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The impact of funded pension schemes in domestic capital markets: evaluating global reforms

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Abstract

This article investigates whether the implementation of funded pension schemes globally has prompted the development of domestic capital markets worldwide, considering 31 pension schemes over the period of 1990-2011. The methodological strategy relies upon panel data regressions applied to depth and liquidity indicators of stock and bond markets. The analysis has revealed that individual capitalization pension schemes have meant a stimulus to stock market depth. A negative causality with stock market liquidity is also evidenced, which is linked to the long-term profile of pension portfolio management, which privileges funding strategies on trading strategies. Given the structural diversity of pension systems studied, the article uses clustering classification tools for segmenting the population according to the importance of pension schemes in the economy. This analysis shows that there are homogeneous groups whose members have similar age of the systems, but not a geographical proximity or type of system structure. It is found that the attribute of belonging to a cluster determines significant impacts of pension systems in relation to indicators of capital market development. Stock markets depth and liquidity indicators receive the positive impacts of greater magnitude from the systems included in the advanced maturation cluster. Pension schemes belonging to the low gradual and incipient maturation cluster exert significant impacts on public bond markets depth.

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1. Introduction

The ageing of the world population, particularly evident in developed countries, and the demographic transition involved have produced important macroeconomic consequences in the past decades (Batini et al. (2006)), particularly as it has to do with pension systems. During the last two decades, PAYG (Pay-As-You-Go) pension schemes have proved not to be efficient enough to provide retired people with a minimum income. Population ageing, governments' deficits and fiscal public unbalances have menaced these schemes for a long time, and their reevaluation brought as a consequence the creation of individual capitalization pension systems.

In 1981, Chile introduced structural reforms in its PAYG social security system, implementing a pure individual capitalization scheme. In 1994, the World Bank released a document on pension reforms, *"Averting the Old Age Crisis: Policies to Protect the Old and Promote Growth"*, which is an avoidable reference in the history of the development of individual capitalization systems and is frequently cited by academic literature as a seminal work in pensions' reforms. That document suggested that countries should adopt a multipillar pension system, whose first pillar was comprised by a PAYG system –or defined benefit system- and the second by an individual capitalization mandatory system, which is a defined contribution scheme, where future pensions are determined by contributions made by workers and the return generated by them. The scheme could be even supplemented with a third defined contribution pillar, consisting of voluntary contributions. This book includes as an additional objective, the hypothesis over the beneficial effect of capitalization systems on domestic capital markets. In other words, in the referred book, the World Bank remarked the multipillar pension systems benefits, including as reforms' expected goals, the increase of long term saving and also the deepening and development of domestic capital markets, through the financing and decentralized control in the second pillar. In particular, after the introduction of pension fund managers in the financial markets, their increasing demand for financial instruments could signify an stimulus to the volume of transactions and the development of capital markets, a reduction in transaction costs, the increase of long-term funds and the reduction of capital costs of companies.

On the contrary, with PAYG systems, generally managed by governments, there is no stimulus to capital markets, as these schemes are based only in contribution transfers between active and passive workers. When institutional investors replace PAYG systems, either partially or totally, managed assets grow as pension systems mature, stimulating the investment and development of capital markets.

Regarding the possible supportive role of pension funds in capital markets, Forteza et al (1999) note that in developed countries, large-scale presence of pension funds is a recent phenomenon (sixties and seventies) and it has become particularly present in countries that already had highly sophisticated capital markets (eg USA, Netherlands and United Kingdom). They explain, however, that pension funds have played a dynamic role in existing capital markets, contributing to the development of new financial

products. Moreover, the development of capital markets in Chile, occurred after the pension reform, has suggested that pension funds can play a foundational role, or at least co-foundational in economies that lacked them.

Over the last two decades, in response to the demographic and fiscal pressures that menaced the traditional PAYG systems, a significant number of countries globally closed their depleted public pension systems based on defined benefits, towards defined contribution schemes. This fact has sparked our interest in studying the impact that the implementation of funded pension schemes has had on the development of domestic capital markets.

Limited to our knowledge, there is no vast literature related to the impact of funded pension schemes on domestic capital markets, not having identified publications on these topics in international indexed publications. Nevertheless, technical reports of local and international organizations related to these issues have been individualized, comprising either individual assessments of pension systems or empirical research methodologies. In particular, Ashok & Spataro (2013), Catalan et al. (2000), Davis & Steil (2001), Hryckiewicz (2009), Impavido et al. (2000, 2001, 2003), Meng (2010) and Walker & Lefort (2002) have produced works that apply statistical-econometric methodologies that are considered of reference for this work. An important channel through which funded pension plans may affect financial efficiency is promoting the development of domestic capital markets. The academic literature recognizes that the stimulus for financial progress is the most important positive externality that the introduction of schemes funded pension can achieve. For example, Iglesias (1997) argues that the introduction of pension funds lowers transaction and emission costs in the capital markets in which they operate. Blommestein (1998) also states that the presence of a world populated by strong institutional investors' environment is a prerequisite for the development of the capital markets. Several authors (including Merton and Bodie (1995), Davis (2011) and Raddatz and Schmukler (2008) argue that the growth of pension funds may increase the development of the capital market through its long planning horizon term ability to attract and shift resources to more productive activities.

The aim of this paper is to analyze the impact of the introduction of funded pension schemes on the development of domestic capital markets in order to verify one of the main objectives of structural pension reforms that were implemented globally from the 90´s onwards. For this purpose, a total of thirty-one personal individual capitalization systems from countries in South America, Central, Caribbean and North America, Western Europe, Eastern Europe, Africa and Oceania were selected. This total includes twenty five mandatory pension systems and six voluntary pension systems. The data used consist of stock markets depth and liquidity indicators, bond markets depth indicators, variables representing the main characteristics of pension systems and other explanatory indicators of the development of financial markets. The methodological strategy employed includes panel data regression and minimum spanning tree (MST) and hierarchical tree (HT) statistical tools as well as dynamic and static clustering classification techniques.

The analysis results show that in general individual capitalization pension systems have a significant impact on domestic capital markets. The affected capital markets development indicator, together with the quantum of the impact and its sign is determined by the stage of maturity of the pension system throughout its life cycle. In this sense, stock markets depth and liquidity indicators are particularly impacted by those pension systems included in the advanced maturation cluster whereas those classified as low gradual or incipient maduration systems especially affect the public bonds markets depth.

The paper is organized as follows. Section 2 describes the data to be investigated in this research. In section 3, the panel regression methodological strategy and the corresponding empirical results are detailed. Section 4 identifies the clustering strategy of capitalization pension systems and its empirical results. Section 5 iterates the panel data regression methodology on each of the identified clusters and results of the impact analysis of funded pension schemes on domestic capital markets development are interpreted. In section 6 the main conclusions of the investigation are reported, including the linkage of the funded pension schemes maturation stage to their impact on capital markets and their policy implications, outlining some future research.

2. Description of data

The variables to explain in this study are related to domestic capital markets' development, while the explanatory variables characterize funded pension systems. Furthermore, as control variables, financial markets' development representative indexes and general economic indicators are used.

Domestic capital markets

In order to characterize the development of domestic capital markets, indicators related to the depth and liquidity of the equity market (stocks) are used, as well as the depth of the bond market (bonds), both at the corporate and public levels.

In particular, as representative indicators of the depth of the stock market, *Market capitalization/GDP* indicator is used. In reference to the liquidity of the stock market, the analysis includes *Stocks traded/GDP* and the *Turnover* ratio, equivalent to *Stocks traded/Market Capitalization*. Finally, the depth of market fixed income securities is measured through *Outstanding private bonds/GDP* and *Outstanding public bonds/GDP* indicators for private and public bond markets, respectively.

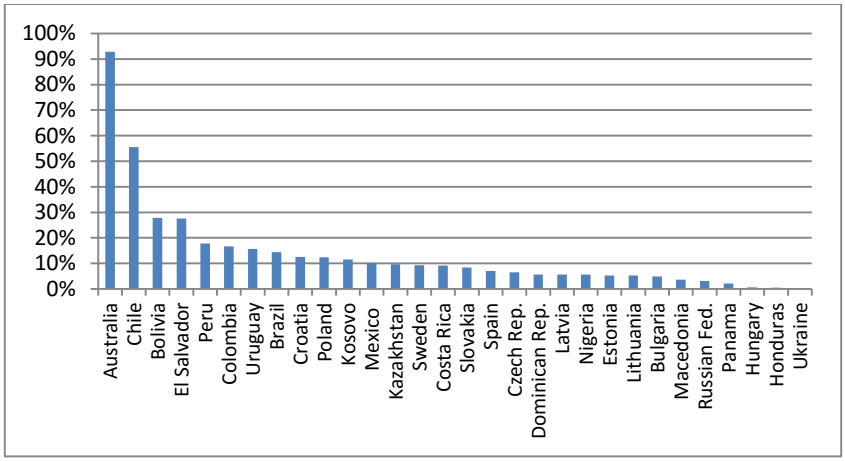
In this regard, it is considered that the most relevant aspects of the development of domestic capital markets are stocks and bonds investments, distinguishing in the latter case between public and private sectors. This characterization corresponds to the two major classes of financial instruments globally and the selection of variables considers

the information available in the period analyzed for the universe of selected systems. Consequently, the indicators to be used in this work turn out to be the most widespread in terms of liquidity and depth of the bond and equity markets.

Funded pension systems

In this work, the variable *Funded pension schemes/GDP* measures the importance of capitalization pension plans in domestic financial markets. This indicator is easy to build and to interpret and is an internationally comparable measure. In this sense, available statistical information on pension funds typically includes individual capitalization pension systems assets managed to GDP ratio in each country, which provides information about the maturity of capitalization pension schemes. According to the OECD, this indicator provides information on the maturity of the system and highlights the importance of individual capitalization pension funds in relation to the size of the economy. Figure 1 shows the situation in 2011 for the countries studied in this paper.

Figure 1: Funded pension schemes/GDP (2011)



Source: AIOS/OECD/FIAP/WB/IOPS
Note: Argentina closed its funded pension scheme in 2008.

In addition, other indicators of pension systems, which relate to voluntary or mandatory schemes are used; lifetime of the systems; distinction between pure, mixed or parallel capitalization systems and the region where they are located, among others.

Financial systems and general economic indicators

Finally, as indicators that can affect both domestic capital markets and pension systems, we consider the following set of indicators: a) the percentage of the population 65 and older; b) the annual rate of inflation; c) the amount of per capita GDP in dollars; d) the legal strength indicator; e) the real interest rate in the economy; f) bank nonperforming loans to total gross loans; g) the spread of interest rates and h) the balance of the current account of the balance of payments to GDP. In this respect, indicators of inflation and current account balance of payments / GDP relate to macroeconomic stability; the legal strength indicator measures the environment of corporate governance in the country; the overall economic development of the population is included by GDP per capita; the

country's credit indicators are measured by the percentage of nonperforming loans in the banking sector and the interest rates indicators' characterize the financial markets.

The sources of information used to compile indicators of pension systems and financial markets and other macroeconomic indicators are described in the appendix. In order to determine the countries with personal pension systems based on individual capitalization, the document *"Social Security Programs throughout the World"*[1], elaborated by AIIS (International Social Security Association) was consulted. This information was supplemented in turn by the pension taxonomy developed by OECD in *"Private Pensions: OECD classification and glossary"*[2]. Based on the combination of the different classifications of systems and available information on pension and capital markets at ISSA, OECD, FIAP and other publications, the set of systems with individual personal capitalization regimes, mandatory or voluntary, was compiled, choosing to work with annual data for the period between 1990 and 2011 inclusive. In this regard, it was decisive the fact that for oldest pension systems, more frequent data were not available. In that sense, it was adopted the criteria of not considering those systems with effect from 2007 onwards, given the low number of available observations.

Thus, in order to test the hypothesis of the beneficial effect of pension reforms in capital markets development a universe of study of twenty-five mandatory systems and six voluntary systems[3] was determined, belonging to countries in South America, Central, Caribbean and North America, Western Europe, Eastern Europe, Africa and Oceania, as depicted by Table I. This Table shows the starting year of each regime, the ISO code of the country, the attribute of mandatory or voluntary and its type of pension fund, whether a pure capitalization, mixed integrated or mixed parallel, depending on its interactions with PAYG systems. This selected group of 31 countries with pension systems based on individual capitalization has also in common that pension funds are the mayor players on those countries.

The choice of the countries included in the study is justified by the fact of these countries incorporated individual capitalization pillars in their pension systems during the past decades. On the other hand, the choice reflects those emerging countries all over the world that substituted existing PAYG earning related pension schemes or added privately managed fully funded pension systems –based on individual capitalization accounts- , following bankruptcy – or near bankruptcy– situations faced by PAYG regimes. These emerging countries had mostly underdeveloped capital markets, with the exception being the case of Australia, Spain and Sweden, included in the sample in order to explore if pension funds affect differently capital markets in developed countries.

[1] Available at www.issa.int/esl/Recursos/Publicaciones-de-la-AISS/Social-Security-Programs-Throughout-the-World11

[2] Available at www.oecd.org/finance/private-pensions/ privatepensionsoecdclassificationandglossary

[3] Since the information of pension systems was available by country, there is one personal pension scheme based on individual capitalization by country, regardless of the number of managed funds.

Table I – Global review of capitalization pension systems

Country	Start year	ISO Code	Mandatory/ Voluntary	Pure capitalization	Mixed integrated	Mixed paralell
Chile	1981	CL	M	X		
Spain	1988	ES	V			
Australia	1992	AU	M	X		
Peru	1993	PE	M			X
Argentina	1994	AR	M			X
Brazil	1994	BR	V			
Colombia	1994	CO	M			X
Czech Rep.	1994	CZ	V			
Uruguay	1996	UY	M		X	
Bolivia	1997	BO	M	X		
El Salvador	1998	SV	M	X		
Hungary	1998	HU	M		X	
Kazakhstan	1998	KZ	M	X		
Mexico	1998	MX	M	X		
Panama	1999	PA	M		X	
Poland	1999	PL	M		X	
Sweden	1999	SE	M		X	
Ukraine	2000	UA	V			
Costa Rica	2001	CR	M		X	
Latvia	2001	LV	M		X	
Bulgaria	2002	BG	M		X	
Croatia	2002	XR	M		X	
Estonia	2002	EE	M		X	
Honduras	2002	HN	V			
Kosovo	2002	XK	M	X		
Russian Federation	2003	RU	M		X	
Dominican R.	2003	DO	M	X		
Lithuania	2004	LT	M		X	
Slovakia	2005	SK	V			
Nigeria	2005	NG	M	X		
Macedonia	2006	MK	M		X	

Source: AIOS, AISS, FIAP, OECD

Note: The countries are identified by the list of ISO codes for countries and territories (ISO 3166: 1993)

Table II includes definitions of the variables used in this work, detailing its unit of measure and source of relevant information.

Table II – Definition of indicators

Indicators	Definition	Source
Funded pension schemes depth indicator	fondospbi - Pension funds administered to each year relative to GDP of each country (in decimals)	AIOS/FIAP
stock market depth indicator	cmpbi - Market capitalization relative to GDP of each country (in decimal)	World Bank, Financial Structure Dataset
Stock market liquidity indicator 1	acctranspbi - Annual traded shares relative to GDP of each country (in decimal)	World Bank, Financial Structure Dataset
Stock market liquidity indicator 2	turnover - Annual traded shares regarding the market capitalization of each country (in decimal)	World Bank, Financial Structure Dataset
Private bonds depth Indicator	circbonosprivpib - Outstanding private bonds in relation to GDP of each country (in decimal)	World Bank, Financial Structure Dataset
Public bonds depth Indicator	circbonospubpib - Outstanding government bonds in relation to GDP of each country (in decimal)	World Bank, Financial Structure Dataset/CIA, The World Factbook
Annual Inflation rate	inflation - Annual rate of domestic inflation (in decimal)	IMF indicators
Population 65 years and older	mas65 - percentage of the population over age 65 (in decimal)	LABORSTA
Pension system mandatory indicator	Mandatory - dummy variable that takes the value 1 if the pension system is mandatory and 0 if it is voluntary	AIOS/FIAP/IOPS/OECD
GDP per capita	pbipercapita - GDP per capita (in US dollars)	IMF indicators
Region	region - Geographical region to which the pension system belongs (Africa, Oceania, Eastern Europe, South America, etc.)	Own elaboration
Legal rights strength index	fortlegal - This index measures the degree to which the laws of collateral and bankruptcy protect the rights of borrowers and lenders and thus facilitate lending in the economy	World Bank, World Development Indicators
Bank nonperforming loans to gross loans	cartvencida - Value of nonperforming loans in the total portfolio value	World Bank, World Development Indicators
Real interest rate	realintrate - Lending interest rate adjusted for inflation as measured by the GDP deflator (in decimal)	World Bank, World Development Indicators
Interest Rate Spread	spreadrate - Lending rate minus the passive interest rate (in decimal)	World Bank, World Development Indicators
Cluster	cluster2 – linkage of a capitalization system to a cluster, according to the classification analysis done in this work	Own elaboration
Current account balance of payments / GDP	ctactepbi - current account of balance of payments to GDP	International Monetary Fund - World Economic Outlook Database

Note: Quantitative variables are expressed in annual terms

3. Panel data regression methodology and empirical results

Through a preliminary descriptive analysis, we determined the existence of a positive correlation of Funded pension schemes / GDP with four capital market indicators, those relating to the stock markets' liquidity and depth and the private bond markets' depth, with a 5% level of significance. In particular, we must emphasize the correlation of individual capitalization pension plans with *Market capitalization/GDP* and *Outstanding*

private bonds/GDP (0.6247 and 0.5137, respectively). On the other hand, the correlation for the entire sample with the *Outstanding public bonds/GDP* is not significant.

Measuring the potential impact of individual pension fund in the domestic capital markets was implemented by performing panel data regressions, controlling for other characteristics of the financial system and the overall economy of each country analyzed, in order to appreciate the levels of association and causality. Given the existence of pension systems with different ages, an unbalanced panel data set -with quantitative and qualitative information on systems and markets- was built. Three methods of estimating panel data were considered: random effects, fixed effects and pooled OLS. Each regression also contains a set of year dummies. Estimates are made in STATA 11. Formally, the panel data regression methodology is given by the following formulation:

$$y_{it} = \alpha + \beta x_{it} + \gamma z_{it} + \mu_i + \lambda_t + \nu_{it}$$

where y_{it} is the dependent variable to be explained, α is the constant of the model, x_{it} are the explanatory variables that incorporate features of pension systems, β are the coefficients of those explanatory variables and z are other variables that explain the development of capital markets or other macroeconomic indicators; μ_i are the unobservable individual effects, λ_t are temporary effects and v_{it} is the idiosyncratic error.

The suitable estimation strategy is determined by the implementation of the Hausman test (1978) and the modified Wald test for heteroskedasticity. In order to avoid endogeneity problems and ensure that the direction of causality is from the funded pension schemes depth variable towards the stock markets' development indicators and not the reverse, the independent variable was included lagged in the various regressions proposals. Following Impavido (2003), the capitalization pension schemes variable is included with only one year lag, in order to maximize the sample size. Using the instrumental variables approach, the independent variable is instrumented in turn through its second lag. Finally, estimates of the regressions are performed with standard errors robust to heteroskedasticity and autocorrelation. The results of the estimation strategy show that *Market capitalization/GDP*, Turnover ratio and *Outstanding public bonds/GDP* variables are best modeled by random effects while *Stocks traded/GDP* and *Outstanding private bonds/GDP* are modeled by fixed effects.

Table III – Funded pensions schemes impact on domestic capital markets

Dependent variable	Market capitalization / GDP	Stocks traded / GDP	Turnover ratio	Outstanding private bonds / GDP	Outstanding public bonds / GDP
Explanatory & control variables					
Inflation (log)	.007 (.0246)	.0209 (.0250)	-.0102 (.0214)	-.0045 (.0102)	-.0087 (.0238)
Per capita GDP (log)	.1385*** (.0424)	.0455 (.0712)	0.199*** (0.004)	-.0163 (.0232)	-.040 (.0370)
Real interest rate	-.1241 (.1487)	-.1106 (.2191)	.2091 (.1760)	.0498 (.0609)	.3077* (.1725)
Legal strength indicator	2.587* (1.556)	-1.509 (.9491)	2.217 (1.170)	-.6305 (.4237)	1.013 (.7733)
Interest rate spread	.3369* (.1980)	.5088 (.4363)	-.2973 (.2493)	-.6305 (.4237)	-.3183 (.2240)
Bank nonperforming loans to total gross loans	.0031 (.1749)	-.0585 (.1860)	-0.582** (0.017)	.0719 (.0561)	.0699 (.2094)
Current account balance of payments/GDP	-.0008 (.0027)	-.0063 (.0044)	.004 (.0038)	-.002 (.0019)	.0050 (.0035)
No. of observations	**347**	**348**	**348**	**346**	**348**
No. of groups	**30**	**30**	**30**	**30**	**30**
R-sq: within	**0.4129**	**0.3202**	**0.3045**	**0.2041**	**0.2991**
F test/Wald test	**237.50 (0.000)**	**4.56 (0.000)**	**129.10 (0.000)**	**3.01 (0.000)**	**125.21 (0.000)**
Inflation (log)	.0145 (.0267)	.0084 (.0192)	-.0206 (.0240)	-.004 (.0104)	-.0170 (.0249)
Per capita GDP (log)	.1428*** (.0430)	.0066 (.0610)	0.170*** (0.061)	-.018 (.0241)	.0407 (.0404)
Real interest rate	-.1100 (.1658)	-.1900 (.2303)	.2686 (.1845)	.0713 (.083)	.3431* (.1859)
Legal strength indicator	1.020 (1.542)	-1.263 (1.064)	2.539* (1.244)	-.5237 (.423)	1.295* (.7128)
Interest rate spread	.2794 (.2541)	.5434 (.438)	-.381 (.2587)	-.1117 (.2060)	-.3767 (.2577)
Bank nonperforming loans to total gross loans	-.0689 (.1729)	.0771 (.1352)	-0.476*** (0.010)	.093 (.0574)	.0750 (.2137)
Current account balance of payments/GDP	.0007 (.0031)	-.0056 (.0038)	.0049 (.0040)	-.0018 (.0018)	.0050 (.0038)
Funded pension schemes/GDP (lagged)	.7091*** (.2018)	-.7244* (.3758)	-.2679 (.2948)	-.1410 (.1323)	-.1101 (.1606)
No. of observations	**325**	**326**	**326**	**324**	**326**
No. of groups	**30**	**30**	**30**	**30**	**30**
R-sq: within	**0.4981**	**0.3430**	**0.3139**	**0.2081**	**0.3072**
F test/Wald test	**237.83 (0.000)**	**4.66 (0.000)**	**133.45 (0.000)**	**3.07 (0.000)**	**128.19 (0.000)**

Notes: t-statistics based on estimations robust to heteroskedasticity and autocorrelation. The value of the estimated coefficient is reported, indicating the standard error in brackets. All regressions include year dummies. ***,**,*: 1%, 5% and 10% significance levels, respectively. According to Hausman and Wald tests, we use a a random effects model for Market Capitalization/GDP, Turnover and Outstanding public bonds/GDP while a fixed effects model is used for Stocks traded/GDP and Outstanding private bonds/GDP. The variable Funded pension schemes/GDP is instrumented through its second lag. Source: Own elaboration using STATA.

Regression estimates results with errors robust to heteroskedasticity and autocorrelation can be found in Table III. In the referred table, depth estimates of the

stock market (Market capitalization/GDP), stock market liquidity (Shares traded/GDP and Turnover) and depth of the bond market (Outstanding private bonds/GDP and Outstanding public bonds/GDP) are showed, depending on the independent and control variables, according to the corresponding estimation method used in each case. In all cases, the regression of the dependent variable corresponding to the referenced control variables is first shown while in the second part, the pension market depth independent variable, *Funded pension schemes/GDP*, is also included. Besides, information on number of observations, number of groups, individual significance tests and overall significance model tests is also provided. In terms of control variables, the regressions show that the rate of legal strength positively affects stock market liquidity and depth of government bonds. This indicator is also positively affected by the real interest rate. On the other hand, the depth and stock liquidity are positively and significantly influenced by GDP per capita and nonperforming loans in the banking sector negatively affects stock liquidity.

Referring to the impact of pension systems on the capital markets, a positive and highly significant direct effect of *Pension funds/GDP* over the depth of the stock market is found, implying that a 1% growth increase in funded pension schemes in the economy leads to a 0.709% increase in stock market capitalization. We also demonstrated the existence of a significant negative relationship with stock liquidity (measured by *Shares traded/GDP*), whereby for every 1% increase in *Pension Funds/GDP*, a 0.724% decrease in stock liquidity is generated. In short, in terms of the entire sample, evidence of a significant increase in the share depth and reductions in stock liquidity (measured by *Shares traded/GDP*) compared to the increase in the pension funds of individual capitalization was detected. These results agree with those recorded in Meng (2010), resulting also reasonable for the type of administration made by pension funds, which emphasizes managing long-term funds (funding strategies), as opposed to a short-term administration (trading strategies). The rest of the indicators of development of capital markets did not report significant findings.

4. Clustering and empirical results

In this section we perform a comparative analysis on the impact of pension systems on capital markets in the different pension systems. Considering that individual capitalization systems incorporate different structural designs, in some cases supported by funded pure systems, in others by mixed or parallel systems, with respect to their interaction with PAYG schemes, it is possible that their development has been dissimilar throughout its existence. In these conditions, it is likely that the impact of pension systems on domestic capital markets has not been identical in the population tested.

In order to compare the results by type of individual capitalization systems, we carried out a segmentation of the population into homogeneous groups according to the importance of pension funds in the economy, measured by *Funded pension schemes/GDP* at different points in time. Therefore each pension system i is represented by the time series $S_i = (s_{i,1999}, s_{i,2000}, ..., s_{i,2011})$ of *Funded pension schemes/GDP* values,

defined in the period 1999-2011. The segmentation is performed using hierarchical clustering techniques, so it is necessary to define a notion of distance between objects. Given two systems i and j we measure the average level of closeness of the two time series by the *Average distance* between them, defined as:

$$d(i,j) = \sqrt{\sum_{t=1}^{t=T} \frac{\left(s_{i,t} - s_{j,t}\right)^2}{T}}$$

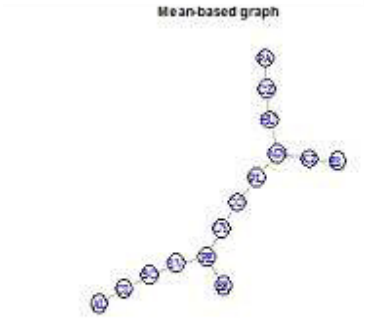
where $s_{i,t}$ and $s_{j,t}$ are the values of *Funded pension schemes/GDP* systems *i* and *j* at time *t*, respectively; where T is the total amount of periods studied. Note that it coincides with T-dimensional space Euclidean metric. This distance may vary between 0 and infinity. A high average distance implies that during some periods studied *Funded pension schemes/GDP* range levels of both systems were very different. The average distance captures how two systems move away from each other, on average, during the period under consideration. This distance, calculated in mobile time windows, allows analyzing whether the performances of two systems converge or not. Based on this metric, a minimum spanning tree (MST) and a hierarchical tree (HT) are built, associating and grouping systems with its closest neighbors, according to the concept of distance used (Ramal et al., 1986; Lia, et al., 2009). These trees can show information about the geometrical aspects from the MST and taxonomic aspects from the HT present in the structure of connections from the systems under study. Given the distance defined, the MST is constructed by connecting the systems by Kruskal's algorithm (Kruskal, 1956). The basic idea is to successively choose the minimum distances between objects. Thus, the MST is a tree graph with many vertices as systems in the population under analysis while links between them select the most relevant connections of each element of the set. The MST makes evident the eventual formation of clusters and denotes those systems more connected with other systems as well as those more isolated in its dynamics, establishing a topology between its *Funded pension schemes/GDP* dynamic evolutions.

Using the information provided by the MST and from the ultrametric distance (see Mantegna, 1999; Brida and Risso (2010a and 2010b)) a hierarchical organization of the vertices of the graph, called the hierarchical tree (HT) is obtained. The ultrametric distance $d^<(i, j)$ between *i* and *j* is the maximum of the distances d(*k, l*) to move from *i* to *j* through the shortest path connecting the vertex *i* to *j* in the MST. That is, from AEM, the distance $d^<(i, j)$ between i and j is given by

$$d^<(i,j) = Max\left\{d_0\left(w_i; w_{i+1}\right); 1 \le i \le n-1\right\}$$

where $\{(w_1; w_2), (w_2, w_3), ..., (w_{n-1}, w_n)\}$ denotes the only minimal path in the MST connecting I and j, where $w_1 = i$ and $w_n = j$ (see Ramal et al, 1986). Calculating the

Figure 2: MST 1999-2011



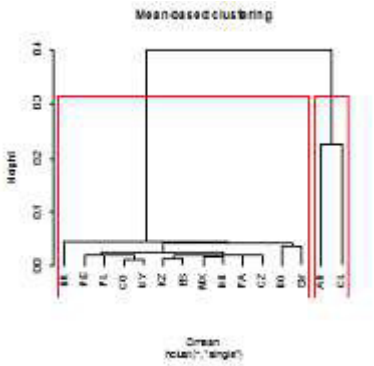
Source: Own elaboration based on R

distances $d^{<}(i, j)$ for each pair of regions allows the construction of the HT. As is known in the literature, determining the number of clusters is a process that requires a combination of statistical techniques as well as the discretion of the investigator applied to the problem under consideration (see Cuevas et al., 2000; Brida et al., 2012). The aggregative-hierarchical clustering algorithm employed in the classification was the Ward algorithm. In turn, two indicators of detention, the pseudo-F and pseudo-t, were used to determine the optimal number of clusters in the population of analyzed systems (see Tibshirani et al., 2001). For the construction of MST and HT the R software was used, version 2.15.3.

In the classification analysis, the period 1999-2011 was selected as the baseline scenario, containing annual information for a set of fifteen pension systems, and a second period was added, from 2006 to 2011, which condensed information for a population of thirty systems. Dynamic clustering analysis involved analyzing distance matrices taking eight mobile windows, each with duration of six years, in order to assess the maintenance of linkages or associations between different pension systems. The MST for the base period (Figure 2) revealed that the most connected systems were Mexico and Peru, each with three connections, occupying central places Poland, Colombia and Uruguay' pension systems. In terms of the distances showed by the Chilean system in relation to other systems, it may be considered as an outlier, reflecting on the usefulness of excluding it from the analysis, in order to obtain more diverse groupings.

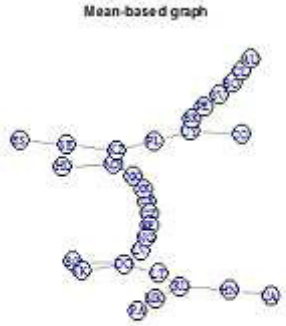
According to the HT (Figure 3) for the base period, the first cluster is recorded between Colombia and Uruguay' pension systems, with the minimum distance, followed by Kazakhstan and Spain. Chile is the system with greater distance, followed closely by Australia. It is concluded that systems that presented an average closest distance in the thirteen-year period surveyed are not necessarily linked by geographical proximity or the fact that it was a mandatory or voluntary system. Considering distance values, associations between on the one hand, Peru, Poland, Colombia and Uruguay and on the other, between Kazakhstan, Spain, Mexico, Hungary, Panama and Czech Republic are observed. Moreover, Bolivia and El Salvador also linked but to a greater distance than the above groups.

Figure 3: HT 1999-2011



Source: Own elaboration based on R

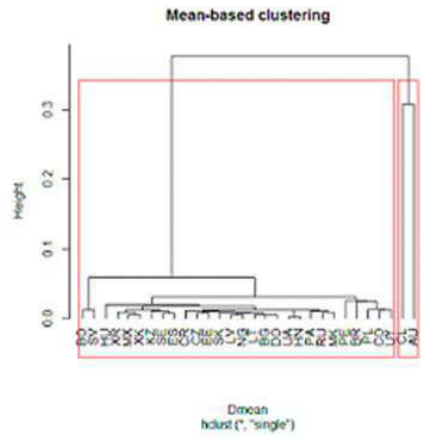
Figure 4: MST 2006-2011



Source: Own elaboration based on R

In accordance with the MST, in the period 2006-2011, the longest distance recorded was between Chile and Bolivia, as in the base period (Figure 4). In this regard, the cluster analysis performed by Seijas (2009) on Latin America pension systems using data from 2005 also showed the greatest differentiation between these systems. Furthermore, it is noteworthy that the second largest distance, between Australia and Chile, is six times larger than the third largest distance, between El Salvador and Peru. The dynamic cluster analysis showed associations between funded pension systems of similar maturity (Chile and Australia; Colombia, Poland and Uruguay; Honduras, Ukraine, Russian Federation, Lithuania, Czech Republic, Latvia, Nigeria, Estonia, Costa Rica, Croatia and Kosovo).

Figure 5: HT 2006-2011



Source: Own elaboration based on R

The HT included in Figure 5 showed the formation of two clusters, the first of them integrated by Chile and Australia, and the second, by the rest of the systems studied. The analysis of the distances revealed that the strongest associations between the surveyed systems (in terms of lower distances) are basically recorded between systems created in this century. Note for example that in the first place Honduras (2002) is linked with Ukraine (2000); then, Nigeria (2005) and Latvia (2001); followed by Bulgaria (2002) and Dominican Republic (2003); Kosovo (2002) and Mexico (1998); Dominican Republic (2003) and Lithuania (2004); Dominican Republic (2003) and Latvia (2001), to name the first associations. In turn, although the largest association was recorded between two voluntary systems, it does not seem to be a constant, considering the links between Estonia and Czech Republic; Spain and Sweden; Slovakia and Dominican Republic or Czech Republic and Costa Rica. So, again we note that the attribute of mandatory or voluntary does not discriminate better between systems, being thereof a defining characteristic their temporal length.

The results of cluster analysis showed that the population of pension systems was divided into five groups, integrating twenty of the thirty-one systems analyzed, along with systems that can be considered heterogeneous or outsiders, as they did not maintain links with other systems analyzed throughout the period studied.

Given the maturity of the pension systems and their levels of depth in their respective domestic economies, it is possible to construct typologies of individual capitalization systems. From the aforementioned typologies, a pension schemes lifecycle is determined, classifying the different regimes depending on the maturation stage found (Seijas, 2009). Indeed, in every life cycle it is possible to distinguish a process of evolution basically scheduled by stages of birth, growth and stability. The process of existence of a pension system, regardless of its nature, also consists of different stages of evolution, which could be characterized generally as of incipient, gradual and advanced maturation. The classification of each system in one process step, although closely linked with the old system, is particularly influenced by a host of different factors - institutional, political, demographic, labor market - that accelerate or slow transition down to different stages of the evolution process.

The launch and implementation of a pension scheme coincides with the stage of *Incipient maturation*, characterized by the exponential growth of managed pension funds and affiliates, a limited selection of allowed investments for funded pension schemes and low levels of profitability. Transiting in the life cycle is the following stage of *Gradual maturation*, or growth, where permitted investments for pension funds are relaxed -with a positive impact on profitability in general-, gradually introducing risk rating to adjust investment limits and general enabling investment in shares and investments abroad. At this stage, widespread in time, it is generally possible to distinguish different sub-stages of evolution, since the demographic, politic and economic characteristics of each system determine a different development over to its stability, affecting their rhythm of transition. Finally, the phase of stability or consolidation of the system, or *Advanced maduration*, where the growth of managed funds and affiliates is stabilized, balancing in turn the contributions of active workers with the retirement benefits outflows. Also, the flexibility of investment options is deepened, raising the ceiling of permitted investments and generally also records the incorporation of multifunds, intended to meet the investment options of different affiliates´ profiles.

The results allow classifying Chile and Australia, the oldest among the studied statutory schemes and with the higher levels of *Funded pension schemes/GDP* in an advanced maturation stage. On the other hand, Colombia, Uruguay and Poland pension systems are located on a high gradual maturation level; Spain and Kazakhstan in an intermediate gradual maturation level; Mexico, Hungary and Panama, in a low gradual maturation level and finally, Czech Republic, Costa Rica, Croatia, Kosovo, Ukraine, Estonia, Honduras, Bulgaria, Russian Federation and Latvia in an incipient stage of maturation. The summary of the results obtained in terms of association between pension systems and their stages of maturity is included in Table III.

Table III - Types of pension systems

Cluster	Maduration stage	Pension systems
1	Advanced	AU-CL
2	High gradual	CO-PL-UY
3	Intermediate gradual	ES-KZ
4	Low gradual	MX-PA-HU
5	Incipient	CZ-CR-HR-XK-UA-EE-HN-BG-RU-LV

Note: Own elaboration based on R – ISO country codes

These findings are in line with Seijas (2009) that, from a cluster analysis applied to a set of quantitative information of pension schemes in Latin America, located Chile (2005, 2007 and 2008) and Uruguay (2007 and 2008) in an advanced stage of maturation; Colombia (2005, 2007 and 2008) in a gradual maturation level, Mexico (2007 and 2008) and Uruguay (2005) and in an incipient stage of maturation, Mexico (2005) and Costa Rica (2005).

To study whether the groups move away or come close between and within them a measure of overall distance is necessary. Following the methodology proposed by Onnela (2002), this measure can be obtained by adding all distances of the MST. This sum represents what in literature is called the *diameter measure*, consisting of an overall distance obtained by adding all the links in the tree and reflecting the convergence or divergence of the pension systems studied in a common dynamic.

In the case of Chile and Australia, it is remarkable to note that the diameter has doubled over the different windows considered, which showed the gradual divergence of the leading systems. The cluster of Colombia, Uruguay and Poland gradually observed a convergent path until 2001-06, which remained about the same in 2002-07, followed by a very atypical diameter in 2003-08, then continued through a converging path to the end of the period. Clearly, these are systems that were less differentiated over time. Spain and Kazakhstan' pension systems observed an approach to 2002-07, notwithstanding which, from that window on further differentiation registers, determining diameter levels greater than initial levels towards the end of period. On the other hand, we note that although the link between the systems of Mexico, Panama and Hungary remained stable for thirteen years, the diameter has more than doubled in the period, which showed a greater deviation between them, leading to a greater divergence. Finally, although the systems in place in Czech Republic, Costa Rica, Croatia, Kosovo, Ukraine, Estonia, Honduras, Bulgaria, Russian Federation and Latvia experienced swings upward and downward during the period, in the final window they recorded very similar diameter values to the initial window, notwithstanding having registered a convergent path within the period analyzed.

5. Impact analysis and empirical results as cluster

For each of the clusters identified in Section 4, the panel data regression methodology was applied, in order to determine the impact of individual capitalization pension systems on domestic capital markets. The dependent variables correspond to the five indicators of domestic capital markets' development, described in Section 2. The main explanatory variable is the importance of capitalization pension plans in the economy, measured by *Funded pension schemes/GDP*. Finally, the control variables correspond to financial systems' development and general economy indicators, also described in Section 2.

Table IV includes estimates for each of the indicators of capital market development used in the analysis, considering the results according to the cluster to which the system was linked to in the classification analysis performed in the first part of the work. These estimates were carried out using in each case the estimation method selected according to the strategy previously specified.

With regard to the depth of the stock market, it is detected that advanced maturation systems experienced a very strong positive reaction in magnitude (0.789%) following a one percentage point increase in pension funds' assets under management. On the other hand, systems that make up the low gradual maturation cluster recorded a significant and positive reaction to the increase in managed pension funds (0.424%). In contrast, intermediate gradual maturation systems exhibit significant negative correlation with the increase of these pension funds (-0.147%). In relation to stock liquidity, it is reported that *Shares traded/GDP* reacted negatively to an increase of the first lag of the variable *Funded pension schemes/GDP* for intermediate gradual maturation countries. In particular, given a 1% increase in this variable, there was a decrease of 0.118% in stock liquidity in this cluster. However, advanced and low gradual maturation systems observed increments (0.326% and 0.145%, respectively).

With regard to private fixed income market depth, the evidence found negative causality of intermediate gradual maturation clusters against the growth of pension fund systems (-0144%). Finally, regarding the development of the public bond markets, the results indicated that low gradual maturation and incipient maturation clusters showed a positive and significant correlation of this indicator to the growth of pension fund assets under management (0.479% and 0.523%, respectively). As can be seen, this causality was of greater magnitude in the case of incipient maturation cluster that consisted mostly of recently incepted systems[4].

[4] Bulgaria (2002), Costa Rica (2001), Czech Republic (1994), Estonia (2002), Honduras (2002), Croatia (2002), Latvia (2001), Russian Federation (2003), Ukraine (2000) and Kosovo (2002).

Table IV – Funded pensions schemes impact on domestic capital markets

Dependent variable	Market capitalization / GDP	Stocks traded / GDP	Turnover ratio	Outstanding private bonds / GDP	Outstanding public bonds / GDP
Explanatory & control variables					
Inflation (log)	.0145 (.0267)	.0084 (.0192)	-.0206 (.0240)	-.004 (.0104)	-.0170 (.0249)
Per capita GDP (log)	.1428*** (.0430)	.0066 (.0610)	0.170*** (0.061)	-.018 (.0241)	.0407 (.0404)
Real interest rate	-.1100 (.1658)	-.1900 (.2303)	.2686 (.1845)	.0713 (.083)	.3431* (.1859)
Legal strength indicator	1.020 (1.542)	-1.263 (1.064)	2.539* (1.244)	-.5237 (.423)	1.295* (.7128)
Interest rate spread	.2794 (.2541)	.5434 (.438)	-.381 (.2587)	-.1117 (.2060)	-.3767 (.2577)
Bank nonperforming loans to total gross loans	-.0689 (.1729)	.0771 (.1352)	-0.476*** (0.010)	.093 (.0574)	.0750 (.2137)
Current account balance of payments/GDP	.0007 (.0031)	-.0056 (.0038)	.0049 (.0040)	-.0018 (.0018)	.0050 (.0038)
Funded pension schemes/GDP (lagged)	.7091*** (.2018)	-.7244* (.3758)	-.2679 (.2948)	-.1410 (.1323)	-.1101 (.1606)
Cluster					
Advanced maduration cluster	0.789*** (0.000)	.3264* (.1691)	-0.337 (0.197)	.0181 (.0561)	-0.217 (0.229)
High gradual maduration cluster	-0.085 (0.312)	.0289 (.0485)	0.098 (0.159)	-.0479 (.2219)	0.055 (0.658)
Intermediate gradual maduration cluster	-0.147* (0.007)	-.1183* (.0644)	0.405 (0.176)	-.1438*** (.0271)	-0.052 (0.756)
Low gradual maduration cluster	0.424* (0.006)	.1449** (.0690)	0.008 (0.996)	.0170 (.0217)	0.479* (0.065)
Incipient maduration cluster	0.038 (0.621)	.0079 (.0543)	-0.034 (0.757)	-.0314 (.0199)	0.523* (0.048)
No. of observations	**325**	**326**	**326**	**324**	**326**
No. of groups	**30**	**30**	**30**	**30**	**30**
R-sq: within	**0.8256**	**0.3616**	**0.6986**	**0.5190**	**0.5541**
F test/Wald test	**623.58 (0.000)**	**4.67 (0.000)**	**576.90 (0.000)**	**5.45 (0.000)**	**172.68 (0.000)**

Notes: t-statistics based on estimations robust to heteroskedasticity and autocorrelation. The value of the estimated coefficient is reported, indicating the standard error in brackets. All regressions include year dummies. ***,**,*: 1%, 5% and 10% significance levels, respectively. According to Hausman and Wald tests, we use a a random effects model for Market Capitalization/GDP, Turnover and Outstanding public bonds/GDP while a fixed effects model is used for Stocks traded/GDP and Outstanding private bonds/GDP. The variable Funded pension schemes/GDP is instrumented through its second lag. Source: Own elaboration using STATA.

6. Conclusions and Final Thoughts

Given the significant growth experienced in recent decades by personal individual capitalization systems globally, the purpose of this study involved determining whether the implementation of these pension schemes had succeeded in developing domestic capital markets, as established by the original goals of structural reforms. For this purpose, over a universe of thirty-one funded pension systems between mandatory and voluntary, panel data regressions were constructed, using stock and bond markets depth and liquidity indicators as well as proxies for pension systems variables and other indicators of financial markets' development over the period 1990-2011. The methodological strategy was complemented by static and dynamic clustering analysis of pension systems, together with MST and HT statistical tooling, applied to representative statistical information of its performance.

The outcomes specified in Section 5 confirmed that the attribute of belonging to a cluster determined significant impacts of pension systems on capital market development indicators. Indeed, although wide sample evidence of the impact of individual capitalization pension systems on the depth and stock liquidity was obtained, consideration of the associations of the systems in clusters helped to confirm the impact of funded pension schemes on all domestic capital markets development indicators surveyed in this paper.

In particular, the advanced maturation systems management is noteworthy, as it hit up stock market depth and liquidity indicators to rising individual pension assets under management, involving the greater magnitude effects among all clusters that were reported as significant. On the other hand, low gradual and incipient maturation systems growth generated significant levels of public bonds markets´ depth. These results demonstrate that advanced maturation systems are related to a further development of capital markets, predominantly equities while those transiting low gradual and incipient stages of maturation were more linked to a greater depth of public debt instruments, which typically enjoy the preference of these pension systems in their early stages of life.

This evidence is in line with the fact that pensions in their early stages of maturation invest mostly in government debt instruments and are gradually easing investment schemes in their portfolios, admitting other financial instruments, including stocks and investments abroad (Seijas, 2009). Also, as Meng (2010) stated, the investment of funded pension schemes in public debt sector might not represent a voluntary investment decision.

On the other hand, intermediate gradual maturation systems observed decreases in

depth and stock liquidity and in private debt depth to the growth of their funded pension schemes. At this point, considering the increasing complexity and diversification of financial instruments in capital markets, it is likely that capitalization pension systems invest in increasing amounts in foreign assets and alternative assets, defined as those investments different from bonds, shares and cash, among which can be found, for example, hedge funds, venture capital, real estate, infrastructure, commodities and others.

The cluster analysis also showed that although high gradual maturation systems exhibit a converging trend from their funded pension schemes, the heterogeneity of their capital markets cannot determine the significance of the selected development indicators with the increase of capitalization pension managed assets. In particular, the depth and liquidity of the stock market was significantly different in the three countries included in this cluster.

The policy implications of this work relate to the differential impact of pension systems on capital markets in relation to the maturation stage of their life cycle. This highlights the importance of existing public policies that encompass individual capitalization pension systems developments in relation to the financial instruments available in the capital markets, in order to enhance its positive effects on the economy.

Towards the future it is considered of relevance to make a sensitivity analysis of the clustering of pension systems made in the present work, using other (s) quantitative (s) variable (s), testing whether changes are recorded between detected linkages of pension systems. Also, comments made regarding the systems included in the intermediate gradual maturation cluster let us think about the suitability of further research including other capital market development indicators, which consider the financial instruments already mentioned. Finally, it is considered appropriate to deepen the analysis in this paper for high gradual maturation pension systems, as a contribution to the academic discussion of the characteristics of pension systems and capital markets consistent with a further development of the latter.

Appendix and statistical tables

Appendix: Sources of information used according to the type of required indicator

i) indicators of pension systems

- AIOS (Asociación Internacional de Organismos de Supervisión de Fondos de Pensiones). Semi-Annual Statistical Bulletin and Monthly Statistics. Available at www.aiosfp.org/

- OECD (Organisation for Economic Co-Operation and Development). *Pension Markets in Focus Issue 9. OECD Global Pension Statistics OECD Pensions at a Glance.* Available at www.oecd.org/daf/fin/private-pensions/PensionMarketsInFocus2012.pdf www.oecd.org/finance/private-pensions/globalpensionstatistics.htm - www.oecd-ilibrary.org/finance-and-investment/pensions-at-a-glance
- FIAP (Federación Internacional de Administradoras de Fondos de Pensiones). Quarterly reports. Semiannual reports. Available at www.fiap.cl/prontus_fiap/site/edic/base/port/semestral.html - www.fiap.cl/prontus_fiap/site/edic/base/port/trimestral.html
- THE WORLD BANK. *World Development Indicators. Financial Structure Dataset 1990-2010* Available at data.worldbank.org/data-catalog/world-development-indicators – econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20696167~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html
- IOPS (International Organisation of Pension Supervisors) *IOPS Country profiles*. Available at www.oecd.org/site/iops/iopsresearch/.
- Regular statistical information of pension fund supervisors
    - Brasil: Assoc. Brasileira das Entidades Fechadas de Previdência Priva - www.abrapp.org.br
    - España: Asociación de Instituciones de Inversión Colectiva y Fondos de Pensiones - www.inverco.es
    - Kosovo: Kosovo Pension Saving Trust (KPST, www.trusti.org)
    - Latvia: State Social Insurance Agency of Latvia (Valsts sociālās apdrošināšanas aģentūra (VSAA), www.vsaa.lv)
    - Nigeria: http://www.pencom.gov.ng
    - Panamá: Sistema de Ahorro y Capitalización de Pensiones de los Servidores Públicos - www.siacap.gob.pa
    - República Checa: Czech Nacional Bank https://www.cnb.cz/en/ -OECD GPS database
    - Ucrania: Non - State Pension Provision System: http://bank.gov.ua/control/en/

ii) Capital markets and general economic indicators

- International Monetary Fund. IMF indicators. World Economic Outlook Database. Available at www.imf.org/external/data.htm - www.imf.org/external/pubs/ft/weo/2012/01/weodata/index.aspx
- WFE (World Federation of Exchanges). Annual statistics reports. Monthly reports. Available at www.world-exchanges.org/statistics/annual-query-tool – www.world-exchanges.org/statistics/monthly-query-tool

- FIAB (Federación Iberoamericana de Bolsas de Valores). Annual and monthly reports. Available at www.fiabnet.org/es/categoria.asp?id_categoria=50 - http://www.fiabnet.org/es/categoria.asp?id_categoria=49
- CIA (Central Intelligence Agency). The World Factbook. Available at https://www.cia.gov/library/publications/the-world-factbook/index.html
- LABORSTA (International Labour Office Database on Labour Statistics). The 2010 Revision of the World Population Prospects. Available at http://laborsta.ilo.org/applv8/data/EAPEP/eapep_E.html
- Regular statistical information of capital markets supervisors

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