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# Regulatory Environment and Pension Investment Performance

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## 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 pension undertakings varies across countries. While the purpose of pension provision institutions across countries is aligned, i.e. to safeguard retirees' welfare, transnational 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. The authorities would like to allow 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<sup>1</sup>. Thus, the importance of each entity's desire in the legislative process would influence the achieved compromise that underlies the regulatory environment.

Since regulations directly govern the behavior of pension funds, such as prohibiting investment in an asset class, it is plausible that transnational regulatory environment and investment results are linked. In this paper, we focus on three aspects of the regulatory framework, namely investment restrictions (IRs), minimum performance or benefit guarantee (MG), and the type of supervising authority (SA), in order to uncover any link between cross-country funded pension investment performance and the regulatory environment.

IRs refer to minimum or maximum portfolio limits by asset classes, such as a 70% limit on equities in Denmark in 2009. These limits may impede optimal asset allocation by restricting opportunities for diversification. Yet, since the limits typically endorse safer fixed-income investments - such as in 2009, Poland imposed a 40% limit on primary markets listed equities but no limit in treasury bonds on its mandatory personal pension fund - they could also avoid severe losses in the event of a stock market crash. 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<sup>2</sup>.

MG is the requirement that providers promise a minimum benefit level to its beneficiaries, or meet a

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<sup>1</sup>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).

<sup>2</sup>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).

minimum investment return guarantee that is either absolute, or relative to the industry average<sup>3</sup>. Such guarantees may induce fund managers to forgo volatile but potentially rewarding investments so as to attain the desired rate of return. On the contrary, the extent to which the guarantees are financed by the fund's resources<sup>4</sup> could lead to varying severity of moral hazard problems that prompt excessively risky investments by the fund managers. For example, in Chile, Argentina, Peru and Colombia, funds are required to achieve a minimum rate of return that is relative to the industry average. The funds set up internal reserves to be able to provide the guarantee in the event of a shortfall in all countries, but only in Chile and Argentina that the government steps in when the internal reserve is insufficient to meet the minimum. In Switzerland, occupational pension funds have to provide an absolute 4% nominal guarantee which may have contributed to the funds' typically conservative investment policies. That pension insurance affects fund behavior has been shown by Love et al. (2011), in which US funds are postulated to choose either one of the extremes on managing the risk of pension promise when the insurance is underpriced or only partial. This toggling of risk levels can be achieved via allocation in risky assets that may yield high, but uncertain returns. Therefore, there exist arguments for and against IR and MG, but it is not immediately evident which among the opposing influences would prevail and the direction of their impact on 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 the pensions investment returns. Two categories of SA 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 more prudential-based regulation, as is the case for banking and insurance regulations. For example, the Netherlands and Denmark are among early adopters of risk-based supervision in Europe, and perhaps non-coincidentally, both have integrated supervisors. 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. The arguments to have an integrated or specialized SA in a more general setting of the financial market is presented in Rocha et al. (1999). Philip Davis (2002) details fundamental differences between life insurance and pension funds that jus-

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<sup>3</sup>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).

<sup>4</sup>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.

tify dissimilar asset regulation. While IR and MG are the more straightforward aspects to study when risk-adjusted returns are concerned due to their direct impact on portfolio allocation hence investment returns, SA may reveal insights on the regulatory environment relative to those of insurance and banking.

The impact of regulation on investment performance has been studied in the context of mutual funds. Almazan et al. (2004) examine the investment restrictions (e.g. no short-selling, no writing or investing in options on equities), as found on investment policy statements of U.S. equity funds, on fund returns. They conclude that there is no statistically significant difference of returns on constrained and unconstrained funds. Indexing a fund's restrictiveness by constructing a score as done by Almazan et al. (2004) is similar to our approach. 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 (e.g. Srinivas and Yermo (1999), Srinivas et al. (2000), Philip Davis (2002)), when many countries underwent pension reform. None of the works that we have come across rely on empirical analyses 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), theoretical (e.g. Philip Davis (2002) assesses the justification, nature and consequences of prudent person rules and quantitative portfolio regulations and concludes that the former is more favorable, although the latter may be provisionally justified in emerging market economies), 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.). The topic of this paper is close to that of Philip Davis (2002) as the countries' level of economic development is taken into account when evaluating the regulation, but our approach resembles that of Musalem and Pasquini (2012), as we rely on cross-country data analysis. We hope to add to the mainly descriptive or geographically localized existing findings on the pension industry regulations and investment returns.

We find that the impact of IR and SA on risk-adjusted returns depends on the country's level of development. IR in emerging market economies is associated to lower Sharpe ratio of investment returns. Furthermore, the severity of IR's 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

better risk-adjusted investment performance but there are too few advanced economies with specialized SAs to be certain about the result. As for MG, it is not found to have any statistically significant impact on the Sharpe ratio regardless of the 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 do not support Philip Davis’ surmise as emerging market economies are found to be adversely affected by quantitative investment restrictions.

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<sup>5</sup> 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)<sup>6</sup>. Eighteen of these countries are Advanced Economies, four are Economies-In-Transition and five are Emerging Market Economies (EME)<sup>7</sup>. 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<sup>8</sup> is the chosen risk-free rate.

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 ob-

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<sup>5</sup>Existing data do not allow for calculation of returns net of fees for all countries.

<sup>6</sup>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).

<sup>7</sup>International Monetary Fund’s (IMF) definition.

<sup>8</sup>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, Colombia, Mexico, Norway, Sweden; deposit rates for New Zealand, Peru, Turkey from Datastream.

tained from the “OECD Annual Survey of Investment Regulation of Pension Funds”. For each country, an annual<sup>9</sup> investment restrictiveness score is first constructed by counting the number of asset classes and subclasses in which a quantitative limit exists<sup>10</sup>. 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<sup>11</sup> (i.e. 100 - Maximum investment allowed in asset class). For instance, since Canada had a 30% limit on foreign assets in 2003, the time series from which its  $IR^f$  is constructed has a value of  $100 - 30 = 70$  in 2003.  $IR^k$ ,  $k \in \{e, b, f\}$  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 international diversification (i.e. via foreign assets), which has high potential in reducing idiosyncratic shocks in pension investment return. The reason to subtract the asset class limit from 100 is to assist interpretation of the estimated coefficients later. For all  $IRs$ , the higher the value, the more stringent the restrictions on asset allocation are.

The variables  $MG$  and  $SA$  is 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, in order 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 ( $SR^e$ ,  $SR^b$ )<sup>12</sup> 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

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<sup>9</sup>No survey was published in 2005 hence the average of 2004 and 2006 is used for that year.

<sup>10</sup>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.

<sup>11</sup>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.

<sup>12</sup>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.

to take 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<sup>13</sup>. As regulations are likely to be tailored to scheme design, there may be suspicion that these design control variables are collinear with  $IR$  or  $MG$ . Hence, variance inflation factors for all regression results in Section 3 are computed to abate any doubts of multicollinearity between  $IR$  or  $MG$  with all design variables. 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 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 investment might be seen as risky in the absence of a well-established derivative market - 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”<sup>14</sup>, 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 is 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  $SR^b$ . The standard deviation

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<sup>13</sup> $OP$  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.

<sup>14</sup>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.

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 five 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) to (2.4)) includes terms interacting  $EME$  with  $IRs$ ,  $MG$  and  $SA$  in order to investigate whether the impact of investment restriction depends on 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

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

$$\begin{aligned}
SR_i^{inv} &= \alpha + \beta^{MG*EME} MG_i \times EME_i + \beta^{MG} MG_i + \beta^{EME} EME_i + \\
&\quad \beta^e SR_i^e + \beta^b SR_i^b + \beta^{DC} DC_i + \beta^{OP} OP_i + \beta^{MV} MV_i + \epsilon_i
\end{aligned} \tag{2.3}$$

$$\begin{aligned}
SR_i^{inv} &= \alpha + \beta^{SA*EME} SA_i \times EME_i + \beta^{SA} SA_i + \beta^{EME} EME_i + \\
&\quad \beta^e SR_i^e + \beta^b SR_i^b + \beta^{DC} DC_i + \beta^{OP} OP_i + \beta^{MV} MV_i + \epsilon_i
\end{aligned} \tag{2.4}$$

Specifications (2.1) and (2.2) represent four models each, with  $k \in \{G, e, b, f\}$ .  $SR_i^{inv}$  is the Sharpe ratio of investment return,  $IR_i^k$  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.  $DC$ ,  $OP$ , 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. For specification (2.1), we also attempt the inclusion of  $IR^k$ ,  $MG$  and  $SA$  singly.

### 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 there are too few advanced economies with specialized authorities to be certain. 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<sup>15</sup> ((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. 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. Additionally, significance of the estimated coefficient of  $IR^f$  is at the 0.05 level, higher than that for  $IR^e$  which is at the 0.1 level, perhaps highlighting foreign asset class' higher potential for improving risk-adjusted returns in EMEs. 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 as-

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<sup>15</sup>The F-Statistic of this model has a p-value of 0.05914, slightly above the usual 0.05 threshold.

set 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, caution is advised on its interpretation as there are only three advanced economies with specialized supervisors in the sample, as opposed to fourteen with integrated supervisors. Thus, the sample from which the estimates are derived from warrants some doubt. 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 are not taken into account, no statistically significant impact is found on aggregate.

## 4 Conclusion

By combining data on pension investment returns, design, 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 performance. An analogous slackening of rules in advanced economies is not found to result in a similarly statistically significant boost in performance.

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## 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.

<b>Economic Development</b>	<b>Countries</b>
<b>Advanced Economies (18)</b>	Australia, Austria, Belgium, Canada, Denmark, Germany, Ireland, Israel, Italy, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.
<b>Economies in Transition (4)</b>	Croatia, Czech Republic, Hungary, Poland
<b>Emerging Market Economies (5)</b>	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 <sup>a</sup>
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 <sup>b</sup>	$EME$	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.	

<sup>a</sup>Croatian financial services supervisory agency

<sup>b</sup>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 remains 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 restriction ( $IR^k$ ,  $k \in \{G, e, b, f\}$ ), 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 (i.e. for Belgium and New Zealand) to highly positive (i.e. 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.

<b>Variable</b>	<b>Min</b>	<b>Median</b>	<b>Mean</b>	<b>Max</b>	<b>Standard Deviation</b>
$IR^G$	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- $R^2$ .

	<i>Dependent variable of OLS model:</i>					
	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 <sup>2</sup>	0.515	0.413	0.361	0.461	0.337	0.395
Adjusted R <sup>2</sup>	0.300	0.152 <sup>15</sup>	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:

\* $p < 0.1$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$