Regulatory Environment and Pension Investment Performance

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May 31, 2013

Abstract

Using the most comprehensive publicly available data to-date, we study the effect of three aspects of pension regulation (namely quantitative investment restrictions, minimum return or benefit guarantee, and the type of supervising authority) on risk-adjusted funded pension performance in 27 countries. Regulatory strictness' influence on the Sharpe ratio of investment return depends on a country's level of economic development. In emerging market economies, existence of quantitative investment restrictions across asset classes adversely affects risk-adjusted returns. This impact is more severe if higher investment limits are imposed on equities and foreign assets, as opposed to on bonds. Having a minimum benefit or return guarantee, as well as having a specialized supervising authority has no statistically significant effect on the risk-adjusted returns regardless of economic development.

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1 Introduction

The regulatory environment of funded pension undertakings varies across countries. While the purpose of pension provision institutions across countries is aligned, i.e. to safeguard retirees' welfare, national regulations are heterogenous. This heterogeneity may stem from the varying extent to which possibly conflicting interest among and within all entities who are engaged in pension provision is reflected. For instance, a retiree's desire to attain safe, sufficient income to maintain a certain standard of living at retirement is contrasted with the disinclination to save large proportions of wages during working years. Thus, individuals seek a balance between security and profitability via investments. Besides that, the authorities would like pension funds to diversify away investment risks, but may also have the subsidiary desire to encourage local capital market development and economic growth by mandating domestic investment[1]. Establishing a sound retirement savings system requires a diversified investment environment to spread risks, and this suggests that development of well-functioning capital markets and financial institutions are intimately linked. Thus, the regulatory environment of funded pensions is situated within the larger financial markets regulation framework, but has unique considerations that extend beyond protection against financial market failures.

The wide scope of funded pension funds' regulation encompasses legal, accounting, technical, financial, and managerial criteria - similar to other financial institutions - but also includes pension-particular ones such as indexation and vesting. In this paper, we focus on three crucial aspects of pension regulation, for which public data is available for a great number of countries, namely investment restrictions (IRs), minimum performance or benefit guarantee (MG), and the type of supervising authority (SA).

IRs refer to minimum or maximum portfolio limits by asset classes . These limits may impede optimal asset allocation by restricting opportunities for diversification. Yet, since the limits typically endorse safer fixed-income investments, they could also avoid severe losses in the event of a stock market crash. While portfolio limits may reduce returns, it also reduces risks, hence the overall impact on risk-adjusted return is unclear. In Latin America, such quantitative limits on investments are the norm. In the European Economic Area, talks are underway to implement a risk-based supervision framework akin to "Solvency II" in the insurance industry. Countries such as the United States, United Kingdom, the Netherlands, Australia and New Zealand have comparatively laxer regulation on investment, many among which are generally based on the prudent person rule[2].

[1]The positive relation between the level of pension assets and economic growth is subject to debate. Evidence to support is provided by Holzmann (1996, 1997), Philip Davis and Hu (2008), Hu (2012). Literature that casts doubt on the link include Zandberg and Spierdijk (2013).

[2]The prudent person rule can be stated along the following principle, "A fiduciary must discharge his or her duties with the care, skill, prudence and diligence that a prudent person acting in a like capacity would use in the conduct of an enterprise of like character and aims" (Galer, 2002).

MG is the requirement that providers promise a minimum benefit level to its beneficiaries, or meet a minimum investment return guarantee that is either absolute, or relative to the industry average[3]. If such guarantees are financed by the fund's resources, this may induce fund managers to forgo volatile but potentially rewarding investments so as to attain the desired rate of return. On the contrary, if this guarantee is at least partially provided by a central pension guarantee fund[4], this could lead to varying severity of moral hazard problems that prompt excessively risky investments by the fund managers. Love et al. (2011) show that the type of pension guarantee (where the insurance is under-priced) that has been set up for private funds in the U.S. could lead pension funds to choose either one of the extremes on managing the risk of pension promise. Therefore, it is not immediately evident which among the opposing influences would prevail and the direction of their impact on risk-adjusted returns.

Apart from IR and MG, we also investigate the impact of the type of supervising authority, SA on risk-adjusted returns. The type of SA may have a less direct, but nonetheless important influence on investment returns. Two categories of SAs are considered. The authority is "specialized" if it supervises the pension industry only and "integrated" if it oversees the pension industry and at least one other financial services industry (e.g. insurance, banks, or both). There may be varying extent of similarity between regulations of pension, insurance and the banking industries - an integrated SA being most likely to result in more similarities. If this were true, then pensions under integrated supervision may face prudential-based regulation, with procedures and controls more alike those in banking and insurance industries. For instance, the Netherlands and Denmark are among early adopters of risk-based supervision in Europe, and perhaps non-coincidentally, both have integrated supervisors. While there are cost savings and efficiency arguments for integrated supervision, another view holds that since there are differences between the types of financial institutions, a differentiated approach allows for a uniquely tailored regulatory framework, so a specialized SA is called for. Philip Davis (2002) details fundamental differences between life insurance and pension funds that justify dissimilar regulation. More specifically, pension funds may have more risk-mitigation policy solutions than insurers as the former can offer solvency-contingent benefits, raise member contribution or fallback on sponsor support in the event of a funding shortfall. Additionally, Shi and Werker (2012) demonstrate that there is sizable wealth loss when a pension has to abide by solvency constraints with shorter horizon than a pension fund's typically long investment horizon. This casts doubt on the adoption of daily or even annual regulatory constraints

[3]The guarantees referred to here are both the central pension guarantee schemes to which plans pay a premium to insure their member's benefits (e.g. Pension Benefit Guaranty Corporation in the U.S.), and the plan-provided guarantee that protect members and beneficiaries from market risk (e.g. 4% target return for Swiss mandatory occupational DC plans).

[4]It is not always clear who is responsible for these guarantees in the event that a plan sponsor cannot honor its obligations. In Latin American countries, Hungary, Poland, and Switzerland, plans have an internal reserve. Some plans in the US, the UK, in addition to Hungary, Poland, and Switzerland, are under the protection of a central pension guarantee fund.

common in banking (e.g. Basel II) and in insurance (e.g. Solvency II) by the pension industry. Therefore, the controls and procedures applicable and relevant to a pension fund may differ. A thorough discussion on integration of pension supervision is presented in Demaestri and Ferro (2004).

The impact of regulation on investment performance has been studied in the context of mutual funds. Almazan et al. (2004) examine the influence of investment restrictions as found on investment policy statements of U.S. equity funds (e.g. no short-selling, no writing or investing in options on equities) on fund returns. Indexing a fund's restrictiveness by constructing a score as done by the authors is similar to our approach. They conclude that there is no statistically significant difference of returns on constrained and unconstrained funds. More recently, Agarwal et al. (2013) investigate the mandatory increase in the frequency of portfolio disclosures among mutual funds in the U.S. to find that the funds' risk-adjusted performance were harmed by the regulation change.

As for pension funds, extensive discussion on the topic has been initiated since the late 1990s, after many countries underwent pension reform. None of the works that we have come across rely on empirical analysis on wide cross-country investment returns data, most likely because data on pension investment had not been available until recently. Attempts to-date at evaluating pension investment performance globally are either descriptive (e.g. Tapia (2008) reports asset allocation, fund size and other summary statistics for private pension funds in 23 countries, Srinivas et al. (2000) compare regulations on pension industry structure, performance and investments of Latin American countries against those of other more developed countries using a patchwork of data from the 1990s), theoretical (e.g. Philip Davis (2002) assesses the justification, nature and consequences of prudent person rules and quantitative portfolio regulations to conclude that the former is more favorable, although the latter may be provisionally justified in emerging market economies), or geographically localized (e.g. Srinivas and Yermo (2010) investigates regulatory regimes of Argentina, Peru and Chile to conclude that the strict regime hampered pension investment performance). Other related works concern the appropriate measurement of performance for pension funds (e.g. Hinz et al. (2010) evaluate investment performance measures for pension funds, taking into consideration particular characteristics and objectives of pension systems), or seek to associate investment returns and pension design (e.g. Musalem and Pasquini (2012) find that higher returns are associated with schemes with larger asset under management, that are occupational and closed, etc.).

Our paper relies on cross-country empirical analysis to assess the impact of the regulatory framework on pension funds performances. We thus expand the analysis of Srinivas et al. (2000) to the global geographical scale, also taking into account the countries' level of economic development as is done in Philip Davis (2002), when evaluating the impact of the differences in regulation. We find that the impact of IRs on risk-adjusted returns strongly depends on the country's level of economic development. IRs in emerging market economies are associated to lower Sharpe ratio of investment returns. Furthermore, the severity of IRs' penalty on returns differs by asset class - restrictions on equities and foreign assets are more penalizing than on bonds. Specialized SAs in advanced economies appear to yield slightly better risk-adjusted investment performance, even if the evidence is only weakly significant. MG is not found to have any statistically significant impact on the Sharpe ratio regardless of the country's level of economic development. Having IR dependent on the country's level of economic development is reminiscent of the distinctions made in Philip Davis (2002). However, our empirical results either do not support Philip Davis (2002) surmise as emerging market economies are found to be adversely affected by quantitative investment restrictions, or suggest that the transitory restrictions are ill-timed (e.g. should be lifted sooner).

This paper proceeds by describing the data and methodology in Section 2, before discussing the results in Section 3. Section 4 concludes.

2 Data Description and Methodology

Funded pensions annual investment returns[5] of 27 countries from 2002-2010 are collected from the OECD Global Pension Statistics (OECD GPS), the Federación Internacional de Administradoras de Fondos de Pensiones (FIAP), and the Association of Latin American Pension Supervisors (AIOS)[6]. Eighteen of these countries are Advanced Economies, four are Economies-In-Transition and five are Emerging Market Economies (EME)[7]. The list of countries is presented in Table 1. In countries with more than one fund, a size-weighted average return is used, with size measured by the value of funds' asset under management. Only countries with complete observations for all years are included.

We investigate the impact of IRs, MG, and SA on pensions investment return via a standard linear regression model (estimated by OLS) with the Sharpe ratio of nominal returns (SR^{inv}) as dependent variable. SR^{inv} is our chosen measure of performance as it considers the tradeoff between risk and return. We preserve only the cross-section dimension of our panel data as the time range of our dataset spans eight years, hence we deem it insufficient to reveal any change in trend. Furthermore, this allows us to take the standard deviation along the sample period when calculating SR^{inv}. A six-month interest rate[8] is the chosen risk-free rate.

[5]Existing data do not allow for calculation of returns net of fees for all countries.

[6]The authors would like to thank Ricardo A. Pasquini and Alberto R. Musalem for the sharing of their data, which has been used to construct the series prior to 2007. Data for Croatia was obtained from the Croatian financial services supervisory agency (HANFA).

[7]International Monetary Fund's (IMF) definition.

[8]Interbank rates for Australia, Austria, Belgium, Croatia, Czech Republic, Denmark, Germany, Hungary, Ireland, Israel, Italy, Netherlands, Poland, Portugal, Spain, Switzerland, UK, US; government bond yields for Canada, Chile,

IR is investigated via four variables IR^k, $k \in \{G, e, b, f\}$. IR^G is the "global (G)" restriction that considers quantitative limit in nine asset classes and sub-classes - equities (listed and non-listed), real estate, bonds, investment funds, loans, bank deposits, foreign (OECD and non-OECD issued) - as obtained from the "OECD Annual Survey of Investment Regulation of Pension Funds". For each country, an annual[9] investment restrictiveness score is first constructed by counting the number of asset classes and subclasses in which a quantitative limit exists[10]. As an example, in Canada in 2003, there was a 15% limit in resource property, 30% limit in foreign securities, and no limit in other asset classes. Therefore, the investment restrictiveness score for Canada in 2003 is two. IR^G is defined as the average over the sample period of the investment restrictiveness score. IR^e, IR^b, and IR^f are refinements of IR^G as they are defined to be the time average of 100% less the actual portfolio limits in "equities (e)", "bonds (b)" and "foreign (f)" assets[11] (i.e 100 - Maximum investment allowed in asset class)[12]. For instance, a 30% limit is recorded as $100 - 30 = 70$. These variables refine the focus of investment restriction onto the two largest asset classes that funds are known to invest in (i.e. equities and bonds), as well as one of the most common restriction among pension funds.

The variables MG and SA are constructed as dummy variables. MG is defined to be one if a minimum return or benefit guarantee exists and zero otherwise. SA takes a value of one if the country's funded pension SA is specialized, zero otherwise. The corresponding coefficients estimated for MG and SA would then reveal the influence of minimum guarantees and the type of authority on risk-adjusted returns respectively.

Control variables are kept minimal due to the data's limited cross-sectional size, so as not to increase the variance of estimated coefficients. Since a pension fund's portfolio is mostly allocated in equities and bonds, the Sharpe ratio of local stock and bond markets index returns (SR^e, SR^b)[13] are included as controls to disentangle investment returns which are attributable to performance of the market, and those arising from portfolio limits. Besides that, pension scheme design variables are included to take

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Colombia, Mexico, Norway, Sweden; deposit rates for New Zealand, Peru, Turkey from Datastream.

[9] No survey was published in 2005 hence the average of 2004 and 2006 is used for that year.

[10] Information for non-OECD countries or countries that joined the OECD during our sample period is obtained from various sources. Chile, Colombia, and Mexico are included in the survey since 2006 but for prior years, the values for 2006 are taken. Investment restrictiveness for Peru and Croatia is gathered from OECD papers, national sources, and extrapolated between years when none could be found.

[11] Actual portfolio limits are often fund- or scheme-dependent. As the size of each fund or scheme is not always available, a size-weighted portfolio limit cannot be computed to be reconciled with the similarly size-weighted returns data. When this occurs, the median of the limits is taken.

[12] The reason to subtract the asset class limit from 100 is to simplify interpretation of the estimated coefficients. For all IRs, the higher the value, the more restrictive the conditions on asset allocation are.

[13] For all countries, SR^e is computed using the local stock market's MSCI total return index, except for the Netherlands (Dow Jones Titans 30), Portugal (FTSE World), and Slovak Republic (S&P BMI). As for SR^b, it is computed using total return index of bonds of all maturities (or those between 5-10 years) in local currencies from Barclays, JP Morgan, or Bank of America, whichever is available for the country. For Germany, the REX Index is used. All indices are obtained from Datastream or Bloomberg.

into consideration heterogeneity of the schemes that are being compared, such as whether the scheme is mainly defined benefit (DB) or defined contribution (DC), occupational or personal (OP), mandatory or voluntary (MV). The variable DC is defined as the percentage of DC schemes within the country. Similarly, OP is the proportion of occupational schemes, whereas MV is the percentage of mandatory schemes[14]. As regulations are likely to be tailored to scheme design, there may be suspicion that these design control variables are collinear with IRs or MG. Hence, variance inflation factors for all regression results in Section 3 are computed to abate any doubts of multicollinearity between IRs or MG with all design variables. Additionally, these classifications are consistent with the OECD taxonomy of pensions (Yermo, 2002). Accessibility of information due to a major portion of the countries in our study being members of the OECD gives us a large incentive to adopt them as control variables.

Besides pension design, we also consider whether a country's economic and financial market development may lead to diverging impact of investment restrictions on returns. Portfolio limits in a country where the financial market is more developed could be less penalizing than in a less developed one as the former may consist of more opportunities for diversification through its more varied economic sector. Furthermore, this approach is motivated by Philip Davis (2002), who suggests that emerging market economies are more likely to have weak capacities for self-regulation and governance structures, hence are more susceptible to manipulation by insiders. Also, foreign investments might be seen as risky in the absence of a well-established derivative market to hedge currency risks - a common situation in emerging market economies. We consider the different levels of economic development with the International Monetary Fund's classification. For each year, a country is assigned a score of 1 if it is an "Emerging Market Economy" (EME), 0.5 if "In Transition"[15], and 0 if an "Advanced Economy". The EME variable is the average score over the time period. It is interacted with IRs, MG, and SA to identify any effect of regulation that is dependent on the level of economic development.

Recap of the variables is presented in Table 2. From the summary statistics provided in Table 3, the maximum Sharpe ratio of investment return at 2.61 is that of the Czech Republic. Since the Czech Republic has no compulsory supplementary pillar, the data here is that of its voluntary personal plans offered by the private sector, which have consistently recorded two digit returns between 2002-2009. Belgium's pension returns are inferior to the risk-free rate on average, thus its SR^{inv} is the lowest among all countries, at -0.61. On average, pension funds achieve better risk-adjusted return than holding either all equities or all bonds as mean SR^{inv} is higher than the means of SR^e and SR^b. Countries impose

[14] OP and MV are size-independent proportions as the fund size-weighted percentages are not available. e.g. if aggregate returns data of a country is comprised of that of two schemes, one mandatory, the other voluntary, then MV takes the value 0.5, regardless of the value of asset under management of each scheme.

[15] This category was abandoned by the IMF since 2004 but we maintain the value of 0.5 for the countries concerned if and until they make the transition into the "Advanced Economy" category.

portfolio limits on fewer than four asset (sub-)classes in the mean. The standard deviation of IR^G is 3.02, which is high considering that it ranges from 1 to 9. Despite its simplicity in construction, IR^G does vary among countries. SR^b varies between countries more than SR^e.

We specify two regression models, the first set (without interaction terms, (2.1)) incorporating the IRs, MG and SA, market performance controls, as well as scheme design controls. These specifications pool all countries regardless of their level of economic development. The second set of specifications, (2.2), includes terms interacting EME with IRs, MG and SA in order to investigate whether the impact of investment restrictions varies with a country's level of economic development.

Without Interaction Terms

$$\begin{aligned} SR_i^{inv} &= \alpha + \beta^k IR_i^k + \beta^{MG} MG_i + \beta^{SA} SA_i + \\ &\quad \beta^e SR_i^e + \beta^b SR_i^b + \beta^{DC} DC_i + \beta^{OP} OP_i + \beta^{MV} MV_i + \epsilon_i \end{aligned} \tag{2.1}$$

With Interaction Terms

$$\begin{aligned} SR_i^{inv} &= \alpha + \beta^{L*EME} L_i \times EME_i + \beta^L L_i + \beta^{EME} EME_i + \\ &\quad \beta^e SR_i^e + \beta^b SR_i^b + \beta^{DC} DC_i + \beta^{OP} OP_i + \beta^{MV} MV_i + \epsilon_i \end{aligned} \tag{2.2}$$

Specification (2.1) represents four regressions, $k \in \{G, e, b, f\}$. Specification (2.2) represents six regressions, $L = IR^k$, $k \in \{G, e, b, f\}$, MG and SA. SR^{inv} is the Sharpe ratio of investment return, IR^k is the investment restrictions, $k \in \{G, e, b, f\}$, for global, equities, bonds, and foreign assets. MG is the indicator variable for whether minimum benefit or guarantee exists, SA is the indicator variable for specialized supervising authority. SR^e and SR^b are the Sharpe ratios of the equities and bond indices respectively. DC, OP, and MV are control variables defined as percentage of defined contribution plans, occupational, and mandatory plans respectively. EME is the emerging market economy variable. i is the country index.

3 Impact of Regulation on Risk-adjusted Returns

The regulatory environment's impact on risk-adjusted returns depends on a country's level of economic development. Investment restrictions, especially limits on equities and foreign assets, adversely affect the Sharpe ratio of investment return in emerging market economies. In advanced economies, specialized supervisory authorities is found to yield higher risk-adjusted return on average, though the estimated coefficient is barely significant. Existence of minimum benefit or return guarantee has no statistically significant impact on the Sharpe ratio of investment return regardless of the country's level of economic development.

The hypothesis that IRs, MG and SA may have different impact in advanced or emerging market economies motivates the analysis that segregates countries by level of economic development. Terms interacting IRs, MG, and SA with EME are introduced into the regression model. In EMEs, quantitative restriction on an additional asset class or subclass is synonymous with almost 0.6 lower SR^{inv} on average ((1) in Table 4). On the contrary, for advanced economies, more quantitative limits are found to improve SR^{inv} by 0.12, a counter-intuitive result. As pension systems in advanced economies have a longer history, this could be due to survivorship bias - countries that appear in the dataset have survived setting up of a pension scheme and are likely to be the ones with higher returns in the first place (Brown et al., 1992). For every additional percentage of investment prohibited by asset classes (i.e. IR^k, $k \in \{e, b, f\}$), equities and foreign assets, but not bonds, are found to lower the Sharpe ratio of investment return by 0.024 points ((4) and (6) in Table 4). However, it does not necessarily suggest that increasing the limit on either of equities or bonds would yield higher SR^{inv} equivalently because the foreign asset limit is all-asset-class-inclusive. Without more details on the schemes' asset allocation, no comparative influence of maximum limits on equities and foreign assets can be deduced. Therefore, investment restrictions are not only shown here to adversely affect the countries with relatively less developed financial markets and economy, but are likely to also have varying severity depending on the asset class concerned (e.g. foreign asset restrictions result in a stronger penalty than restrictions on bonds).

Since the coefficient associated to SA is significant and positive in the interaction model, having a specialized supervising authority corresponds to higher Sharpe ratio of investment return for advanced economies ((3) in Table 4). However, the estimated coefficient is only barely significant. Among the specifications with interaction terms, except for the specifications in which MG and IR^b are interacted with EME, the adjusted-R^2 is between 12 to 30%.

In the specifications without interaction terms, the coefficients of interest, that is, those corresponding to IR, MG and SA are statistically insignificant. To attempt to mitigate the possible issue of a large number of regressors with a small number of observations, IRs, MG, and SA are included singly. None of the estimates are statistically significant as well. Thus, even a simple analysis does not reveal any statistically detectable relation between IRs, MG, SA, and risk-adjusted returns.

Lower maximum investment allowed in equities and foreign assets is found to be associated to poorer risk-adjusted returns in EMEs. This outcome can be reconciled with that from the absence of statistical significance using the specification without interaction terms, by the observation that investment limits are much more stringent in EMEs. For instance, the average maximum limit on equities is 45% for EMEs, 61% for countries in transition, and 79% for advanced economies. As advanced economies are shown to not be adversely affected by investment restrictions, when the countries' level of economic development is not taken into account, no statistically significant impact is found on aggregate.

4 Conclusion

By combining data on pension investment returns, regulation on investment, performance and type of supervising authority of multiple countries from numerous sources, an attempt to uncover any global link between funded pension risk-adjusted investment returns and regulatory environment is carried out. Making the distinction between emerging market economies and advanced economies is an insightful way of investigating investment regulations on pensions. Stringent portfolio limits are associated with worse performance in EMEs. The stricter rules that EMEs face relative to advanced economies allow for noticeable improvements in the Sharpe ratio of investment returns if the restrictions were lifted. An analogous slackening of rules in advanced economies is not found to result in a similarly statistically significant boost in performance. There is weak evidence that specialized supervising authorities generate higher risk-adjusted returns among advanced economies. Existence of minimum guarantee on return or benefits has no statistically significant impact on the Sharpe ratio of investment returns.

A sustainable pension system evolves along with demographic changes and financial innovation, among other factors. Regulatory strategies and practices have to be adapted concurrently. With increased labor mobility, there is ongong effort for harmonized regulation among countries with close economic ties (e.g. revision of the IORP Directive in the European Union). Hence, the interest in comparing and contrasting approaches to pension regulation globally, beyond the three aspects considered here, is profound. In due time, more thorough analyses would be possible with improved data quality and consistency of its collection across countries.

References

Agarwal, V., Mullally, K., Tang, Y., and Yang, B. (2013). Mandatory portfolio disclosure, stock liquidity, and mutual fund performance. Working paper.

Almazan, A., Brown, K. C., Carlson, M., and Chapman, D. A. (2004). Why constrain your mutual fund manager? *Journal of Financial Economics*, 73(2):289–321.

Brown, S. J., Goetzmann, W., Ibbotson, R. G., and Ross, S. A. (1992). Survivorship bias in performance studies. *Review of Financial Studies*, 5(4):553–80.

Demaestri, E. and Ferro, G. (2004). *Private Pensions Series Supervising Private Pensions: Institutions and Methods*, chapter Integrated Financial Supervision and Private Pension Funds. OECD.

Galer, R. (2002). Prudent person approach. OECD, Second OECD Conference on Private Pensions in Brazil.

Hinz, R., Rudolph, H. P., Antolin, P., and Yermo, J., editors (2010). *Evaluating the Financial Performance of Pension Funds*. The World Bank.

Holzmann, R. (1996). Pension reform, financial market development, and economic growth: Preliminary evidence from chile. IMF Working Papers 96/94, International Monetary Fund.

Holzmann, R. (1997). On economic benefits and fiscal requirements of moving from unfunded to funded pensions. *European Economy Reports and Studies*, 4(121-166).

Hu, Y. (2012). Growth of asian pension assets: Implication for financial and capital markets. ADBI Working Paper Series 360, Asian Development Bank Institute.

Love, D. A., Smith, P. A., and Wilcox, D. W. (2011). The effect of regulation on optimal corporate pension risk. *Journal of Financial Economics*, 101(1):18–35.

Musalem, A. R. and Pasquini, R. (2012). Private pension systems - cross-country investment performance. Social Protection and Labor - Discussion Paper 1214, World Bank.

OECD. Annual survey of investment regulation of pension funds by the OECD. Technical report, OECD, http://www.oecd.org/finance/privatepensions/annualsurveyofinvestmentregulationofpensionfunds.htm.

OECD Pension Statistics (database). Pension indicators.

Philip Davis, E. (2002). Prudent person rules or quantitative restrictions? The regulation of long-term institutional investors' portfolios. *Journal of Pension Economics and Finance*, 1(02):157–191.

Philip Davis, E. and Hu, Y. (2008). Does funding of pensions stimulate economic growth? *Journal of Pension Economics and Finance*, 7(02):221–249.

Poteraj, J. (2008). *Pension Systems in 27 EU Countries.* The Association of Polish Scientists of Lithuania.

Shi, Z. and Werker, B. (2012). Short-horizon regulation for long-term investors. *Journal of Banking and Finance Finance*, 36(12):3227 – 3238.

Srinivas, P., Whitehouse, E., and Yermo, J. (2000). Regulating private pension funds' structure, performance and investments: Cross-country evidence. MPRA Paper 14753, University Library of Munich, Germany.

Srinivas, P. and Yermo, J. (2010). Do investment regulations compromise pension fund performance? evidence from latin america. *Revista de Análisis Económico – Economic Analysis Review*, 14(1).

Tapia, W. (2008). Comparing aggregate investment returns in privately managed pension funds - an initial assessment. OECD Working Papers on Insurance and Private Pensions 21, OECD.

Yermo, J. (2002). Revised taxonomy for pension plans, pension funds and pension entities. Technical report, OECD.

Zandberg, E. and Spierdijk, L. (2013). Funding of pensions and economic growth: Are they really related? *Journal of Pension Economics and Finance*, 12(2):151–167.

5 Tables

Table 1: List of countries by IMF classification

These are the countries included in our study, categorized by their level of economic development as determined by the IMF.

Economic Development	**Countries**
Advanced Economies (18)	Australia, Austria, Belgium, Canada, Denmark, Germany, Ireland, Israel, Italy, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.
Economies in Transition (4)	Croatia, Czech Republic, Hungary, Poland
Emerging Market Economies (5)	Chile, Colombia, Mexico, Peru, Turkey

According to the Tapia (2008), all countries in our data officially adopt marked-to-market reporting, except for Mexico (e.g. marked-to-model) and the Czech Republic (e.g. financial instruments held to maturity, securities of a collective investment fund or financial instruments not actively traded on a market is valued at the average price of transactions). All reported returns are annual except for Colombia, which reports the 36-month moving average return (Hinz et al., 2010).

Table 2: Description of Variables

This table presents all variables used in our analysis. Sources are listed in the rightmost column.

Variable	**Symbol**	**Description**	**Source**
Global Investment Restriction	IR^G	Average over the time period of the series of scores assigned to indicate existence of quantitative investment limits for equities (listed & non-listed), bonds, real estate, investment funds, loans, bank deposits, foreign assets (OECD & non-OECD issued).	OECD, and National Sources
Maximum Investment Allowed	IR^k $k \in \{e, b, f\}$	Average over the time period of the shortfall (relative to 100%) of maximum investment allowed, as a % of total portfolio, in equities [IR^e], bonds [IR^b] and foreign assets [IR^f]. e.g. if the maximum investment allowed in equities is 80%, then $IR^e = 100 - 80 = 20$.	OECD, and National Sources
Minimum Guarantee	MG	Equals 1 if the system provides a minimum return or benefit guarantee, zero otherwise.	Musalem and Pasquini (2012)
Specialized Supervisory Authority	SA	Equals 1 if the supervisory authority of the pension scheme in the country is specialized (i.e. supervises pension provision institutions only).	FIAP and National Sources
Sharpe Ratio of Funded Pension Investment Return	SR^{inv}	Sharpe ratio of funded pension nominal investment returns in local currency.	OECD GPS FIAP, AIOS, HANFA[a]
Sharpe Ratio of Stock Market Index	SR^e	Sharpe ratio of the stock market index of the country in which the pension schemes are located.	Datastream Bloomberg
Sharpe Ratio of Bond Market Index	SR^b	Sharpe ratio of the bond market index of the country in which the pension schemes are located.	
Emerging Market Economy[b]	EME	Average over the time period of the series that equals 1 if the country is classified as an "Emerging Market Economy", 0.5 if "In Transition", and 0 if an "Advanced Economy".	IMF
DC vs. DB	DC	Average over the time period of the percentage of DC schemes.	Musalem and Pasquini (2012) OECD Pension Statistics (database) Poteraj (2008)
Occupational vs. Personal	OP	Percentage of occupational scheme.	
Mandatory vs. Voluntary	MV	Percentage of mandatory scheme.	

[a]Croatian financial services supervisory agency

[b]Since the IMF ceased classifying countries as "Economies in Transition" in 2004, countries in this category were relegated to EMEs post-2004, but their corresponding values for the EME variable remain at 0.5 unless they made the transition to become an advanced economy within our sample period. Czech Republic made the transition in 2009. Its value for the EME variable is taken to be the mean of 0.5 between years 2002-08, and 0 in 2009-10, which is 0.3889.

Table 3: Summary Statistics

This table presents summary statistics of all variables used in our analysis. We observe that investment restrictions (IR^k, $k \in \{G, e, b, f\}$), our key measures of regulatory strictness have high standard deviations, reflecting the heterogeneity of the portfolio limits between countries. On average, our sample consists of less than half DC schemes, more occupational than personal schemes, and more voluntary than mandatory schemes. For pension scheme investment return, Sharpe ratios range from negative (e.g. for Belgium and New Zealand) to highly positive (e,g. Czech Republic and Italy). The standard deviation for maximum portfolio allocation allowed in foreign assets is higher than that for equities and bonds, as foreign assets are among the asset class with the most stringent limit in numerous countries such as Poland, Peru, Mexico and Croatia.

Variable	**Min**	**Median**	**Mean**	**Max**	**Standard Deviation**
IR^G	0	4.44	3.89	9.00	3.02
IR^e	23.50	83.75	72.17	100	28.41
IR^b	30	100	81.44	100	25.51
IR^f	5	91	70.61	100	34.73
MG	0	1	0.63	1.00	0.49
SA	0	0	0.26	1	0.45
SR^{inv}	-0.61	0.44	0.60	2.61	0.62
SR^e	-0.14	0.19	0.25	0.79	0.24
SR^b	-0.49	0.33	0.54	1.18	0.39
EME	0	0	0.26	1.00	0.40
DC	0	29.79	46.48	100	44.80
OP	0	66.67	58.67	100	37.59
MV	0	37.50	38.96	100	39.69

Table 4: Impact of IR, MG, and SA on risk-adjusted return: With interaction terms

Results of specifications with interaction terms imply that in emerging market economies, the Sharpe ratio of investment returns is lower when there are more stringent investment restrictions. This is not the case in advanced economies. Maximum limits on equities and foreign assets, but not bonds are shown to be associated to lower SR^{inv} in EMEs as well. The F-statistic's P-value for the model with IR^G (column (1)) is 0.05914, slightly above the usual threshold of 0.05. Moreover, it has among the best adjusted-R^2.

	Dependent variable of OLS model:					
	Sharpe Ratio of Investment Returns					
	(1)	(2)	(3)	(4)	(5)	(6)
IR^G	0.120** (0.053)					
IR^e		0.001 (0.006)				
IR^b			0.006 (0.007)			
IR^f				0.005 (0.005)		
MG					0.027 (0.306)	
SA						0.758* (0.390)
EME	3.136* (1.764)	0.459 (0.826)	0.026 (0.782)	0.269 (0.696)	−0.100 (0.829)	−1.233 (0.810)
SR^e	0.950 (0.837)	1.095 (0.907)	0.948 (0.983)	1.127 (0.891)	1.424 (0.978)	2.128** (0.973)
SR^b	0.053 (0.294)	0.276 (0.319)	0.209 (0.323)	0.206 (0.313)	0.207 (0.345)	0.423 (0.335)
DC	0.004 (0.004)	0.005 (0.004)	0.005 (0.004)	0.006 (0.004)	0.005 (0.004)	0.004 (0.004)
OP	−0.003 (0.004)	−0.003 (0.005)	−0.004 (0.005)	−0.003 (0.005)	−0.005 (0.006)	−0.005 (0.005)
MV	−0.003 (0.003)	−0.004 (0.003)	−0.004 (0.003)	−0.003 (0.003)	−0.005 (0.003)	−0.004 (0.003)
$IR^G * EME$	−0.635** (0.248)					
$IR^e * EME$		−0.024* (0.013)				
$IR^b * EME$			−0.024 (0.015)			
$IR^f * EME$				−0.024** (0.010)		
$MG * EME$					−1.146 (0.904)	
$SA * EME$						−0.548 (0.675)
Constant	0.358 (0.460)	0.454 (0.504)	0.564 (0.536)	0.391 (0.504)	0.599 (0.563)	0.257 (0.523)
Observations	27	27	27	27	27	27
R^2	0.515	0.413	0.361	0.461	0.337	0.395
Adjusted R^2	0.300	0.152	0.078	0.221	0.042	0.126
Residual Std. Error (df = 18)	0.519	0.571	0.595	0.547	0.607	0.579
F statistic (df = 8; 18)	2.394*	1.584	1.274	1.921	1.141	1.470

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$