explain the reasons for the incorrect stock pricing in light of the CAPM. In the paper we continue these works and study the impact of penny stock on pricing that could be observed with classic CAPM validity. Because the basis of proper testing of CAPM application is appropriate forming of portfolios, we apply two portfolio forming procedures, using the instructions proposed by Cochrane¹⁵. We analyze

four modes of penny stock and two modes of speculative stocks influence for each portfolio building procedure. In addition, we explore the relationship between penny and speculative stocks. Therefore, we expect that the following conjectures are true:

Conjecture 1.

Penny stocks are speculative, characterized by weak financial indicators and high returns.

Conjecture 2.

Penny stocks are the components of inconsistent stock pricing in light of the CAPM.

Conjecture 3.

Improper procedures of portfolio forming lead to incompatible stock pricing.

Section 1 presents the fundamental model of portfolio management. Section 2 discusses the procedures of chosen methods of portfolio construction. In section 3 we study the relationship between penny stock and speculative stock. Section 4 widely analyzes the results of pricing in light of the CAPM for each case presented in Section 2. The final part of the paper presents conclusions.

1. The procedures of portfolio management

We analyze two procedures of portfolio construction. Procedure 1 is proposed by Urbański¹⁶. This model selects components of portfolio on the basis of the functional *FUN*, defined by equations (1), (2) and (3). This procedure of portfolio management provides practical investment strategies.

$$FUN = \frac{nor(ROE) \times nor(AS) \times nor(APO) \times nor(APN)}{nor(MV / E) \times nor(MV / BV)} \tag{1}$$

where

$$ROE = F_1; AS = F_2 = \frac{\sum_{t=1}^i S(Q_t)}{\sum_{t=1}^i S(nQ_t)}; APO = F_3 = \frac{\sum_{t=1}^i PO(Q_t)}{\sum_{t=1}^i PO(nQ_t)}; \tag{2}$$

$$APN = F_4 = \frac{\sum_{t=1}^i PN(Q_t)}{\sum_{t=1}^i PN(nQ_t)}, MV / E = F_5; MV / BV = F_6$$

Functions F_j ($j = 1, \dots, 6$) are transformed to normalized areas $\langle a_j; b_j \rangle$, according to equation (3):

$$\text{nor}(F_j) = \left[a_j + (b_j - a_j) \times \frac{F_j - c_j \times F_j^{\min}}{d_j \times F_j^{\max} - c_j \times F_j^{\min} + e_j} \right] \quad (3)$$

In equations (1), (2) and (3), the corresponding indications are as follows: *ROE* is return on book equity; $\sum_{t=1}^i S(Q_t)$, $\sum_{t=1}^i PO(Q_t)$, $\sum_{t=1}^i PN(Q_t)$ are values that are accumulated from the beginning of the year as net sales revenue (*S*), operating profit (*PO*) and net profit (*PN*) at the end of “*i*” quarter (Q_t); $\sum_{t=1}^i \overline{S(nQ_t)}$, $\sum_{t=1}^i \overline{PO(nQ_t)}$, $\sum_{t=1}^i \overline{PN(nQ_t)}$ are average values, accumulated from the beginning of the year as *S*, *PO* and *PN* at the end of Q_t over the last *n* years (the present research assumes that $n = 3$ years); *MV/E* is the market-to-earning value ratio; *E* is the average earning for the last four quarters; *MV/BV* is the market-to-book value ratio; a_j , b_j , c_j , d_j , e_j are variation parameters. Calculations prove that in modeling equilibrium on the stock market, it is possible to assume identical values for all parameters. The functions F_j ($j = 1, \dots, 6$) are transformed into equal normalized area $\langle 1; 2 \rangle$ (if $\sum_{t=1}^i \overline{PN(nQ_t)}$, $\sum_{t=1}^i \overline{PO(Q_t)}$, $\sum_{t=1}^i \overline{PN(nQ_t)}$ or $\sum_{t=1}^i \overline{PO(nQ_t)}$ in equation (2) is negative, the functions F_j ($j = 1, 3, 4$) are transformed into area $\langle 0; 1 \rangle$).

Functional *FUN* contains a clear economic interpretation and may constitute a criterion for selecting securities for the portfolio. Functional *FUN* is a gauge of securities which are assessed well by *NUM* and at the same time priced lowly by *DEN*. Long investments are more attractive if the *FUN* value is greater. Therefore, short investments are more attractive for smaller values of *FUN*.

Portfolio forming according to this model uses the first advice of Cochrane¹⁷. A select group of market participants invests in companies that publish the best financial results – these investors form their portfolio using *NUM* function. Another group of market participants invests in companies that have low *MV/E* and *MV/BV* indicators, and forms their portfolio using *DEN* function¹⁸. However, some market participants invest in companies that publish the best financial results while *MV/E* and *MV/BV* indicators are characterized by low values – these investors form their portfolio using *FUN*.

In procedure 2, portfolios are built according to Fama and French¹⁹ methods. In this case portfolios are formed on the basis of *BV/MV* and capitalization (company size). The results

of many previous works show a significant influence of BV/MV and capitalization on future returns²⁰. The reason for these connections is explained by Fama and French²¹. This work shows that stock prices in relation to capitalization and BV/MV are influenced by earning structure in the last five years. Thus, one can conclude that prices (and returns) are directly generated by earnings in the period preceding the investment, while BV/MV and size also result from the recorded changes of earnings.

Also, the above analysis indicates that portfolio forming parameters should be based on a company's earning structure in the last several years. These findings are taken into account by Urbański's model which (in the light of Fama and French²² research) can be an alternative to Fama and French²³ method of portfolio construction.

2. Data and construction of testing portfolios

We analyzed the quarterly returns of the stocks listed on the WSE in 1995–2012²⁴. Data referring to the fundamental results of the inspected companies are taken from the database drawn up by Notoria Serwis Sp. z o.o. Data for defining returns on securities are provided by the Warsaw Stock Exchange.

Tested portfolios are built by two procedures, as mentioned in Section 1. In each procedure seven modes of samples are analyzed. Mode M1 considers all WSE stocks except companies characterized by a negative book value. In four modes: MP1, MP2, MP3 and MP4 we eliminate penny stocks with market values lower than 0.50, 1.50, 5.00, and 15.00 PLN, respectively, and in two modes MS1 and MS2 we eliminate speculative stocks²⁵.

Analyzed securities are sorted into quintile portfolios built on the basis of fundamental functional FUN , NUM and DEN functions, presented in equation (1) – in procedure 1 (5 portfolios are formed on FUN , 5 on NUM and 5 on DEN) as well as on BV/MV and capitalization (CAP) (5 portfolios are formed on BV/MV and 5 on CAP) – in procedure 2. FUN , NUM , DEN , BV/MV and CAP are calculated for all analyzed securities at the beginning of each investment period in which the return is to be calculated. FUN , NUM , DEN , BV/MV and CAP for portfolios constitute average arithmetical values of these functions of various portfolio securities. Returns on given portfolios are average stock returns weighted by market capitalizations at the beginning of the investment period.

Table 1 presents the number of listed companies classified into quintile portfolios in the chosen periods.

Table 1. Number of companies in quintile portfolios

Quintile	IQ1996				IQ2005				IVQ2011			
	M1	MP3	MP4	MS2	M1	MP3	MP4	MS2	M1	MP3	MP4	MS2
1	11	11	7	11	33	28	19	27	63	36	19	50
2	11	11	7	11	33	28	19	27	63	36	19	50
3	11	11	7	11	33	28	19	27	63	36	19	50
4	11	11	7	11	33	28	19	27	63	36	19	50
5	13	10	8	10	34	27	19	29	62	37	18	49

In M1 negative-*BV* stocks are excluded from the portfolios. Modes MP3 and MP4 eliminate penny stocks with market values below 5.00 and 15.00 PLN, respectively. Mode MS2 eliminates speculative stocks meeting one of the following boundary conditions: a) $MV/BV > 100$, b) $ROE < 0$ and $BV > 0$ and $r_{it} > 0$, c) $MV/BV > 30$ and $r_{it} > 0$, d) $MV/E < 0$, where MV is the stock market value, ROE is the return on book value (BV), r_{it} is the return of portfolio i in period t , E is the average earning for the last four quarters.

Source: modes MP3 and MP4 own research, modes M1 and MS2 Urbański (2014).

Table 2. The average return spreads of portfolios formed on maximal and minimal values of *FUN*, *NUM*, *DEN*, *BV/MV* and *CAP*

	Procedure 1			Procedure 2	
	<i>FUN</i>	<i>NUM</i>	<i>DEN</i>	<i>BV/MV</i>	<i>CAP</i>
M1 \bar{r} (<i>p</i> -value)*	0.07 (0.00)	0.05 (0.00)	-0.06 (0.00)	0.05 (0.05)	-0.01 (0.53)
$\bar{r}_{procedure}$	$\bar{r}_{procedure\ 1} = 0.06$			$r_{procedure\ 2} = 0.02$	
<i>p</i> -value**	0.01				
MP1 = 0.50 \bar{r} (<i>p</i> -value)*	0.07 (0.00)	0.05 (0.00)	-0.06 (0.00)	0.03 (0.08)	-0.03 (0.24)
$\bar{r}_{procedure}$	$\bar{r}_{procedure\ 1} = 0.06$			$r_{procedure\ 2} = 0.03$	
<i>p</i> -value**	0.02				
MP3 = 5.00 \bar{r} (<i>p</i> -value)*	0.08 (0.00)	0.06 (0.00)	-0.05 (0.00)	0.02 (0.49)	-0.03 (0.32)
$\bar{r}_{procedure}$	$\bar{r}_{procedure\ 1} = 0.06$			$r_{procedure\ 2} = 0.02$	
(<i>p</i> -value)**	0.01				
MP4 = 15.00 \bar{r} (<i>p</i> -value)*	0.06 (0.00)	0.07 (0.00)	-0.05 (0.00)	0.01 (0.47)	-0.03 (0.26)
$\bar{r}_{procedure}$	$\bar{r}_{procedure\ 1} = 0.06$			$r_{procedure\ 2} = 0.02$	
<i>p</i> -value**	0.01				
MS2 \bar{r} (<i>p</i> -value)*	0.09 (0.00)	0.00 (0.00)	-0.06 (0.00)	0.03 (0.03)	-0.03 (0.16)
$\bar{r}_{procedure}$	$\bar{r}_{procedure\ 1} = 0.07$			$r_{procedure\ 2} = 0.00$	
<i>p</i> -value**	0.00				

\bar{r} is average spread value; * $H_0: \bar{r} = 0, H_1: \bar{r} \neq 0$; ** $H_0: \bar{r}_{procedure\ 1} = r_{procedure\ 2}, H_1: r_{procedure\ 1} > r_{procedure\ 2}$. In M1 negative-*BV* stocks are excluded from the portfolios. Modes MP1, MP3 and MP4 eliminate penny stocks with market values below 0.50, 5.00 and 15.00 PLN, respectively. Mode MS2 eliminates speculative stocks meeting one of the following boundary conditions: a) $MV/BV > 100$, b) $ROE < 0$ and $BV > 0$ and $r_{it} > 0$, c) $MV/BV > 30$ and $r_{it} > 0$, d) $MV/E < 0$, where MV is the stock market value, ROE is the return on book value (BV), r_{it} is the return of portfolio i in period t , E is the average earning for the last four quarters. The sample period is from 1995 to 2012, 64 Quarters.

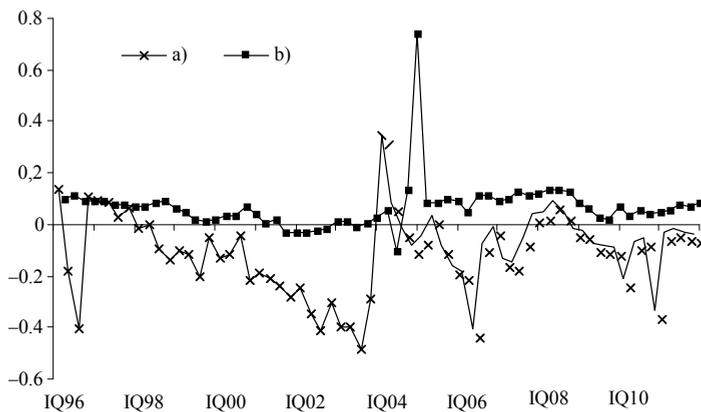
Source: modes MP1, MP3 and MP4 own research, modes M1 and MS2 Urbański (2014).

Table 2 shows the return spreads of portfolio formed on maximal (quintile 1) and minimal (quintile 5) values of *FUN*, *NUM*, *DEN*, *BV/MV*, and *CAP*.

The spreads for portfolios formed on *FUN*, *NUM* and *DEN* (in procedure 1) are significantly different from zero (p -values < 0.00). The spreads for portfolios formed on *BV/MV* and *CAP* (in procedure 2) are equal to zero. The spreads for portfolios formed in procedure 1 are significantly higher than for portfolios formed in procedure 2 (p -values < 0.01). However, the spreads for portfolios formed on *FUN*, *NUM*, *DEN*, *BV/MV* or *CAP*, but in different modes, do not differ²⁶.

3. Penny stocks versus speculative stocks

Figure 1 shows changes of *ROE* indicator of stock portfolios with market values below and above 5.00 PLN, in 1996–2011. Table 3 shows average values of price, *ROE* and *MV/BV* indicators, and return for chosen portfolios.



a) portfolio of stocks with market values below 5.00 PLN; b) portfolio of stocks with market values above 5.00 PLN. The values of *ROE* indicator for portfolio are determined as an arithmetic mean of *ROE* for stocks included in the portfolio.

Fig. 1. Changes of *ROE* indicator of positive book value stock portfolios

Source: own research.

Table 3. Average values of *MV*, *ROE* and *MV/BV* indicators, and return (*r*) for positive-BV stock portfolios*

Prices of stocks (P) in portfolio	Average quarter values of portfolios			
	<i>MV</i>	<i>MV/BV</i>	<i>ROE</i> %	<i>r</i> %
<i>P</i> < 15 PLN	7.00 ^{DSLJ} (1.24)	1.95 (1.19)	-3.05 (9.52)	2.67 ^L (19.72)
<i>P</i> > 15 PLN	74.55 (19.57)	2.51 (0.95)	12.12 ^{DSLJ} (4.19)	1.53 ^{DSJ} (15.11)
<i>P</i> < 5 PLN	2.83 (0.51)	2.26 (1.98)	-10.66 ^{DSLJ} (15.97)	3.26 (23.23)
<i>P</i> > 5 PLN	51.91 (15.50)	2.22 (0.87)	9.31 (10.88)	1.90 ^{DSJ} (15.84)
<i>P</i> < 1.5 PLN	1.00 (0.36)	2.329 (3.83)	-30.88 (38.78)	2.2 ^{DSLJ} (26.97)
<i>P</i> > 1.5 PLN	44.30 (15.18)	2.27 (0.91)	6.77 (10.28)	2.0 ^{DJ} (16.72)
<i>P</i> < 0.5 PLN	0.33 ^L (0.07)	1.94 (2.29)	-21.18 ^{DSLJ} (28.62)	3.48 (32.14)
<i>P</i> > 0.5 PLN	42.83 (15.22)	2.25 (0.93)	4.19 (8.97)	2.09 ^{DJ} (16.97)

* Stocks in the portfolios are weighted linearly. Standard deviations are indicated below in brackets. *MV* is a market value of portfolio. ^D, ^S, ^L, ^J Doornik-Hansen, Shapiro-Wilk, Lilliefors or Jarque'a-Bera tests show a normal distribution of the variable. The sample period is from 1995 to 2012, 64 Quarters.

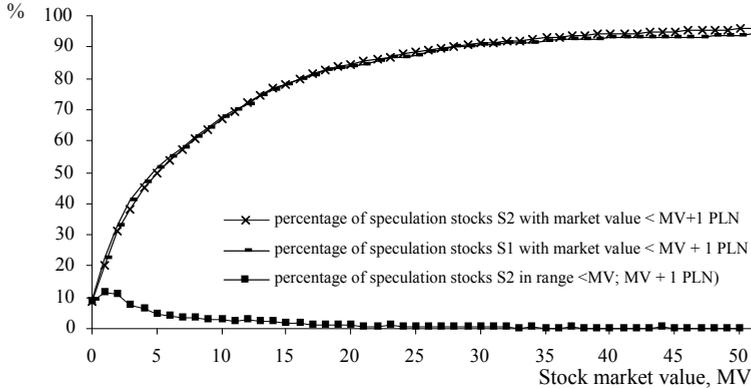
Source: own research.

In the case of *ROE* indicator, substantial and visual differences are identified for the portfolios below and above assumed borders of 0.50, 1.50, 5.00 and 15.00 PLN. The lower values of *ROE* for penny stock portfolios point to speculation. The average values of *BV/MV* and returns for this portfolios appear to be the same. Statistical testing is not possible because the two variables do not have a normal distribution. The higher values of standard deviation of returns for portfolios below assumed borders indicate a greater total risk for portfolios of penny stocks.

Figure 2 shows the percentage of speculative stocks depending on the price, at the beginning of 64 quarters in 1996–2011.

The largest number of speculative stocks is in the range of market values (1.00 PLN; 2.00 PLN>). In the case of speculative stocks S2 it is 238 stocks, which account for 11.73% of all S2 stocks. In the case of speculative stocks S1 it is 95 stocks, which account for 12.75% of all S1 stocks²⁷. On the other hand, 49.58% of S2 and 51.54% speculative stocks S1 have a price of less than 5.00 PLN. These results indicate that speculative stocks are mostly penny stocks.

However, in terms of conducted research, it is not possible explicitly to state that penny stock portfolios are speculative (see Figure 1 and Table 2).



The percentage of speculation stocks is determined by the relation between the number of speculation stocks with market value $< MV$ and the number of all speculation stocks, listed on WSE, at the beginning of 64 quarterly investment periods in 1996–2011. Speculative stocks S1 are defined as meeting one of the following boundary conditions: a) $MV/BV > 100$, b) $ROE < 0$ and $BV > 0$ and $r_{it} > 0$, c) $MV/BV > 30$ and $r_{it} > 0$, where ROE is the return on book value (BV), r_{it} is the return of portfolio i in period t . Speculative stocks S2 are defined as meeting an additional condition d) $MV/E < 0$ and $BV > 0$, where E is the average earning for the last four quarters.

Fig. 2. The percentage of speculation stocks depending on the market value

Source: own research.

4. Stock pricing in light of the CAPM

The statistical model which tests the classic CAPM can be described by equations (4) and (5). The regressions of time series (4) are analyzed in the first pass. The equation (5) is analyzed in the second pass as the time-cross-section regression, using panel data.

$$r_{it} - RF_t = \alpha_i + \beta_{i,M}(RM_t - RF_t) + e_{it}, \quad t = 1, \dots, T; \quad \forall i = 1, \dots, 15 \quad (4)$$

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \varepsilon_{it}, \quad i = 1, \dots, m; \quad t = 1, \dots, T \quad (5)$$

The response variable of the above regressions is the excess of return ($r_{it} - RF_t$) of $m = 15$ test portfolios constructed on FUN , NUM and DEN as well as the excess of returns of $m = 10$ portfolios built on BV/MV and CAP . The risk-free return (RF) is evaluated by the 91-day Treasury bill return. The explanatory variable of regression (4) is a market factor defined as an excess market return over the risk-free return ($RM_t - RF_t$). The market return (RM) is evaluated by the

return on the WIG index of the WSE. The explanatory variable of regression (5) constitutes the loading of market factor (beta), estimated in the first pass, for i portfolio.

The values of parameters of regressions (4) are determined by means of the GLS method with the application of the Prais-Winsten procedure with first-order autocorrelation.

Estimators of systematic risk (betas) are significantly different from zero for all the tested cases (p -values = 0.00). They are similar for different modes and procedures of portfolio building, and their values change as follows: for portfolios formed on *FUN* from 0.72 to 1.20, for portfolios formed on *NUM* from 0.75 to 1.17, for portfolios formed on *DEN* from 0.83 to 1.20, for portfolios formed on *BV/MV* from 0.75 to 1.08, and for portfolios formed on *CAP* from 0.93 to 1.30. Coefficients R^2 for portfolios formed on *FUN*, *NUM* and *DEN* range from 43% to 89%, while for portfolios formed on *BV/MV* and *CAP* seem to be lower and range from 29% to 91%.

The betas loading, defining the risk premium, is estimated in the second pass. The lack of autocorrelation of the residual component may be assumed due to the fact that beta is constant for all periods and returns should by nature be random²⁸. The impact of heteroskedasticity is corrected by means of the change of variables method. The errors in variables are taken into account by adjusting the standard errors, using Shanken's estimator²⁹.

Table 4 presents the values of estimated parameters of regressions (5) and the cross-sectional R^2_{LL} measure employed by Lettau and Ludvigson (2001)³⁰.

If portfolios are built on *FUN*, *NUM* and *DEN*, and speculative stocks are removed from analysis (modes MS1 and MS2) the tested application prices the risk premium (γ_M) at the level of 12% and 19% quarterly. Also, the risk premium is priced if penny stocks with market values below 15.00 PLN (mode MP4) are not considered. In this case the value of γ_M is similar to mode MS2 and equals 13%.

The elimination of stocks below 0.50, 1.50 and 5.00 PLN (modes MP1, MP2 and MP3) does not allow for significant estimates of the risk premium.

If portfolios are built on *BV/MV* and *CAP*, the classic CAPM does not price risk premium. In this case, the values of γ_M are insignificantly different from zero for all modes (p -values > 0.46).

Coefficient R^2_{LL} assumes extremely small values, in the cases of M1, MP1, MP2 and MP3 modes, and grows after elimination of stocks below 15.00 PLN, as well as exclusion of speculative stocks (in modes MS1 and MS2) assuming 23%, 11% and 57%, respectively.

Table 5 presents the values of GRS and $Q^A(F)$ statistics for the tests of Gibbons et al. and Shanken³¹.

Table 4. The parameters of regression which tests the classic CAPM*

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \varepsilon_{it}, \quad i = 1, \dots, m; \quad t = 1, \dots, 64$$

	M1	MP1	MP2	MP3	MP4	MS1	MS2
Panel A. Portfolios are formed on <i>FUN</i> , <i>NUM</i> and <i>DEN</i> ; $m = 15$; Procedure 1							
γ_0	-0.03	-0.03	-0.05	-0.08	-0.14	-0.14	-0.19
p -value	0.41	0.40	0.29	0.15	0.01	0.00	0.00
p -value ^s	0.41	0.41	0.30	0.19	0.05	0.03	0.01
γ_M	0.02	0.02	0.03	0.06	0.13	0.12	0.19
p -value	0.70	0.62	0.51	0.26	0.02	0.02	0.00
p -value ^s	0.70	0.63	0.52	0.30	0.07	0.07	0.01
R^2_{LL} , %	-0.99	-1.28	-0.94	0.52	23.18	11.48	56.74
Panel B. Portfolios are formed on <i>BV/MV</i> and <i>CAP</i> ; $m = 10$; Procedure 2							
γ_0	-0.00	-0.04	0.01	-0.01	0.01	-0.00	-0.08
p -value	0.98	0.45	0.84	0.90	0.94	0.94	0.47
p -value ^s	0.98	0.46	0.84	0.90	0.94	0.94	0.53
γ_M	-0.00	0.04	-0.02	0.00	-0.02	-0.01	0.08
p -value	0.94	0.50	0.76	99.6	0.84	0.89	0.46
p -value ^s	0.94	0.51	0.76	99.6	0.84	0.89	0.52
R^2_{LL} , %	0.23	27.82	4.12	-0.01	1.95	0.39	10.70

* In mode M1 negative-*BV* stocks are excluded from the portfolios. Modes MP1, MP2, MP3 and MP4 eliminate penny stocks with prices under 0.50, 1.50, 5.00 and 15.00 PLN, respectively. Mode MS1 eliminates speculative stocks meeting one of the following boundary conditions: a) $MV/BV > 100$, b) $ROE < 0$ and $BV > 0$ and $r_{it} > 0$, c) $MV/BV > 30$ and $r_{it} > 0$, where MV is the stock market value, ROE is the return on book value (BV), r_{it} is the return of portfolio i in period t . Mode MS2 eliminates speculative stocks meeting an additional condition d) $MV/E < 0$, where E is the average earning for the last four quarters. RF is the 91-day Treasury bill return. $\hat{\beta}_{i,M}$ is the loading on the market factor ($RM - RF$, for i portfolio) estimated from first-pass time-series regressions. RM is evaluated by the return on the WIG index of the WSE. R^2_{LL} is a measure, follows Lettau and Ludvigson (2001), showing the fraction of the cross-sectional variation in average returns that is explained by each model. The response variable is excess return on 15 stock portfolios formed on *FUN*, *NUM* and *DEN* values, in Panel A, and on *BV/MV* and capitalization (*CAP*), in Panel B. The Prais-Winsten algorithm is used for correction of autocorrelation. ^s after adjusting for errors-in-variables, according to Shanken (1992). The sample period is from 1995 to 2012, 64 Quarters.

Source: modes MP1, MP2, MP3 and MP4 own research, modes M1, MS1 and MS2 Urbański (2014).

The removal of penny stocks from portfolios does not affect the intercepts values of regressions (4). This is confirmed by the GRS statistic ranging from 2.67 (p -value = 0.00) to 3.86 (p -value = 0.00). On the other hand, if speculative stocks are eliminated, the GRS falls to the value of 1.18 (p -value = 0.32) for mode MS1, and 0.78 (p -value = 0.69) for mode MS2.

Pricing errors decrease rapidly after elimination of speculative stocks. Also, the removal of penny stocks, but only with the market values below 15.00 PLN decreases pricing errors, at 0.08 significance level. It is documented by the values of $Q^4(F)$ statistic (see Table 5). This proves that mean-variance-efficient portfolios are generated if speculative stocks are excluded from consideration, while the removal of penny stocks with the market values below 5.00 PLN does not affect the portfolio efficiency.

Table 5. The results of tests of portfolio efficiency*

$$r_{it} - RF_t = \gamma_0 + \gamma_M \hat{\beta}_{i,M} + \varepsilon_{it}, \quad i = 1, \dots, 15; \quad t = 1, \dots, 64$$

Portfolios are formed on <i>FUN</i> , <i>NUM</i> and <i>DEN</i> ; <i>m</i> = 15							
	M1	MP1	MP2	MP3	MP4	MS1	MS2
GRS	3.65	3.86	3.86	2.67	3.10	1.18	0.78
<i>p</i> -value	0.00	0.00	0.00	0.01	0.00	0.32	0.69
$Q^4(F)$	4.05	3.49	3.59	2.95	1.74	1.28	0.81
<i>p</i> -value	0.00	0.00	0.00	0.00	0.08	0.26	0.65

* In mode M1 negative-*BV* stocks are excluded from the portfolios. Modes MP1, MP2, MP3 and MP4 eliminate penny stocks with prices under 0.50, 1.50, 5.00 and 15.00 PLN, respectively. Mode MS1 eliminates speculative stocks meeting one of the following boundary conditions: a) $MV/BV > 100$, b) $ROE < 0$ and $BV > 0$ and $r_{it} > 0$, c) $MV/BV > 30$ and $r_{it} > 0$, where P is the stock market value, ROE is the return on book value (BV), r_{it} is the return of portfolio i in period t . Mode MS2 eliminates speculative stocks meeting additional condition d) $P/E < 0$, where E is the average earning for the last four quarters. RF is the 91-day Treasury bill return. $\hat{\beta}_{i,M}$ is the loading on the market factor ($RM - RF$, for i portfolio) estimated from first-pass time-series regressions. RM is evaluated by the return on the WIG index of the WSE. GRS is the F -statistics of Gibbons et al. (1989). $Q^4(F)$ reports F -statistic and its corresponding p -value indicated below for Shanken's (1985) test that the pricing errors in the model are jointly zero. The response variable is excess return on 15 stock portfolios formed on *FUN*, *NUM* and *DEN* value in period t . The Prais-Winsten algorithm is used for correction of autocorrelation. The sample period is from 1995 to 2012, 64 Quarters.

Source: Modes MP1, MP2, MP3 and MP4 own research, modes M1, MS1 and MS2 Urbański (2014).

Conclusions

In this paper we explore the impact of penny stocks on the pricing which would result from the correctness of CAPM assumptions. The conducted research leads to the following conclusions:

1. The return spreads for portfolios formed on *FUN*, *NUM* and *DEN* are significantly higher than spreads for portfolios formed on *BV/MV* and *CAP*, however the penny stocks do not affect the size of spread.
2. Approx. 50% of speculative stocks listed on WSE in 1995–2012 show the market value below 5 PLN.
3. Penny stock portfolios are characterized by lower values of *ROE* indicator, and higher total risk, which is in line with Conjecture 1. However, the values of *MV/BV* and return on penny stock portfolios, and portfolios which do not contain penny stocks are similar, which contradicts Conjecture 1.
4. Speculative stocks are mostly penny stocks. However, in terms of conducted research, it cannot be explicitly stated that penny stocks are speculative. These results are not in line with Conjecture 1.

5. A systematic risk is significantly different from zero for all the tested cases, and it is similar for different modes and procedures of portfolio construction.
6. If portfolios are formed on *FUN*, *NUM* and *DEN*, the exclusion of stocks with market values below 5.00 PLN does not allow for significant estimates of the risk premium, however the risk premium is priced if penny stocks below 15.00 PLN are not considered.
7. If portfolios are built on *BV/MV* and *CAP*, the classic CAPM does not price the risk premium on WSE. Incorrect pricing is caused by improper procedures for the portfolio forming, characterized by small return spreads. This is in line with Conjecture 3.
8. If penny stocks (below 15 PLN) are excluded from portfolios, R^2_{LL} grows from 1% to 23%. This is in line with Conjecture 2. If speculative stocks are excluded from the portfolios, R^2_{LL} grows to 56%.
9. The removal of penny stocks from portfolios does not affect the intercepts values of regressions. This does not confirm Conjecture 2. If speculative stocks are eliminated values of intercepts fall to zero.
10. The removal of penny stocks, but only with the market values below 15.00 PLN, decreases pricing errors. This is in line with Conjecture 2. Also, pricing errors decrease after elimination of speculative stocks.
11. The removal of penny stocks with the market values below 5.00 PLN does not affect the portfolio efficiency. This does not confirm Conjecture 2. Classic CAPM generates mean-variance-efficient portfolios if speculative stocks are excluded from consideration.

The identification of correlations between penny stocks and speculation stocks requires further research.

Notes

¹ Fama, MacBeth (1973).

² Banz (1981).

³ DeBondt, Thaler (1985).

⁴ Jegadeesh, Titman (1993).

⁵ Adamczak (2000).

⁶ Jajuga (2000).

⁷ Bołt, Miłobędzki (2002).

⁸ Osińska, Stempińska (2003).

- ⁹ Byrka-Kita, Rozkrut (2004).
- ¹⁰ Zarzecki et al. (2004–2005).
- ¹¹ Fiszeder (2006).
- ¹² Czapkiewicz, Skalna (2010).
- ¹³ Urbański (2012a, 2014).
- ¹⁴ WSE defines penny stock as a security whose price is below 0.50 PLN (and 1.00 PLN starting from December 2015) per share. A penny stock in the USA is defined, by the Securities and Exchange Commission (SEC) as a security whose price is below 5\$ per share, while in the UK under 1£. Penny stocks are often traded on over-the-counter markets. WSE and SEC define specific rules for the sale of penny stocks.
- ¹⁵ “Finally, I think much of the attachment to portfolios comes from a desire to more closely mimic what actual investors would do rather than simply form a test.” (see Cochrane, 2001, p. 445). “If your portfolios have no spread in average returns – if you just choose 25 random portfolios – then there will be nothing for the asset pricing model to test.” (see Cochrane, 2001, p. 453).
- ¹⁶ Urbański (2011, 2012b).
- ¹⁷ Cochrane (2001).
- ¹⁸ Investments on the basis of low values of MV/E and MV/BV are often made in emerging markets.
- ¹⁹ Fama, French (1993).
- ²⁰ See e.g. Rosenberg et al. (1985) and Fama, French (1992).
- ²¹ Fama, French (1995).
- ²² Ibidem.
- ²³ Fama, French (1993),
- ²⁴ The first quarterly investment periods begins on 10 May 1996. The last investment period ends on 21 May 2012.
- ²⁵ Modes MS1 and MS2 are analyzed in Urbański’s (2014) paper and in present research are compared with penny stock analysis. Mode MS1 eliminates speculative stocks meeting one of the following boundary conditions: a) $MV/BV > 100$, b) $ROE < 0$ and $BV > 0$ and $r_{it} > 0$, c) $MV/BV > 30$ and $r_{it} > 0$, where MV is the stock market value, ROE is the return on book value (BV), r_{it} is the return of portfolio i in period t . Mode MS2 eliminates speculative stocks meeting an additional condition d) $MV/E < 0$, where E is the average earning for the last four quarters.
- ²⁶ The spreads for portfolios formed on *DEN* are negative because return of portfolio with higher values of MV/E and MV/BV is smaller than return of portfolio with lower values of these indicators (see equation 2). Also, nominal values of spread for portfolios formed on *CAP* are negative. This apparently indicates (but does not prove) the effect of small companies. This anomaly is widely shown in Urbański (2011).
- ²⁷ Speculative stocks S1 and S2 are eliminated in modes MS1 and MS2.
- ²⁸ See Cochrane (2001), p. 231.
- ²⁹ See Shanken (1992), p. 13.
- ³⁰ The R^2_{LL} measure is calculated as follows: $R^2_{LL} = [\sigma_c^2(\bar{r}_i - \sigma_c^2(\bar{\epsilon}_i))] / \sigma_c^2(\bar{r}_i)$, where σ_c^2 denotes a cross-sectional variance, and variables with bars above denote time-series averages.
- ³¹ GRS reports F -statistic for the test of Gibbons et al. (1989) that the intercepts of regression are jointly equal to zero. $Q^4(F)$ reports F -statistic for the test of Shanken (1985) that the pricing errors in the model are jointly equal to zero. A pricing model generates mean-variance-efficient portfolios if intercepts as well as the pricing errors in the model are jointly equal to zero.

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