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Institutional Trading and Stock Return Autocorrelation: Empirical Evidence on Polish Pension Fund Investors' Behavior*

Bartosz Gebka†, Harald Henke, and Martin T. Bohl

Abstract

In this paper, we extend the empirical finance literature about the influence of institutional traders by investigating the impact of Polish pension funds trading on individual stock return autocorrelation. The pension reform in 1999 and the associated increase in institutional traders' investment activities provides the unique opportunity to receive additional insight into the behavior of institutional investors in an emerging capital market. Performing a variant of the event study methodology we find only very little empirical evidence supporting existing theories predicting positive return autocorrelation due to the influence of institutional traders' investment activities. Rather, our cross-sectional analysis reveals a negative relationship between the trading of pension funds and autocorrelation in returns of individual stocks.

JEL Classification: G14, G23

Keywords: Institutional trading, pension funds, return autocorrelation, Polish stock market

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1 Introduction and Literature Review

In the late 1980s, the capital markets world-wide experienced an unprecedented increase in the number of stocks traded by institutional investors which increased the interest of researchers into the impact of institutional trading on stock prices. In particular, due to the specific trading behavior of institutions a reasonable number of theoretical and empirical investigations put forward arguments in favor of their impact on autocorrelation in stock returns. First, Barclay and Warner (1993) argue that informed investors will break up their trades and distribute them over time to lower their price impact. This will induce an increase in autocorrelation of stock returns. As far as trades are cross-sectionally correlated, simultaneous actions of informed institutional traders will induce positive return autocorrelation. Chan and Lakonishok (1995) also find empirical evidence for order-splitting by institutional traders.

A second argument for positive return autocorrelation can be derived from the model put forward by Wang (1994). It relies on the information asymmetry between traders and on the impact of informed trading on the behavior of uninformed investors. The main finding is that as the share of informed traders increase, autocorrelation in returns also increases. Cooper (1999) finds that for stocks with high information asymmetry autocorrelation in returns becomes positive. If institutional investors are assumed to be informed (e.g. Arbel and Strebel (1983), Sias and Starks (1997), Sias, Starks, and Titman (2001)), institutional ownership increases return autocorrelation.

Third, it can be argued that sequential information arrival induces increases in return autocorrelation. As the best informed traders receive price-relevant information and trade on it, prices move in one direction. As the second-best informed receive the same information afterwards, they also

trade on it, moving the prices even further on. This sequential trading causes the price to move in one direction for a certain period of time, inducing positive autocorrelation. Findings of Sias and Starks (1997) that autocorrelation in stock returns depends positively on the fraction of (best informed) institutional traders, and that this autocorrelation is positive, provide us with empirical evidence in favor of this reasoning. Holden and Subrahmanyam (2002) also show that returns are positively autocorrelated under the condition of sequential information acquisition.

Fourth, positive feedback trading and herding by institutional investors may increase return autocorrelation. Results reported by Sias and Starks (1997) and Nofsinger and Sias (1999) are in line with this hypothesis. From their analysis of mutual funds, Grinblatt, Titman, and Wermers (1995) conclude that there is evidence of momentum trading by these institutions. Lakonishok, Shleifer, and Vishny (1992), however, find only weak evidence that pension funds engage in positive feedback trading and herding. Only for small stocks, their findings support the positive feedback trading and herding hypothesis. McQueen, Pinegar, and Thorley (1996) note that momentum trading and herding are more pronounced in the case of up markets compared to down markets. Badrinath and Wahal (2002) analyze the behavior of various institutions at different stages of the investment process and find only modest evidence for momentum trading. This is due to the fact that institutions act as momentum traders when they initiate a new position in a stock, but follow a contrarian approach when they rebalance portfolios or terminate their position in a stock. Evidence of momentum trading for pension funds is especially weak.

In contrast to the large body of empirical evidence predicting an increase in autocorrelation in stock returns due to institutional trading, the argument that increasing institutional ownership lowers autocorrelation in stock returns finds only weak support in the literature. Badrinath, Kale,

and Noe (1995) argue that, due to the differential information set-up costs and legal restrictions, institutional investors will acquire information on (and purchase) only a subset of traded firms. This will cause a shift in stock prices. The remaining stocks traded by less informed investors will adjust to the market-wide information contained in these trades with a lag. One prediction of their model is that stocks with a higher (lower) level of institutional ownership will experience quicker (slower) adjustment to information and, hence, lower (higher) autocorrelation in returns. Empirical results presented by the authors are in line with these predictions.

This short review of the literature shows that the available empirical findings mainly provide evidence in favor of positive stock return autocorrelation and that the investigations concentrate, without exception, on the US stock market. In contrast, by exploiting a unique institutional characteristic of the Polish stock market, our empirical findings do not support the hypothesis of positive return autocorrelation due to institutional investors' trading. The special feature arises from the pension reform in Poland in 1999 when privately managed pension funds were established and invested on the domestic capital market. We focus on the return behavior of stocks listed on the Warsaw Stock Exchange (WSE) prior to and after the first transfer of money to the pension funds on May 19, 1999. The appearance of large institutional traders and the resulting increase in institutional ownership allows us to investigate the impact on return autocorrelation. Specifically, relying on both a standard and a non-linear autoregression-cum-GARCH framework, we test whether autocorrelation coefficients in the return series of stocks actively traded by pension funds increase after the increase in institutional holdings, as predicted by the prevailing theory. Moreover, we investigate the relationship between the change in return autocorrelation and the increase in institutional trading after the appearance of pension funds in the cross-section of our sample.

The remainder of this paper is organized as follows. In Section 2, the pension reform in Poland, its consequences for the capital market, and the data are described. We present the time series methodology, the cross-sectional approach, and empirical results in Section 3, while Section 4 concludes.

2 Institutional Traders on the Polish Stock Market and Data

Trading on the Polish stock market exclusively takes places on the WSE. Re-established in 1991, the WSE was designed as an order-driven call market. Continuous trading was launched in 1996 and the most liquid stocks were gradually introduced into this system. The market attracted considerable interest from foreign investors. Nevertheless, the majority of traders were small, private investors.[1]

A major change in the investor structure took place after the Polish pension reform. In 1999, the public pension system was enriched by a private component. Younger citizens were forced to invest part of their income in privately managed open-end pension funds, the so-called "Otwarte Fundusze Emerytalne" (OFEs).[2] A significant share of the workforce chose the new system and a large amount of money was transferred to the OFEs by the Polish Social Security Institution, the so-called "Zakład Ubezpieczeń Społecznych" (ZUS). The ZUS has the task to collect the savings of all employees and transfer them to the OFEs. The first transfer of money to the OFEs took place on May 19, 1999. By the end of the year 1999, Polish OFEs had 2.3 billion Polish zlotys at their disposal, and by the end of 2001, their holdings

[1]For a detailed description of the trading systems and the investor structure see WSE (2002).

[2]Older citizens had the choice to invest in OFEs or to exclusively rely on the public pension system.

amounted to 18.5 billion Polish zlotys.

OFEs are obliged to publish their entire portfolio holdings annually and all holdings that exceed 1% of their funds invested semi-annually. We combined the data from the publications of all pension funds to construct a hand-collected data set of pension fund holdings in Poland. These publications show that the number of OFEs active on the market varies over time due to the liquidation of old and the emergence of new funds, but it is relatively stable between 15 and 20. The four largest OFEs account for 70% of all pension funds holdings.[3]

In the portfolios of the OFEs, common stocks comprise an important proportion. The share of stocks constantly amounted to more than 20% of total funds invested and gradually increased over time. Thus, OFEs became important players on the Polish stock market. The appearance of OFEs allows us to compare the period before May 19, 1999, that is mainly characterized by non-institutional trading with the period after that date, where OFEs account for a considerable share of market volume.

From the publications of OFEs, we are able to identify those stocks that they traded actively. We select the thirty stocks most actively traded by OFEs on the Polish stock market. By focusing on the stocks that were subject to institutional trading, we can test the influence of institutional traders on stock return autocorrelation. As a measure of OFE trading activity in stock i, we choose as a relative measure the monetary value of the OFE holdings of stock i at the end of the year 2000 divided by total turnover of stock i during the same period. This variable measures the share of pension funds trading volume.[4] Data on trading volume and stock prices were

[3]Data on the portfolio structures of all Polish OFE are available on request from the authors.

[4]Since we do only have data on the OFE holdings and not on OFE trading volume, the true share of OFE trading volume may even be higher. This would be the case if some funds bought additional shares during the investigation period and sold them before the reporting day. Since OFEs are long-term investors and had to invest large amounts of

provided by the WSE. We prefer a relative measure over the absolute value of OFE holdings as the theory outlined in section 1 predicts that the impact of institutional trading is higher the larger the share of these players in the market. As a robustness check, however, we selected the thirty stocks with the largest absolute values of OFE holdings. Several of these stocks were identical to the stocks selected using a relative measure and the overall results did not vary significantly from those reported in the paper. Additional information on the stocks used in our study are presented in Table 1.

[Table 1 around here]

The table shows that OFE holdings of the thirty stocks comprise more than 6% of the overall trading volume for each of the stocks. For the five stocks with the highest percentage share of institutional trading, the ratio of OFEs holdings to total volume is larger than one third. Thus, trading of pension funds accounts for a large percentage share of overall trading volume. The descriptive statistics in Table 1 indicate that our sample is well-suited for the investigation of institutional trading on stock return autocorrelation. We will now turn to the econometric techniques used and the results of our empirical analysis.

3 Methodology and Empirical Results

First, we conduct an empirical investigation of institutional traders' influence on return autocorrelation by estimating the following model for daily returns

$$R_{it} = \alpha_{i0} + \alpha_{i1} R_{it-1} + \alpha_{i2} D_t R_{it-1} + \varepsilon_{it} \tag{1}$$

and

$$h_{it} = \beta_{i0} + \beta_{i1} \varepsilon^2_{it-1} + \beta_{i2} h_{it-1}. \tag{2}$$

money in a relatively short period of time, it is likely that the number of sells is rather low and that our indicator consistently mirrors OFE trading behavior.

The return on stock i is defined as the logarithmic difference in prices, $R_{it} = \ln P_{it} - \ln P_{it-1}$, where P_{it} denotes the stock price. $\varepsilon_{it} \sim N(0, h_{it})$ is the unpredictable component of the returns. The dummy variable, D_t, in equation (1) is zero before May 19, 1999, and one afterwards. Note that before May 19, 1999, the expected return is $E(R_{it}) = \alpha_{i0} + \alpha_{i1}E(R_{it-1})$, while in the period after the entrance of institutional traders in the Polish stock market it is $E(R_{it}) = \alpha_{i0} + (\alpha_{i1} + \alpha_{i2})E(R_{it-1})$. Consistent with our discussion on the influence of institutional traders on stock returns, the α_{i2} parameter is expected to be positive and statistically significant resulting in a positive sum $(\alpha_{i1} + \alpha_{i2})$. With the GARCH(1,1) model (2) we take into account the well-known conditional heteroscedasticity characteristics of many financial time series.[5]

Table 2 reports the test results of the impact of institutional traders on the autocorrelation structure of the Polish stocks discussed in section 2. Equations (1) and (2) are jointly estimated for three different periods, namely January 2, 1999 - December 30, 1999; July 1, 1998 - June 30, 2000; and January 2, 1998 - December 30, 2000, to provide a check of robustness. As can be seen from Table 2, in the minority of all cases we observe statistically significant α_{i1} and α_{i2} coefficients. Although the α_{i2} parameters are positive for a reasonable number of stocks only six of them are positive and statistically significant at the conventional levels. With respect to the sum of coefficients, in the majority of cases $\alpha_{i1}+\alpha_{i2}$ is negative. The values of the remaining positive sums are relatively low and result from statistically insignificant α_{i1} and α_{i2} parameters. Only for three stocks (Stalprodukt, BSK, and PBK), the empirical results are in line with the theoretical prediction that institutional

[5]In addition to the standard GARCH(1,1) model we estimated a modified GARCH specification in line with Glosten, Jaganathan, and Runkle (1993) to take into account asymmetry in individual stock returns' volatility. In only six out of 90 regressions we found evidence in favor of asymmetries (results are not reported but are available on request). Hence, we rely on the standard GARCH(1,1) model.

trading generates positive autocorrelation in individual stock returns. In all other cases the findings are not consistent with this hypothesis.

[Table 2 around here]

Second, we analyze whether the lack of significant changes in the autocorrelation structure is due to a misspecification of the model for daily returns. Substantial empirical evidence (LeBaron (1992), Booth and Koutmos (1998a), Booth and Koutmos (1998b), Watanabe (2002)) shows that the autocorrelation pattern of stock returns exhibits complexity that cannot be captured completely by the simple first-order autocorrelation coefficient in equation (1). In particular, an inverse relationship between first-order return autocorrelation and volatility has been found for some markets. To account for this effect, we model stock returns as conditionally heteroscedastic processes with time-dependent autocorrelation, in line with LeBaron (1992), in the following way

$$R_{it} = \gamma_{i01} + \gamma_{i02} D_t + f(h_{it}) R_{it-1} + f'(h_{it}) R_{it-1} D_t + \varepsilon_{it}, \tag{3}$$

where

$$f(h_{it}) = \gamma_{i11} + \gamma_{i21} \exp(-h_{it}/\sigma_i^2) \tag{4}$$

and

$$f'(h_{it}) = \gamma_{i12} + \gamma_{i22} \exp(-h_{it}/\sigma_i^2). \tag{5}$$

In addition, the simple GARCH(1,1) process may be misspecified because the volatility process contains a structural break after May 19, 1999. A general model specification for the conditional volatility is given by

$$h_{it} = \beta_{i01} + \beta_{i02} D_t + \beta_{i11} \varepsilon_{it-1}^2 + \beta_{i12} \varepsilon_{it-1}^2 D_t + \beta_{i21} h_{it-1} + \beta_{i22} h_{it-1} D_t. \tag{6}$$

The notation is known from the discussion above. σ_i^2 is the sample variance of the return time series of stock i. Before May 19, 1999, the expected return equals $E(R_{it}) = \gamma_{i01} + \gamma_{i11} E(R_{it-1})$ during high volatility periods, and

$E(R_{it}) = \gamma_{i01} + (\gamma_{i11} + \gamma_{i21})E(R_{it-1})$ during low volatility periods. In the period after the entrance of institutional traders into the Polish stock market the expected return is equal to $E(R_{it}) = (\gamma_{i01} + \gamma_{i02}) + (\gamma_{i11} + \gamma_{i12})E(R_{it-1})$ when the conditional volatility is high and $E(R_{it}) = (\gamma_{i01}+\gamma_{i02})+(\gamma_{i11}+\gamma_{i21}+\gamma_{i12}+\gamma_{i22})E(R_{it-1})$ when the conditional volatility is low. Hence, the change in the autocorrelation coefficient resulting from the entrance of pension fund investors is given by γ_{i12} for the high volatility regime, and by $(\gamma_{i12} + \gamma_{i22})$ for the low volatility regime. Consistent with our discussion of the influence of institutional traders on stock returns, the parameters γ_{i12} and $(\gamma_{i12} + \gamma_{i22})$ are expected to be positive and statistically significant resulting in positive sums $(\gamma_{i11} + \gamma_{i12})$ and $(\gamma_{i11} + \gamma_{i21} + \gamma_{i12} + \gamma_{i22})$.

Table 3 reports the results of the estimation of equations (3) to (6) for our three estimation periods. As can be seen from the table, for both low and high volatility regimes only a minority of the parameters of interest is statistically significant. Focusing on the significant ones, no definite conclusion can be made about the prevailing sign of stock return autocorrelation. This statement is valid for both the period before and after the entrance of pension fund investors in the Polish stock market. In sum, we have found little empirical evidence for Polish stocks that would support the hypothesis that institutional trading induces positive return autocorrelation. Only in a few cases, the estimated coefficients are statistically significant and consistent with the hypothesized positive return autocorrelation, while in the majority of cases the parameters are insignificant or their values contradict the hypothesis under study.

[Table 3 around here]

Finally, we investigate the relationship between stock return autocorrelation and institutional trading in the cross-section of our sample. In order to have a sufficient number of observations, we include all stocks in the cross-

sectional regressions that were traded by Polish pension funds. We end up with 53 stocks to be included in the analysis. We aim to investigate whether there is a systematic relationship between the increase in institutional trading and the change in return autocorrelation after the appearance of pension fund investors on the market.

To answer this question, we first estimate equation (1) for all 53 stocks and obtain estimates of $\hat{\alpha}_{2i}$. This parameter measures the increase in return autocorrelation of stock i after the appearance of pension funds. We then regress the estimated coefficient $\hat{\alpha}_2$ on the change in institutional trading. Institutional trading in stock i is captured by our relative measure of pension fund activity outlined in section 2, $INST_i$,

$$\hat{\alpha}_{2i} = \beta_0 + \beta_1 INST_i + \varepsilon_i. \tag{7}$$

If there is a positive relationship between the amount of institutional trading in stocks i, $INST_i$, and the change in autocorrelation, $\hat{\alpha}_{2i}$, as suggested by theory, we will observe positive and significant values of β_1.

The appearance of institutional investors on the market also increases the trading volume of stocks. Since it is well known that higher volume decreases autocorrelation (see Boudoukh, Richardson, and Whitelaw (1994)), we disentangle the effects of increases in institutional trading and in trading volume and run a second regression with the relative institutional trading measure and the change in trading volume as the explanatory variables. The change in trading volume of stock i, ΔVOL_i, is defined as the logarithm of the ratio between average trading volume of the stock in the post-event and pre-event period, where pre- and post-event periods are separated by the event day May 19, 1999. The extended regression model has the form

$$\hat{\alpha}_{2i} = \beta_0 + \beta_1 INST_i + \beta_2 \Delta VOL_i + \varepsilon_i. \tag{8}$$

In Table 2, we have reported coefficient estimates of $\hat{\alpha}_{2i}$ for three different subperiods. We therefore calculate regressions (7) and (8) for all three estimates

of $\hat{\alpha}_{2i}$ separately. We end up with six individual regression equations. Results are presented in Table 4.

[Table 4 around here]

The table reports results of estimates of $\hat{\alpha}_{2i}$ over three different time periods. t-statistics are calculated from heteroscedasticity-consistent standard errors using the White (1980) correction. Moreover, we checked the regression for possible multicollinearity between the relative institutional trading measure and the change in trading volume. Since the absolute value of the correlation coefficients between the institutional trading measure and the change in volume varied between 0.15 and 0.29 in the three estimation periods, multicollinearity does not seem to be present in the data.

The results reported in Table 4 indicate a negative relationship between changes in autocorrelation and the amount of institutional trading in our sample. All estimated β_1 coefficients are significant at the 1% level. Volume has a positive impact on autocorrelation, but the estimates of β_2 are only significant at the 10% level for the period 1998-2000, at the border of significance for the period 98-07-01 to 00-06-30, and insignificant for the shortest period covering the year 1999. The explanatory power of the regressions measured by R^2 coefficients is higher for the periods covering the year 2000 with values between 0.187 and 0.280. Overall, the findings indicate a robust negative relationship between the amount of institutional trading and the change in autocorrelation across our sample. This is in contrast to the majority of empirical studies on the impact of institutional trading on return autocorrelation as outlined in section 1. The negative relationship between autocorrelation and institutional trading can be motivated by increased information flow due to the trades of pension funds as outlined in Badrinath et al. (1995). If pension fund managers are better informed than other investors about the fundamental values of the stocks they trade, their

trading may cause a faster adjustment of stock prices to fundamentals and, correspondingly, a decrease in return autocorrelation.

4 Conclusions

In this paper, we provide additional empirical evidence on the impact of institutional investors on stock return autocorrelation. The reform of the Polish pension system in 1999 is used as an institutional peculiarity to perform a variant of the event study methodology for individual stock returns traded by pension fund investors. Furthermore, to the best of our knowledge, all studies investigating the impact of institutional investors on stock prices rely on US data and no study is available for an emerging capital market. The implementation of a standard and a non-linear autoregression-cum-GARCH framework allows us to answer the question of whether the increase in institutional ownership after the first appearance of Polish pension funds on May 19, 1999, resulted in increasing and positive return autocorrelation as suggested in a reasonable number of theoretical and empirical studies. Cross-sectional regressions on the relationship between the change in return autocorrelation and the increase in institutional trading provide further insight into the importance of pension fund trading for return autocorrelation.

Our empirical findings for 30 stocks most actively traded by Polish pension funds show that in the vast majority of cases the increase in institutional ownership does not have an impact on the return autocorrelation structure of the individual stocks. This empirical finding is fairly robust with respect to different model specification and the selection of sample periods. Furthermore, our findings from cross-sectional analysis show that the level of pension funds' trading in a stock is negatively related to its return autocorrelation. These results are in contrast to theoretical arguments in favor of positive return autocorrelation due to institutional ownership. However, the findings

are consistent with the empirical results in Lakonishok et al. (1992) as well as Badrinath and Wahal (2002) who also find only weak evidence in favor of positive feedback trading or momentum trading and herding by pension fund investors. Our findings indicate that institutional traders encourage information flows and speed up the adjustment of stock prices to their fundamental levels, thereby increasing efficiency of the stock market (Lakonishok et al. (1992), Badrinath et al. (1995)).

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Table 1: Institutional characteristics of stocks actively traded by pension funds

Company	Sector	OFE holdings / total turnover	OFE holdings (million zlotys)
Inter Groclin	Other Industry	0.485	6.73
Petrobank	Bank	0.466	12.19
Echo	Construction	0.431	48.32
Permedia	Chemicals	0.382	4.01
Instal	Construction	0.346	4.02
NFI 03	Investment fund	0.210	49.65
Ropczyce	Chemicals	0.201	3.38
Strzelec	Food	0.189	5.26
Lentex	Building materials	0.173	21.35
NFI 04	Investment fund	0.165	10.42
Kety	Metals	0.162	46.01
Bauma	Building materials	0.150	1.92
Stomil Olsztyn	Chemicals	0.118	69.35
Swiecie	Wood and paper	0.116	55.76
Viscoplast	Light Industry	0.104	2.32
Grajewo	Wood and paper	0.102	7.60
Stalprodukt	Metals	0.094	5.46
WBK	Bank	0.094	69.44
Pekao S.A.	Bank	0.092	239.29
NFI10	Investment fund	0.088	6.70
BPH	Bank	0.086	50.54
Poligrafia	Other services	0.084	1.92
PGF	Wholesale & Retails	0.077	13.45
Kable	Electronics	0.072	1.87
Budimex	Construction	0.071	30.10
Impexmetal	Metals	0.071	8.17
PBK	Bank	0.069	120.25
BSK	Bank	0.068	64.14
Pia Piasecki	Construction	0.066	3.17
Yawal	Building materials	0.062	2.94

Note: The table presents the thirty stocks most actively traded by Polish pension funds and their corresponding sectors. Column three displays our measure of institutional trading activity. It is defined as the absolute holdings of pension funds at the end of the year 2000 divided by absolute trading volume over the period May 19, 1999 to the end of the year 2000.

Table 2: Autocorrelation in stock returns in different sample periods

	99-01-02	-	99-12-31	98-07-01	-	00-06-30	98-01-02	-	00-12-31
Stock	α_{i1}	α_{i2}	$\alpha_{i1}+\alpha_{i2}$	α_{i1}	α_{i2}	$\alpha_{i1}+\alpha_{i2}$	α_{i1}	α_{i2}	$\alpha_{i1}+\alpha_{i2}$
Inter Groclin	-0.11	0.04	-0.07	-	-	-	-	-	-
	(-0.69)	(0.26)							
Petrobank	0.07	0.01	0.08	0.04	-0.01	0.03	0.00	-0.03	-0.03
	(0.43)	(0.06)		(0.52)	(-0.10)		(0.03)	(-0.36)	
Echo Invest	-0.00	-0.12	-0.12	0.17	-0.31	-0.14	0.15	-0.26	-0.11
	(-0.02)	(-0.75)		(1.48)	(-2.18)**		(2.30)**	(-2.98)***	
Permedia	-0.19	-0.10	-0.29	0.19	-0.40	-0.21	-	-	-
	(-2.34)**	(-0.90)		(0.49)	(-1.00)				
Instal	0.05	-0.12	-0.07	0.04	-0.03	0.01	-	-	-
	(0.64)	(-1.10)		(0.66)	(-0.38)				
NFI03	0.03	0.04	0.07	0.10	-0.02	0.08	0.03	-0.01	0.03
	(0.17)	(0.21)		(1.21)	(-0.24)		(0.53)	(-0.06)	
Ropczyce	-0.04	0.00	-0.04	-0.13	0.11	-0.02	-0.05	0.01	-0.05
	(-0.80)	(0.05)		(-1.61)	(-1.05)		(-0.88)	(0.08)	
Strzelec	-0.14	0.09	-0.05	0.00	-0.09	-0.09	0.03	-0.12	-0.09
	(-1.11)	(0.61)		(0.04)	(-1.06)		(0.52)	(-1.70)*	
Lentex	-0.15	0.06	-0.09	-0.01	-0.06	-0.07	-0.05	-0.01	-0.06
	(-2.18)**	(0.61)		(-0.20)	(-0.61)		(-0.79)	(-0.20)	
NFI04	0.08	-0.11	-0.03	0.06	-0.11	-0.05	0.05	-0.10	-0.05
	(0.71)	(-0.84)		(0.75)	(-1.18)		(0.88)	(-1.40)	
Kety	-0.19	0.15	-0.04	-0.12	0.02	-0.10	-0.13	0.07	-0.06
	(-1.85)*	(1.14)		(-1.84)*	(0.28)		(-2.28)**	(0.98)	
Bauma	-0.24	-0.01	-0.25	-0.07	-0.12	-0.19	-0.01	-0.15	-0.16
	(-2.44)**	(-0.09)		(-1.11)	(-1.32)		(-0.23)	(-1.83)*	
Stomil Olsztyn	-0.14	0.18	0.04	-0.14	0.17	0.03	-0.09	0.12	0.03
	(-1.45)	(1.44)		(-1.68)	(1.66)		(-1.43)	(1.55)	
Swiecie	0.21	-0.18	0.03	-0.00	0.02	0.02	-0.02	0.01	-0.01
	(0.99)	(-0.74)		(-0.01)	(0.18)		(-0.38)	(0.16)	

Table 2 (continued)

Stock	99-01-02 α_{i1}	- α_{i2}	99-12-31 $\alpha_{i1}+\alpha_{i2}$	98-07-01 α_{i1}	- α_{i2}	00-06-30 $\alpha_{i1}+\alpha_{i2}$	98-01-02 α_{i1}	- α_{i2}	00-12-31 $\alpha_{i1}+\alpha_{i2}$
Viscoplast	0.34	-0.44	-0.10	0.16	-0.33	-0.17	0.19	-0.32	-0.13
	(3.01)***	(-3.21)***		(2.38)**	(-3.62)***		(3.68)***	(-4.21)***	
Grajewo	0.00	-0.13	-0.13	-0.09	0.08	-0.01	-0.02	-0.10	-0.12
	(0.02)	(-0.82)		(-0.92)	(0.68)		(-0.31)	(-1.16)	
Stalprodukt	-0.01	0.24	0.23	0.15	0.02	0.17	-0.01	0.24	0.23
	(-0.09)	(1.87)*		(2.05)**	(0.19)		(-0.09)	(1.87)*	
WBK	-0.22	0.19	-0.03	-0.25	0.18	-0.07	-0.18	0.12	-0.06
	(-1.53)	(1.30)		(-3.09)***	(1.75)*		(-2.80)***	(1.55)	
Pekao S.A.	-0.08	0.12	0.04	-0.04	0.03	-0.01	-	-	-
	(-0.99)	(1.08)		(-0.51)	(0.27)				
NFI10	-0.04	0.03	-0.01	0.07	-0.05	0.02	0.04	0.02	0.06
	(-0.40)	(0.23)		(0.85)	(-0.50)		(0.70)	(0.19)	
BPH	-0.00	-0.03	-0.03	0.01	-0.07	-0.06	-0.01	-0.08	-0.09
	(-0.08)	(-0.78)		(0.12)	(-0.76)		(-0.21)	(-1.06)	
Poligrafia	-0.33	0.24	-0.09	-0.11	0.05	-0.06	-0.02	-0.03	-0.05
	(-4.39)***	(2.02)**		(-1.58)	(0.50)		(-0.42)	(-0.40)	
PGF	-0.20	0.18	-0.02	0.10	-0.11	-0.01	-	-	-
	(-2.23)**	(1.42)		(1.25)	(-0.11)				
Kable	-0.09	0.03	-0.06	-0.08	0.07	-0.01	-0.08	0.09	0.01
	(-0.76)	(0.19)		(-1.22)	(0.77)		(-1.34)	(1.12)	
Budimex	-0.20	0.16	-0.04	-0.11	0.12	0.01	-0.12	0.10	-0.02
	(-1.86)*	(1.41)		(-1.80)*	(1.41)		(-2.39)**	(1.37)	
Impexmetal	-0.07	0.05	-0.02	0.06	-0.06	0.00	0.09	-0.23	-0.14
	(-0.58)	(0.36)		(0.70)	(-0.47)		(1.42)	(-2.30)**	
PBK	0.01	0.17	0.18	0.01	0.10	0.11	-0.04	0.15	0.11
	(0.08)	(1.34)		(0.16)	(1.14)		(-0.67)	(1.86)*	
BSK	-0.21	0.37	0.16	0.11	-0.02	0.09	0.04	0.01	0.05
	(-1.93)*	(2.54)**		(1.51)	(-0.26)		(0.63)	(0.08)	

Table 2 (continued)

	99-01-02	-	99-12-31	98-07-01	-	00-06-30	98-01-02	-	00-12-31
Stock	α_{i1}	α_{i2}	$\alpha_{i1} + \alpha_{i2}$	α_{i1}	α_{i2}	$\alpha_{i1} + \alpha_{i2}$	α_{i1}	α_{i2}	$\alpha_{i1} + \alpha_{i2}$
Pia Piasecki	-0.03	0.06	0.03	0.04	-0.02	0.02	-	-	-
	(-0.24)	(0.45)		(0.53)	(-0.23)				
Yawal	-0.12	0.05	-0.07	0.11	-0.09	0.02	-	-	-
	(-0.83)	(0.33)		(1.36)	(-0.88)				

Note: The estimations results rely on the model given by equations (1) and (2). t-values are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level of significance, respectively.

Table 3: Autocorrelation in stock returns in high and low volatility regimes

Stock/Parameter	γ_{11}	γ_{12}	$\gamma_{11}+\gamma_{12}$	$\gamma_{11}+\gamma_{21}$	$\gamma_{12}+\gamma_{22}$	$\gamma_{11}+\gamma_{21}$ $+\gamma_{12}+\gamma_{22}$
Volatility	high			low		
Panel A: 99-01-02 to 99-12-31						
Inter Groclin	-0.371	0.139	-0.232	0.733	-0.621	0.119
	(-1.51)	(0.36)		[0.89]	[0.56]	
Petrobank	-0.127	-0.545	-0.672	0.279	0.768	1.047
	(-0.61)	(-1.73)*		[2.47]**	[5.71]	
Echo Invest	0.245	-0.591	-0.346	-0.545	0.512	-0.033
	(1.33)	(-1.40)		[7.96]***	[2.75]*	
Permedia	-1.041	0.920	1.961	2.196	-2.607	1.670
	(-1.15)	(1.01)		[3.59]*	[4.86]**	
Instal	-0.093	-0.411	-0.504	0.402	0.159	0.562
	(-0.24)	(-0.74)		[0.31]	[0.03]	
NFI03	-0.124	0.395	0.271	-0.850	0.697	-0.153
	(-1.29)	(1.09)		[4.79]**	[1.47]	
Ropczyce	0.001	-0.361	-0.359	0.063	0.322	0.385
	(0.01)	(-1.16)		[0.02]	[0.35]	
Strzelec	-0.326	0.436	0.110	-0.062	0.200	0.139
	(-6.63)***	(1.18)		[1.28]	[0.37]	
Lentex	-0.306	0.071	-0.235	-0.056	0.173	0.117
	(-1.25)	(0.09)		[0.05]	[0.03]	
NFI04	-0.034	-0.009	-0.044	0.283	-0.058	0.224
	(-0.11)	(-0.03)		[0.05]	[0.01]	
Kety	-0.108	-0.274	-0.382	-0.470	0.853	0.382
	(-0.18)	(-0.31)		[0.24]	[1.16]	
Bauma	-0.140	0.114	-0.026	0.179	0.689	0.886
	(-3.69)***	(0.65)		[9.55]***	[14.03]***	
Stomil Olsztyn	-0.094	-0.263	-0.357	-0.228	0.832	0.603
	(-0.24)	(-0.45)		[0.29]	[1.38]	
Swiecie	-0.006	-0.392	-0.398	1.138	-0.447	0.691
	(-0.02)	(-1.13)		[9.61]***	[0.77]	
Vicoplast	0.231	-0.443	-0.212	0.702	-0.455	0.247
	(0.81)	(-1.20)		[2.79]*	[0.53]	
Grajewo	-0.215	0.752	0.536	0.555	-0.991	-0.436
	(-0.89)	(0.98)		[1.40]	[2.41]	

Table 3: (continued)

Stock/Parameter	γ_{11}	γ_{12}	$\gamma_{11}+\gamma_{12}$	$\gamma_{11}+\gamma_{21}$	$\gamma_{12}+\gamma_{22}$	$\gamma_{11}+\gamma_{21}$ $+\gamma_{12}+\gamma_{22}$
Stalprodukt	0.340	0.051	0.391	-0.202	-0.014	-0.216
	(0.72)	(0.10)		[0.31]	[0.00]	
WBK	-0.660	0.940	0.280	1.346	-1.697	-0.351
	(-3.17)***	(1.56)		[5.80]**	[6.57]	
Pekao S.A.	-0.183	-1.259	-1.442	0.898	0.350	1.248
	(-0.61)	(-0.99)		[1.92]	[0.08]	
NFI10	-0.265	0.339	0.075	0.988	-1.088	-0.100
	(-0.58)	(0.60)		[0.42]	[0.47]	
BPH	0.155	-0.451	-0.296	-0.395	1.529	1.134
	[0.23]	[-0.63]		[0.41]	[3.24]*	
Poligrafia	-0.299	0.111	-0.188	-0.192	0.514	0.323
	(-1.73)*	(0.35)		[0.75]	[1.56]	
PGF	-0.276	0.205	-0.070	-0.050	0.038	-0.012
	(-0.29)	(0.21)		[0.00]	[0.00]	
Kable	-0.299	-0.150	-0.449	0.209	0.223	0.433
	(-2.69)***	(-0.41)		[0.14]	[0.11]	
Budimex	-0.517	0.379	-0.138	0.923	-0.823	0.100
	(-2.18)**	(0.67)		[4.34]**	[0.92]	
Impexmetal	-0.028	-0.158	0.186	-0.261	0.558	0.297
	(0.10)	(-0.41)		[1.23]	[0.56]	
PBK	0.259	0.048	0.307	-0.041	-0.127	-0.168
	(0.45)	(0.08)		[0.01]	[0.08]	
BSK	-0.111	-0.153	-0.264	0.010	0.932**	0.943
	(-0.34)	(-0.37)		[0.00]	[4.79]	
Pia Piasecki	-0.088	-5.810	5.898	-0.350	6.436	6.086
	(-0.46)	(-0.36)		[0.18]	[0.17]	
Yawal	-0.454	7.360	6.906	1.017	7.878	8.895
	(-0.28)	(0.49)		[0.07]	[0.25]	
Panel B: 98-07-01 to 00-06-30						
Inter Groclin	-	-	-	-	-	-
Petrobank	-0.607	0.494	-0.113	1.732	-1.490	0.242
	(-2.80)***	(1.90)*		[9.46]***	[6.19]**	
Echo Invest	0.154	-0.334	-0.181	0.274	-0.408	-0.134
	(1.25)	(-1.41)		[0.76]	[1.00]	
Permedia	0.384	-0.867	-0.483	-1.021	1.259	0.238
	(0.55)	(-1.21)		[2.24]	[3.27]*	

Table 3: (continued)

Stock/Parameter	γ_{11}	γ_{12}	$\gamma_{11}+\gamma_{12}$	$\gamma_{11}+\gamma_{21}$	$\gamma_{12}+\gamma_{22}$	$\gamma_{11}+\gamma_{21}$ $+\gamma_{12}+\gamma_{22}$
Instal	-0.081	1.075	0.994	0.610	-1.142	-0.532
	(-3.45)***	(3.13)***		[8.31]***	[17.51]***	
NFI03	-0.110	-0.272	-0.382	0.823	3.578	4.401
	(-0.32)	(-0.73)		[0.76]	[11.98]***	
Ropczyce	-0.110	0.674	0.563	-0.110	-0.323	-0.433
	(-0.66)	(2.60)***		[0.04]	[0.30]	
Strzelec	-0.519	0.330	-0.189	1.219	-1.130	0.089
	(-1.03)	(0.62)		[1.22]	[1.08]	
Lentex	-0.090	0.105	0.015	0.359	-0.512	-0.153
	(-0.70)	(0.35)		[0.66]	[1.10]	
NFI04	-0.004	-0.241	-0.245	0.362	-0.087	0.275
	(-0.02)	(-0.74)		[0.44]	[0.02]	
Kety	-0.065	-0.850	-0.915	-0.238	0.676	0.438
	(-0.57)	(-1.44)		[0.96]	[3.23]*	
Bauma	-1.484	1.177	-0.307	4.176	-4.149	0.027
	(-0.97)	(0.76)		[1.71]	[1.68]	
Stomil Olsztyn	-0.170	0.012	-0.158	-0.156	0.452	0.296
	(-1.26)	(0.03)		[0.20]	[0.65]	
Swiecie	-0.124	-0.150	-0.274	0.518	-0.185	0.333
	(-0.83)	(-0.57)		[1.15]	[0.13]	
Vicoplast	-0.127	-0.446	-0.572	0.912	1.329	2.242
	(-0.68)	(-1.53)		[4.71]**	[7.68]***	
Grajewo	0.007	0.625	0.633	-0.186	-0.516	-0.702
	(0.05)	(30.06)***		[0.27]	[1.56]	
Stalprodukt	0.313	-0.322	-0.009	-0.067	0.568	0.501
	(2.75)***	(-1.20)		[0.45]	[2.01]	
WBK	-0.372	-0.088	-0.460	0.147	0.096	0.244
	(-3.23)***	(-0.11)		[0.23]	[0.02]	
Pekao S.A.	-0.074	-0.387	-0.461	0.075	0.287	0.362
	(-0.55)	(-0.77)		[0.05]	[0.35]	
NFI10	-0.133	0.090	-0.043	0.639	-0.496	0.143
	(-0.53)	(0.28)		[0.86]	[0.42]	
BPH	0.011	0.053	0.065	-0.052	-0.153	-0.205
	(0.09)	(0.05)		[0.02]	[0.02]	
Poligrafia	-0.251	0.011	-0.241	0.406	0.245	0.651
	(-1.69)*	(0.05)		[1.14]	[0.31]	

Table 3: (continued)

Stock/Parameter	γ_{11}	γ_{12}	$\gamma_{11}+\gamma_{12}$	$\gamma_{11}+\gamma_{21}$	$\gamma_{12}+\gamma_{22}$	$\gamma_{11}+\gamma_{21}$ $+\gamma_{12}+\gamma_{22}$
PGF	0.336	-0.728	-0.392	-0.702	1.207	0.505
	(1.94)*	(-2.02)**		[2.44]	[4.05]**	
Kable	-0.238	0.403	0.165	0.156	-0.355	-0.199
	(-2.37)**	(2.06)**		[1.15]	[2.92]**	
Budimex	-0.163	0.020	-0.143	-0.116	0.463	0.348
	(-1.58)	(0.08)		[0.49]	[1.78]	
Impexmetal	0.159	-0.207	-0.048	-0.247	0.213	-0.034
	(1.52)	(-0.90)		[0.90]	[0.41]	
PBK	0.010	0.121	0.131	0.093	-0.006	0.088
	(0.08)	(0.46)		[0.15]	[0.26]	
BSK	0.243	-0.487	-0.244	-0.206	0.661	0.455
	(2.03)**	(-1.80)*		[0.85]	[3.08]*	
Pia Piasecki	-0.082	-0.116	-0.198	0.472	-0.167	0.305
	(-0.55)	(-0.44)		[1.57]	[0.12]	
Yawal	-0.116	0.024	-0.092	0.953	-0.700	0.253
	(-0.57)	(0.10)		[2.10]	[1.01]	
Panel C: 98-01-02 to 00-12-31						
Inter Groclin	-	-	-	-	-	-
Petrobank	-0.434	0.262	-0.172	1.504	-1.201	0.303
	(-2.64)***	(1.26)		[12.45]***	[6.69]***	
Echo Invest	0.072	-0.246	-0.173	0.457	-0.414	0.044
	(0.66)	(-1.22)		[3.98]**	[1.45]	
Permedia	-	-	-	-	-	-
Instal	-	-	-	-	-	-
NFI03	0.193	-0.239	-0.046	-0.279	0.545	0.265
	(1.89)*	(-1.39)		[2.94]*	[4.27]**	
Ropczyce	-0.208	-0.104	-0.312	0.670	-0.295	0.375
	(-1.26)	(-0.36)		[1.56]	[0.24]	
Strzelec	0.009	-0.259	-0.251	0.127	-0.001	0.126
	(0.05)	(0.15)		[0.04]	[0.00]	
Lentex	-0.094	0.058	-0.036	0.208	-0.313	-0.105
	(-0.97)	(0.21)		[0.69]	[0.83]	
NFI04	-0.057	-0.233	-0.290	0.885	-0.563	0.322
	(-0.55)	(-1.02)		[4.36]**	[1.32]	

Table 3: (continued)

Stock/Parameter	γ_{11}	γ_{12}	$\gamma_{11}+\gamma_{12}$	$\gamma_{11}+\gamma_{21}$	$\gamma_{12}+\gamma_{22}$	$\gamma_{11}+\gamma_{21}$ $+\gamma_{12}+\gamma_{22}$
Kety	-0.010	-0.268	-0.278	-0.430	0.619	0.189
	(-0.11)	(-1.05)		[6.18]**	[5.34]**	
Bauma	-0.718	0.419	-0.299	2.263	-2.180	0.083
	(-1.86)*	(1.01)		[7.89]***	[6.78]***	
Stomil Olsztyn	-0.057	0.159	0.102	-0.266	0.217	-0.048
	(-0.52)	(0.45)		[0.78]	[0.24]	
Swiecie	-0.182	-0.028	-0.210	0.515	-0.295	0.220
	(-1.48)	(-0.13)		[1.99]	[0.52]	
Vicoplast	-0.240	-0.091	-0.331	1.683	-0.014	1.669
	(-1.31)	(-0.37)		[14.95]***	[0.00]	
Grajewo	-0.125	0.496	0.370	0.420	-1.042	-0.622
	(-1.07)	(2.04)**		[4.88]**	[12.84]***	
Stalprodukt	0.090	0.048	0.138	0.154	0.024	0.178
	(0.68)	(0.25)		[0.38]	[0.00]	
WBK	-0.376	-0.032	-0.407	0.688	-0.478	0.210
	(-3.19)***	(-0.06)		[2.79]*	[0.85]	
Pekao S.A.	-	-	-	-	-	-
NFI10	-0.205	0.319	0.113	0.843	-0.871	-0.028
	(-0.76)	(1.03)		[1.42]	[1.35]	
BPH	-0.009	-0.075	-0.084	0.083	-0.213	-0.130
	(-0.08)	(-0.15)		[0.06]	[0.15]	
Poligrafia	-0.197	-0.009	-0.206	0.601	0.047	0.648
	(-1.65)*	(-0.05)		[4.51]**	[0.02]	
PGF	-	-	-	-	-	-
Kable	-0.306	0.437	0.133	0.462	-0.602	-0.140
	(0.10)***	(0.19)**		[3.58]*	[4.18]**	
Budimex	-0.159	-0.066	-0.225	0.027	0.140	0.167
	(-1.53)	(-0.30)		[0.01]	[0.21]	
Impexmetal	-0.244	-0.052	-0.296	4.026	-3.926	0.100
	(-2.86)***	(-0.29)		[111.68]***	[89.83]***	
PBK	-0.066	0.227	0.162	0.057	-0.028	0.030
	(-0.62)	(1.14)		[0.06]	[0.01]	
BSK	0.013	-0.288	-0.275	0.040	0.338	0.378
	(0.14)	(-1.21)		[0.03]	[1.04]	

Table 3: (continued)

Stock/Parameter	γ_{11}	γ_{12}	$\gamma_{11}+\gamma_{12}$	$\gamma_{11}+\gamma_{21}$	$\gamma_{12}+\gamma_{22}$	$\gamma_{11}+\gamma_{21}$ $+\gamma_{12}+\gamma_{22}$
Pia Piasecki	-	-	-	-	-	-
Yawal	-	-	-	-	-	-

Note: The estimated model is given by equations (3) to (6). For high volatility regimes, the parameters γ_{11} and γ_{12} represent the changes in autocorrelation prior to and after the appearance of pension funds, respectively. For low volatility regimes, these values are given by $(\gamma_{11}+\gamma_{21})$ and $(\gamma_{12}+\gamma_{22})$. t-values are in parentheses. In brackets, we report the Wald $\chi^2(1)$ statistic with the null hypothesis that the parameters are jointly zero. *, **, and *** denote significance at the 10%, 5%, and 1% level of significance, respectively.

Table 4: Cross-sectional regression results on the relationship between institutional trading and the change in return autocorrelation

Dependent variable: $\hat{\alpha}_{2i}$				
Period	Intercept	$INST_i$	ΔVOL_i	Adj. R^2
99-01-02 to 99-12-31	0.107	-0.410		0.086
	(4.28)***	(-3.44)***		
	0.107	-0.383	0.017	0.072
	(4.31)***	(-3.03)***	(0.58)	
98-07-01 to 00-06-30	0.081	-0.667		0.261
	(3.62)***	(-3.14)***		
	0.067	-0.624	0.038	0.280
	(3.14)***	(-3.00)***	(1.63)	
98-01-02 to 00-12-31	0.066	-0.538		0.187
	(3.17)***	(-3.06)***		
	0.063	-0.498	0.037	0.215
	(3.17)***	(-3.13)***	(1.87)*	

Note: The table presents regression results of the change in autocorrelation of stock i, $\hat{\alpha}_{2i}$, on the relative institutional trading measure, $INST_i$, and the change in trading volume of stock i, ΔVOL_i, as described in equations (7) and (8). All t-statistics (in parentheses) are calculated from heteroscedasticity-consistent standard errors using the White (1980) correction. *** and * denote significance at the 1% and 10% level, respectively.