Pension Funds and Stock Market Volatility: An Empirical Analysis of OECD Countries[•]

Ashok Thomas[*], Luca Spataro[†], Nanditha Mathew[‡]

Abstract:

The paper explores the empirical relationship between the share of pension funds' assets invested in stocks and stock market volatility in OECD markets. For this purpose, by using panel data of 34 OECD countries from 2000 to 2010, we estimate both a random effects panel model and a Prais-Winsten regression with panel corrected standard errors and autoregressive errors. The econometric estimation documents that there is a significant negative relationship between the share of pension funds assets invested in stocks and stock market volatility in OECD markets. The binary Probit and Logit models further validate the argument that pension funds as institutional investors can dampen stock market volatility.

Keywords: *Pension funds, Stock market volatility, Panel data*

J.E.L. Classification: G23, G14, C23.

[•] *The authors are grateful to Laura Magazzini, Jerome Adda and the partecipants at the PhD biannual meeting of the Department of Economics, for their useful suggestions. The usual disclaimer applies.*

[*] Corresponding author. Dipartimento di Scienze Economiche, University of Pisa (Italy). Email: ashokthomas@ec.unipi.it.

[†] Dipartimento di Scienze Economiche, University of Pisa (Italy) and CHILD. Email: l.spataro@ec.unipi.it.

[‡] Dipartimento di Scienze Economiche, University of Pisa (Italy). Email: nandithamathew@ec.unipi.it.

1. Introduction

Pension funds (PF henceforth) have accumulated large amounts of assets over the years in most of the OECD countries (See Table 1). With increasing aging population and less reliance on pay-as-you-go public pensions, in many developed economies the size of complementary social security is expected to increase even further in the future.

The shift from the traditional defined benefit (DB) scheme to the defined contribution scheme (DC) since the early 2000s is one of the main features characterizing the recent growth path of PF. Such a shift has been primarily originated by the dramatic changes both in the industrial structure and in the labor markets triggered by the globalization, which has led both capital and workforce to be increasingly mobile. As a consequence, many countries have implemented reforms aiming at coping with the deterioration in the funding of DB pension plans and with some longstanding concerns regarding the effect of complex, opaque pension accounting methods.

Table 1: Assets managed by PF as a share of GDP of selected OECD countries over the period from 2001 to 2010, selected years (% values)

Country	2001	2005	2008	2010
Australia	75.29	80.38	93.008	90.94
Canada	52.48	58.15	51.43	64.65
Chile	--	59.35	52.76	66.97
Denmark	27.18	33.70	47.54	49.71
Finland	49.47	68.61	60.55	82.11
Germany	3.44	4.03	4.73	5.17
Iceland	83.96	119.57	114.05	123.91
Israel	25.10	34.01	42.80	48.94
Netherlands	102.61	121.72	112.72	128.51
Switzerland	102.45	117.02	101.15	113.72
United Kingdom	72.00	78.63	64.29	88.68
United States	71.51	74.84	57.92	72.67

Source: OECD Global Pension Statistics

Thanks to such a growth, not only will PF grant a significant share of the old-age retirement income, but they are currently playing as important institutional investors in most of the OECD countries. For example the share of assets managed by occupational PF as a percentage of GDP in the last decade has grown from 15% to 31%, despite in the same period two intense crises have affected the financial markets of these economies. Given such an unprecedented scenario, the analysis of the effects of the aforementioned trend on financial markets is a crucial issue.

Earlier literature has highlighted that PF can be beneficial to financial development[4] through different channels: 1) PF long term planning horizon favours more efficient and innovative investment opportunities (Vittas, 1995, Davis 1995, Meng and Pfau 2010, Niggeman and Rocholl 2010; as for developing economies, see Catalan et al 2000, Musalem 2000, Walker and Lefont 2002, Impavido et al 2002); 2) PF may stimulate both private and national savings (Schmidt – Hebbel 1999, Kohl and Obrien 1998, James, 1998, Reisen et al 1997, Musalem et al 2004); 3) PF may improve the efficiency of firms' management (Wahal 1996, Smith 1996, Clark and Hebb 2003, Myners 2001, Woikdtke 2002, Barr and Diamond 2006, Davis and Hu 2008 and Coronado et al 2003); 4) PF can increase financial market efficiency by lowering asset prices volatility.

The analysis of the last channel is the focus of our paper. The latter argument is supported in pioneering theoretical works such as Friedman (1953) who argues that the role of rational speculators is to stabilize asset prices. Later, Fama (1965) argues that although heterogeneous agents can trade irrationally due to poor information processing, the presence of sophisticated and well informed institutional investors could help eliminate huge disparities in the deviation of equity prices from their fundamentals. By the same token, later contributions by Shiller (1990), Chopra et al (1992), Lakonishok et al (1994), Brennan (1995) and Delong et al (1990) argue that institutional investors are more likely to behave rationally in that they are less sensitive to noise and fads. According to such a view, institutional investors are depicted as "smart money" investors that stabilize asset prices by offsetting the irrational trades of individual investors. More recently, studies by Cohen (1998) and Dennis and Strickland (2002) document that institutions and individuals differ in their trading behaviors due to their difference in information gathering and processing of available information. In fact, they argue that institutional investors can help financial markets restore the long term equilibrium by avoiding huge volatility in the markets. This argument is

[4] We recall here that several authors have produced evidence of the fact that financial development can trigger economic growth. For theoretical studies see Benecivenga and Smith (1991), Obstfeld (1994); horizontal cross analysis includes King and Levine (1993), Levine and Zeros (1998), Levine (1997), Beck et al (2004); international analysis comprises studies by Rajan and Zingales (1998), Levine and Zeros (1998), Demirguc- Kunt and Maksimovic (1998).

further accepted in the works looking at the relationship between noise trading and market efficiency: according to such works, the fact that risk aversion keeps rational speculators (such as PF) from taking large arbitrage positions can avoid any situation in which noise traders produce huge swings in the asset prices (Figlewski 1979, Kyle 1985, Campell and Kyle 1987, Delong et al 1987).

Finally, other authors claim that PF can stabilize the market because they are governed by prudent man rules[5], aiding in accumulating less risky stocks thus indirectly reducing the overall volatility in the equity markets.

Summarizing, according to this view, lower levels of noise trading and/or the stabilizing behavior of institutional investors should result in lower volatility for those securities in which the presence of PF is predominant.

On the other hand, there are several reasons to suspect that markets dominated by institutional investors such as PF may exhibit larger return volatilities. First, securities that display greater volatility may attract institutional investors, in that the latter might view riskier securities as more likely than other stocks to outperform market benchmarks. Institutional investors like PF tend to trade in larger volumes than individual investors, which may induce greater volatility in the market (Ang and Maddaloni 2003, Gabaix 2005). In addition, the program trading employed by most of the institutional investors, including PF, could pave way for higher volatility. Finally, PF may engage in “noise” trading and “herding behavior” due to the close-knit nature of the institutional investor community, which might exacerbate price movements and increase volatility (Lakonishok et al 1992, Scharfstein and Stein 1990, Froot et al 1992, Dow and Gorton 1994).

From this preliminary discussion one can understand the difficulty to draw a clear-cut line in the existing theoretical debate. In fact, the existing empirical studies at both micro and macro level produce mixed results. The present study aims at providing new empirical evidence as to whether investments of PF in stocks and equities could dampen stock market volatility, thus promoting the

---

[5] The prudent man standard could be summarized according to one or a combination of the following three fundamental approaches (Badrinath, Gay, and Kale 1989)

- Buy and sell as others do in similar circumstances.
- Buy and sell from an approved universe of investments (such as those listed in the Trust Fund Investment Act).
- Buy and sell at the level at which the trust beneficiaries feel comfortable.

efficiency of financial markets. In this work we focus on a panel of 34 OECD countries, from year 2000 to 2010.

The work is organized as follows: Section 2 reviews the related literature on the role of PF on financial market volatility. Section 3 describes the dataset used in the empirical analysis. Section 4 presents the estimated empirical models and discusses their respective results. Section 5 concludes.

2 Pension funds and financial market volatility: Related literature

The literature on the relationship between PF and financial market volatility has been intensely flourishing in the last two decades, with a particular focus on micro-level analysis and the US market[6].

For example, Lakonishok et al (1992) examine the impact of PF on stock prices in United States. They investigate the holdings of 769 US PF and conclude that PF herding and positive feedback trading in large stocks is very modest. Though they have evidence of positive feedback trading for smaller stocks, however, the latter did not have destabilizing influence on stock prices. Moreover, the authors find that PF managers do not herd except for smaller stocks, where there is a slight degree of herding.

Jones et al (1999) have investigated the relationship between stock prices and different types of institutions in the United States using quarterly data from 1984 to 1993. They find that all institutions are engaged in positive feedback training. However there was no evidence of institutions destabilizing equity prices. The authors report that PF managers act as feedback traders especially on the buy side and mostly in small stocks with a high past performance.

Different conclusions are reached by Dennis and Strickland (2002) on the linkage between returns and aggregated and segregated institutional ownership in United States. By using the segregated data on mutual funds and PF, the paper shows that both funds move in the direction of

[6] A number of works have also analysed the impact of institutional investors on financial market volatility. Early studies find negative relation between volatility and institutional trading for the U.S. and for some other developed markets (Grier and Albin 1973, Reily 1977, 1979 and Arbel et al 1983) while others gave mixed results (Sias 1996, Cohen et al 2002, Dennis and Strickland 2002). For more recent works, see Peng (2007) and Wang (2010) for China, Wemers (1999) and Rubin and Smith (2009) for United States and Azzam (2010) for Egypt. However, in this section we focus only on the works specifically dealing with the role of PF.

the market with positive feedback herding behavior, particularly mutual funds. Hence, they conclude that, firstly, institutions herd together and trade with the momentum of the market on large market movement days. Hence, they conclude that the consequence of this behavior is that, at least in the short term**,** these institutions contribute to market volatility[7], which leads to a rise in stock prices beyond their fundamental values. This could be due to the fact that mutual funds and PF managers are subject to more severe scrutiny and therefore have more incentives to herd.

Finally, Lipson and Puckett (2005) revisit the issue of herding behavior for the US market and find that there is a "negative contemporaneous trading"[8] behavior of institutions using daily institutional trade executions for 716 institutional investors (90 money managers and 620 pension plan sponsors) on large market movement days during the period from 1999 to 2003.

As for studies of other countries, Voronkova and Bohl (2005) contribute to the literature on institutional herding and feedback trading by analyzing the investment behavior of PF on the Polish stock market. The application of the measure suggested by Lakonishok et al (1992**)** enables the authors to compare the degree of herding and feedback trading between the Polish and developed stock markets. The estimated values of herding and positive feedback trading measures for Polish PF are considerably higher than the corresponding values reported for mature markets. This finding is primarily attributed to a stringent investment regulation and high market concentration. In short, trading by PF exerts significant influence on the future stock prices.

For the same Polish market, Bohl et al (2005, 2010) find empirical evidence that the increase of institutional ownership has temporarily changed the volatility structure of aggregate stock returns. Secondly, PF in Poland reduced stock market volatility (their results are consistent with the evidence of Dennis and Weston 2001 for the United States).

Research on the macro front, which is the approach we follow in the present paper, is very embryonic and limited to few markets. Walker and Lefont (2002) have carried out a panel study for 33 emerging markets and find a positive link between pension reforms enhancing PF and capital market development. The results show that regardless of the indicator used, PF importance significantly decreases the average dividend yield and increases price to book ratios. The authors

[7] This empirical result is in line with the theoretical argument by Scraferstein and Stein (1990) and Froot et al (1992).

[8] This expression points to the fact that an increase in the investment of institutional investors in stocks and equities precedes a fall in volatility of stocks and equities.

also find a negative and statistically significant relationship between market volatility and share of PF invested in stocks and equities.

On the other hand, Hu and Davis (2004) find that in the G-7 countries, the share of institutional investors in total equities has, in some cases, a positive effect on equity price volatility. Similar results are obtained by Hu (2006), who empirically explores the impact of PF on market volatility, equity prices, government and corporate bonds for a panel of 24 countries. The data set used for the study covers 16 OECD countries and 8 emerging market economies for a time period from 1960 to 2004. The results show that there is a positive link between volatility and PF assets in OECD countries, in line with Davis (2004), and negative relationship was discovered in the short run in the case of emerging markets.

As mentioned, our paper follows the macro-approach and aims at adding new evidence on the relationship between PF investments in stocks and financial market volatility. Differently from previous works we focus on the panel of the whole set of OECD countries, from year 2000 to 2010.

3. Data Description

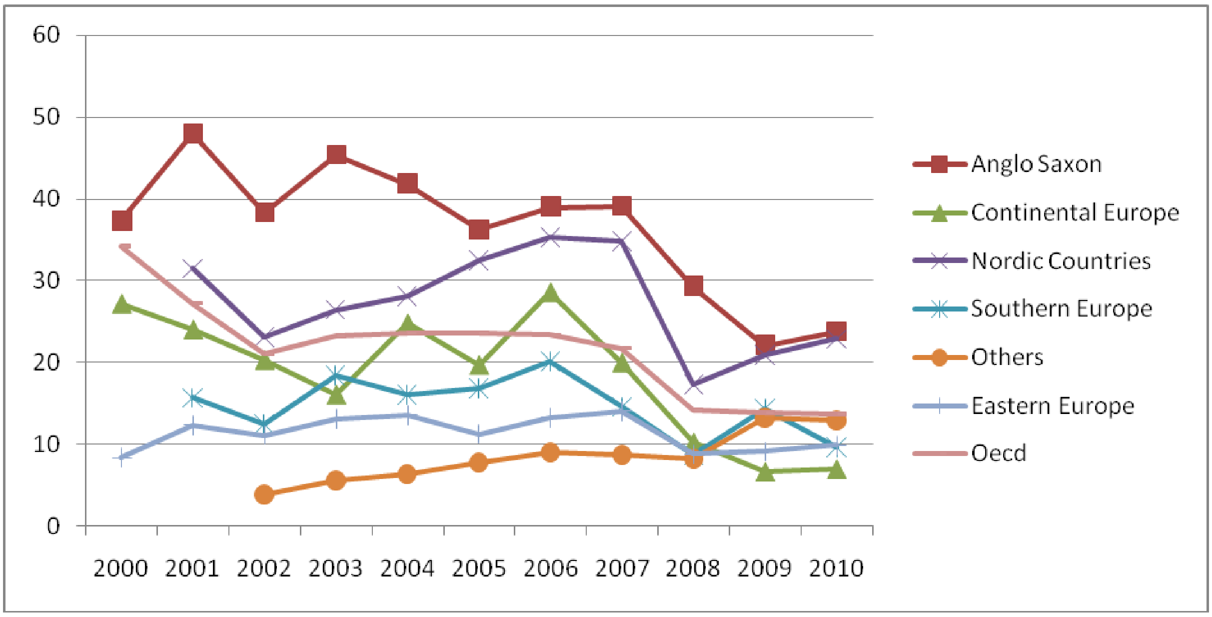
The countries comprised in the panel include Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. The data is drawn from OECD database and World Bank database.

The specific time span we focus on goes from 2000 to 2010 and is due to data availability. However, this period has witnessed a relevant growth of PF, although at different rates among countries, which may allow us to have enough variability to get robust estimates.

In order to examine and quantify the effect of PF on stock market volatility, we employ, as explanatory variable capturing such an effect, the ratio between PF assets invested in shares and total PF assets at a country level[9]. We have a total of 374 observations on every variable.

Figure 1: Trend of the share of PF assets invested in stocks across all OECD countries for the time period between 2001 and 2010

[9] PF investments in financial market are broadly categorized into investments in Bills and Bonds, Mutual Funds, Currency and Deposits, Shares and Equities, Land and Buildings and Other Investments. Among them, our study concentrates on the Investments in shares and equities which along with Bills and Bonds and Mutual funds form a significant portion of the total investments of PF in OECD markets.



Source : OECD Global Pension Statistics

*Note: The Y axis shows the share of PF assets invested in stocks and X axis shows the years (2001-2010). The Southern Europe includes: Italy, Spain, Portugal and Greece. The Nordic countries includes: Denmark, Finland, Iceland, Norway and Sweden. The Continental Europe includes: Austria, Belgium, Germany, Luxembourg, Netherlands and Switzerland. The Anglo Saxon countries includes: Australia, Canada, Ireland, New Zealand, United Kingdom and United States. The Eastern Europe includes: Czech Republic, Hungary, Slovenia, Slovak Republic, Poland and Estonia. Others include: Chile, Israel, Mexico, Japan, Korea and Turkey.

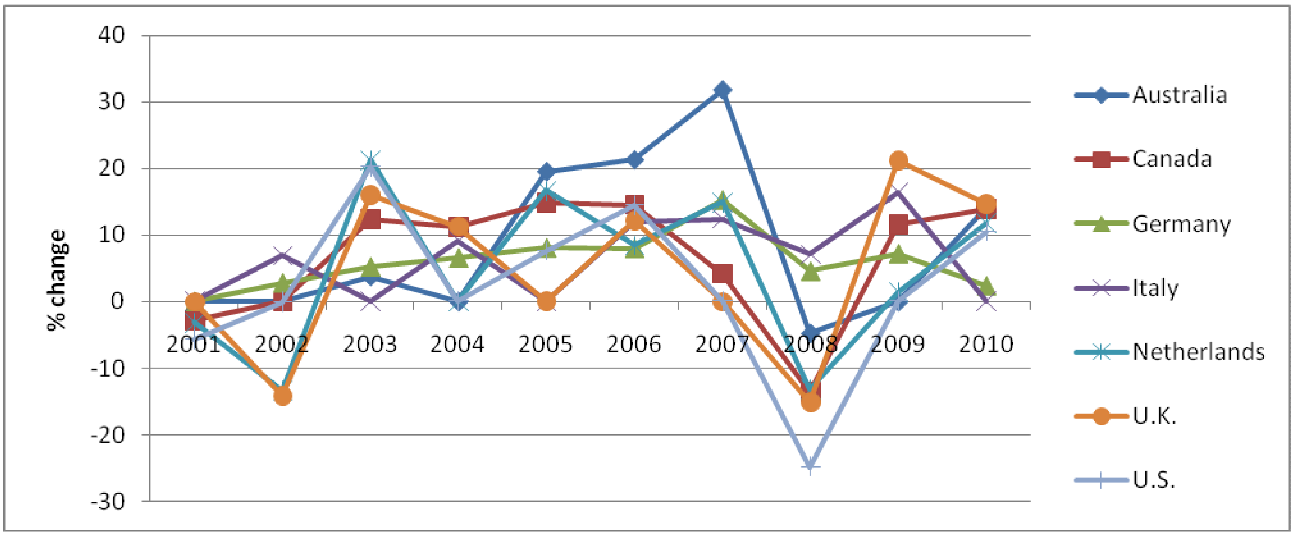
Source: OECD Global Pension Statistics, Author's Calculation

Figure 1 shows the trend in the investments of PF in stocks among OECD countries divided into seven groups- Anglo Saxon, Continental Europe, Southern Europe, Nordic Countries, Eastern Europe, Others and OECD average from 2000 to 2010. From the picture two features emerge: first, Anglo Saxon and Continental Europe economies are the ones in which PF predominantly invest in stocks. Second, the trend of the share of PF assets invested is decreasing at the tails of the time interval, and increasing within it.

The shape of PF investments in stocks through time reveals that PF have very plausibly adjusted their portfolios composition according to the trends of financial markets, which have been characterized by two crises in year 2001 and 2007 respectively. Overall, the average share of stocks held by PF in the period under investigation has gradually decreased from 34.67 percent in 2000 to

13.95 percent in 2010. The uncertain (or, better, prudent) trend of PF behavior can also be recognized by the growth rates depicted in Figure 2 in selected OECD countries[10].

Figure 2: Percentage change in the overall PF assets in selected countries from 2000 to 2010



Source: OECD Global Pension Statistics

* Data on France is not available for most of the period

As for market volatility, in our empirical model we define it as the 12-month-annualized volatility of stocks for each OECD country, that is, the annualized standard deviation of monthly stock prices. We need to annualize the volatility because all other variables are available on a yearly basis. The annualized volatility T for time horizon T in years is expressed as :

$$\sigma_T = \sigma\sqrt{T}$$

where,

σ_T = Annualized Volatility;

σ = Standard Deviation for a particular time period;

T =Number of times (count) of such time periods in a year (in our case 12). Moreover, in our estimations we take logs because volatility cannot be negative.

Another measure of the overall market volatility we employ in our analysis is the (logs of) average volatility of all OECD economies in each year, in order to take care of the economic cycles.

10 All the above mentioned economies have invested more than 25 percent of total assets in shares and equities.

In Table 2 we report a dummy variable which takes value 1 if the observed variability of stocks in a country at any year is below the OECD average and 0 if this value lies above the average, respectively: we can notice that almost 60 percent of observations in each year lie below the overall mean volatility and 40 percent of observed countries lie above the average.

Table 2: Frequency and percentage of observations above and below the yearly average volatility of OECD countries (dummy variable: 0 if below, 1 if above the average)

Volatility	Freq.	Percentage
0	223	59.47
1	151	40.53
Total	374	100.00

Source : OECD Global Pension Statistics, Authors' Calculation

Finally, Table 3 shows the main summary statistics of all the explanatory variables that we use in our empirical analysis, that is the per-capita income in thousand USD as a general measure of economic country development, the annual inflation rate as an indicator of macroeconomic stability, and volume of stocks trades at constant year 2000 prices in trillion USD as a measure of financial development.

Table 3: Descriptive Statistics of the variables included in the study

Variable	Obs	Mean	Std. Dev	Min	Max
Volatility	374	.172	0.088	.049	.943
Share of PF assets invested in stocks and equities (%)	361	17.1	0.16	0	66.29
Inflation(%)	374	3.317	4.979	-4.479	54.915
Per capita Income*	374	28.365	11.12	9.053257	74.1438
Value of Stocks Traded**	374	1.387	5.171	0.000016	52.2454

*Per capita Income measured in thousand USD

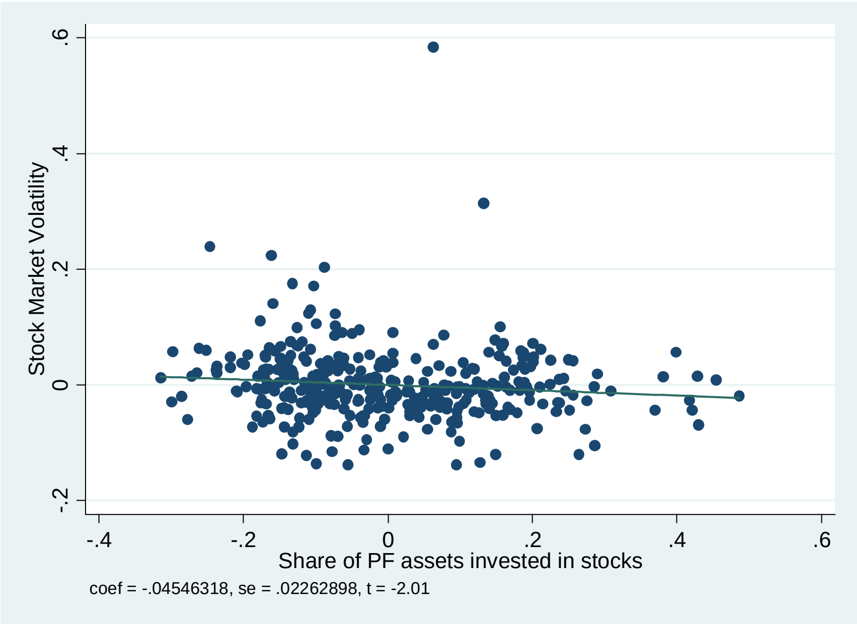
**Value of Stocks Traded measured in trillion USD

Note that the share of PF assets invested in stocks varies between 0% and about 60%. This shows that OECD countries are marked by heterogeneous behavior in investment policies, which are also found to be changing over time. The countries in which the share of PF investments in stocks and equities is zero include Estonia, France, Japan, Greece, New Zealand and Turkey[11].

4. Empirical models

In this section we present the empirical models odopted in the study and the results. However, preliminarily, we resort to an added variable plot, depicted in Figure 3. The added variable plot is based on two residual series. The first series contains the residuals from the regression of the variable 'share of PF assets invested in stocks' on all other independent variables presented in Table 2, whereas the second series contains the residuals from the regression of 'volatility of stock prices' on all other independent variables except 'share of PF assets invested in stocks'. Therefore, the first series represents the part of x_1 (here, share of PF assets invested in stocks) that cannot be linearly related to those other regressors, whereas second series represents the information in y (here, volatility of stocks) that is not explained by all other regressors (excluding x_1).

Figure 3: Added Variable Plot of Share of PF assets invested in stocks and stock market volatility in OECD markets



[11] From the OECD data base the countries in which the share of PF investments in stocks and equities is zero in the whole period include Estonia, France, Japan, Greece, New Zealand and Turkey Greece and Turkey showed zero share of PF invested in stocks till 2007 and 2008, respectively.

The strength of the relationship between the two variables is evident from Figure 4. The slope of the least squares line through this scatter of points representing the marginal value of the variable 'share of PF assets invested in stocks' is significantly different from zero. The t statistics of -2.1, reported in the figure (identical to those from a simple OLS regression), suggests that the least squares line has a slope significantly different from zero. The outlying values are evident where low values of 'share of PF invested in stocks' are associated with volatility much higher than those predicted by the model.

As for the estimations, preliminary we need to confirm the causality relation between the stock market volatility and the share of PF assets invested in stocks. For doing this we resort to an inverse causality test in order to check whether there is any evidence that higher volatility in stock market reduces the share of PF assets invested in stocks. We employ a Granger causality test and the results confirm that there is no evidence of inverse causality (see Appendix A2).

We now turn to the empirical models. The first empirical model is a random effects model followed by a Prais-Winsten model which takes into account autocorrelation and heteroscedacticity embedded in the data. A further examination of the data is carried out using a binary logit and probit model. The detailed methodology and results are discussed in the following section.

4.1 Empirical Model 1: Random effects /Prais-Winsten method

The empirical model we estimate has the following specification:

$$y_{it} = \alpha_i + x_{it}'\beta_i + \varepsilon_{it} \qquad (1)$$

$i = 1,...N,\ t=1,....T$

where, y_{it} is the dependent variable, i is the cross-sectional dimension for individual countries, t is the time series dimension of the data, α_i denotes country specific intercept, $\beta_i = (\beta_{1i}, \beta_{2i}, _{\text{t}} ..... \beta_{Mi})$ is the vector of coefficients to be estimated, $x_{i,t} = (x_{1i,t}\ , x_{2i,t} ...... x_{Mi,t})$ is the vector of explanatory variables, with $m = 1,.....M$ where M is the total number of regressors, ε_{it} is the error term. Therefore, based on equation (1) the following specification equation is estimated:

$$\log VOL_{it} = \alpha_i + \beta_1 PF_{it} + \beta_2 \sigma_t^{all} + \beta_3 ST_{it} + \beta_4 IF_{it} + \beta_5 PCI_{it} + \varepsilon_{it} \qquad (2)$$

where VOL_{it} represents the estimated 12 month annualized rolling volatility, *PF* is the share of pension fund assets in stocks. We expect β_1 to be negative (i.e. share of pension fund investment reduces volatility). A set of concurrent conditions are included as control variables; σ_t^{all} represents the average volatility of all OECD countries, and we expect β_2 to be positive (volatility is contagious). The annual inflation rate, *IF*, is a proxy for macroeconomic stability and is expected to have a positive effect; per capita income, *PCI*, is a general measure of country's development, with β_4 expected to have negative sign, while *ST*, the value of stocks traded in the market, is a proxy to measure the depth of the market and is likely to reduce market volatility.

We now present a series of tests that help us choose the exact specification of the model to be estimated.

Fixed vs Random Effects: Hausman Test

We first employ the Hausman specification test to test the null hypothesis that there is no correlation between the composite error and explanatory variables. The results of the test show that there is no evidence to reject the null hypothesis and hence the random effect model is applicable[12]. The results are shown in Appendix A3. We also perform Bruesh-Pagan Lagrange Multiplier test which helps to decide between random effects regression and a simple OLS regression[13].

Cross-Sectional Dependence among Countries

The random effects model requires strong assumptions regarding error terms, autocorrelation, and heteroscedacticity. The probability of cross sectional dependence of country level data as compared to individuals and firms is generally low. However if present in cross country panels due to unobserved common shocks that become a part of error term (De Hoyos and Sarafidis 2006), cross sectional dependence can cause inconsistency in the estimated parameters (see Driscoll and Kraay 1998).

---

[12] The Hausman test is a kind of Wald χ^2 test with *k-1* degrees of freedom (where *k* = number of regressors) on the difference matrix between the variance-covariance of the Least Square Dummy Variable with that of the Random Effects model.

[13] The null hypothesis in the Bruesh-Pagan LM test is that variances across entities are zero, i.e., no significant difference across units (i.e. no panel effect). Here we reject the null and conclude that random effects is appropriate.

A semi parametric test proposed by Friedman (1937) and Pesaran (2004) for panels with N>T has been employed and the results suggest that there is no evidence of cross sectional dependence in the model (the test results are provided in Appendix A4).

Test for heteroscedacticity and Serial Correlation

To test the null hypothesis of no first-order serial correlation in the residuals, we use the Baltagi-Wu locally best invariant test statistics. The Baltagi LBI statistic of 1.67 and the Bhargava et al (1982) Durbin-Watson statistic for zero first order serial correlation statistic of 1.53 both reject the null hypothesis of no first order serial correlation (see Appendix A5). The rejection of the null hypothesis of no serial correlation indicates the need to correct the standard errors for serial correlation. Moreover, we perform a Wald Test for heteroscedacticity and the results suggest that there is evidence of heteroscedacticity (see Appendix A6).

Prais-Winsten method

If the error terms exhibit heteroscedacticity and autocorrelation, it has to be decided which panel data approach to choose: individual effects model or panel corrected standard errors method. In the presence of autocorrelation and heteroscedacticity, fixed and random effects estimators are inefficient and biased and therefore we require a methodology which corrects the standard errors of the panel in order to solve these issues (i.e. the problem of heteroscedacticity, autocorrelation and correlation across panels if present). Therefore, we estimate the parameters of the model by Prais-Winsten method and then adjust the standard errors for the panel data as suggested by Beck and Katz (1995). This approach is used when the residuals are modelled as a first order auto regression or AR (1) process.

$$\varepsilon_{it} = \rho_{\,it-1} + \eta_{it} \tag{3}$$

where η_{it} is independent and identically distributed with mean 0 and ρ is the autocorrelation parameter with order 1. The model is estimated by Feasible Generalised Least Squares (FGLS). The method consists in first estimating equation (1) by OLS. The residuals from this estimation are used to estimate the rho (ρ) in equation (3). The estimate of ρ in turn is used to transform the data and this transformed model is again estimated using OLS. The estimator by Prais and Winsten (1954) transforms the data as described in Appendix A7.

4.1.1. Results of the Random effects and Prais-Winsten models

The results of the random effect model and the Prais –Winsten approach are reported in Table 4(a) and Table 4(b), respectively.

Table 4 (a) Random Effects Model Estimation

Variables	Coefficients	P value
Share of PF assets invested in stocks	-0.0681 (0.02)	0.02
Average volatility	0.93 (0.08)	0.000
Value of Stocks Traded at constant prices	-0.009 (0.00)	0.04
Inflation	0.004 (0.008)	0.00
Per Capita Income	0.0009 (0.0005)	0.103
Constant	-0.016	0.561
R^2 Within	0.51	-
R^2 Between	0.37	-
R^2 Overall	0.48	-
Joint Significance Test for all	$\chi 2$ (5) =200.04	0.000

As for the results from the random effects model, preliminarily it is worth recalling that the interpretation of the coefficients is somehow tricky since the latter include both the within entity and between entity effects. However, by observing the p values, we can note that all coefficients of the independent variables except for per capita income are significant. The joint significance test (χ^2) with a significant p value suggests that all coefficients are significant. Among the coefficients, we note that the one associated with the share of PF assets is negative, as expected, confirming that PF investments in the markets may contribute to enhance the efficiency of the latter. The coefficient is significant at 5% level.

The inflation rate, which is a proxy for macroeconomic stability, shows a positive effect and the coefficient is significant at 1% level. The theoretical argument that larger financial markets are more liquid and hence may possibly reduce the volatility of stock prices is also confirmed by the fact that the coefficient of the volume of stocks traded is negative, at a 5% level. Finally, the per capita income employed as a proxy to take care of cross country differences has no effect on volatility of stocks.

Table 4(b) Estimation results using the Prais-Winsten method

Variables	**Coefficients.**	**P value**
Share of PF assets invested in stocks	-0.060 (0.015)	0.00
Average volatility	0.93 (0.027)	0.000
Value of Stocks Traded at constant prices	-0.001 (0.0003)	0.001
Inflation	0.005 (0.0008)	0.000
Per Capita Income	0.0008 (0.0006)	0.27
Constant	-0.021	0.319
R2 Within	0.48	-
Joint Significance Test for all variables	$\chi2$ (4) =1612.63	0.000

By comparing the random effects model results and the ones stemming from the Prais-Winsten transformation, we can notice that we do not observe a marked difference neither in the sign of the coefficients nor in the value of the estimated coefficients and their respective p values. However, we know that the random effects estimation is biased due to the presence of heteroscedacticity and serial correlation. By looking at Table 4(b), we observe that the coefficients of average volatility, inflation, share of pension funds in stocks and value of stocks traded are statistically significant. The joint significance level (χ^2) also shows significance of all coefficients in the model. As expected, the coefficient value of average volatility is positive and significant at 1% level, thus confirming that overall volatility is contagious. The coefficient value of share of PF assets invested in stocks is negative and significant at 1 percent level, showing that PF asset growth leads to less volatility in stock markets.

All in all, the results provided so far confirm the positive effect of PF investments in stocks on financial markets efficiency. On the other hand, per capita income does not seem to have a significant role in explaining the volatility in stock markets. The homogeneity of the countries under the study could be sought as a reason for such a finding.

However, we also observe that the value of the coefficient of the average volatility seems to overshadow the other coefficients. In fact, the value of average volatility coefficient using Prais-Winsten method is 0.94 and thus appears to be the most significant variable influencing volatility of stocks. This result is expected, as there is a lot of interdependence between OECD countries markets and moreover volatility is intrinsically contagious, such that the volatility in one country certainly will have influence on the volatility experienced by others, possibly due to high financial networks among these well-developed financial markets.

In order to purge out the effect of the overall variability from the model, we resort to a binary model which tries to explain the presence of differential variability over the cycle in OECD countries, that is the level of volatility beyond the overall average financial markets value.

4.2. Empirical Model 2: Binary Choice - Probit Model with dependent variable taking value 1 (if stock volatility is greater than average volatility) or 0 otherwise

The variable that we have now at the LHS of the empirical model is a dummy variable that is built as follows:

$y_{it} =$ [1 if volatility of a country i is bigger than the average volatility observed
0 if volatility of a country i lower than the average volatility observed]

Since binary choice models are stronger in cases where the independent variables are discrete (see Wooldridge 2002, chapter 16), we decided to build a dummy variable (D_{it}) that takes value 1 if PF invested in stocks and 0 otherwise. Out of the total data points, 23.9% are referred to countries in which PF have not invested in stocks over the time period under consideration. The other variables are the same used in the previous models. Finally, under assumption that ε is N (0,1), we can estimate the Probit model and the results are shown in Table 5.

We perform a likelihood ratio (L-R test) in order to check for variables relevance. The null hypothesis is that all coefficients except that of the intercept are equal to zero. Here the LR $\chi^2(3)=$

12.37 with prob >chi^2 =0.00. Therefore the hypothesis that all coefficients are equal to zero can be rejected at 1% level of significance.

Table 5: Estimated Coefficients, Standard Error and P-values from the Probit Regression and their respective marginal effects computed

Probit Estimation			**Marginal effects of Probit Estimation**	
Variables	**Coefficient**	**P value**	**dy/dx**	**P value**
Dummy*=1 if PF invested in stocks, 0 otherwise	-0.437 (0.165)	0.00	-0.169 (.064)	0.00
Inflation	0.057 (0.030)	0.05	0 .021 (.011)	0.06
Per- capita income	0.004 (0.006)	0.46	0.001 (.002)	0.464
Value of Stocks traded at constant prices	-0.162 (0.069)	0.019	-0.61 (.024)	0.014
Constant	-0.104 (0.27)	0.69		

The most interesting result we get is that the dummy is now significant at 1% level. The sign of the coefficient is negative which confirms the negative relation between investment of PF in stocks and volatility of financial markets.

Moreover, as expected and in line with the results of the random effects model and Prais-Winsten method, the inflation rate coefficients have the expected signs and are significant at 5% level, while the value of stocks traded is significant at 6% level showing a negative sign as expected. However the coefficient of per capita income remains insignificant in this model (we still add this variables as it could catch any country differences; see also Walker and Lefont 2002).

In order to better quantify the influence of the variables on the right hand side on the probability that y_{it} takes value 1, we look at the marginal effects of the right hand side variables. Since we have both continuous variable like inflation rate, value of stocks traded, per capita income and the dummy variable we can use two different methods to compute the marginal effects.

- Continuous Variable

Average Marginal Effects = $1/n \sum^{n}_{i=1} \Omega (Xi'\beta) \beta$

- Dummy Variable

Average Marginal effect = $1/n \sum^{n}_{i=1} [\Phi(Xi'\beta \mid x_i^k =1) - (\Phi(Xi'\beta \mid x_i^k =0)$

According to our findings, a 1% change in the inflation rate changes the probability that y_{it} takes value 1 (countries having a higher volatility than the average volatility) by 2.1%. The most interesting result is with respect to the dummy variable (whether in the country PF have invested in the stock market). The probability of volatility to take value 0 is around 17% when the dummy variable shows value 1. By this result we further confirm and quantify the negative relationship between investments of PF in stocks and stocks return volatility. The 1% change in the unit measurement of stocks traded changes the probability that y_{it} takes value 1 decreases by 6.1%.

4.3. Empirical Model 3: Binary Logistic Regression where dependent variable taking value 1 (if stock volatility is greater than average volatility) or 0 otherwise.

In this section we also check the results using the logit model which does not require the assumption of normal distribution of error terms. All the variables remain the same as those of the Probit model (recall that the Logit model is assumed to have a standardized logistic with known variance equal to $\pi^2/3$).

The results of the logistic regression and the marginal effects are presented in Table 6. The likelihood chi square of 36.86 with p value 0.000 shows that our model as a whole fits significantly better than a model with no predictors. While looking at the significance and signs coefficients, it can be seen that the results do not change much with respect to the probit model. Except for the variable per capita income, the other three important variables are significant and with expected signs.

Recall that the logistic regression coefficients give the change in the log odds[14] of the outcome for one unit increase in the predictor variable. As seen in Probit regression, since beta

[14] We recall that log (odds) = log (p/q) where p = probability for y of taking value 1/and q the probability that y=0. Therefore, for example, one unit change in inflation rate provides 10% increase in the log odds of y_{it} taking value 1 versus y_{it} taking value 0 increases by 2.3%. Similarly for a change of dummy form 0 to 1 (i.e.

coefficients do not have a direct interpretation we compute the marginal effects in the similar way as we performed in the Probit model. Table 6 explains the result.

Table 6 : Estimated Coefficients, Standard Errors and p-values from Logistic Regression and their respective Marginal effects

Logit Estimation			**Marginal effects of Logit Estimation**	
Variables	**Coefficient**	**P value**	**dy/dx**	**P value|**
Dummy*=1 if PF invested in stocks, 0 otherwise	-.686 (.270)	0.01	-0.164 (-065)	0.012
Inflation	.095 (.048)	0.05	0 .022 (.011)	0.05
Per- capita income	0.008 (.010)	0.44	0.001 (.002) .	0.44
Value of stocks trades at constant prices	-0.276 (.121)	0.02	-0.064 (.026)	0.015
Constant	-.189 (.435)	0.664		

A change in the inflation rate changes the probability that y_{it} takes value 1 (countries having a higher volatility than the average volatility) by 2.2%. Similarly an increase in the volume of stocks traded in the market decreases the probability that y_{it} takes the value 1 by 6.4%. As for the dummy variable concerning the presence of PF in the stock markets, we can see that probability of volatility to take value 0 (i.e. volatility of the respective country to be less than the average volatility) is around 16.4 % when the dummy variable takes value 1 (i.e. the country has PF that invested in stocks). By this result we further confirm the negative relationship between PF investment in stocks and stock return volatility in the financial markets.

---

whether the country has invested have invested in stocks or not), the log odds of y_{it} taking value 1 decreases by 0.17%

5. Conclusions

The pension fund industry has witnessed a significant growth in the past few years and this phenomenal growth trend is likely to continue for the coming decades. In this background, we studied the impact of investments of pension funds in stocks on stock market volatility. This paper contributes to the current literature by looking at macro effects of pension funds' assets on stock market efficiency.

Using panel data of 34 OECD countries from 2000 to 2010, we estimate the impact of pension funds on stock market volatility by applying random effects panel model as well as Prais-Winsten regressions with panel-corrected standard errors and autoregressive errors. Our empirical findings using both models reveal that there is significant reduction in volatility of stock prices when the investment of pension funds in stock increases. This finding thus is consistent with other studies such as the one Walker and Lefont (2002) who find the same results with an emerging country database and using a different set of variables.

However the methodology revealed that the coefficient of average volatility is very high and thus the latter emerges as the most significant variable influencing volatility of stocks. Hence, we also focus on the explanation of the amount of volatility observed in each country above the level of average volatility due to the business cycle. For doing this we estimate both binary probit and logit models. The results of these models clearly show that the countries in which pension funds invested in stocks have higher probability of witnessing lower volatility than the average volatility. In the case of a probit the probability of volatility to take value 0 (i.e. volatility of the respective country to be less than the average volatility) is around 17 percent when the dummy variable shows value 1 (i.e. the country has pension funds that invested in the stocks), while in the case of logit the marginal effect is around 16.4 percent. Hence, we can conclude that the presence of pension funds in the stock markets produces higher efficiency in the financial markets by reducing stock return volatility.

References

Ang, A. and Maddaloni, A. , 2003. Do demographic changes affect risk premiums? Evidence from International data. *ECB Working Paper No 208.*

Arbel, Avner, Carvell, Steven and Paul Strebel, 1983. Giraffes, institutions and neglected firms. *Financial Analysts Journal* 39, 55-63.

Bailliu, J., Reisen, H., 1998. Do Funded Pensions Contribute to Higher Aggregate Savings? A Cross- Country Analysis *OECD Working Paper* 130.

Badrinath S.G., Gerald D. Gay, and Jayant R. Kale, 1989. Patterns of Institutional Investment, Prudence and the Managerial Safety-net Hypothesis. *Journal of Risk and Insurance, Vol.* 55, no. 4 (December 1989): 605-29.

Baltagi, B. H. 2008. Econometric Analysis of Panel Data. John Wiley and Son, 4th Ed.

Barr, Nicholas and Diamond, Peter 2006, The Economics of Pensions, *Oxford Review of Economic Policy*, 22(1).

Barr, N. and Diamond, P. 2008. Reforming pensions: Principles and Policy Choices. *New- York and Oxford: Oxford University Press.*

Beck, T., Demirgüç-Kunt, A., Levine, R., 2000. A New Database on Financial Development and Structure. *World Bank Economic Review* 14, 597-605.

Beck T, Levine R, 2004. Stock markets, banks and growth: panel evidence. *Journal of Banking Finance 28(3):423–442.*

Bencivenga, V. R., Smith, B.D., 1991. Financial Intermediation and Endogenous Growth *The Review of Economic Studies*, Vol. 58, No. 2. pp. 195-209.

Bhargava, A., Franzini, L. and Narendranathan, W. 1982. Serial correlation and the fixed effects model. Review of Economic Studies 49 (4), 533–49.

Bohl, M.H., Lischewski, J., and Voronkova, S., 2010. Pension Funds' Performance in Strongly Regulated Industries in Central Europe: Evidence from Poland and Hungary. *Emerging Markets Finance and Trade*, Volume 47, Issue 04S3, 2011, 81-94.

Bosworth, B. and Burtless, G., 2003. Pension reform and saving. *Mimeo, The Brookings Institute*.

Brennan M. J.,1995. The Individual Investor, *The Journal of Financial Research*, vol. 18, no. 1 (Spring): 59-74.

Campbell, J. Y, and Kyle, A., 1987. Smart Money, Noise Trading, and Stock Price Behavior, Mimeographed. Princeton, *NJ: Princeton University, 1987.*

Catalan, M., Impavido. G., Musalem, A.R., 2000. Contractual Savings or Stock Market Development: Which Leads?. *The World Bank, Social Protection Discussion Paper Series* 20.

Chan-Lau, J.A., 2005. Pension Funds and Emerging Markets. *Financial Markets, Institutions and Instruments* 14, 107-134.

Chopra, N., Lakonishok, J., Ritter, J., 1992. Measuring Abnormal Performance-Do Stocks Overreact?. *Journal of Financial Economics, vol. 31,* no. 2 (April 1992):235-68

Clark, G. L. and T. Hebb, 2003. Understanding Pension Fund Corporate Engagement in a Global Arena. *Working Paper in Geography No WPG 03-01; Oxford University, England.*

Coronado, J. L., E. M. Engen and B. Knight; 2003. Public Funds and Private Capital Markets; The Investment Practices and Performance of State and Local Pension Funds. *National Tax Journal; Vol. 56; 579-594.*

Cohen B, 1998. The geography of money. *Cornell University Press, Ithaca.*

Cohen R, Gompers P. and Vuolteenaho, T. 2002. Who under reacts to cash flow news? Evidence from trading between individuals and Institutions. *Journal of Financial Economics*, Vol 66, pp 409-462.

Davis E P,1995. Pension Funds, Retirement income security and capital markets- an international Perspective. *Oxford University Press.*

Davis, E.P., 1998. Pension Fund Reform and European Financial Markets - A Reappraisal of Potential Effects in the Wake of EMU. *Financial Markets Group, London School of Economics*, Special Paper No. 107.

Davis, E.P., 2005. The Role of Pension Funds as Institutional Investors in Emerging Markets. *Paper Presented at the Korean Development Institute Conference*, Population Aging in Korea: Economic Impacts and Policy Issues, March, 2005, Seoul.

Davis E.P, Hu, Y-W., 2004. Is there a Link Between Pension Fund Assets and Economic Growth?, A Cross Country Study, *Brunel* University, *Working Paper, NIESR.*

Davis, E.P., Hu, Y.-W., 2008. Does funding of pensions stimulate economic growth? *Journal of Pension Economics and Finance*, Vol 7 : 221-249.

De Hoyos, R.E., Sarafidis, V., 2006. Testing for cross-sectional dependence in panel-data models. *Stata Journal*, StataCorp LP, vol. 6(4), 482-496.

DeLong J. B., Shleifer, A., Summers, L.H., and Waldmann, R.J., 1990. Noise Trader Risk in Financial Markets, *Journal of Political Econom*y 98: 4, 703-738.

Demirgüç-Kunt, A., Maksimovic, V., 1998. Law, Finance, and Firm Growth. *The Journal of Finance*, 53 No. 6, 2107-2137.

Dennis, P. J., Strickland, D., 2002, Who blinks in volatile markets, individuals or Institutions? *Journal of Finance*, 57, pp.1923–1949.

Dennis, P. J. & Weston, J. P, 2001. Who's informed? an analysis of stock ownership and informed trading. Working paper, University of Virginia.

Dow, J., Gorton, G., 1997. Noise Trading, Delegated Portfolio Management, and Economic Welfare. Journal of Political Economy, *University of Chicago Press*, 105(5), 1024-50.

Edelen R.M and J.B. Warner, 2001. Aggregate Price effects of Institutional trading: A study of mutual fund flows and market returns. *Journal of Financial Economics*, Vol 59 (2), pp: 195-220.

Fama E.F, 1965.The behavior of stock market prices. *Journal of Business*, Vol 38, pp 34-105.

Faugère, C., Hany, A. S., 2003. Volatility and institutional investors holdings during a declining market: a study of NASDAQ during the Year 2000. *Center for Institutional Investment Management* University at Albany.

Figlewiski, S., 1979. Subjective Information and Market Efficiency in a Betting Market. *Journal of Political Economy, 87* (February 1979): pp 75-88.

Friedman M., 1937. The use of ranks to avoid the assumption of normality implicit in the analysis of variance, *Journal of the American Statistical Association*, Vol 32:675–701

Friedman, M., 1953. The Case For Flexible Exchange Rates Essays in Positive Economics. Chicago: *University of Chicago Press*.

Fontaine, J. A., 1997. Are there good macroeconomic reasons for limiting external investments by pension funds? The Chilean experience. in ed. *Valdes-Prieto S "The economics of pensions"*, Cambridge University Press.

Froot, K. A., D. S. Scharfstein, and J. C. Stein, 1992 . Herd on the Street: Informational Inefficiencies in a Market with Short-term Speculation. *Journal of Finance*, 47, 1461-1484.

James, E., 1998. Pension Reform: An Efficiency-Equity Tradeoff? In Beyond Tradeoff. ed. Nancy Birdsall, Carol Graham, and Richard Sabot; *Brookings Institution Press; Washington. Cited in Orszag and Stiglitz (1999).*

John C. Driscoll & Aart C. Kraay, 1998. Consistent Covariance Matrix Estimation With Spatially Dependent Panel Data. *The Review of Economics and Statistics MIT Press*, vol. 80(4), pages 549-560, November.

Jones, S., D. Lee, and E. Weis, 1999. Herding and Feedback Trading by Different Types of Institutions and the Effects on Stock Prices. *Working Paper*, Indiana University-Indianapolis, Kennesaw State University, and Merrill Lynch.

Gabai, Xavier, 2005. Institutional Investors and Stock Market Volatility. *NBER, Working Paper* 11722

Gale, W.G., 1998. The Effects of Pensions on Household Wealth: A Revaluation of Theory and Evidence. *The Journal of Political Economy* 106 No. 4, 706-723.

Grier, P., Albin, P.S., 1973, Nonrandom price changes in association with trading of large blocks. *Journal of Business* 46, 425-433.

Holzmann, R., Hinz, R., 2005. Old Age Income Support in the 21st Century: An International Perspective on Pension Systems and Reform. *The World Bank*, 2005.

Qi, B., Huang, M., and Chen, Z.S., 2006. Institutional investors and stock market volatility. Journal of Financial Research, 2006, pp. 54-64.

Hu, Y, 2005. Pension Reform, Economic Growth and Financial Development- An Empirical Study. *Economics and Finance Working Paper* No 05-05, Brunel University.

Hu Y, 2006. Impact of pension funds on financial markets, *Financial Market Trends*, Volume 2006 Issue 2, pp 145-167

Impavido, G., A. R. Musalem and T. Tressel, 2002. Contractual savings, capital markets and firms' financing choices. *World Bank Policy Research Working Paper*, 2948; January. The World Bank.

Islam, A., 2010. The Impact of Institutional Ownership and Dividend Policy on Stock Returns and Volatility: Evidence from Egypt. *International Journal Of Business*, 15(4), 2010

King, R.G., Levine, R., 1993. Finance and Growth: Schumpeter May Be Right. *The Quarterly Journal of Economics*, August 1993, 717-737.

Kohl, R., O'Brien, P., 1998. The Macroeconomics of Ageing, Pensions and Savings: A Survey. *OECD, paper:* AWP 1.1.

Kyle, A. S., 1985. Continuous Auctions and Insider Trading. *Econometrica 53 (November)*: 1315-36.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R.W., 1997. Legal Determinants of External Finance. *The Journal of Finance* 52 No. 3, 1131-1150.

Lakonishok, J., Shleifer, A., and Vishny, R.W., 1992. The impact of institutional trading on stock prices, *Journal of Financial Economics*, Vol 32, pp 23-43

Lakonishok, J., Shleifer, A., and Vishny, R.W., 1994. Contrarian Investment, Extrapolation, and Risk. *The Journal of Finance, vol. 49,* no. 5 pp :1541-78

Levine, R., Zervos, S., 1998. Stock Markets, Banks, and Economic Growth. *The American Economic Review* 88 No. 3, 537-558.

Levine, R. , (1997), Financial Development and Economic Growth: Views and Agenda , Journal of Economics Literature, Vol.35.

Li,W., Wang , S.S., 2010. Daily institutional trades and stock price volatility in a retail investor dominated emerging market. *Journal of Financial Markets*, vol. 13, issue 4, pages 448-474

Lipson, M., Puckett, A., 2005. Volatile Markets and Institutional Trading. W*orking Paper*, University of Georgia.

Meng, C., Pfau, W.D., 2010. The Role of Pension Funds in Capital Market Development. *GRIPS Discussion Paper 10-17, National Graduate Institute for Policy Studies.*

Murphy, L. P., Musalem, A.R., 2004. Pension Funds and National Saving. *World Bank Policy Research Working Paper, No. 3410.*

Musalem, A. R., Impavido, G., 2000. Contractual savings, stock, and asset markets. (World Bank Policy Research Working Paper 2490) Washington DC: The World Bank

Myners, P., 2001. Myners Review of Institutional Investment. *Final Report; London*

Obstfeld, M., 1994. The Logic of Currency Crises, *NBER Working Paper 4640.*

OECD , stats.oecd.org, Various years.

Pagano, M., Volpin, P.F., 2006. Shareholder Protection, Stock Market Development and Politics. *Journal of the European Economic Association,* 4 No. 2/3, 315-341.

Pesaran, M., Hashem ,2004. General Diagnostic Tests For Cross Section Dependence In Panels. *Cambridge Working Papers in Economics, no 0435,* Faculty of Economics, University of Cambridge.

Peng, X., N. Zhou, 2007. The empirical evidences for institutional investors' influence on the return variability of China's stock markets. *Systems Engineering, vol. 25*, pp. 58-62.

Raddatz, C., Schmukler, S. L, 2008. Pension funds and Capital market development: How much bang for the buck? *World Bank Policy Research Working Paper* 4787). Washington DC: The World Bank.

Rajan, R.G., Zingales, L., 1998, Financial Dependence and Growth, *The American Economic Review,* 88 No. 3, 559-586.

Rajan, R.G., Zingales, L., 2003, The Great Reversals: The Politics of Financial Development in the Twentieth Century. *Journal of Financial Economics* 69, 5-50.

Reilly, F. K., 1977. Institutions on trial: Not guilty. *Journal of Portfolio Management* 3 (2), 5-10.

Reilly, F.K., Wachowicz, J.M.Jr., 1979. How institutional trading reduces market volatility. *Journal of Portfolio Management* 5 (2), 11-17.

Rocholl, J., Niggemann, T., 2010. Pension Funding and Capital Market Development. *Working Paper, ESMT.*

Rubin, A., Smith, D.R., 2009. Institutional Ownership, Volatility, and Dividends, *Journal of Banking and Finance* 33, 627-639.

Samwick, A. A., 1999. Is Pension Reform Conducive to Higher Saving ? November; *The World Bank.*

Scharfstein, D.S., Stein, J., 1990. Herd Behaviour and Investment, *American Economic Review* 80, no. 3 (June 1990): 465-479.

Sias, R.W, 1996. Volatility and the Institutional Investor. *Financial Analysts Journal*, March/April

Schmidt-Hebbel, K., 1999. Does Pension Reform Really Spur Productivity, Saving and Growth. The World Bank.

Shiller, R., 1990 Market Volatility and Investor Behavior," *American Economic Review, Papers and Proceedings* 80(2): 58–62.

Smith M.P., 1996. Shareholder Activism by Institutional investors: Evidence from CALPERS, *Journal of Finance*, 51, 227-252.

Vittas, D.,1995. Pension Funds and Capital Markets. mimeo, *The World Bank, Washington, D.C.*

Vittas, D., 1998. Institutional Investors and Securities Markets: Which Comes First? *Paper Presented at the ABCD LAC Conference*, June 28-30, 1998, Development Research Group, World Bank. San Salvador, El Salvador.

Vittas, D., 1999. Pension Reform and Financial Markets, *Development Discussion Paper* No.697, Harvard Institute for International Development, April 1999.

Voronkova, S., Bohl, M.T., 2005. Institutional Traders' Behavior in an Emerging Stock Market: Empirical Evidence on Polish Pension Fund Investors. *Journal of Business Finance & Accounting* Volume 32, Issue 7-8, pages 1537–1560.

Wahal S, 1996. Pension Fund Activism and Firm Performance. *The Journal of Financial and Quantitative Analysis*, Vol 31; No.1; March Pp. 1-23.

Walker, E., Lefont, F., 2002. Pension Reform and Capital Markets: Are There Any (Hard)Links? *The World Bank, Social Protection Discussion Paper Series* 201.

Woidtke.T, 2002. Agents Watching Agents? Evidence from Pension Fund Ownership and Firm Value. *Journal Of Financial Economics* ; Vol 63(1): 99-131.

Wei, S., and C. Zhang, 2006. Why Did Individual Stocks Become More Volatile?, *Journal of Business*, 79, 259–291.

Wermers, R., 1999. Mutual Fund Trading and the Impact on Stock Prices. *Journal of Finance*, 54,581-622.

Woolridge, J.M., 2001. Econometric Analysis of Cross sectional and Panel data 2nd Edition. *MIT press.*

Appendix

Appendix A1: Share of Pension fund assets invested in stocks and equities among various country groups.

Year	Anglo Saxon	Continental Europe	Nordic Countries	Southern Europe	Eastern Europe	Others	OECD
2000	37.3	-	25.66	-	8.36	-	34.27
2001	47.93	24.09	32.93	15.67	12.35	-	27.3
2002	38.3	20.35	22.45	12.43	11.11	3.88	21.12
2003	45.34	16.12	25.38	11.05	13.1	5.66	23.32
2004	41.76	24.81	26.66	12.09	13.6	6.34	23.62
2005	36.22	19.76	31.88	12.8	11.28	7.74	23.59
2006	38.96	28.65	34.29	15.2	13.27	9.06	23.39
2007	39.05	20.06	34.88	14.61	14.08	8.71	21.82
2008	32.75	10.37	17.09	8.68	8.8	8.25	14.29
2009	26.42	6.72	20.61	11.48	9.12	13.25	13.9
2010	23.76	7.03	22.86	9.48	9.91	12.87	13.76

Source: OECD Global Pension Statistics, Authors Aggregation of countries

The countries Southern Europe includes: Italy, Spain, Portugal and Greece. The classification under Nordic countries include Denmark, Finland, Norway and Sweden. The Continental Europe include: Austria, Belgium, Germany, Netherlands, Luxembourg and Switzerland. The Anglo Saxon countries include Australia, Canada, Ireland, New Zealand, United Kingdom and United States. The Eastern Europe includes: Czech Republic, Hungary, Slovenia, Slovak Republic, Poland and Estonia. Others include: Chile, Israel, Mexico, Japan, Korea and Turkey

Appendix A2: Inverse Causality between Share of Pension funds invested in stock markets and stock market volatility

Lagged volatility = 0

$F(1, 314) = 1.30$

Prob > F = 0.2550

Appendix A3: Hausman Test

Coefficients	Fixed (b)	Random(B)	Difference(b-B)
Average Volatility	0.930	0.917	0.013
Share of PF assets invested in stocks	0.068	-0.097	.029
Inflation	.0049	.0043	.0005
Per capita Income	.0009	.0024	-.0001
Value of Stocks Traded in constant prices	-.0009	-.0007	-.0002

b = consistent under H_0 and H_a

B = inconsistent under H_a, efficient under H_o

Test: H_o: difference in coefficients not systematic

Appendix A4: Tests for cross sectional dependence

Pesaran's test of cross sectional independence = -0.259, Pr = 1.2042

Friedman's test of cross sectional independence = 13.221, Pr = 0.9992

Appendix A5: Test for first order serial correlation

Modified Bhargava et al Durbin Watson =1.5370

Baltagi -Wu- LBI =1.67

Appendix A6: Wald Test for Heteroskedasticity

Modified Wald test for group-wise heteroskedasticity in fixed effect regression model

H_0: $\sigma(i)^2 = \sigma^2$ for all i

χ^2 (34) = 927.79

Prob> χ^2 = 0.0000

Appendix A7: Prais Winsten Transformation Formula

The transformation formula is provided in Wooldridge (2001). Panel Corrected Standard Errors (PCSE) using Prais-Winsten are calculated with the use of following formula:

$$\text{Var}\ \{\hat{\beta}_{PCSE}\} = (X'X)^{-1} X' \, \Omega \, X \, (X'X)^{-1}$$

where matrix X represents the explanatory variables, whereas Ω is the covariance matrix for all error terms.