Pension Funds, Large Capital Inflows and Stock Returns in a Thin Market

Janusz Brzeszczyński *

Newcastle Business School (NBS)
Northumbria University
Newcastle-upon-Tyne, United Kingdom

Martin T. Bohl

University of Münster
Münster, Germany

Dobromił Serwa

National Bank of Poland (NBP)
Warsaw, Poland

and

Warsaw School of Economics
Warsaw, Poland

* *Corresponding author*: Department of Accounting and Financial Management, Newcastle Business School (NBS), Northumbria University, Newcastle-upon-Tyne, NE1 8ST, United Kingdom, Tel: + 44 191 243 7491, E-mail: janusz.brzeszczynski@northumbria.ac.uk

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ABSTRACT:

Using unique data about capital flows from the public social security institute ZUS (Zakład Ubezpieczeń Społecznych) to private pension funds OFEs (Otwarte Fundusze Emerytalne) in Poland, we find that their impact, as a group of large institutional investors, on stock returns is statistically significant in short-term but no such effect exists in the long-run. This result is consistent with the temporary price pressure hypothesis of Ben-Rephael *et al*. (2011). We analyze the capital transfers, in form of the aggregated pension contributions collected from all employees in the entire Polish economy, from the ZUS in Poland to the private pension funds, which further invest this capital on the stock market. The average time for the subsequent reaction of stock prices is found to be 4 days. The trading strategy based on this result generates superior outcomes in comparison with the passive strategy, which further confirms the price impact of capital inflows.

Keywords: Pension Funds; Stock Market Returns; Capital Flows; Short-run and Long-run Stock Price Behavior.

JEL: G23, G15

1. Introduction

Large institutional investors, such as pension funds, which generate intensive capital flows are likely to have a substantial impact on stock prices. This effect should, by nature, be more visible and more strongly pronounced in thinly traded markets that are characterized by relatively low volume of transactions, low capitalization and low liquidity comparing with the amounts of capital being injected on regular basis by these large institutions.

On the other hand, it is known that the number of institutional investors trading on stock markets world-wide increased significantly in the past two decades, which has caused a gradually intensified interest among financial economists, practitioners as well as financial markets regulators in the issue of the impact of those institutions on stock prices. It is widely believed that institutional traders have direct influence on stock returns and the existing empirical evidence from international markets backs this conjecture, as reported, among others, by Kraus and Stoll (1972), Chan and Lakonishok (1993), Gompers and Metrick (2001), Bikker *et al*. (2007), Coval and Stafford (2007), Rakowski and Wang (2009), and more recently Foster *et al*. (2011) and references therein.[1] Moreover, capital inflows generated by institutional investors can have also positive effects on economic growth, as has been evidenced recently by Slesman *et al*. (2015).

The specific history of the Polish stock market provides a unique institutional feature and opportunity allowing us to contribute to the literature on the institutional investors' impact on stock prices, arising from the pension system reform in Poland in 1999, when privately managed pension funds (OFEs) were established and allowed to invest on the capital market. We study this impact and focus on the returns dynamics of the Warsaw Stock Exchange (WSE) blue chip stocks index WIG20 after the first transfer of money to the pension funds on May 19, 1999 until the end of 2008

and, subsequently, we provide further analysis in the out-of-sample period from January 2009 to December 2011.

Our data sample is deliberately restricted to the period 1999 – 2011 to avoid any distortions in results related to the political turmoil around pension funds, which was the case in Poland in more recent years.

An important characteristic of our dataset provides an unique opportunity to measure both the short-run and long-run effects in the nearly laboratory conditions where clear positive liquidity shocks affect decisions of the pension funds. Namely, the Polish pension funds have been receiving exogenous capital injections (completely independent from their earlier performance) throughout the whole sample and they have never been forced to withdraw any large amounts of capital from the market, because the future pensioners were still too young to receive any pension payments in the investigated period. In contrast to the previous studies, where endogenous transfers of capital to financial institutions were used to measure demand shocks and their impact on stock returns, we are employing the data capturing truly exogenous capital transfers. These transfers flow to all pension funds from the government pension institute (ZUS) which in turn collects mandatory contributions from all employees' wages from the entire Polish economy. Therefore, the transfers do not depend on the current developments regarding the demand shocks of investors or price developments (price trends) on the stock market.

Earlier studies had to deal with the problem of endogenous demand shocks (influenced by past and present stock returns) by estimating the direct (immediate) price impact of institutional transactions, measuring the impulse-response effects between capital flows and asset returns in multi-equation models or by investigating shifts in the composition of funds (e.g., Gompers and Metrick, 2001; Chiyachantana *et al*. 2004; Coval and Stafford, 2007; Ben-Rephael *et al*., 2011 and 2012; Koch *et al.*, 2016). Our data and our modeling approach has the advantage that it does not necessitate making the statistical and economic assumptions required by the above methodologies.

The appearance of large institutional traders and the resulting increase in institutional ownership allows us, therefore, to investigate directly the impact they have on stock returns. We analyze the impact of ZUS transfers on the returns of the Polish market WIG20 index from the perspective of four frequencies of data: quarterly, monthly, weekly and daily in order to examine not only the effect of those capital flows on stock prices but also to investigate, more specifically, the pattern of propagation of their impact across time. We also distinguish between the effect of global factors from international markets and the local factors related to the institutional demand generated by the capital accumulated from the pension contributions.

The problem of high and regular capital flows, generated by large institutional investors, as well as, additionally, the limited liquidity of the Polish stock market provide a motivation for this study. The empirical results obtained in this investigation allow us to conclude about the direct impact of pension funds on the movement of stock prices at the WSE. We find the significant impact of capital transfers on stock returns within the first four days after the transfer. In light of the existing theories, this can be interpreted as evidence of the temporary price pressure hypothesis, while the absence of significant effects in longer horizons leads to the rejection of the information-based trading hypothesis.

The paper is organized as follows. Section 2 contains review of the relevant theoretical and empirical literature. Section 3 discusses the data and methodology. Section 4 presents empirical findings. Section 5 provides counterfactual analysis and trading strategy out-of-sample. Section 6 summarizes and concludes.

2. Literature Review

2.1. Institutional Investors Trading on Stock Markets

The theoretical explanations for the short-term impact of institutional trades on stock returns are the temporary price pressure hypothesis (e.g., liquidity shocks pushing prices away from fundamentals), informational trades of institutions linked to changing expectations of market participants and differences in investor preferences also involving a change in equilibrium prices (e.g., Kraus and Stoll, 1972). In the long-run, the price pressure hypothesis suggests that prices should reverse to fundamentals, while the latter two propositions imply deepening of the price impact effect (e.g., Gompers and Metrick, 2001; Christoffersen *et al*. 2006; Coval and Stafford, 2007; Foster *et al*. 2011; Ben-Rephael *et al*., 2012).

The empirical literature related to our study and based on the data from international markets presents different types of evidence about the impact of institutional trading on asset prices. Chan and Lakonishok (1993) analyzed the price impact of institutional trades using the data from 37 large money management firms in the years 1986 – 1988. They documented an immediate impact of transactions on stock price changes even after controlling for market-wide stock price movements. International evidence on the impact of institutional trading on stock prices is provided also by Domowitz *et al*. (2001) and Chiyachantana *et al*. (2004), among others.

Furthermore, Kraus and Stoll (1972) and Chan and Lakonishok (1993) document asymmetric effects between the price impact of buy and sell orders. Several studies found that buys have larger price impact than sells. Holthausen *et al*. (1987) argue that price effects are predominantly temporary for seller-initiated transactions and permanent for buyer-initiated transactions on the New York Stock Exchange. According to Keim and Madhaven (1996) the buyer-initiated transactions are more often information-based than sell transactions, which in turn

are more often liquidity-motivated than buy transactions. While buys are driven by the preference to hold some specific stocks and therefore they may set new higher values for their prices, the liquidity-driven sells do not change the prices, at least not permanently. Saar (2001) developed a theoretical model, where the history of price performance of stocks affects the degree of asymmetry between the price impact of buys and sells. Longer bull market periods reduce this asymmetry, or even reverse it, and longer episodes of price depreciation strenghten such asymmetric effects.

Chiyachantana *et al*. (2004) investigated the price effects of institutional trading in international stocks from 37 countries in the period 1997-2001 and found that the asymmetry of the price impact depends on market conditions: buys have a larger effect on prices during bull market periods and the impact of sells is stronger during bear market periods. Chiyachantana *et al*. (2004) argue that it is easy to sell a stock in a bull market, when many traders want to buy. Similarly, it is easy to find a seller of a stock in a bear market.

Bikker *et al*. (2007) analyzed the impact of trades by ABP, the largest Dutch pension fund, and found that price effects of buy transactions (sell transactions) tend to be larger than those of sells (buys) in bull (bear) markets. The overall price effects are also moderate in comparison to similar effects studied earlier for other types of institutions. Bikker *et al*. (2007) explain this result by the fact that the analyzed ABP trades are generally rebalancing activities, not coinciding with news-driven trades and therefore they cause less price impact. Dasgupta *et al*. (2011) developed a theoretical model to analyze the impact of institutional herding on asset prices. They found that institutional trades in the presence of herding positively predict short-term returns, but negatively predict long-term returns.

The number of studies investigating emerging or smaller markets is still very limited. The short-run impact of institutional trades in multiple emerging markets has been documented by Domowitz *et al*. (2001) in the context of trading costs and Chiyachantana *et al*. (2004 and 2006) who reported evidence about temporary spikes in price volatility during the trade execution

periods. Charoenwong *et al*. (2010) also found that large-sized trades account for a substantial impact on stock prices in Thailand.

In turn, Lee *et al*. (2010) show that institutional trades affect market returns in longer (ten-day) horizons on the Chinese market. Ben-Rephael *et al*. (2011) discover the temporary price pressure with prices reversed within 10 trading days on the stock market in Israel. For Australia, Comerton-Forde *et al*. (2010) reveal that institutional trades exhibit price continuations after the execution of trade package, consistent with the informational trading hypothesis. There also exists evidence for the Polish market about the stabilizing effect of pension funds, as a group of large institutional investors, on stock prices volatility, presented in Bohl and Brzeszczynski (2006) and Bohl *et al*. (2009).

It is worthwhile to note that the Polish market has specific characteristics of an emerging stock market, which make it different from other, well developed and mature, stock markets. In particular, what has happened in Poland was the *reversal of roles of individual and institutional investors* after the pension system reform in Poland in 1999, i.e. the informational role of the institutions relative to individuals was principally different before and after the year 1999.[2] In Poland until the end of the 1990s, the individual investors (private people) constituted the majority of stock market investors and generated most of the trading volume. This was due to certain legal regulations not allowing such institutional investors as pension funds to invest in stocks and to the fact that the whole capital market itself was at the very early stage of its development and many types of institutions (like the pension funds or other kinds of investment funds) simply did not exist. The individual investors, who dominated the market, were just ordinary people who (sometimes very naively) followed the news, newspaper articles, various information in other media (very often not professional sources, having little to do with the financial markets) as well as the rumours – and therefore they, as a whole group, exhibited herding behavior. After 1999 the pension funds entering the market played the role of informed traders relative to the individuals. Some evidence confirming the impact of institutional trading on stock prices is the decrease in stock returns volatility after the

entrance of pension funds on the market in Poland, as reported in Bohl and Brzeszczynski (2006) and Bohl *et al*. (2009).

Even though the previous studies on the role of pension funds, as a group of very large institutional investors, and the Polish market are scarce and provide only limited evidence about their impact on the movement of stock prices, this issue has been often discussed in popular business and financial press in Poland. For example, "Rzeczpospolita", a major Polish business and financial daily newspaper, reported that after the entrance of large pension funds the liquidity of the Polish market has become too low relative to the amounts of capital they managed and invested in stocks. There exists also anecdotal evidence in form of stories about stock market investors who have achieved very high returns by implementing a simple strategy relying on the analysis of transactions of large pension funds and predicting (or betting on) which stocks these institutional investors may favor in the future.

In this paper we provide new evidence about the role of a group of large institutional investors (i.e. private pension funds) on the stock market prices, in particular when their impact is viewed from the perspective of various time horizons, such as quarterly, monthly, weekly and daily. In the only other study, directly related to ours, Zalewska (2006) analyzed the long-run effects of the pension reform in 1999 and found that the Polish stock market was performing worse than other emerging markets in the region afterwards. However, Zalewska (2006) did not investigate capital flows to the market, as we do in this paper, and could not assess their direct impact on stock prices in the short-run or in the long-run.

2.2. Stock Market and Pension System Reform in Poland

2.2.1. Stock Market and Investors' Structure

Re-established in 1991, the Polish stock market has grown rapidly during the last two decades in terms of the number of listed companies and market capitalization. The capitalization of Warsaw Stock Exchange (WSE) is comparable to the smaller, mature European markets, like the Austrian or the Greek stock markets, and equals currently about 45 bn US dollars.

The present investors' structure of the Polish stock market has its origin in the pension system reform in the year 1999, when the public system was enriched by a private component, represented by open-end pension funds. Participation in this component, often called the "second pillar", is mandatory for employees below certain age. Employees are obliged to transfer 7.3% of their gross salary to the government-run social insurance institute called Zakład Ubezpieczeń Społecznych (ZUS), which in turn transfers the collected contributions to the private pension funds OFEs. The first transfer of money from the ZUS to the pension funds took place on May 19, 1999. This date marks a significant change of the investors' structure in the Polish stock market. In 1999, about 20% of the domestic institutional investors and 45% of the domestic individual investors traded at the Warsaw Stock Exchange. This situation has nearly reversed and the number of institutional traders approximately doubled after 1999 (e.g., Warsaw Stock Exchange, 2011). Constantly about 35% of the investors on the Polish stock market adhere to the group of foreign investors.

While before May 19, 1999 the majority of traders were small, private investors, after that date pension funds became important players on the stock market in Poland. There were also some mutual funds active in the market but they had relatively small amounts of capital under

management. Moreover, the role of corporate investors, i.e. companies investing their capital surpluses, was very marginal.

The number of pension funds in Poland over the analyzed period of time varied. The change in their numbers occurred mainly due to the mergers and acquisitions of the smaller funds by the larger ones. It is important to note, however, that their structure as well as the structure of the assets under their management remains rather invariant. Right after the start of pension system reform in 1999 the share of pension funds investments in stocks was relatively very low, typically in the range of 3% - 10% of their total assets, but it soon increased to 30% in 2000 and stayed consistently at that level in the subsequent years. For example, in the snapshot at the end of 2003, 16 pension funds operated in Poland with 11.8 bn US dollars under management. In comparison, Polish insurance companies and mutual funds had only 3 and 1 bn US dollars of assets, respectively. The pension funds invested about 3.8 bn US dollars in stocks listed on the Warsaw Stock Exchange in that year. At the end of 2009 the total portfolio of these pension funds was almost six-fold larger: 62.8 bn US dollars including the 18.7 bn US dollars invested in shares on the Warsaw Stock Exchange.

The share of pension funds in the Warsaw Stock Exchange turnover reached its maximum level in the years 2002 and 2003, i.e. 13.6% and 10.1% of average daily turnover, respectively. Taking into account only the free floating stocks, this share was even larger, 21.7% and 23.2%, respectively. In the next years, the share of pension funds in the Warsaw Stock Exchange turnover has been steadily decreasing and has fluctuated around the 5% level since 2006. More importantly, the share of Polish pension funds in free floating stocks has had a positive trend and reached the level of 30.4% in 2009, as reported by Narodowy Bank Polski (2004, 2011).

The stock holdings of pension funds predominantly consist of large capitalization stocks that are listed in the blue-chip index WIG20 and usually belong to the largest ones in their industries. Therefore, pension funds have emerged as important players on the Polish stock market with the amounts of capital capable to affect stock prices.

2.2.2. Origins and Implementation of the Pension System Reform in Poland

Through the entire 1990s all the consecutive governments in Poland, regardless of the political orientation, were aware of the necessity of pension system reform and they openly articulated it. It has been becoming increasingly apparent that the old pension system, inherited from the centrally planned economy overthrown in 1989, was going to bankrupt, as evidenced by, for example, Superintendency of Pension Funds (2000, p.6-13).

As a result of the pensions reform in the year 1999, the "three pillars" system has been introduced, where the first pillar is a state pension (paid to every citizen, however in very small amounts), the second pillar are the private pension funds OFEs (with compulsory participation for people below certain age) and the third pillar are other private investment funds (with voluntary participation).

Despite the political discussions, the new system started to operate in May 1999. New pension funds received a lot of media attention and positive publicity right from the start in 1999 (e.g. Rzeczpospolita, 1999), however the implementation of the reform raised new concern connected with the concentration of capital in the pension funds industry and the stock market liquidity. First, since the start of the reform the number of funds has been decreasing because of mergers and acquisitions. In consequence, more of the fresh capital has been accumulating in a smaller number of pension funds. Second, the pension funds - forced by law to invest mainly in the domestic market – jointly gained significant control in the public companies quoted at the Warsaw Stock Exchange. In some cases the cumulated share of all pension funds in a single company exceeded 25%. Taking into account a limited number of stocks at the Warsaw Stock Exchange and a small number of new issues on the one hand and the rapidly growing mass of capital in the pension funds on the other hand, this trend was likely to be continued.

The problem of limited liquidity of the Polish stock market after the new pension funds started their investments and have been accumulating increasingly larger amounts of capital from employees' pension contributions has been reported by major Polish business and financial

newspapers and magazines (e.g. Rzeczpospolita, 2002). At the start of the reform in the late 1999s this situation may have had following two serious implications for stock market in Poland: (1) pension funds could collectively execute their rights as shareholders in the public companies by appointing members of supervisory boards, thus gaining more control over these firms and possibly causing such threats as manipulation of the information from the companies (and manipulation of their prices at the stock exchange) and (2) pension funds could have too strong impact on the stock market because the amount of capital they had under management was too high and gave them power to move prices in the market characterized by relatively low liquidity. One of the possibilities this effect might have is triggering volatility and destabilizing stock market (however evidence about the opposite effect of an impact of institutional investors in Poland on stock prices volatility was presented in, e.g., Bohl and Brzeszczynski, 2006, and Bohl *et al*., 2009).

The issue of too strong concentration of pension funds industry creating the risk of damaging the competition between them has also been often discussed in popular business and financial press in Poland already after the start of the pension system reform (e.g. Rzeczpospolita, 2001).

3. Data and Methodology

3.1. Data

In this investigation we use unique database composed of very detailed data about the transfers from the public pension funds institute Zakład Ubezpieczeń Społecznych (ZUS) in Poland (Social Security Institute) to the private pension funds OFEs, which invest this capital on the stock market and on other financial markets. The data was obtained directly from the ZUS.

We also use the data about the prices and returns of the blue-chip stock index of the Warsaw Stock Exchange (WSE) – the WIG20 index – and the Dow Jones Industrial Average (DJIA) index

from the New York Stock Exchange (NYSE). The latter is assumed to represent the movements of the global stock market and is used as a control variable that allows us to extract the effect of the local factor (capital from ZUS invested in stocks at the Warsaw Stock Exchange) comparing with the effect of the influence of the global market volatility. The source of the WIG20 and DJIA data is Datastream.

The important characteristic of capital transfers from the ZUS to the OFE pension funds as the main explanatory variable in our models is that it does not directly depend on any other variable used in this study. The transfers from ZUS obviously affect the value of pension funds' investments on the stock market, but the transfers themselves are independent of the global and local financial market conditions in contrast to the investments of pension funds. Therefore, our proposed variable is distinctly exogenous in nature and it acts as a natural tool to analyze the impact of capital investments on stock returns.

The dataset from ZUS about the transfers to private pension funds spans over the period from May 1999 to December 2011 and covers a total of 1,857 individual observations (1,098 in the in-sample period and 759 in the out-of-sample period). All transfers are expressed in local currency (Polish zloty, PLN), similarly to WIG20 returns.

Due to the political turmoil around pension funds in Poland in recent years, our data sample is deliberately restricted to the period 1999 – 2011 to avoid any distortions in results after the year 2011.

This data sample provides unique laboratory-like conditions not only because it allows to analyze directly the impact of transfers from ZUS to the pension funds on the stock prices, but also because during this period of time the market was completely dominated by domestic pension funds while foreign pension funds started to invest in Poland only later (Parkiet, 2010). Hence, in this study we can extract the effect of the impact of pension funds investments as a homogenous group of investors and analyze their impact on stock prices without the influence of foreign pension funds as a different type of institutional investors.

It is important to note that the ZUS transfers variable is trending upwards over time, which is most likely caused by such long-term factors as: increasing wages (both in nominal and real terms), rising number of employees in the real economy (which overall results in the increasing pension contributions) and the inflation. In order to avoid obvious problems resulting from the use of a trending variable in our models, we de-trend it by dividing the transfers for all data frequencies by their respective moving averages, which allows us to analyze the long-run impact of pension funds investments on stock prices. Hence, the variable which we use as ZUS transfers, denoted as *TRANSbyMA*, can be interpreted as relative (percentage) deviation of ZUS capital transfers from the long-run trend.

As an additional control variable we exploit the WIG20 volume of trade, which we also de-trend using the same technique (deviations from the moving average) as in case of the ZUS transfers.

3.2. Modeling Strategy

First, we investigate the long-term effects of pension funds investments in the stock market in Poland and construct the models for quarterly and monthly frequency of data. Then we turn our attention to the short-term effects and analyze the models for weekly and daily data frequencies. Such modeling strategy is similar to the approach applied e.g. in the study of Brzeszczynski and Melvin (2006). It also allows us to compare the impact of the ZUS transfers on the stock prices from various perspectives and in different time-horizons.[3]

There exists broader evidence about the impact of capital flows on stock returns in the long-run – as documented by, for example, Bekaert *et al*. (2002), Goyal (2004), Lou (2012), and Shive *et al.* (2013) – and we investigate whether the flows generated by investments of the group of large institutional investors in Poland, i.e. the private pension funds, have similar effects in the longer term but also in shorter time periods.

Models for quarterly, monthly, weekly and daily data were constructed using the variables aggregated to their respective frequencies of observation. Additionally, we created the variables that span over the period of 2-, 3- and 4-days to investigate the effects of the ZUS capital flows on stock prices in the intervals longer than 1 day but shorter than 1 week.

The quarterly / monthly / weekly / daily returns for the WIG20 and DJIA indices were computed using the values of those two indices at the end of every quarter / month / week / day (and similarly so for 2-, 3- and 4-days long intervals). The value of individual ZUS transfers has been added within every quarter / month / week etc. and divided by respective moving averages to create the de-trended transfers variable: *TRANSbyMA*. The same technique has been adopted for the WIG20 volume of trade, which has been aggregated in a similar way and allowed us to create the de-trended volume variable: *VOLbyMA*.

For the quarterly data we calculated the deviations of transfers and volume from their moving averages from the previous 4 quarters of the year. Due to the fact that the transfers at the very beginning of the period in the first year in the sample (i.e. year 1999, starting in May 1999) were significantly lower than later, we did not use this period for the measurement of the de-trended transfers (or any other variable) and we started our estimation period for all models in the year 2001. The first de-trended transfer (*TRANSbyMA*) and de-trended volume (*VOLbyMA*) was calculated for Q1 2001 (using data from four previous quarters from Q1 2000 to Q4 2000). Similarly, we used the first 12 months of the year 2000 to calculate the moving average for the de-trended transfers and the de-trended volume for the monthly data. For the weekly and daily data we divided the transfers by their 12-week (3-month) moving averages and the 60-day (3-month) moving averages, respectively. Therefore, we were able to start our estimation sample with daily and weekly data already in the second quarter of the year 2000 and we set the end of the sample at December 31, 2008.

The variables for a respective data frequency are denoted using letters "*q*" (for quarterly), "*m*" (for monthly), "*w*" (for weekly), "*d*" (for daily) and "*2d*", "*3d*" and "*4d*" (for multiple day long

intervals) at the end of every variable's name. Hence, for example, the de-trended quarterly transfers from the ZUS pensions institute to the private pension funds are denoted as: $TRANSbyMAq_t$ and the de-trended transfers for the monthly frequency are denoted as: $TRANSbyMAm_t$. Similarly, the names of variables for quarterly (monthly) de-trended volume of trade are: $VOLbyMAq_t$ ($VOLbyMAm_t$) and for the quarterly (monthly) stock index returns: r_t^{WIG20q} and r_t^{DJIAq} (r_t^{WIG20m} and r_t^{DJIAm}). The same system has been used to create names of all other variables for other data frequencies.

The variability of ZUS transfers and the WIG20 index is clearly different during bull and bear market periods, so in order to be able to extract the effects of ZUS transfers on the WIG20 index in those two distinct market phases we estimated variants of models using those segmented sub-samples, which allowed us to assess the impact of transfers during the time when the markets are characterized by a general rise or general fall of stock prices and also provides robustness check of the results (e.g., Chan and Lakonishok, 1993; Chiyachantana *et al*., 2004).

In our sample of 8 calendar years 2001 - 2008, the bull market covers the period: Q2 2003 – Q2 2007 for the quarterly data and April 2003 – June 2007 for the monthly data while the bear market period covers: Q1 2001 – Q3 2001 and Q3 2001 – Q4 2008 for the quarterly data and January 2001 – September 2001 and July 2007 – December 2008 for the monthly data. For the weekly and daily models the cut-off dates are analogous to those from the monthly data.

Any possible conditional heteroscedasticity of residuals in empirical versions of all the models was tested using the Engle's (1982) LM multiplier test and it was subsequently eliminated using appropriate GARCH specifications. Autocorrelation, if it existed, was eliminated by the imposition of AR and/or MA terms. All variables used in our models were also confirmed to be stationary.

3.3. Modeling Long-run and Short-run Effects of Pension Funds Investments

We estimated the following models for the returns of the WIG20 index for all analyzed frequencies of data:

$$r_t^{WIG20i} = \alpha + \beta \cdot TRANSbyMAi_t + \delta \cdot r_t^{DJIAi} + \gamma \cdot VOLbyMAi_t + \xi_t \qquad (1)$$

where:

$i = q, m, w, 4d, 3d, 2d, d$ and

$q = quarterly$,

$m = monthly$,

$w = weekly$ frequency

and:

$4d = 4day$, $3d = 3day$, $2d = 2day$ and $d = 1day$ - denote the frequencies for intervals of 4, 3, 2 and 1 day length.

The returns of the WIG20 and DJIA indices are denoted as: r_t^{WIG20i} and r_t^{DJIAi}, respectively, and the de-trended ZUS transfers and the de-trended volume of trade of the WIG20 index volume as: $TRANSbyMAi_t$ and $VOLbyMAi_t$, for various intervals and data frequencies i as defined and explained above. The ξ_t is an error term.

In addition, we extended our analysis by checking specifications of models with lags of transfers, volume and the DJIA returns and also segmented the entire sample into the sub-samples covering bull and bear market periods.

The impact of capital injection from ZUS into the stock market is expected to be more pronounced when higher frequency data rather than low frequency data is used for analysis. Such an impact can be interpreted as evidence that the effects of pension fund investment on the stock market are short-lived in nature and that they are most likely a market microstructure phenomenon

rather than the long-run tendency affecting the development of the market. For example, Zalewska (2006) suggests that the introduction of the pension fund investments on the WSE stock exchange in 1999 did not improve the long-run performance of the Polish stock market in relation to other competing markets in the region. According to the market microstructure theory the changes in stock prices are related to the mechanism of selling and buying stocks. In line with this concept, the increased supply of capital (and greater demand for stocks) usually increases the volume of long (buying) positions relative to short (selling) positions on the market and moves the prices up.[4]

Therefore, we pay particular attention to the analysis of short-run impact of OFE investments on stock prices and we use a range of high frequencies of data, such as daily, 2-day, 3-day, and 4-day long intervals as well as weekly changes in WIG20 and other variables. The use of different short-term frequencies is motivated by the fact that the observed transfers of capital from the ZUS (and subsequently from the OFEs) are not likely to be immediately invested in stocks (e.g. on the same day when the ZUS transfer to the OFE pension funds has taken place) and such process may, in fact, require a number of days. The investment may be postponed by the internal decision process in individual OFE pension funds, overall principles of their specific investment strategies (e.g. gradual investment of large amounts of capital, such as "stealth trading" techniques) or other technical barriers. In our analysis, the lagged variables are used to control for the delayed impact of transfers, while the multi-day frequencies of data control for gradual capital investment strategies (over a number of days).

We employ the opening prices of the DJIA index to construct a proxy for the returns from the world market, i.e. the following return of the DJIA: $r_t^{DJIA} = \log(DJIA_t^{open}) - \log(DJIA_{t-1}^{open})$. We use similar definitions for 2-day, 3-day, 4-day and weekly returns of the DJIA index.

In the daily and multi-daily models the transfers $TRANSbyMAd_t$ (and the respective variables in the multi-day models, i.e.: $TRANSbyMA2d_t$, $TRANSbyMA3d_t$ and $TRANSbyMA4d_t$) have also been lagged to test and check the robustness of the delay effects between the actual

transfer and the time during which the capital from ZUS is invested on the stock market. We investigate each model in the full sample, in the bull market periods and in the bear market periods.

4. Empirical Results

4.1. Results of the Long-run Analysis

Table 1 presents the estimates of quarterly and monthly models for the returns of the WIG20 index r_t^{WIG20q} with the de-trended ZUS transfers ($TRANSbyMAq_t$) as well as the control variables: returns of the DJIA index (r_t^{DJIAq}) and the de-trended volume of trade ($VOLbyMAq_t$). The correlation between $TRANSbyMAq_t$ and $VOLbyMAq_t$ in the whole sample is only 0.04, so there is no problem with multicollinearity if those two variables are introduced simultaneously in one equation.

[Table 1 around here]

The first important finding in Table 1 is that in the entire sample of data (specifications of models from s1 to s4) all estimates of the r_t^{DJIAq} are positive and significant (at the p =0.01 level) while the estimates of the transfers $TRANSbyMAq_t$ are not significant in any specification of any model (with or without the control variables), which clearly demonstrates the dominance of the global factor represented by the DJIA index and no evidence of impact of the ZUS transfers when the entire period of analysis is taken into account.

The estimation results paint a similar picture, when the whole period is disaggregated into bull and bear market phases (specifications of models from s5 to s8 and from s9 to s12). In both

bull and bear market sub-samples the estimates of r_t^{DJIAq} are positive and in all cases but one they are significant, which confirms very strong impact of the DJIA index in both periods of bull and bear market phases, however there is evidence of a stronger relationship in the bear rather than bull market as indicated by higher values of parameter estimates. It suggests that the WIG20 is more strongly influenced by the DJIA index during the bear market, which provides evidence of tighter linkages between Polish stock market and the US market (which represents here the global factor) and possibly also a stronger contagion effect related to the times of the financial crises.

By segmenting the sample into sub-samples of bull and bear market phases, we can also extract the effect of ZUS transfers on the WIG20 index returns when the markets are in an upward or downward trend. The results in Table 1 demonstrate, however, that the estimates of the parameters for the de-trended transfers $TRANSbyMAq_t$ in either the bull or in the bear market periods are not statistically significant in the quarterly models, so they do not have any impact on stock prices in such long horizon in any of those two distinct sub-periods.

Table 1 presents also the estimates of monthly models for the returns of the WIG20 index r_t^{WIG20m} with the ZUS transfers ($TRANSbyMAm_t$) as explanatory variable and monthly returns of the DJIA index (r_t^{DJIAm}) as well as the WIG20 volume of trade ($VOLbyMAm_t$) as a control variables.

The findings from monthly frequency data are very similar to the results from quarterly models, where the DJIA index is the main driving force for the WIG20 index returns. The bottom panel in Table 1 shows that all estimates of r_t^{DJIAm} are positive and significant at the p=0.01 level for the whole sample and in both sub-samples, but higher estimates have been observed in the bull market than in the bear market period.

In summary, the evidence from quarterly and monthly models clearly indicates that there is no relationship between ZUS transfers and the subsequent stock price changes in the long run, however it cannot be excluded that it may exists in shorter horizons and can be identified using models built for higher frequency data.[5] We investigate such short term effects in the next section.

4.2. Results of the Short-run Analysis

In the next step we analyze the impact of ZUS transfers over much shorter horizons: i.e. over the weekly and daily time intervals.

Table 2 presents first the estimation results for the weekly frequency models. The return from the US market (r_t^{DJIAw}) is again the most significant explanatory variable in all specifications. There is also a statistically significant immediate impact of the trading volume ($VOLbyMAw_t$) on the WIG20 returns r_t^{WIG20w}.

[Table 2 around here]

The most important finding in Table 2 from the point of view of the main objective of this study is the positive and statistically significant estimate of the ZUS capital transfers variable ($TRANSbyMAw_t$) on the WIG20 returns. It means that there exists an impact of ZUS funds being injected by the OFE pension funds into the stock market. Moreover, it persists only within one week's space of time since the lagged weekly transfer variables are not statistically significant (estimates for further lags than *t-1* are not reported in Table 2 but are available upon request). The positive relationship between capital transfers and WIG20 returns is statistically significant in the full sample (but usually not significant in the shorter bull and bear periods, however the parameter values remain consistently always positive there). We also investigated results from our models in three-yearly sub-samples (constructed as a moving window) and found that the transfers from ZUS are positively related to WIG20 returns in all of those sub-periods, although the estimated impact is not statistically significant in some of them. These periods cannot be linked directly to bear or bull market phases.

It is important to emphasize that the evidence about the short-run impact of transfers on stock prices in the weekly models is robust to adding control variables, as indicated by the results in the subsequent columns in Table 2.

Given this robust finding about the impact of ZUS transfers on stock prices within the period of one week's time reported and discussed above, we further investigate shorter intervals and higher data frequencies to provide more robustness checks and to see additionally if this effect can be identified more precisely over a certain number of days within a week. In other words, we extend our analysis in order to find out how quickly (in terms of the number of days) the impact of ZUS capital injected into the stock market is materialized after the transfer of capital from ZUS to the OFE pension funds takes place and whether this effect is a gradual process (e.g. due to gradual investments of capital or possibly because investors interpret news and react to them with a lag) or rather a more rapid phenomenon. If the latter is the case, it should be possible to identify such impact on a specific day (e.g. first or second or third or fourth day etc.) after the transfer from ZUS is completed by employing lagged transfers as explanatory variables. In turn, analyzing different frequencies of data will help in identifying whether the impact is gradual in nature and if it is spread over some longer time.[6] This investigation, hence, allows to answer the question what is the degree of the delay between the transfer of capital from ZUS to the OFE private pension funds and the length of time the OFEs need, on average, to invest those funds on the stock market.

Below we discuss estimation results from models where variables are based on data using the 4-, 3-, 2 and 1-day long intervals. The parameter estimates from those models are presented in further panels in Table 2.

The results from models using 4-day long intervals for the construction of all variables indicate that in the full sample the impact of ZUS transfers on the stock prices is even stronger than in the weekly models – both in terms of the statistical significance (the *p*-values are at the 0.01 level rather than 0.05 or 0.1 levels as in case of the previous, weekly frequency, models' estimates) and in terms of the magnitude of the estimated parameter (e.g. 0.0031 versus 0.0048 in specifications s3

and similarly so in other specifications in Table 2) which is higher by about 50% in the 4-day interval models in comparison with the weekly ones. This is a very important finding, which shows that the impact of ZUS transfers is stronger within 4 rather than within 5 days long (i.e. weekly) intervals and it means that the OFE pension funds usually invest the capital received from the ZUS in the periods of *up to* 4 days. This result is also confirmed below by estimates from higher frequency models, in particular the daily ones, with their respective lags.

Table 2 illustrates also that the impact of the ZUS transfers is stronger during bull periods than during bear periods in all specifications, but the values of the relevant parameters are positive in every case in both sub-samples. This result confirms the findings from earlier studies on the impact of institutional trades on asset prices that the effects of buy transactions are stronger in bull periods, because it is easier to buy stocks when others are selling than when others are also buying and moving the prices up. Buys are also driven by the preference to hold some specific stocks and therefore they may set new higher and permanent values for these stocks.

In the full sample, the impact of the ZUS capital transfer lagged by one period is significant and negative, but the cumulated impact remains positive in all cases. We additionally investigated sub-samples of 200 observations (constructed as a moving window) and found a significant positive impact of capital transfers on WIG20 during the second half of the full sample rather than during the first half of that sample. This result points to the increasing impact of trades by pension funds on stock prices, which is consistent with the increasing share of pension funds in the turnover of free floating stocks.

The estimates from models using 3-day long intervals for construction of all variables presented in Table 2 show, generally, that the impact of capital transfers is not statistically significant in most specifications (however the estimates are mostly positive yet not as consistently so as in the previous models). Some results from bull and bear sub-samples indicate a negative instantaneous link between capital flows and WIG20 returns, but the cumulative impact, taking into account lagged variables, is positive. Analyzing again the sub-samples of 200 observations (as a

moving window), we find a positive impact in most of the sub-periods with the exception only of the first 200-observations long window. We also find that this impact becomes the most significant at the end of our entire 8-year sample.

Similar results are obtained from the models estimated for the 2-day long intervals. They do not allow us to identify any robust evidence on the impact of the ZUS capital flows on the Polish stock market in this particular interval of time. The instantaneous impact is usually positive in the full sample and in the bull sub-sample, but it is not statistically significant in almost all of the reported specifications. Moreover, the aggregated lagged impact is negative in the full sample and in the bear market sample. Analyzing again the moving windows of 200 observations, we find the aggregated (instantaneous and lagged) impact of capital flows to be positive in most cases.

Finally, the last panel in Table 2, which presents estimation results from daily frequency models, provides more evidence about the length of delay between the ZUS transfers and the reaction of stock prices. The estimates show that in the whole sample there is no statistically significant impact of the ZUS capital flows on day *t*, which is the day on which the transfers from the ZUS to the OFE pension funds take place (however, the respective parameter estimates from all model specifications are positive). Hence, the result that the ZUS transfers lose significance within the periods of time shorter than 4 days, as already observed in the models for 3- and 2-day intervals in other panels in Table 2, is confirmed also here using the daily models.

The lags in all other higher frequency models tend to confirm the above effect as well.[7] The estimates for lags in the models in full sample in the bottom panel of Table 2 in the specification s4 with all controlling variables are positive for all first 3 lags (*t-1*, *t-2* and *t-3*) and the estimate is statistically significant (at the 0.1 level) only for the lag *t-3*. This means that up to the day *t-3* the impact of ZUS transfers on stock prices is positive and the strongest effect is detected for lag *t-3*. However, this positive effect completely disappears already in lag *t-4*, which is consistent with findings in Table 2 presented in panels for the weekly and for the 4-day long intervals and corresponds exactly with the estimates for weekly (i.e. 5-day intervals) and 4-days intervals models

(c.f. the respective specifications in Table 2), where the strongest impact was observed for 4-day intervals rather than for the 5-day intervals, i.e. rather than within the entire week (this is because the lag *t-4* is the one which is included in the weekly interval but not in the 4-day interval, which covers only days: *t*, *t-1*, *t-2* and *t-3*).

Moreover, this lagged effect is confirmed also by the estimates of lags in 3-day intervals (showing no statistical significance of any lags) and the 2-day intervals models. The obtained estimation results provide evidence that for day *t* no statistically significant effect exists (only except for the specification s4 in the full sample, where the estimate gains significance but only at the weak $p = 0.1$ level), however the lag *t-1* is significant (at the stronger $p = 0.05$ level) and also positive (note that the lag *t-1* in the 2-day interval models covers the lags *t-2* and *t-3* in the daily models). The estimate of the *t-2* lag is negative and significant at the $p = 0.05$ level (again, lag *t-2* in the 2-day interval models covers the lags *t-4* and *t-5* from the daily models), which is fully consistent with the negative and also statistically significant estimate for lag *t-4* in daily models.[8]

The results discussed above, in conjunction with the findings reported already in Table 1 and previous panels in Table 2, suggest that the impact of the injection of the ZUS capital into the stock market is spread over longer time of approximately 4-5 days after the transfer from the ZUS to the OFEs takes place and it is most strongly marked within the first 4 days. In consequence, we can conclude that it is quite likely that the large institutional investors, i.e. the OFE pension funds in Poland, engage in the "stealth trading" investment strategies when buying stocks.[9] Additionally, the significant influence of capital flows on stock market returns might not necessarily be solely due to the "price impact" effect, but also due to the indirect effect of investors following the dates of capital injections to pension funds.[10] The findings from the short-run analysis for the full sample suggest that the main effects of capital transfers from the ZUS to the OFE pension funds, and subsequently to the stock market, are most significant during the first week after the transfer takes place. In the shorter sub-periods there is more evidence on the positive impact of capital flows during the bull market than the bear market and towards the end of the sample.[11]

Finally, the results from short-run analysis, using the models built for the daily frequency data, reveal an interesting finding which allows us to asses quite precisely the scale of the delay, and even estimate the average length of time, between the transfer of capital from ZUS to the OFE pension funds in Poland and its further investment in the stock market. It appears from our models that this delay is contained within the 4 day long period of time (i.e. from day *t-3* until day *t*, while on day *t-4* this effect already disappears), which is consistent with the "stealth trading" hypothesis of stock market investors. This is a new result which sheds more light and provides more evidence about the trading habits of large institutional investors, such as large pension funds trading in a relatively small and thin market, which has not been reported in the literature before. This is also consistent with the temporary price pressure hypothesis discussed in Section 2.

[Figure 1 around here]

As a robustness check, we estimated the structural vector autoregression (SVAR) model with the US returns, transfers of funds from ZUS to OFEs, WIG20 returns, and trading volume as endogenous variables. The results are depicted by Figure 1. This is a standard approach in the literature to analyze causal effects between capital flows and stock returns (see, for example, Ben-Rephael *et al*., 2011 and 2012). Again, we find a significant positive reaction of WIG20 returns to independent shocks in flows of funds to the OFE pension funds three and four days after the shock. The effect is persistent and is robust to the lag order of our SVAR model and to the estimation window.

5. Counterfactual Analysis and Trading Strategy Out-of-Sample

In this section we present two different types of robustness analysis for our results obtained in the in-sample period from 1999 to 2008: (1) counterfactual analysis for the period *before* the

pension system reform and *before* the entrance of the OFE pension funds in 1999 and (2) performance of a trading strategy based on the findings from the in-sample period, simulated out-of-sample in the period *after* 2008, i.e. from January 2009 to December 2011 (full 3 calendar years).

Since there is no data available about transfers from ZUS to the OFE private pension funds for the period preceding the reform, the only possibility to conduct a counterfactual analysis in case of this study is to exploit the pattern of transfers observed in the in-sample period (after the pension system reform when ZUS started to transfer first funds) and use it for the simulation of investment results in the period before the reform. Hence, we calculated the frequency of the ZUS transfers in the period between 1999 and 2008 and noticed that the transfers after the reform were taking place mostly at the beginning and at the end of each calendar month. There were five days in an average month, between the 14th and the 18th day of each calendar month, when transfers were about 27% less frequent than on other days and the daily amounts transferred equaled on average only 22% of the daily amounts transferred on other days (cf. Figures 2 and 3), meaning nearly 80% less capital being transferred by ZUS on those days.

[Figures 2 and 3 around here]

Next we compared results from investments only on the days in the middle of each month and on the other days every month. We did calculations of returns for the three sub-periods: pre-reform subsample (from January 1, 1998 to April 30, 1999), after-reform sub-sample in which we did estimations of all models (from May 1, 1999 to December 31, 2008) and out-of-sample period (from January 1, 2009 to December 31, 2011). The results are presented in Table 3. It demonstrates that the investments on the days when on average larger and more frequent transfers to OFEs took place (after the reform) resulted in positive returns, while the investments on the days with less frequent transfers were characterized by negative returns. In contrast, the investments in the middle of the month in the sample before the reform (following the "low-transfers strategy") returned on

average positive profits and the investments on other days (following the "large-transfers strategy") led to negative returns. These findings show that the introduction of OFEs and their investments on the Warsaw Stock Exchange fuelled by the funds transferred from ZUS to the OFEs could lead to construction of simple and profitable investment strategies that were not possible to execute in the earlier period (i.e. before the pension system reform).

[Table 3 around here]

Finally, we checked if the results from the in-sample estimation hold out-of-sample and we investigated in more details the effects of the Polish pension reform on investment strategies in the Warsaw stock market in the out-of-sample period in years 2009 – 2011 (full 3 calendar years). The end of the out-of-sample interval was set as the end of 2011 because of the political turmoil around the ZUS and OFE pension funds in the later period, which qualitatively changed the environment within which the OFEs operated and invested their capital on the stock market (the discussion among main political parties in Poland was focused on the proposals to use the OFEs money by the government for contributions to the payment of the public debt, which was an idea that was, in turn, negatively perceived by the financial market investors). Hence, we deliberately wanted to restrict our out-of-sample period to exclude this unusual time dominated by qualitative (political) factors.

The estimation results from the in-sample period (in Tables 1 and 2) indicate that the stock prices react most strongly to the capital flows from ZUS to the OFEs during the first 4 days after the funds are transferred, i.e. between days t and $t+3$, so we simulated an investment strategy which relies on this finding and where a hypothetical stock market investor buys the WIG20 index at the end of the day preceding the day when each transfer was made and holds the position open for the next 4 days.

Table 4 presents results for such strategy as well as for the benchmark buy-and-hold strategy in the whole period of January 2009 – December 2011. The strategy is presented in two different

variants: for all ZUS transfers regardless of their size (Strategy 1) and only for large transfers when a transaction is made depending on the value of the capital flows measured by the deviation from their moving average and filtered using the threshold of 1, i.e. when the transfer is larger than its moving average from the last 3 months it is considered as large and only then the investment is made (Strategy 2). Returns in Strategy 1 and 2 are calculated as compounded returns after each transaction.

[Table 4 around here]

[Figure 4 around here]

The results in Table 4 and in Figure 4 show that in the whole out-of-sample period both strategies would have performed better than the benchmark, i.e. than a simple buy-and-hold strategy.[12] Strategy 1 based on all transfers made 21.57% profit (with 0.05% average daily return in the WIG20 portfolio holding-period computed as the ratio of total return and the number of days when the investor held the WIG20 portfolio) and Strategy 2 based on only large transfers achieved even better result of 26.30% (with 0.13% average daily return), while the buy-and-hold strategy returned 19.82% in the same period of time (with 0.03% average daily return).

It is important to emphasize that both investment strategies have beaten the benchmark index not only from the point of view of the overall return but also in terms of the average daily returns. Strategy 1 achieved the daily average return almost twice as high as the benchmark (0.05% *versus* 0.03%) while Strategy 2 has beaten it over 4-fold (0.13% *versus* 0.03%). The latter result for Strategy 2 relying on the information about large transfers of capital to the OFE pension funds means that it can be further extended to apply leveraged trades (e.g. using the futures contracts or other derivative instruments) by, for example, allocating higher leverage to the individual transactions in proportion to the size of the ZUS transfer on particular days.

Moreover, the outperformance of strategies based on the information about the flows of capital from ZUS to the OFE pension funds is even clearer when the analysis is conducted on the risk-adjusted basis, which we present below.

We investigated the performance of both strategies based on the ZUS capital flows in the out-of-sample period by using the most important risk-adjusted measures, such as the modified Sharpe ratio of Israelsen (2005) and the Certainty Equivalent returns (see e.g., DeMiguel *et al*., 2009), which we computed for Strategy 1 and Strategy 2 as well as for the benchmark buy-and-hold strategy (i.e. for the WIG20 index). The Sharpe ratio measures excess return per unit of risk, however the classical definition of the Sharpe ratio suffers from inaccuracy errors and incorrect assessment of risk when returns are negative in some sub-periods, so we calculated the modified Sharpe ratio (*MSR*) of Israelsen (2005) defined as:

$$MSR = ER/SD^{(ER/absER)} \tag{2}$$

where *ER* is the excess return defined as mean monthly difference between the strategy (or index) return and the risk-free return computed for the number of trades in our strategies (or number of trading days for the index in the whole out-of-sample period), and *SD* is the corresponding sample standard deviation of the differences of returns. The risk-free rate for the Polish market which we used was the return of the 3-month Treasury Bill obtained from the National Bank of Poland. *MSR* is a commonly used measure to deal with the problem of negative returns and alleviates the problems with the traditional Sharpe ratio.

Certainty Equivalent (*CEQ*) returns are an alternative risk-adjusted measure and they are defined as:

$$CEQ = \hat{\mu}_k - (\gamma/2)\hat{\sigma}_k^2 \tag{3}$$

where $\hat{\mu}_k$ and $\hat{\sigma}_k^2$ are the mean and variance of excess returns of the strategy or an index *k* and γ is the risk aversion parameter. As in case of the modified Sharpe ratio (*MSR*), the risk-free rate was the return of the 3-month Treasury Bill obtained from the National Bank of Poland. The formulation

of *CEQ* in (2) assumes a multi-period investor with quadratic utility. The 'normal' level of risk aversion is γ=1, while higher (lower) values of γ indicate higher (lower) levels of risk aversion.

Results in Table 4 show that both Strategies 1 and 2 achieved better values of modified Sharpe ratio than the passive strategy (0.0205 and 0.0359, respectively, *versus* 0.0158 for the simple buy-and-hold strategy) in the whole out-of-sample period. In particular, the *MSR* for Strategy 2 based on large ZUS transfers is more than twice as high as the corresponding *MSR* value for the benchmark buy-and-hold investment.

The values of Certainty Equivalent (*CEQ*) returns are presented also in Table 4. They have been calculated for five variants representing normal risk aversion of investors (γ=1), lower risk aversion (γ=0.5, i.e. half of normal risk aversion level) and higher risk aversion levels (γ=2, i.e. double the normal risk aversion level, as well as γ=5 and γ=10). The *CEQ* measure results illustrate a similar picture as the *MSR*: Strategies 1 and 2 have consistently higher *CEQ* values than the buy-and-hold strategy for all values of the γ parameter.[13]

In summary, results reported in Table 4 depict a clear pattern of outperformance of investment strategies based on the information available for investors about the ZUS transfers of new capital to the OFE pension funds not only in terms of raw returns but also on the risk-adjusted basis. Since the investigated trading strategies concern short-term investments, the results corroborate our finding of significant short-term effects of ZUS transfers on stock returns and no long-term effects. This finding also confirms usefulness of the publicly available data about large capital flows for prediction of stock market movements, which we identified initially in the in-sample period in our study and subsequently verified in the out-of-sample experiment.

6. Conclusions

Using unique database about transfers of large amounts of capital from the public social security institute ZUS in Poland to the private pension funds OFEs, which further invest it on the stock market, we investigated the impact of large institutional investors on stock prices.

Our findings indicate that in the longer horizon, for quarterly and monthly data, the global factor in form of the returns of the DJIA index returns dominates over local capital flows from the ZUS and explains better the returns of the WIG20 index than the ZUS transfers. This suggests that capital flows to pension funds have a negligible long-run impact on stock prices. Therefore, based on this evidence, the hypothesis of information-based trades of pension funds cannot be confirmed in our study.

However, in short horizon, for the weekly and daily data, we found robust evidence that the transfers of capital from ZUS to private pension funds are related to the subsequent changes of the WIG20 index. From the market microstructure perspective, this result may be explained by the price impact of capital flows to the stock market and the effect of other investors following these trades (i.e., supporting the temporary price pressure hypothesis).

We also present unique evidence about the exact length of time between the ZUS transfers of capital and its subsequent investment by the OFEs private pension funds on the stock market, which sheds light on the nature of trading of those large institutional investors. We find that the OFE pension funds investments affect stock prices only during the first week after the transfers of capital from ZUS, but not immediately after these transfers have been made. The stock returns reaction is strongest within the first 4 days after the ZUS transfers took place, which can be interpreted as the amount of time required by the OFEs to the invest the capital that they receive from the ZUS, on the stock market. This result is consistent with the “stealth trading” hypothesis but the identified delay effect is contained within a relatively small number of days.

Our findings provide new evidence about the impact of pension funds as a group of large institutional investors on stock returns on a relatively thinly traded market and may have direct and very practical implications for the investment strategies of other stock market participants. They also provide useful knowledge for financial markets regulators whose aim is to supervise stock markets and understand the nature of impact of trading by large institutional investors on stock prices and on market volatility.

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Footnotes:

[1] More evidence on institutions' trading behaviour, in particular their impact on volatility, autocorrelation and the issue of stabilization / destabilization of stock prices, can be found in earlier literature in, for example, Lakonishok, Shleifer, and Vishny (1992), Grinblatt, Titman, and Wermers (1995), Sias and Starks (1997), Nofsinger and Sias (1999), Wermers (1999), Dennis and Weston (2001), Badrinath and Wahal (2002), Cohen, Gompers and Vuolteenaho (2002), Dennis and Strickland (2002) and Griffin, Harris, and Topaloglu (2003), Sias, Starks, and Titman (2006), among others, and more recently in Schuppli and Bohl (2010).

[2] Sias, Starks, and Titman (2006) provide the evidence that it is the "informed trading" that moves prices and it is institutional investors (not individuals) who are more likely to be informed than other investors (see also Dennis and Weston, 2001, and Kamesaka, Nofsinger and Kawakita, 2003). If this is the case, then the entrance of pension funds in Poland in 1999 could, indeed, affect the behaviour of stock prices.

[3] We opted to use regression models as our main methodological tool in this study, although we acknowledge that other similar papers adopt event studies in this type of research (based on abnormal returns (AR), cumulative abnormal returns (CAR), buy-and-hold abnormal returns (BHAR) etc.). However, in this particular case, the use of AR, CAR or BHAR etc. measures is not possible, because of the nature of data, i.e. because the ZUS transfers occur too often and the "post-event periods" inevitably have to overlap with each other. Therefore, the measurement of abnormal returns in such event study would be contaminated by the overlapping periods problem and, hence, we can not use this method in our analysis. Instead, rely on the regression models and we additionally apply the approach of Ben-Rephael, Kandel, and Wohl (2011) and estimate impulse response functions from structural VAR models. This methodology allows us to analyse causal effects between flows of funds to OFEs and local stock returns.

[4] Another possible channel for the ZUS transfers to affect stock prices could be through the macroeconomic information contained in the amounts of capital invested on the stock exchange and the timing of investments. For example, weaker economic conditions in the household sector could limit the capital available at ZUS and subsequently reduce capital transfers from ZUS through the OFE pension funds into financial markets.

[5] The analysis of the goodness of fit measure R^2 also reveals that the ZUS transfers have a poor power in explaining the returns of the WIG20 index for the quarterly and monthly data (but not in higher frequency models presented and discussed in the next section).

[6] Gradual investment of large amounts of capital by large institutional investors, such as the OFE pension funds in Poland, which is divided into many transactions that are spread over a number of days, would be consistent with the "stealth trading" effects known in the financial markets whereas the traders do not want to signal to the market that they intend to buy or sell large quantities of stocks, so they execute their transactions using smaller portions of capital and spread them gradually over a longer interval of time, e.g. a week rather than a day.

[7] Note that the respective intervals on which the construction of all variables is based (i.e. the returns of both stock market indices WIG20 and DJIA as well as the aggregated ZUS capital flows and the aggregated volume of trade) cover the following days: the weekly intervals (i.e. 5-day

intervals) cover days *t, t-1, t-2, t-3* and *t-4*; the 4-day intervals cover days *t, t-1, t-2* and *t-3*; the 3-day intervals cover days *t, t-1* and *t-2*; the 2-day intervals cover days *t* and *t-1*; and, finally, the daily intervals cover only the day *t*.

[8] The negative and statistically significant estimate for the lag *t-4* in the daily models, as well as the findings for the weekly and 4-day interval models, might additionally suggest that there exists some *correction mechanism* in stock prices after the period of 4 days of constant injection of the new capital from the ZUS by the OFE pension funds into the stock market (i.e. beyond the space of time between days *t-3* and *t*).

[9] As a further robustness check, we also normalized the variable *ZUS* containing the nominal values of capital transfers from the ZUS to the OFE pension funds by dividing it by its 60-day sample standard deviation. We did that because the volatility of the variable *TRANSbyMA*, used in our investigations, shows some downward trend for some higher frequencies of data, namely daily, 2-day and 3-day long intervals. We found a positive and often significant impact (instantaneous and lagged) of the de-trended transfers on the WIG20 returns for daily and for the 2-day interval models. The results for the 3-day interval models were similar to those obtained and explained above using the variable *TRANSbyMA*. Detailed results are available upon request.

[10] The dates and amounts of capital flows from ZUS to OFE are known to the public immediately after the transfer takes place.

[11] This result could imply that the fund managers in the OFEs do not tend to play against the market as they invest in stocks in times of prosperity. The administrative limits on stock market investments do not seem to play a role here, at least in the short-run. The explanation for the lower price impact of investments during the bear market periods could be that the managers in OFEs limit their investments in stocks during the weaker market conditions.

[12] In Figure 3 the adjusted cumulative return at time *t* is calculated by dividing the total compounded return at time *t* by the number of days (until time *t*) when investors held their investment positions in WIG20 and multiplying by the total number of days until time *t*.

[13] When the out-of-sample period is divided into bull and bear market phases, both Strategies 1 and 2 underperform in the bear market sub-sample in terms of simple raw returns, which is mainly related to fewer number of trades, but they achieve similar results of the risk adjusted measures *MSR* and *CEQ*, in particular for higher values of the γ parameter. However, in the bear market sub-periods Strategies 1 and 2 exhibit remarkable resilience and very clearly outperform the benchmark buy-and-hold strategy by achieving better (less negative) raw returns and also much better values of all variants of the risk-adjusted measures. These findings show that capital flows from the ZUS to the OFE pension funds create additional demand and help to counteract stock price falls during the bear market episodes.

Table 1. Estimates of parameters from the models for long-run relationships (for quarterly and monthly frequency of data).

	Quarterly models			
	s1	s2	s3	s4
const.	0.1362 (0.2579)	0.1135 (0.1527)	0.0604 (0.2001)	0.3802 (0.3282)
$TRANSbyMAq_t$	-0.1236 (0.2468)	-0.0987 (0.1481)	-0.0984 (0.1613)	-0.1552 (0.2095)
$TRANSbyMAq_{t-1}$				-0.1926 (1.1680)
r_t^{DJIAq}		1.1646*** (0.1273)	1.1406*** (0.1477)	1.1680*** (0.1490)
r_{t-1}^{DJIAq}				0.2495 (0.1779)
$VOLbyMAq_t$			0.0465 (0.0658)	0.0333 (0.0660)
$VOLbyMAq_{t-1}$				-0.0402 (0.0738)
	Monthly models			
	s1	s2	s3	s4
const.	-0.0025 (0.0206)	-0.0013 (0.0164)	-0.0414 (0.0279)	-0.0077 (0.0429)
$TRANSbyMAm_t$	0.0050 (0.0187)	0.0053 (0.0149)	0.0041 (0.0147)	-0.0014 (0.0166)
$TRANSbyMAm_{t-1}$				-0.0043 (0.0177)
r_t^{DJIAm}		1.1380*** (0.1334)	1.1082*** (0.1443)	1.1466*** (0.1498)
r_{t-1}^{DJIAm}				-0.1087 (0.1275)
$VOLbyMAm_t$			0.0354 (0.0235)	0.0495* (0.0293)
$VOLbyMAm_{t-1}$				-0.0342 (0.0248)

Notes:

(a) Robust standard errors of parameter estimates are presented in parentheses.

(b) Highlighted cells indicate statistical significance, which is denoted as: *** significant at 0.01 level, ** significant at 0.05 level and * significant at 0.1 level.

Table 2. Estimates of parameters from the models for short-run relationships (for weekly and daily frequency of data).

	Weekly models			
	s1	s2	s3	s4
const.	-0.0011 (0.0022)	-0.0016 (0.0018)	-0.012*** (0.0039)	-0.0062 (0.0052)
$TRANSbyMAw_t$	0.0028* (0.0016)	0.0028** (0.0013)	0.0031** (0.0014)	0.0034** (0.0015)
$TRANSbyMAw_{t-1}$				-0.0013 (0.0014)
r_t^{DJIAw}		0.6132*** (0.1277)	0.6047*** (0.1412)	0.6502*** (0.0984)
r_{t-1}^{DJIAw}				0.1266 (0.1076)
$VOLbyMAw_t$			0.0092*** (0.0032)	0.0106*** (0.0037)
$VOLbyMAw_{t-1}$				-0.0057 (0.0039)
	4-daily models			
	s1	s2	s3	s4
const.	-0.0013 (0.0017)	-0.0017 (0.0015)	-0.0090** (0.0035)	-0.0007 (0.0044)
$TRANSbyMA4d_t$	0.0049** (0.0019)	0.0045*** (0.0017)	0.0048*** (0.0017)	0.0053*** (0.0017)
$TRANSbyMA4d_{t-1}$				-0.0031* (0.0018)
r_t^{DJIA4d}		0.5680*** (0.0694)	0.5569*** (0.0687)	0.5832*** (0.0544)
r_{t-1}^{DJIA4d}				0.2261*** (0.0490)
$VOLbyMA4d_t$			0.0068** (0.0032)	0.0097*** (0.0037)
$VOLbyMA4d_{t-1}$				-0.009*** (0.0030)
	3-daily models			
	s1	s2	s3	s4
const.	0.0001 (0.0012)	0.0002 (0.0011)	-0.0058** (0.0023)	-0.0024 (0.0027)
$TRANSbyMA3d_t$	0.0016* (0.0009)	0.0012 (0.0009)	0.0014 (0.0009)	0.0013 (0.0009)
$TRANSbyMA3d_{t-1}$				0.0000 (0.0010)
r_t^{DJIA3d}		0.5207*** (0.0533)	0.5112*** (0.0531)	0.5125*** (0.0515)
r_{t-1}^{DJIA3d}				0.1162** (0.0498)
$VOLbyMA3d_t$			0.0056** (0.0022)	0.0077*** (0.0025)
$VOLbyMA3d_{t-1}$				-0.0055** (0.0022)

Table 2. (continued)

	2-daily models			
	s1	s2	s3	s4
const.	0.0003 (0.0007)	0.0001 (0.0007)	-0.004*** (0.0013)	0.0001 (0.0019)
$TRANSbyMA2d_t$	0.0006 (0.0006)	0.0007 (0.0006)	0.0007 (0.0006)	0.0011* (0.0006)
$TRANSbyMA2d_{t-1}$ and further lags				lags: +**,-***, -*
r_t^{DJIA2d}		0.4589*** (0.0428)	0.4559*** (0.0429)	0.4548*** (0.0419)
r_{t-1}^{DJIA2d} and further lags				lags: +***,+ ,+
$VOLbyMA2d_t$			0.0041*** (0.0012)	0.0057*** (0.0013)
$VOLbyMA2d_{t-1}$ and further lags				lags: -**,-**, +
	Daily models			
	s1	s2	s3	s4
const.	0.0004 (0.0003)	0.0003 (0.0003)	-0.002*** (0.0007)	0.0003 (0.0009)
$TRANSbyMAd_t$	0.0003 (0.0003)	0.0003 (0.0003)	0.0003 (0.0003)	0.0003 (0.0003)
$TRANSbyMAd_{t-1}$ and further lags				lags: +,+,+*,-*
r_t^{DJIAd}		0.2906*** (0.0301)	0.2851*** (0.0300)	0.2868*** (0.0297)
r_{t-1}^{DJIAd} and further lags				lags: +,+***,+,+
$VOLbyMAd_t$			0.0022*** (0.0006)	0.0027*** (0.0008)
$VOLbyMAd_{t-1}$ and further lags				lags: -,-,-*,-

Notes:

(c) Robust standard errors of parameter estimates are presented in parentheses.

(d) Highlighted cells indicate statistical significance, which is denoted as: *** significant at 0.01 level, ** significant at 0.05 level and * significant at 0.1 level.

(e) In the bottom two panels, which present estimates for daily and 2-daily models, for the parameters of lagged variables only the signs of individual parameters and their significance levels are reported and denoted with asterisks next to the sign of the respective estimate.

Table 3: Estimates of parameters from the models for various measures of capital flows from ZUS and global returns.

Panel A: Transfers from ZUS divided by their moving average as a measure of capital flows

	s1	s2	s3	s4	s5	s6
$const.$	-0,002	-0,001	-0,009***	-0,009***	-0,001	-0,001
$r_t^{SP\,GLOBAL\ 4d}$	0,797***		0,792***		0,796***	
$r_{t-1}^{SP\,GLOBAL\ 4d}$					0,279***	
$r_t^{MSCI\,WORLD\ 4d}$		0,801***		0,796***		0,802***
$r_{t-1}^{MSCI\,WORLD\ 4d}$						0,289***
$TRANSbyMA4d_t$	0,004**	0,004**	0,004**	0,004**	0,005**	0,005**
$TRANSbyMA4d_{t-1}$					-0,004**	-0,004**
$VOLbyMA4d_t$			0,007**	0,007**	0,009***	0,009***
$VOLbyMA4d_{t-1}$					-0,008***	-0,009***

Panel B: Transfers from ZUS divided by their moving standard deviation as a measure of capital flows

	s7	s8	s9	s10	s11	s12	s13	s14	s15	s16
$const.$	-0,002	-0,002	-0,002	-0,002	-0,009***	-0,010***	-0,009***	-0,002	-0,002	-0,001
r_t^{DJIA4d}		0,568***			0,557***			0,584***		
r_{t-1}^{DJIA4d}								0,228***		
$r_t^{SP\,GLOBAL\ 4d}$			0,795***			0,791***			0,796***	
$r_{t-1}^{SP\,GLOBAL\ 4d}$									0,277***	
$r_t^{MSCI\,WORLD\ 4d}$				0,800***			0,794***			0,802***
$r_{t-1}^{MSCI\,WORLD\ 4d}$										0,286***
$TRANSbySD4d_t$	0,003***	0,003***	0,002**	0,002**	0,003***	0,003***	0,003***	0,004***	0,003***	0,003***
$TRANSbySD4d_{t-1}$								-0,002	-0,002*	-0,002*
$VOLbyMA4d_t$					0,007**	0,007**	0,007**	0,010***	0,009***	0,009***
$VOLbyMA4d_{t-1}$								-0,009***	-0,008***	-0,009***

Table 3. (continued)

Panel C: Original transfers from ZUS as a measure of capital flows

	s17	s18	s19	s20	s21	s22	s23	s24	s25	s26
const.	-0,002	-0,002	-0,002	-0,001	-0,009***	-0,009***	-0,009***	-0,002	-0,002	-0,001
r_t^{DJIA4d}		0,567***			0,555***			0,584***		
r_{t-1}^{DJIA4d}								0,230***		
$r_t^{SP\ GLOBAL\ 4d}$			0,794***			0,788***			0,792***	
$r_{t-1}^{SP\ GLOBAL\ 4d}$									0,277***	
$r_t^{MSCI\ WORLD\ 4d}$				0,798***			0,792***			0,798***
$r_{t-1}^{MSCI\ WORLD\ 4d}$										0,287***
$TRANS4d_t$	1,61E-11***	1,43E-11***	1,06E-11***	1,07E-11***	1,53E-11***	1,17E-11***	1,18E-11***	1,71E-11***	1,3E-11***	1,29E-11***
$TRANS4d_{t-1}$								-5,85E-12	-7,78E-12*	-7,68E-12*
$VOLbyMA4d_t$					0,007**	0,007***	0,007***	0,010***	0,010***	0,009***
$VOLbyMA4d_{t-1}$								-0,009***	-0,008***	-0,009***

Notes:
(a) Robust standard errors of parameter estimates are presented in parentheses.
(b) Highlighted cells indicate statistical significance, which is denoted as: *** significant at 0.01 level, ** significant at 0.05 level and * significant at 0.1 level. Results are presented for four-daily data.

Table 4. Results depicting investment on days in the middle of each month and on other days of each month.

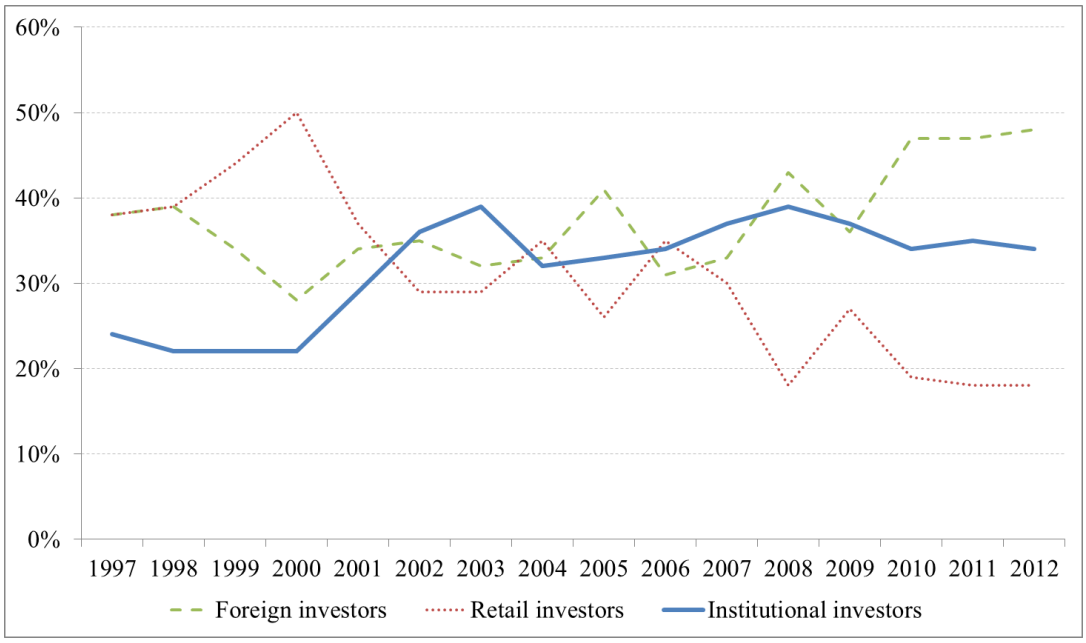
Returns from investments:	In the middle of each month:	On other days of each month:
Pre-reform sub-sample January 1, 1998 to April 30, 1999	11.97%	-12.55%
After-reform sub-sample (in-sample estimation period) May 1, 1999 to December 31, 2008	-24.49%	43.64%
After-reform sub-sample (out-of-sample period) January 1, 2009 to December 31, 2011	-30.95%	49.03%

Table 5. Results of trading strategies in the out-of-sample period (January 2009 – December 2011).

Strategy:	Number of trades:	Total Return (Average Daily Return)	Modified Sharpe Ratio (*MSR*):	Certainty Equivalent (*CEQ*) measure:				
				$\gamma = 0.5$	$\gamma = 1$	$\gamma = 2$	$\gamma = 5$	$\gamma = 10$
Simple buy-and-hold strategy	1	19.82% (0.03%)	0.0158	0.0197%	0.0123%	-0.0025%	-0.0470%	-0.1212%
Strategy 1 based on all ZUS transfers	108	21.57% (0.05%)	0.0206	0.0229%	0.0185%	0.0097%	-0.0168%	-0.0609%
Strategy 2 based on only large ZUS transfers	50	26.30% (0.13%)	0.0359	0.0295%	0.0276%	0.0238%	0.0122%	-0.0070%

Note: The values in parentheses are average daily returns in the WIG20 portfolio holding-period computed as the ratio of total return and the number of days when the investor held the WIG20 portfolio.

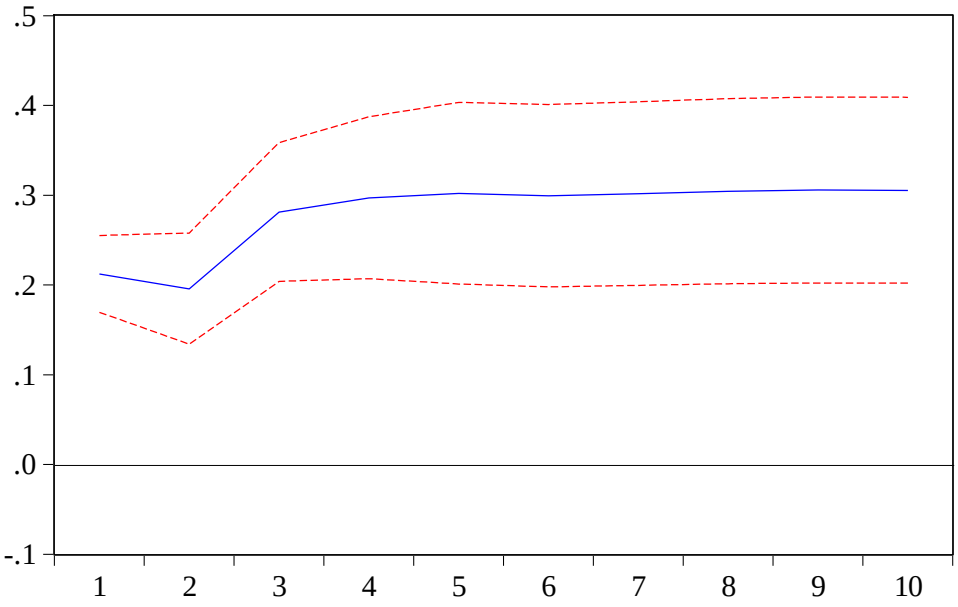
Figure 1. Shares of individual and institutional investors trading stocks at the Warsaw Stock Exchange.



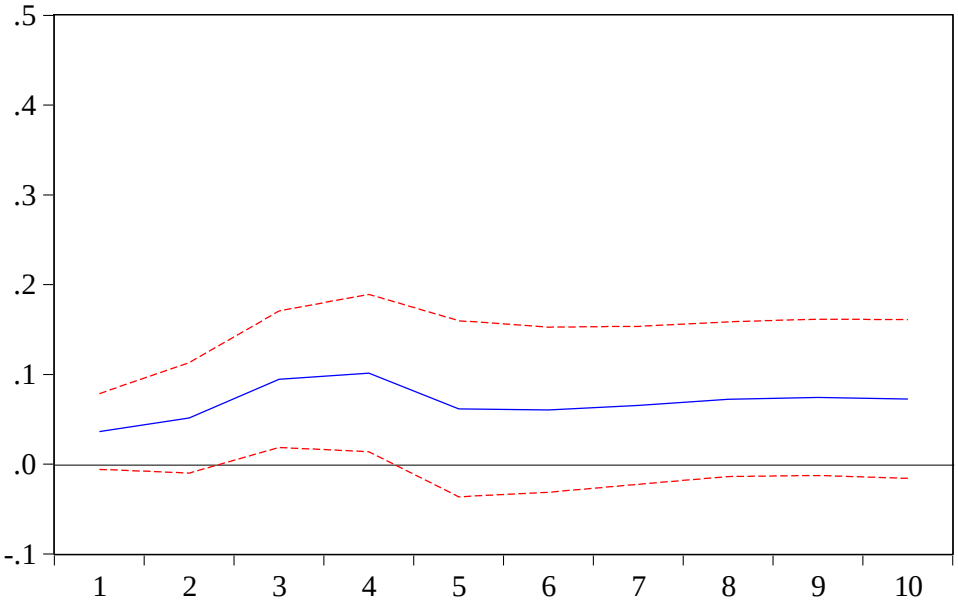
Source: Survey data from stock exchange members on trading in shares on the main market of the Warsaw Stock Exchange (Warsaw Stock Exchange, 2013).

Figure 2. Accumulated responses of WIG20 returns
to shocks in capital inflows and to shocks in global returns.

Panel A: Accumulated response of r^{WIG20d} to one standard deviation innovation in r^{DJIAd}

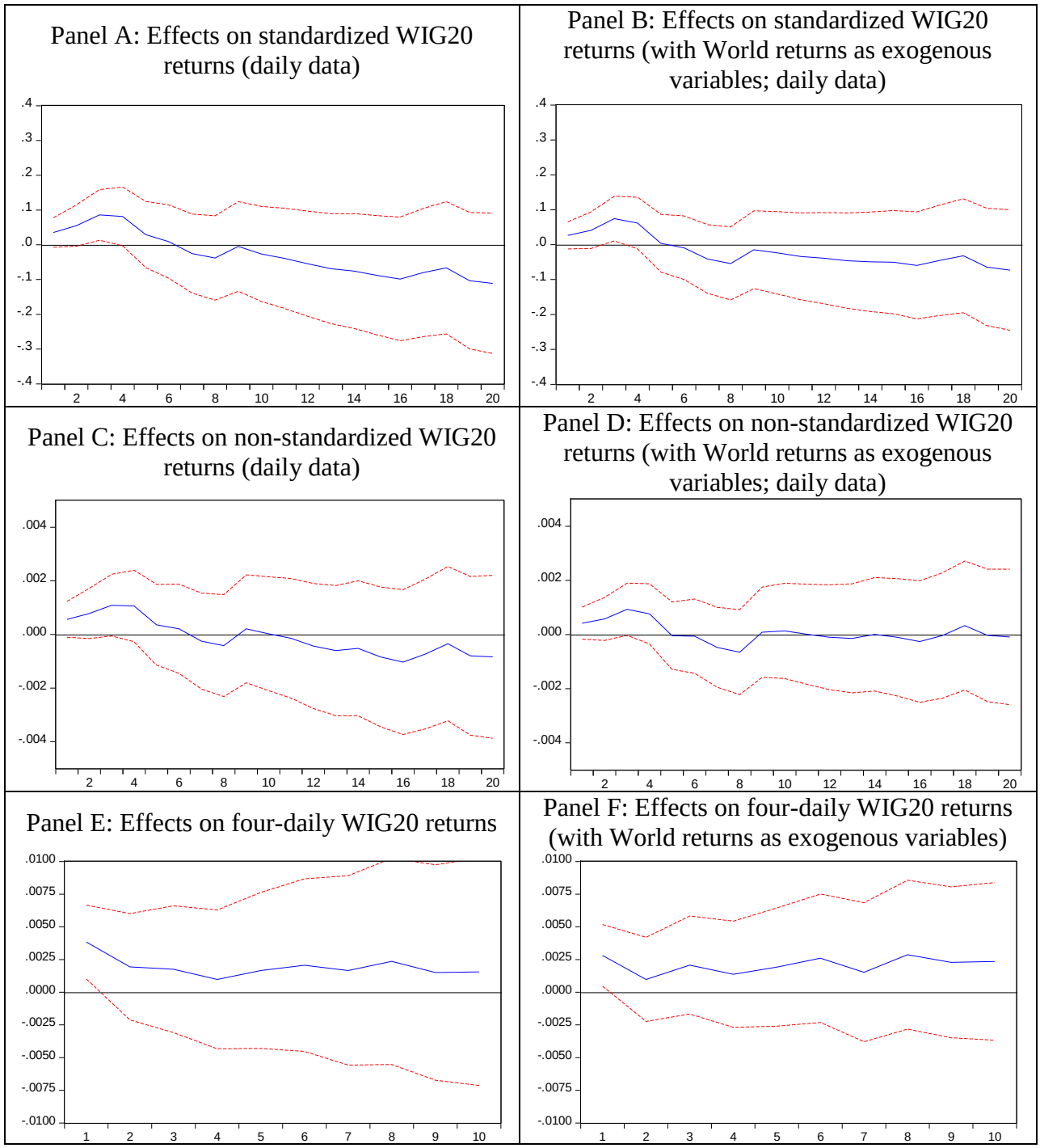


Panel B: Accumulated response of r^{WIG20d} to one standard deviation innovation in *TRANSbyMAd*



Note: This figure presents accumulated responses of WIG20 returns to one-standard-deviation shocks in: (a) global stock returns and (b) capital inflows to OFEs. The dotted lines denote the range of two standard deviations around the mean response. The estimated SVAR model with 4 lags contains the following endogenous variables: standardized DJIA return, de-trended flows of capital to OFEs, standardized WIG20 return, de-trended trading volume of WIG20. Cholesky decomposition was used to identify the model and to orthogonalize innovations. We standardized stock returns by dividing them by their moving standard deviations to control for possible heteroskedasticity and volatility clustering.

Figure 3. Response of WIG20 returns to one standard deviation shocks in standardized capital flows from ZUS to OFEs.



Note: The accumulated impulse-responses are presented. All estimates control for heteroscedasticity of residuals. World returns enter models with 0, 1, and 2 lags.

Figure 4. Value of transfers of funds from the ZUS on specific days of the month between May 1999 and December 2008.

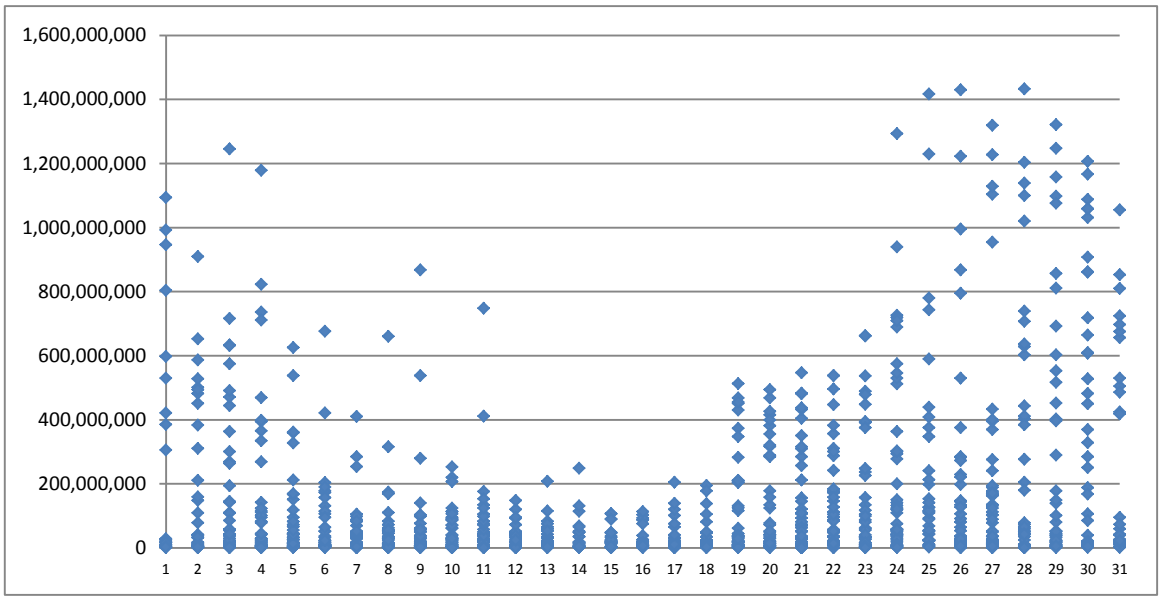


Figure 5. Frequency of transfers from the ZUS on specific days of the month between May 1999 and December 2008.

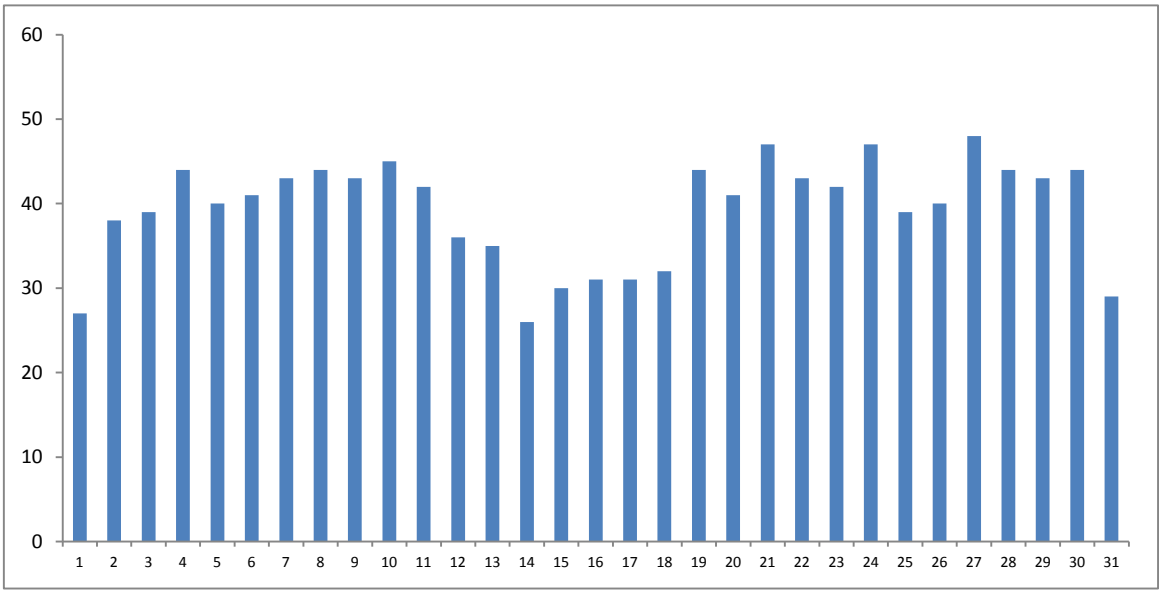
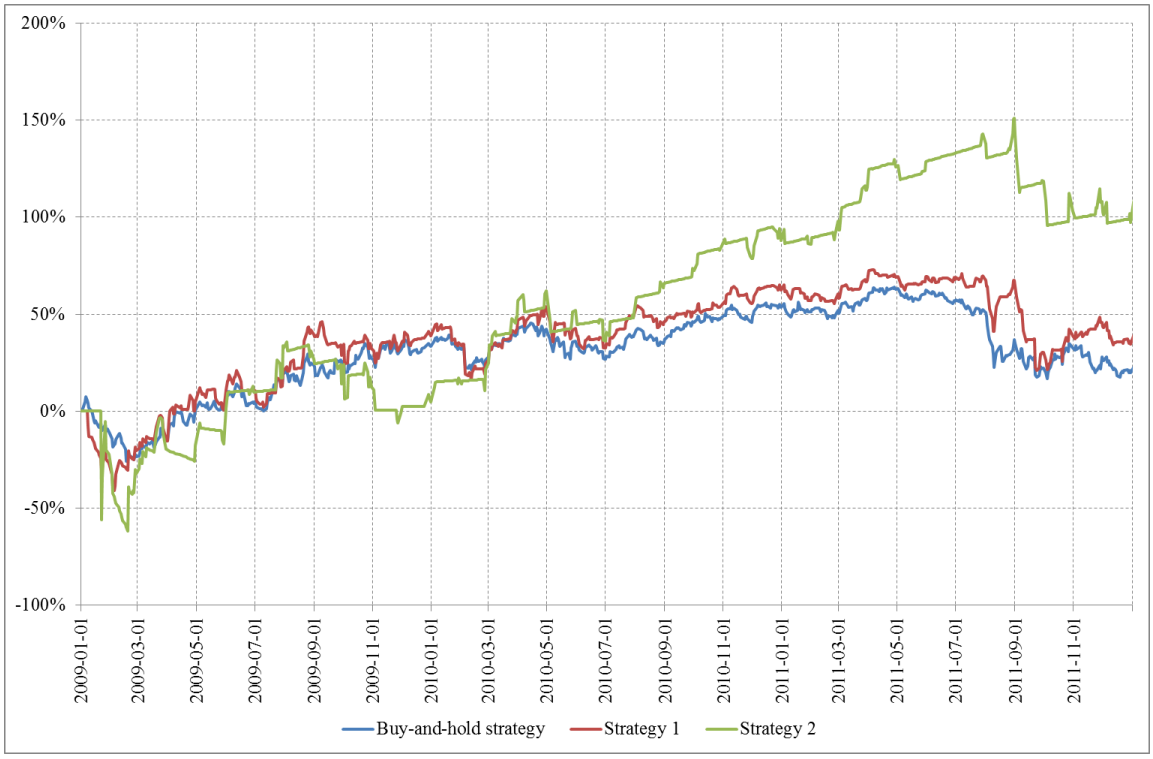
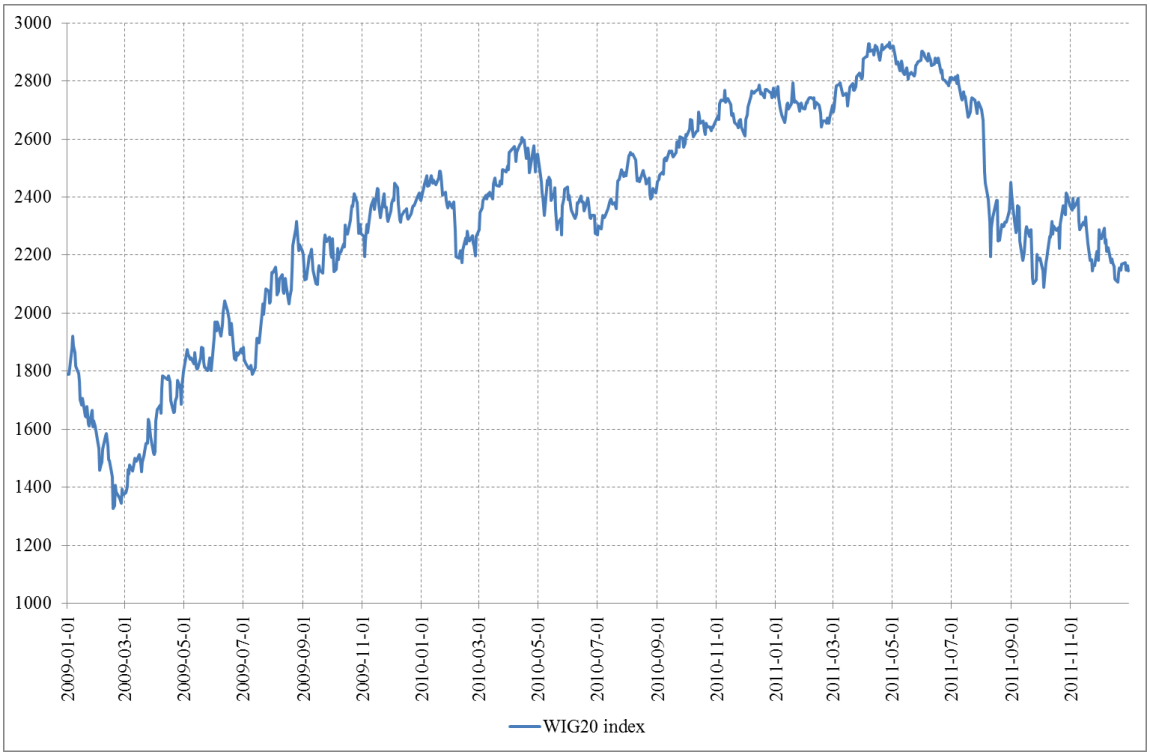


Figure 6. Cumulative returns from the three strategies adjusted for investment and non-investment days in the out-of-sample period (January 2009 – December 2011).

Panel A: Cumulative returns



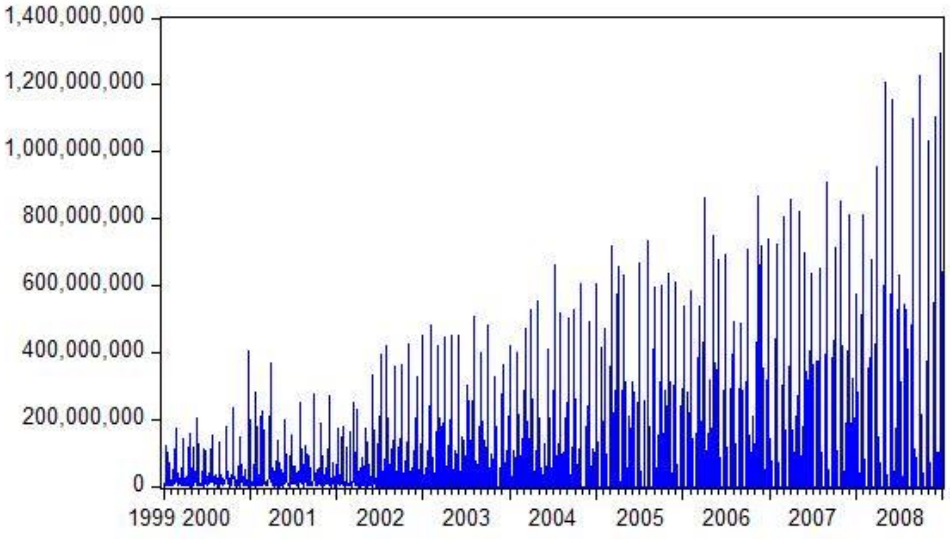
Panel B: WIG20 Index



Note: Adjusted cumulative return at time *t* is calculated by dividing the total compounded return at time *t* by the number of days (until time *t*) when investors held their investment positions in WIG20 and multiplying by the total number of days until time *t*.

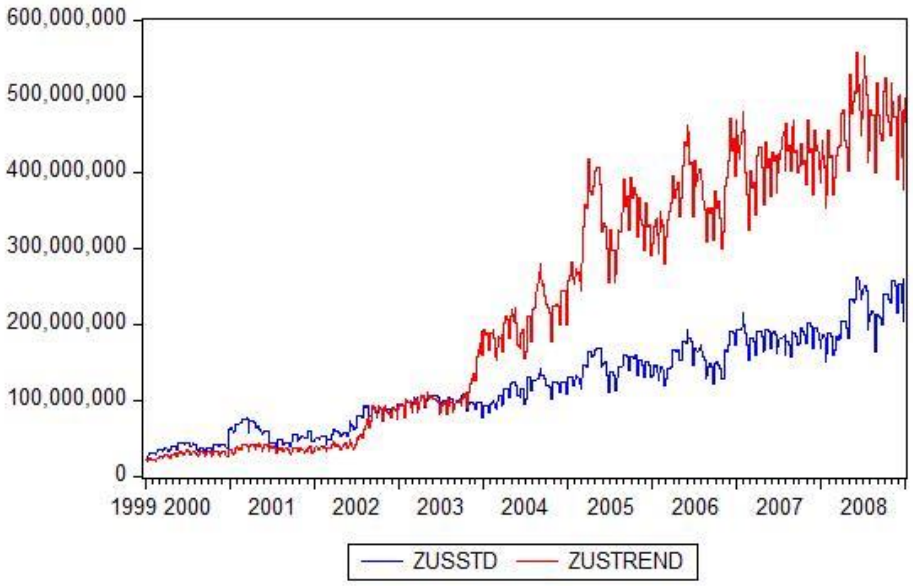
APPENDIX:

Figure A1. Daily capital flows from ZUS to pension funds in the estimation sample



Note: Capital flows are measured in złoty (PLN), the Polish currency.

Figure A2. Trends of capital flows from ZUS to pension funds



Note: ZUSSTD is a moving standard deviation statistic and ZUSTREND is a moving average statistic for capital flows from ZUS to pension funds. The size of a moving window is 60 days. Capital flows are measured in złoty (PLN), the Polish currency.

Figure A3. Capital flows from ZUS to pension funds
detrended with the moving average function

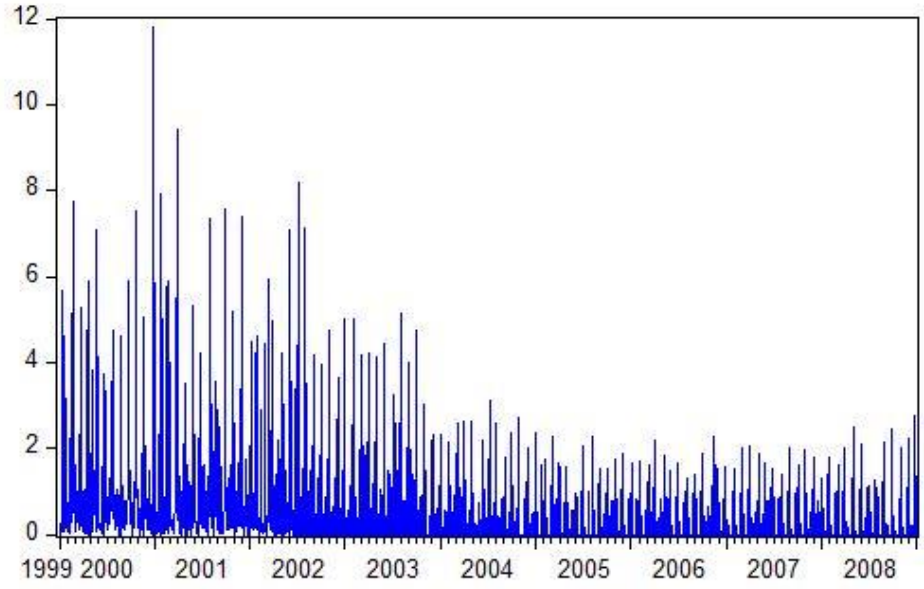


Figure A4. Capital flows from ZUS to pension funds
detrended with the moving standard deviation function