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The Impact of Minimum Return Guarantees on Management of Mandatory Pension Funds in Croatia*

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Abstract

Mandatory pension funds in Croatia are defined contribution funds, meaning the investment risk is transferred to fund members. However, fund members are entitled to a guaranteed relative return: pension companies have to set aside a guarantee deposit that would be activated in case of underperformance. In this article, we quantify the risk of activation of the guarantee scheme and explore the impact of return guarantees on the way pension funds are managed. Findings suggest that the risk of activation of the guarantee scheme is quite low. We also find some evidence of herding among portfolio managers, as pension fund management companies could further reduce the risk of activation of the guarantee scheme by aligning their portfolios with competitors.

1. Introduction

Faced with an aging population, many countries, such as Croatia, introduced mandatory defined contribution pension plans (DC plans) to complement struggling government-sponsored PAYG systems. DC plans are a way to mitigate long-term financial pressure on budgets by transferring part of the responsibility for old-age financial security from the government to individuals. In DC plans, plan participants bear the investment risks. Because of that, in many jurisdictions DC plans are accompanied by some kind of return guarantee.

The Mandatory pension fund Act (2014) prescribes a relative return guarantee to be paid to fund members by pension fund management companies in case they underperform the pension funds' market return by a certain margin. Because such guarantees may have significant financial impact on a pension company, one could debate whether they are motivating managers to converge towards similar investment portfolios rather than encouraging them to compete by developing individual investment strategies. In this paper we are investigating how relative return guarantees can impact the way pension funds are managed. We quantify the risk of activation of the guarantee scheme in Croatia and look for evidence of herding.

The rest of this paper is organized as follows. In the second section, we present an overview of the pension system in Croatia focusing on the second pillar, i.e.

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mandatory pension funds.[a] The third section discusses guarantees in defined contribution pension plans while in the fourth section we are bringing a critical overview of the current guarantee scheme in Croatia along with its historical evolution. Methodological considerations and the results of our research on the risk of activation of the guarantee scheme and the herding effect are presented in the fifth and sixth section. The seventh section concludes.

2. Overview of the pension system in Croatia

Mandatory defined contribution pension funds have been in existence in Croatia since 2002. The Act (1999) was the first legislative document establishing the legal regime for pension funds management: it introduced mandatory and voluntary privately managed pension funds to complement the existing government sponsored pay-as-you-go system (PAYG). The PAYG mechanism is called the first pillar of the pension system. Mandatory pension funds are referred to as the second pillar, while voluntary pension funds are called third pillar funds. In parallel, the Act on Pension Insurance Companies and the Pay-outs of Pensions Based on Individual Capitalized Accounts provided for the creation of specialized insurance companies to which the assets accumulated in mandatory and voluntary pension funds must be transferred at retirement and where they are transformed into annuities. Every month, 15% of each employee’s gross salary is transferred to the government PAYG system while 5% is transferred to a defined contribution mandatory pension fund. Current pensions’ pay-outs are financed with this 15% contribution and substantial subsidies from the state budget. The 5% are credited to employees’ individual accounts in pension funds and are deemed their private property. Pension funds’ members bear the investment risk during their membership in the mandatory pension fund. At retirement, their assets are transferred to a pension insurance company which will offer them a defined benefit program and will guarantee lifelong pay-outs. At employment, new employees are allowed to choose their pension fund. Employees that opt not to make this choice are allocated automatically and randomly to a pension fund.

Mandatory pension funds are managed by specialist enterprises created for this exclusive purpose, operating under the name of mandatory pension companies. The market consists of four mandatory pension companies. Until 2014, each of these companies managed one pension fund and all the participants were assuming the same risk profile. A proxy life-cycle model introduced by the Act (2014) saw the creation of three mandatory pension funds categories with different risk profiles: category A, B and C. Each pension company must offer all three categories to the system participants. The models differ with respect to their maximum exposure to equities. Category C funds are the most conservative and do not involve equity exposure. In terms of

[a] For the purpose of this paper, the following definitions shall apply:

a) “Fund” means a mandatory pension fund, if not stated differently.

b) “Pension company” means a mandatory pension fund management company, if not stated differently.

c) “NAV” means net asset value and refers to the value of assets under management in a mandatory pension fund, if not stated differently.

d) “Act (2014)” refers to the Act on Mandatory Pension Funds from 2014.

e) “Act (1999)” refers to the Act on Mandatory and Voluntary Pension Funds from 1999.

investment strategy and limits as well as assets under management, category B funds are clearly the successors of the funds created in 2002. Category A funds are the most aggressive as regards to equity exposure. The Act (2014) also allowed pension companies to manage voluntary pension funds, which led to some consolidation of activities within financial groups that were offering both mandatory and voluntary pension funds. The third pillar voluntary pension funds are not analysed in this paper.

Mandatory pension companies are profit organizations charging fees to fund members. The regulations currently allow them to charge entry fees, management fees and exit fees. Entry and exit fees represent only a marginal source of revenue to the pension companies. The bulk of their revenues comes from a yearly management fee charged on the assets of the pension funds. Until 2014 the Croatian Financial Services Supervisory Agency (HANFA) had the right to set the maximum level of fees, while the Act (2014) stipulated a regular yearly decrease in fees from 2016 forward until it reaches the level of 0.3% p.a. The maximum yearly management fee in 2015 was 0.45%.

The growth of assets under management of mandatory pension funds has been quite significant since the start of the reform: at the end of 2016 they managed around 11.1 billion euros for more than 1.7 million members. Their assets represented over 20% of Croatia's GDP. Pension companies are currently by far the country's largest institutional investors and occupy a prominent position in the organization and functioning of the national capital market.

Pension companies are subject to various regulations and are supervised by HANFA. The Act (1999) introduced investment and diversification rules and some minimum standards of corporate governance. It also stipulated a minimum percentage of assets invested in Croatian government bonds. The rationale for such a provision was the necessity to finance the increased deficit in the PAYG system when part of the mandatory monthly contributions diverted to second pillar funds. Although the Act (2014) allowed the funds to diversify their investments away from Croatian government bonds, the latter still represent the bulk of the funds' assets. Continuous budget deficits and an environment of historically low yields in countries with higher investment ratings are probably the most important reasons for that. The Act (2014) did not change radically the investment limits set in 1999 but it introduced more stringent governance rules.

3. Guarantees in defined contribution pension plans

Unlike in traditional defined benefit schemes, participants in DC plans are faced with capital market risk during the accumulation phase. Obviously, the risk for the individual fund member is higher in later years, when the amount accumulated is substantial while time before retirement remaining to recoup the losses is limited. Grande and Visco (2010) are highlighting this risk using the example of the 2008 financial crisis: "For the United States, for instance, there is evidence that in 2008 many 401(k) participants nearing retirement (aged 56–65) had very high exposures to equities and suffered large reductions in their account balances (on the order of 25 per cent)". As a result, academics and practitioners are putting forward two main proposals to alleviate the impact of market risk on DC plans: the establishment of default life-cycle investment strategies and the introduction of minimum return guarantees. One does not exclude the other. The role of the guarantee is to protect retirement income against major investment losses. Enhanced confidence in DC plans should then facilitate public support of pension reforms. There is a number of papers dealing with the issue of protection against capital losses for defined contribution fund members. Some authors such as Grande and Visco (2010) or Deelstra et al. (2004) offer ideas for improving the existing guarantee models while others like Pennacchi (1999), Lachance et al. (2002) or Mahayni et al. (2003) examine the cost of the guarantees. This paper takes a different approach as it deals with the decision-making process within pension companies, the calculation of the probability of activating the guarantee scheme and looks for evidence of herding.

The focus of guarantees can be the level of retirement income (e.g. maintaining a “flat benefit” independent of past contribution and wage history or topping up insufficient retirement savings) or the rate of return of retirement savings. Rate of return guarantees can take two major forms: absolute return guarantees and relative return guarantees. Absolute return guarantees are set against a pre-specified return in nominal or in real terms. One could also envisage using the nominal growth rate of the GDP as a reference (Grande and Visco, 2010). One special case is a 0% return guarantee, which protects only the nominal value of contributions. Relative return guarantees are determined in relation to the market benchmark, a synthetic investment portfolio or the average performance of pension funds in the industry. Relative return guarantees do not predetermine the minimum value of the accumulated savings. In other words, they protect participants against underperformance of a specific plan provider rather than against generalized adverse conditions in financial markets. If they are not based on long return periods and appropriate benchmarks, relative return guarantees can create behavioural biases unfavourable to plan participants.

Although they are appealing to the public, guarantees are costly and have to be paid for, eventually. The higher the reference return, the more the guarantee will cost. The price of the guarantees also varies with the contribution period, the investment strategy and initial capital market conditions. The shorter the contribution period and the riskier the investment strategy is, the higher the cost of the guarantee. For example, according to Antolín et al. (2011), protecting only the nominal value of the contribution would be relatively cheap and may cost less than ten basis points of the net assets accumulated p.a., provided that the guarantee is given in the context of a defined contribution plan with a fixed contribution period and with a pre-set investment strategy. Ongoing guarantees (valid at any time during the contribution period), guarantees offering higher minimum returns or guarantees for plans whose investment strategy may change would be much more expensive and would therefore reduce substantially the expected values of savings at retirement. Whether they are provided commercially or not, the cost of guarantees can be calculated using option-pricing models and should be made as transparent as possible. An idea of the cost of the guarantee is important in order to make an informed decision whether to offer a guarantee or not. In this study, we do not engage in the calculation of the cost of guarantees, but rather with the probability of triggering the guarantee.

Grande and Visco (2010) have identified three basic forms of minimum return guarantees:

a) Financial market based instruments, where portfolio choices are circumscribed to fixed-income securities or derivatives options contracts are subscribed.

b) Third parties, such as an insurance company or the pension fund sponsor, can provide them.

c) They can be based on a reserve fund (at the level of the individual fund or groups of funds) or on other forms of mutual risk transfer.

Depending on the model, if the returns fall below the predefined minimum threshold, the difference will be made up from resources within the pension fund, from the capital of the pension fund manager, from a central guarantee fund, from a third party commercial provider or from the government. Local regulation often states the sequential order in which the gap should be filled from the various sources.

In any case, guarantees reduce the expected value of retirement income, whether a guarantee premium is paid directly or the investment strategy adapts to the risk of activation of the guarantee. For instance, in Slovakia when the 0% guarantee was introduced after the financial crisis, the pension fund managers moved to more conservative investment strategies, with higher bond and bank deposit allocations (Antolín et al., 2011). This can have a detrimental impact on the long-term return of the plan participants.

Besides their explicit or implicit cost, there are other drawbacks to return guarantees in DC plans:

a) Moral hazard: pension fund managers may choose high-risk assets knowing that the returns will be protected if the investment does not pay off. The risk of moral hazard can be reduced by imposing portfolio restrictions and/or financing at least partly the cost of the guarantee by self-insurance on the fund managers' own resources.

b) Public deficit: if the government guarantees minimum returns, it will increase its liabilities, which may not be opportune. In addition, a public guarantee may favour moral hazard.

c) Herding effect: the result of the combination of rate-of-return guarantees and portfolio restrictions in a number of countries has been herding of fund managers (World Bank, 2005). To avoid being an outlier in the distribution of returns (or relative to a benchmark) and so triggering guarantees that may impose a cost on the fund-management company, fund managers regress towards the same portfolio. The herding effect is reinforced by the relatively short period over which rate-of-returns are often assessed. This encourages fund managers to reject potentially rewarding, but volatile investments, which has a detrimental effect on long-term returns for plan participants.

d) Hampering mobility: return guarantees may hamper members' mobility across providers or fund managers. Antolín et al. (2011) propose several solutions to make the guarantee portable: making the guarantee ongoing (which makes it very expensive), having an independent guarantee underwriter or introducing a compensation mechanism between providers. In any case, portability issues add complexity to the system.

e) Lack of transparency: a danger with guarantees is that their costs, both on pension members and the potential liability to the government, are not transparent (World Bank 2005). This encourages governments to offer or impose larger guarantees than would be chosen if the costs were clearer.

f) Counterparty risk: counterparty risk over long-term horizons is a major concern if commercial third parties such as insurance companies provide guarantees. This is why Grande and Visco (2010) suggest that the government is a preferred provider of guarantees for pension plans.

g) Procyclical effects: guarantees can have procyclical effects, requiring larger capital demands in down markets. This is particularly relevant if guarantees are offered by commercial institutions or less creditworthy governments.

h) Not viable in case of extreme shocks: Grande and Visco (2010) warn that guarantees may not be able to insure against simultaneous, extreme, systemic shocks to a range of portfolio asset classes.

The merits and disadvantages of guarantees cannot be assessed without taking into consideration the context in which they are introduced. Antolín et al. (2011) underline that the rationale for introducing guarantees depends critically on the overall design of the pension system and whether there are already strong benefit guarantees embedded in public pensions, old-age safety nets, occupational defined benefit pensions, and some insurance products that may be bought during the working life, such as deferred annuities. The more generous such protection is, the smaller will be the share of retirement income affected by market risk and the least valuable minimum return guarantees will be. Another aspect that should not be neglected is that minimum return guarantees may help overcome popular fears over saving for retirement in DC plans. However, one must be aware that poorly designed guarantees can undermine reform and create large liabilities. As Walliser (2003) puts it: "The ultimate mix between individual risk exposure, government guarantees and government regulation determines the viability of the pension system in the long term."

Although it is self-evident, we believe that it is important to highlight that public-sector pension schemes are not risk-free either. They involve "policy risk" – the risk that the scheme might be reformed in the future so that benefits turn out differently than expected. This is particularly relevant for countries such as Croatia, which are facing a severe demographic decline and high level of public debt.

Finally, notwithstanding guarantees and life cycle investment strategies, governments can do much to mitigate capital-market risk and investment risk in general, mostly by enforcing prudential investment rules, imposing stringent governance and risk management standards, promoting transparency and competition and improving the efficiency of domestic capital markets.

4. Evolution of the return guarantee in the Croatian defined contribution mandatory pension funds

4.1 The evolution of the return guarantees regulation

Minimum return guarantees in Croatian defined contribution mandatory pension funds were introduced together with the pension reform through the Act (1999). The original version of the guarantee defined a reference return as the asset weighted average return of all mandatory pension funds calculated for each calendar year. In case the reference return for the year was positive, each fund member was guaranteed a minimum return of 1/3 of the reference return or a return equal to the Croatian National Bank discount rate, whichever was lower. In case the reference return was negative, each fund member was guaranteed a minimum return of three times the reference return. In case the return of a particular fund would be lower than the guaranteed return, the difference would have to be credited to the fund members' individual accounts. The sources to pay the difference were; firstly, the guarantee deposit, secondly the pension company share capital (up to 20% per year) and finally as the last resort – the government budget. The pension company had to maintain a guarantee deposit on a guarantee account opened with the depositary of the fund. It had to set aside 1 million Kuna (HRK) for each 10,000 fund members above an initial threshold of 100,000 members. The value of the minimum guarantee deposit was linked to the consumer price index and pension companies had to make additional yearly payments to maintain the real value of the initial payment. The pension company would retain a yearly success fee equal to 25% of the real return of the fund. 75% of this success fee had to be added to the guarantee deposit for a period of at least three years.

Although the original Act was passed in 1999, pension funds started gathering and managing assets three years later – in 2002. The original model of guarantees was amended for the first time as early as 2003, and again in 2007 and in 2014. In a nutshell, the main modifications included the following; the explicit guarantee by the government was excluded from the model, participation of fund members in the cost of the guarantee through the success fee was also waived, reference period was extended from one to three years and previously unlimited liability of the pension companies has been limited to 50% of their share capital.[b]

[b] In 2003, the threshold of 100,000 members, above which the guarantee deposit needs to be set aside, was lowered to 50,000 and the 1-year calculation period was replaced by a 3-years period. The 2007 changes were more substantial. The formulas for the calculation of the guaranteed minimum returns in case of positive or negative reference returns were replaced by a single formula guaranteeing to each fund member the reference return over the previous three calendar years reduced by 6 percentage points. The government disappeared as the guarantor of last resort. The stipulation on the pension company filling the gap with 20% of its share capital per year was replaced by a more general obligation of the pension company. In 2014, the stipulation on a 6-percentage point buffer was adapted to the creation of three proxy life-cycle funds (categories A, B, C): a buffer of 3, 6 and 12 percentage points was introduced for categories C, B and A, respectively. The pension companies were obligated to fill the gap in case of insufficient guarantee deposits with up to 50% of their share capital. Besides keeping the guarantee deposit in the depositary bank of the fund, pension companies were allowed to invest the money in Croatian treasury bills.

4.2 Critical aspects

In the following section, we debate the clarity and effectiveness of the guarantee return model. The original model included a relative return guarantee where each fund's yearly performance was compared to the performance of the market as a whole. The rules were initially set in a manner which ensured that activating the guarantee in the laggard fund would require severe underperformance: a fund would have to underperform the market by more than 66% in case of positive, or as much as three times, in case of negative returns. This seems unlikely to happen in a single year, especially in an environment with strict investment rules and high absolute levels of positive or negative returns. Of course, in case of near-zero returns, one can more easily imagine a fund breaking below the guaranteed return. However, the difference to be paid to fund members would then also be quite low.

The model also included an explicit guarantee from the government that it would fill the gap in case the guarantee deposit and the share capital of the pension company would be insufficient. However, it is not clear when the government would step in as the pension company was probably required to fill the gap in yearly instalments (it is difficult to precisely interpret the exact meaning of the provision of art. 58 of the 1999 Act). This implies that the government guarantee would be activated only if the pension company would refuse to pay the difference, its license would be revoked and another pension company, taking over the management of the fund, would negotiate with the government not to pay the difference.

It is not clear whether the guaranteed returns were meant to be calculated individually or at a fund level. On one hand, Article 58, Paragraph 1 of the Act (1999) explicitly stated that each fund member was guaranteed a minimum return and that his or her personal account would be credited with the difference. On the other hand, Paragraph 3 of the same article stipulated that the guarantee is to be activated if the return of the fund is below the guaranteed return. Obviously, an assumption was made that each fund member would realize the same time-weighted return in a calendar year, which is not completely true because it is possible that a member joins the fund during the year. Similar provisions are included in Article 113 of the Act (2014). Luckily, the model has never been tested in practice.

Although this could not have been known in advance, the fact is that only four pension companies managed to gather a sufficient number of members to remain in business. Two of the companies achieved a high market share while the other two are significantly smaller. In such a situation, when calculating the reference return as the asset weighted average return of the four funds, a clear advantage is given to larger funds as they have more influence on the reference return and hence a much lower risk of underperforming it significantly. This flaw could easily be corrected, for instance by using an equally weighted average return or comparing funds to the best performing fund for the calculation period.

In addition, the time horizon of one calendar year within which funds' performance was being evaluated clearly did not contribute to the development of distinctive long-term investment strategies. The fact that only four mandatory pension funds remained in business further facilitated the possibility of herding effect because it is easier to adapt its strategy to only a handful of competitors. This provision was subsequently modified to include a three-year average. Although the horizon was expanded, a three-year period still does not correspond to a long-term investment strategy. There is another, less obvious but more perverse, effect of the model. A fund manager continuously underperforming its peers, albeit within the allowed margin, will never be penalized while a competitor fund exhibiting a brilliant track record can potentially be severely punished for a single year of underperformance even though its members are much better off than members of the first fund, even when taking into account the single year of underperformance.

Another interesting feature of the model is that the value of the guarantee deposit to be maintained was not linked to the assets under management but to the number of members in the fund. Although this might have seemed irrelevant at the outset of the pension reform, the value of the guarantee deposit relative to the assets under management has been continuously decreasing since.

Furthermore, it is not clear why the guarantee deposit has to be maintained with the depositary of the fund. In our opinion, this only increases the risk for fund members in case of default of the depositary.

Finally, it is not clear how the guarantee applies to members switching funds during the calendar year. This practical problem is similar to the one described above involving the calculation of the precise amount that should be credited to members' accounts and should be solved simultaneously.

Although it might seem that the level of guarantees decreased over the years, it is only fair to say that other risk mitigation instruments were introduced, which could be at least as effective as the guarantee. First, the Act (2014) introduced a proxy life-cycle system with three categories of pension funds with different target exposures to the equity market. Category C funds, which are mandatory for the final five years before planned retirement, are prohibited from gaining exposure to the stock market. Category B and category A funds investment limits include only maximum exposure to the equity asset class. For category B funds, it is set to 35% of the net asset value of the fund. For category A funds, it is set to 55% of the net asset value of the fund. This significantly reduces the fund members' exposure to capital market risk in the final years before retirement, when they are most sensitive to losses. Secondly, the Act (2014) introduced more stringent governance rules and sanctions for non-compliance compared to the Act (1999). Such governance rules encompass the investment process, risk management procedures, internal audit, compliance and the management of conflicts of interest. It also introduced a proportionality principle meaning that pension companies must acquire adequate resources before increasing the level of complexity of their investment strategies or instruments involved. Clark and Urwin call this principle the "synchronization of the risk and the governance budget" (Clark and Urwin, 2010).

More importantly, it is not the relative time-weighted but the absolute money-weighted rate of return that should really matter to fund members. From that perspective, the elimination of the government guarantee from a relative-guarantee model is irrelevant. As an extreme case, let us envisage the situation of the guarantee being activated after a prolonged bull market - why should the government pay for the fact that a fund underperformed its competition even if the performance it recorded was very satisfactory from an absolute standpoint? In addition, if we consider the lack of an absolute-return guarantee in the context of the pension system as a whole and the structure of the investment portfolios of pension funds, the need for such a guarantee is not that obvious. Firstly, the vast majority of the population expects to receive most of their pensions from the PAYG system into which their employers currently transfer as much as three quarters of their monthly pension contributions. Secondly, around 70% of pension funds' assets are invested in Croatian government bonds, while the average exposure to equities has been around 22% (Matek and Radaković, 2015). This has two main implications: firstly, the residual risk stemming from exposure to equity markets is quite low and secondly, the major risk exposure is country specific risk. An absolute rate of return guarantee provided by government for the investment performance of portfolios invested 70% in bonds issued by the same government is inherently preposterous. Although many studies (e.g. Burtless, 2007) have demonstrated that internationally diversified portfolios beat local portfolios on a risk-adjusted basis, it is probably not realistic to expect more internationally diversified portfolios in Croatian mandatory pension funds as long as the country runs budgetary deficits and the transition cost has not been digested by the PAYG system. The latter will happen when the major part of retired citizens will receive their pensions both from the first and second pillar. Nowadays most of the people still receive pensions only from the first pillar PAYG system. To conclude: a relative-return guarantee does not make much sense if one is interested in protecting fund members from downturns in capital markets. However, it has at least one beneficial effect: it incentivizes pension companies to implement solid risk management procedures in order to avoid non-systematic and operational risks.

Finally, the capital of pension companies would not be sufficient to cover the cost of a severe performance gap in large funds. *Table 1* shows the assets under management, the accumulated guarantee deposits, minimum regulatory requirements for pension companies' share capital and their net income in 2014. Although the actual share capital of pension companies is somewhat larger than the one required by regulations, it would be reasonable to expect withdrawal of any capital surplus by the companies' owners in case a fund significantly underperformed the pension funds' performance index, i.e. Mirex.

Table 1 Assets under management, guarantee deposits and required capital minimum, net income in 2015 (in HRK millions, end-2016)

Pension company/ fund	Assets under management	Guarantee deposit	Minimum share capital	Net income
AZ [p]		78	40	76
AZ-A [a]	240			
AZ-B [b]	31,670			
AZ-C [c]	1,213			
EP [p]		28	55	21
EP-A [a]	70			
EP-B [b]	11,008			
EP-C [c]	323			
PBC [p]		35	40	27
PBC-A [a]	67			
PBC-B [b]	13,365			
PBC-C [c]	455			
RB [p]		66	55	66
RB-A [a]	130			
RB-B [b]	24,581			
RB-C [c]	1,058			

Source: Financial statements of pension companies and HANFA monthly reports.
Notes: [p] Pension company
[a] Category A pension fund
[b] Category B pension fund
[c] Category C pension fund

As shown in Table 2, a three-year underperformance of only one percentage point in category B fund would create a gap of 316.70 million Kuna (HRK) to AZ fund – almost four times the size of the guarantee deposit. If we imagine an unlimited guarantee, a five-percentage point underperformance in category B fund would cost the owners of AZ pension company 1.58 billion Kuna (HRK), or as much as almost 22 yearly profits. Obviously, an unlimited guarantee would not be viable and would most probably result in the owners of pension companies discontinuing their operations. The entire deposit guarantee and half of the share capital represent only 0.31% of AZ-B fund assets but as much as 40.90% of AZ-A fund. This simple illustration shows that the existing guarantee scheme is sufficient to cover underperformance risk only in funds that represent a smaller part of a pension company's assets under management but is not viable for the largest funds (category B).

Table 2 Performance gap in case of a 1 pp underperformance and a 5 pp underperformance (in HRK millions, end-2016)

Fund	1 pp	5 pp
AZ-A	2.40	11.98
AZ-B	316.17	1583.52
AZ-C	12.13	60.65
EP-A	0.70	3.48
EP-B	110.08	550.39
EP-C	3.23	16.17
PBC-A	0.67	3.37
PBC-B	133.65	668.27
PBC-C	4.55	22.74
RB-A	1.30	6.50
RB-B	245.81	1229.03
RB-C	10.58	52.88

Source: Authors' calculations based on data from HANFA monthly reports.

The larger the negative impact of return guarantees on the pension company, the smaller the incentive for fund managers to develop individual portfolios and diverge from competition. As we have seen from *Table 1* and *Table 2*, the financial impact of underperforming on a large fund can be catastrophic for the pension company. The incentive to converge is clear for category B funds. Category A funds are smaller and hence the negative financial impact of activating the guarantee is also smaller. Would fund managers therefore try to achieve outstanding performance on such funds and use these results as a marketing tool to attract clients that choose funds on their own? This seems to make sense from a marketing perspective. However, data available in HANFA monthly reports shows that around 95% of new members are allocated automatically to their pension funds and that every year less than 0.02% of fund members decide to switch to another fund. Fund members inertia is present despite the fact that funds have been operating for 16 years and differences in returns are substantial. It is interesting to note that although freshly employed persons can become members of fund categories A or C only if they actively choose them (the default allocation is in category B funds) the majority of people that autonomously choose their fund prefer category B funds. This might lead us to the conclusion that people prefer to choose the pension company over the fund category, and secondly, that, although it might appear as an attractive idea, to use a fund's outstanding performance results as a marketing tool might yield meagre results.

Another factor influencing the investment strategy could be relative investment results achieved during the previous two years. A pension company that has achieved a substantial positive buffer in comparison to its competitors might be motivated to take more relative risk and vice versa: a pension company that is dangerously close to the activation of the guarantee will be motivated to converge to competitors.

Finally, it is important to emphasize that funds with a larger market share will have a lower risk of activating the return guarantee due to the way the calculations are defined in the regulations.

5. The probability that the guarantee is triggered

5.1 Methodological considerations

As prescribed by the article 113 of the Act (2014), every pension fund member is guaranteed a return in the amount of the reference return for the corresponding category of pension fund reduced by twelve, six or three percentage points for category A, B or C, respectively. The reference return of pension funds is calculated for the previous calendar year for every category of pension funds as the annual geometric return of the corresponding Mirex index for the previous three years period. The annual Mirex index return is the weighted mean of the annual rates of return of all the pension funds of the same category, whereby the weight of a particular pension fund is calculated as its weight in the total NAV of all the pension funds of the same category on the last working day in the calendar year. If the geometric average annual return of the pension fund over the period of the previous three calendar years is lower than the guaranteed return, the guarantee scheme will be activated. Equations (1) to (4) describe the guaranteed return calculation process.

$$MIREX_m \coloneqq \sum_{i=1}^{n} r_i w_i \tag{1}$$

$$r_{3y} \coloneqq \left[\prod_{i=1}^{3} (1 + MIREX_i)\right] - 1 \tag{2}$$

$$r_{ref} \coloneqq \sqrt[3]{1 + r_{3y}} - 1 \tag{3}$$

$$r_g \coloneqq r_{ref} - p \tag{4}$$

Where m denotes a year in which Mirex was calculated, w_i represents the weight of a particular pension fund in the NAV of all pension funds from the same category, r_i represents the annual return of a particular pension fund and n is the number of funds of the same category. The rate of guaranteed return r_g is the reference rate of return reduced by the number of percentage points p, where p is determined in accordance with article 113 of the Act (2014).

In order to examine the risk of underperformance of a particular pension fund, we used a method common in inferential statistics, i.e. Monte Carlo simulations. The principle intrinsic to the Monte Carlo simulations is that a random fragment tends to display properties similar to the population from which it originates. We chose a stochastic approach although the return of a fund could be viewed as the product of a deterministic process because of the large number of variables describing the state, complex equations that relate the state to the outcome and sensitivity to the conditions on financial markets, regulations, governance of the fund etc. We used a random numbers generator as a tool for estimating the probability of underperformance. During our study, we implemented and conducted various algorithms with different inputs and observed outcomes of each test. It is important to emphasize that we produced an independent process, which assumed that past returns would not affect future returns. We used historical data sets to estimate the parameters of the distribution, i.e. mean and variance of a random variable. Therefore, in order to examine all types of representations of a realization of a variable, we have decided to conduct four types of simulations. Conducted simulations used inputs from yearly and monthly returns of funds as well as yearly or monthly returns of benchmark indices.

The first type of simulations we conducted, with respect to the frequency, used yearly returns for funds and asset classes in funds as inputs. We have decided to represent all asset classes across funds by selected benchmark indices. Those benchmark indices were the same among various funds. The second type of simulations encompassed monthly frequency of the data. With respect to the type of data used, the first type of algorithm used actual historical returns of the funds to generate outcomes, while the second type used returns of asset class proxies, i.e. benchmark indices for the generation of funds returns. With respect to the available data, we have categorized investment assets of pension funds in one of the following asset classes: domestic equity, foreign equity, domestic bonds, foreign bonds and money market.

We adopted benchmark indices introduced by Matek and Radaković (2015) for this research. For domestic equity market, we used a custom total return free float capitalisation weighted index of the stocks from the Zagreb Stock Exchange, Crostock. The Zagreb Stock Exchange did not start publishing its Total Return equity index (Crobex Total Return) until February 2014. To overcome this, we first used data available for the Crobex index, which is not total return, from 2005 to 2014 and "grossed it up" with an assumed uniformly distributed annual dividend yield of 3%. We named the described index Crostock. A local asset management company calculated and published on Bloomberg a total return, market value weighted, Croatian government bond index for euro and kuna (HRK) denominated bonds. Unfortunately, the CROBOND index (Bloomberg ticker ZBIBOND Index) covers only the period until September 2013. The Zagreb Stock Exchange started publishing a total return bond index in December 2011. We did not use it to construct our custom index because it does not include Croatian Eurobond issues. To complete our data set from September 2013 to December 2014 we used internal data provided to us by one of the pension companies. We tailored it to our needs by including only kuna (HRK) and euro denominated bonds. We called this blended index Crogov. As with stocks and bonds, there is no publicly available index for the HRK money market. Market data from which an index could be constructed retroactively are also not readily available. Therefore, we decided to create a proxy for the HRK money market asset class return by using equally weighted returns of the four largest HRK denominated money market funds in Croatia (ZB plus, PBZ novčani, Raiffeisen cash, Erste novčani). All four funds were active through the entire period covered by our study. We "grossed up" net-of-fees returns and called this index Cromm. We believe that money market funds return is a valid benchmark for the cash equivalent asset class. For the euro-zone government bonds asset class we selected the Bloomberg/Effas Euro bloc government bond index (Bloomberg ticker EUGATR Index). The Bloomberg/Effas Euro bloc government bond index computes daily returns and index characteristics for each maturity sector. Finally, for the global stocks, we chose the daily total return index with net dividends reinvested, the MSCI World index (unhedged, Bloomberg ticker NDDUWI Index). All of the above-mentioned indices are total return indices, i.e. they assume reinvesting of investment proceeds like dividends or coupons. In order to achieve full comparability with results obtained by using actual funds' returns, we boosted the benchmark indices returns for the corresponding management and depositary fee. For consistency, we expressed all benchmark indices values in Croatian kuna (HRK). *Table 3* shows the selected benchmark indices.

Table 3 Benchmark index for each asset class

Asset class	Benchmark index
Croatian gov. bonds	Crogov [a]
Euro. gov. bonds	Bloomberg/EFFAS EUGATR Index
Croatian stocks	Crostock [a]
Global stocks	MSCI World NDDUWI Index
Cash equivalents	Cromm [a]

Source: Bloomberg, HANFA monthly reports, Zagreb Stock Exchange and internal base of a pension company

We defined delimitations of this section in the manner that set the scope of this section as the calculation of the probability of triggering the guarantee using Monte Carlo simulations. We included only Croatian mandatory pension funds in the study. There are some limitations to this study. The study regarding probability that the guarantee is triggered is limited in its findings in the following ways. Since the pension fund industry in Croatia is of the relatively young age and there is limited and small number of funds the scarcity of the data was a major drawdown. Also, pension funds are subject to changing regulations. Due to the absence of data on actual fund performance at asset class level, we used benchmark indices as proxies, i.e. the benchmark indices were inputs for one type of simulations.

The abovementioned limitations considerably affect the scope of the study regarding the estimation of the probability that the guarantee is triggered. The results of the paper should thus be regarded as preliminary evidence.

For simulations that used yearly data and funds' actual returns, inputs were data sets of returns from 2003 to the end of 2014. Due to difficulties in obtaining earlier data, all other simulations used data sets of returns from 2005 until the end of 2014.

The analysis relies on the following assumptions:

a) Due to the Central limit theorem and some of the characteristics of a density function of normal random variable, normality of the random variables was ubiquitously implied in our research.

b) The function implemented to compute Mirex used pension funds' weights (the weight of a particular pension fund is calculated as its weight in the total NAV of all the pension funds of the same category on

[a] Custom indices due to lack of adequate publicly available total return indices.

the last working day in the calendar year) as of December 31st 2014 and considered them constant.

c) The function used to compute the strategic asset allocation of a particular fund used asset allocation of a particular fund as of December 31st 2014 as input and considered it constant.

d) Portfolio managers will continue to govern funds similarly in the future as they did in the past.

e) Simulations that generate funds' returns proxies, i.e., simulations that use asset classes' proxies (benchmark indices) as inputs neglect the selection effect.

f) Simulations that generate funds' returns proxies, i.e., simulations that use asset classes' proxies (benchmark indices) as inputs neglect the market timing ability of portfolio managers, i.e. their ability to make money by anticipating short-term movements in asset prices.

g) Portfolio managers are making investment decisions within regulatory limits.

Of course, despite the assumption of constant asset allocation, the model can easily be adapted to accommodate for different or even variable asset allocations. If this algorithm was implemented as an internal risk management tool among pension companies, portfolio managers could, for instance, make risk assessments of their targeted asset allocation against the market allocation. Such assessments could be complemented by stress tests simulating swift changes in competitors' portfolios or assessing the maximum risk in case of extreme positioning within the regulatory limits. The pension company would probably assess its own risk appetite and create its portfolio accordingly. The introduction of a buffer for non-systematic risk or selection effect could also be envisaged.

The number of trials, i.e. number of average three-year returns, produced by each simulation was 10.000. As mentioned earlier, we implemented algorithms for four slightly different types of simulations. The calculation of a continuously compounded return over successive periods is defined by equation (5).

$$r_t = \ln(\frac{\alpha_t}{\alpha_{t-1}}) \tag{5}$$

Where α_t denoted NAV per share of a particular fund or a benchmark value at a time t. Besides, t varied from 1 to 120 if simulations used monthly data or from 1 to 12 if simulations used yearly funds' returns or from 1 to 10 if simulations used yearly benchmark indices returns. We considered the return of a particular fund or benchmark index to be one realization of a normal random variable. As mentioned before, the parameters describing the variable, i.e. mean and variance, are drawn from historical data sets. Depending on the type of entry data, we had four or five different random variables, each with its own mean and standard deviation. That is because there were only four mandatory pension funds (predecessors of current category B funds) during the period covered by our study and five asset classes in each fund represented by five benchmark indices. We denoted each random variable with X_i, and i varied from 1 to n, where n was equal to 4 or 5, depending on whether simulations used funds' or benchmark indices' returns. We followed the above-mentioned assumptions and set each random variable to draw its mean and standard deviation from historical data sets.

$$X_i \sim N(\mu_i, \sigma_i^2) \tag{6}$$

Each random variable represented returns of one mandatory pension fund or one benchmark index, i.e. asset class proxy. Furthermore, we calculated the sample covariance matrix and denoted it with Σ, which served as an estimation for the forecasts.

$$\boldsymbol{\Sigma} = \left[Cov\left[X_i, X_j\right]\right] \tag{7}$$

Where i and j varied from 1 to n. Of course, n was depending on the type of entry data simulations used as inputs. In addition, we defined the vector of expectations, in accordance with the definition of an expectation of a multivariate normal vector. Let us denote it with $\boldsymbol{\mu}$.

$$\mu_i = \boldsymbol{E}[X_i], i = 1, \dots, n \tag{8}$$

$$\boldsymbol{\mu} = [\mu_1, \dots, \mu_\mathrm{n}] \tag{9}$$

At this point, we could create n-dimensional multivariate normal distribution vector $\boldsymbol{X}$. Hence,

$$\boldsymbol{X} \sim \boldsymbol{N}(\boldsymbol{\mu}, \boldsymbol{\Sigma}) \tag{10}$$

Expressions (6) to (10) illustrate the general process implemented throughout the simulations. Moreover, expression (10) represents the output produced by mathematical software. The fundamental idea of the algorithm was to generate multivariate normal random vectors chosen from the multivariate normal distribution with mean $\boldsymbol{\mu}$, and covariance $\boldsymbol{\Sigma}$. The output of the algorithm was a matrix of simulated possible outcomes that represented monthly or yearly returns of each fund or benchmark index. If the matrix represented simulated monthly returns, the algorithm geometrically linked them into yearly returns. In addition, if the matrix represented benchmark indices returns, the algorithm used the function mentioned in the assumptions, to assign to each fund its' strategic asset allocation. Therefore, it was possible to calculate the average annual returns for three years periods for each fund as well as a set of possible values of Mirex. Afterwards, the algorithm was able to calculate the possible rates of guaranteed return for all known values of Mirex. Thus, we observed and counted the number of trials in which the return of a particular fund was below or exceeded the guaranteed return.

Each type of simulation has its own advantages and disadvantages. For instance, simulations that use actual historical fund returns are taking correlations between returns of different funds into consideration and therefore are generating outcomes in accordance with those. However, the drawbacks are that they could only be conducted for category B funds due to the fact that category A and C funds were established in August 2014 and lack of history. Using benchmark indices returns to generate funds' returns overcomes the problem of the lack of history. It also considers correlations between returns of different benchmark indices, i.e. asset classes' proxies while generating outcomes. However, a major constraint of such an approach is that all asset classes among various funds are represented with the same proxies and therefore funds are submitted to realizing similar returns differing only from diverse strategic asset allocation. In other words, those simulations do not take into account the selection effect nor market timing ability of the portfolio manager governing a particular fund.

During this research, we did not conduct any simulations regarding category C funds due to specific risks to which those funds are exposed. Namely, for category C funds any exposure to the equity market is prohibited by the Act (2014), thus the greatest risks that could arise in that specific category of funds are credit and exchange rate risk.

5.2 Results

Firstly, we conducted simulations that use yearly data and the funds' actual returns. Although there were very few inputs in the simulations, the produced outputs were in line with our intuition. Results are shown in *Figure 1* and *Table 4*. The fund least likely to activate the guarantee scheme is AZ-B, due to its market share as well as the characteristics of its returns in the past. The fund most likely to activate the guarantee scheme is PBC-B. It is safe to say that, even within "the riskiest fund", the risk of triggering the guarantee is quite low.

Table 4 Percentage of trials in which the average three-year return of a certain fund was below the guaranteed return

Fund	% below GR
AZ-B	0.04%
EP-B	2.53%
PBC-B	7.10%

Source: Authors' algorithm.

Vertical axes in *Figures 1* to *6* represent simulated average three-year returns of a particular fund while the number of simulations lie on the horizontal axes. The simulated returns of each fund were represented with different shapes. The simulated guaranteed return is represented with the white character "o". Outcomes that were smaller than the guaranteed return were shown below characters representing the guaranteed return while outcomes that were greater than the guaranteed return were positioned above the aforementioned characters.

Afterwards, we conducted simulations that use yearly returns of benchmark indices, i.e. asset classes' proxies as inputs to produce funds' returns proxies. The results, shown in *Figure 2* and *Table 5,* were somewhat different. While the average number of trials in which they did not achieve the guaranteed return remained quite similar for EP-B and RB-B, the number of negative outcomes significantly increased for AZ-B and significantly decreased for PBC-B. We believe this to be the consequence of the fact that these simulations do not encompass the selection effect nor market timing ability of a particular fund manager.

Table 5 Percentage of trials in which the average three-year return of a certain fund was below the guaranteed return

Fund	% below GR
AZ-B	0.65%
EP-B	2.83%
PBC-B	5.05%
RB-B	2.14%

Source: Authors' algorithm.

Simulations that used funds' monthly returns as inputs also showed a relatively low risk of activation of the guarantee scheme. Although the least and the most risky funds remained the same as in previous simulations, a significant decrease in the risk profile was noticeable for EP-B, PBC-B and RB-B. This decrease resulted from the fact that the standard deviation of yearly returns is considerably lower for AZ-B than for the other three funds, while the differences among standard deviations of monthly returns of all funds are somewhat smaller. Results are shown in *Table 6*.

Table 6 Percentage of trials in which the average three-year return of a certain fund was below the guaranteed return

Fund	% below GR
AZ-B	0.02%
EP-B	0.73%
PBC-B	1.51%
RB-B	0.05%

Source: Authors' algorithm.

The last type of simulations conducted were those that used monthly returns of benchmark indices, i.e. assets class proxies as inputs. Results are shown in *Table 7*.

Table 7 Percentage of trials in which the average three-year return of a certain fund was below the guaranteed return

Fund	% below GR
AZ-B	0.22%
EP-B	1.73%
PBC-B	3.32%
RB-B	1.45%

Source: Authors' algorithm.

Although the risk of activating the guarantee scheme is relatively low in all cases, it is noticeable that simulations, which are using benchmark indices returns as inputs are underestimating the amount of risk undertaken by funds whose managers make poor decisions regarding security selection and market timing. At the same time, they are overestimating the amount of risk undertaken by funds whose managers excel at security selection and their market timing ability is outstanding. As shown by Matek and Radaković (2015), selection effect plays an important role in active management of pension funds in Croatia. We believe that the risk profile of a particular fund regarding this specific risk is closely related to the ability of fund managers to make decisions regarding security selection, portfolio managers' market timing ability, as well as the market share of a particular fund.

In addition to simulations for the real category B funds, we also produced simulations for a theoretical category A fund and a theoretical category B fund. We created hypothetical funds that were small in size (10% of the market share) and as risky as the Act (2014) permits it. The category A fund had 55% of assets allocated to the Crostock index, i.e. Croatian stocks, and 45% to the Crogov index, i.e. Croatian government bonds. The category B fund had 30% of assets allocated to the Crostock index and 70% to the Crogov index. Furthermore, the assumption was that all other market participants were holding 100% of their assets in Croatian bonds, represented by the Crogov index. The idea behind creating this scenario was to determine the highest possible probability of activating the guarantee scheme by a small and aggressive fund that assumes the legally largest possible amount of relative risk. Although this scenario is not plausible, the results, shown in *Figures 3* and 4, are rather interesting.

The simulated three-year returns of the risky category A fund were below the guaranteed return in approximately 20% of trials. The results were around 15% for the category B fund. Since the number of trials in which the category A fund activates the guarantee scheme is not substantially larger than the number of trials in which the category B fund activates it, we conclude that the risk is quite similar for both categories of funds. This also implies that the guaranteed return scheme is well calibrated between category A and category B funds.

In the final set of simulations, we reduced the reference return by 3 percentage points instead of 6 for the category B funds. The results showed, on average, four times increase in the number of trials in which funds underperformed the guaranteed return. This result was rather anticipated as well.

It is difficult to imagine a realistic scenario in which a concrete pension fund triggers the guarantee. If a systemic risk event were to occur, it would probably have had similar impact on all pension funds. On the other hand, materialisation of an idiosyncratic risk of a specific asset in a particular fund could not affect the return of that fund in a manner that would cause the latter to activate the guarantee. Even in the extreme cases, like shown in *Figures 5* and *6* for the riskiest possible and not so prudently managed funds, the risk of triggering the guarantee remains quite low. Therefore, we conclude that the risk of triggering the guarantee should not have the decisive influence when it comes to investment decisions.

6. Herding effects among pension funds

6.1 Methodological considerations

To supplement our research regarding the probability that the guarantee deposit is triggered, we decided to search for the evidence of herding. It would be rational to explore the possibility that pension fund managers are aligning portfolios in order to avoid underperformance. This phenomenon is widely recognized in literature dealing with the issue of return guarantees and is called the herding effect. In a nutshell, herding is not desirable, particularly if reference returns are calculated over short periods of time, because portfolio managers will not be motivated to engage in investments that are more profitable if they are more volatile. In addition, herding reduces incentives for creativity and the introduction of new investment strategies and instruments in the pension funds' portfolios. As recognized by Bikhchandani and Sharma (2000), herding increases the level of systemic risk as portfolio managers tend to invest in the same instruments and act in the same manner.

Due to guarantee considerations, it is reasonable to expect that a prudent portfolio manager would probably construct his portfolio very carefully in order to avoid triggering the guarantee and potentially losing the 100% of the guarantee deposit and 50% of the share capital. One of the ways in which pension companies can mitigate the risk of activation of the relative return guarantee is through aligning the portfolio structure with their competition. In order to align their portfolios with the competition, portfolio managers need to have insight into the portfolios of other pension funds. Croatian pension funds usually apply a top-down investment process. They create optimal asset allocations across a range of asset classes and regularly (usually quarterly) adjust the allocation to market developments. Portfolio managers can use various reports to gather information about competitors' portfolios. Firstly, each pension company has the legal obligation to publish monthly reports. These monthly reports include top 10 holdings and portfolio breakdown by asset class, geographical exposure, industry sectors and currency exposure. Another source of information at asset class level are HANFA's monthly reports. In these reports, the portfolio structure of each particular fund is broken down into types of financial instruments (equity, government bonds, corporate bonds etc.). In addition, the proportion of domestic and foreign instruments is specified for each type of instrument. Pension companies also have the legal obligation to make public semi-annual reports where their portfolios are broken down to the level of every single instrument. It is important to note that precise ownership data for Croatian securities can be obtained on a daily basis from the central depository of securities. Since, according to Matek and Radaković, domestic assets historically represent around 80% of the total assets, we conclude that portfolio managers can easily track 80% of their competitors' portfolios on a daily basis.

To define herding intuitively, we used a characterization from Bikhchandani and Sharma (2000). They defined herding as imitation of others while the investor must be aware of and be influenced by others' actions. An individual can be said to herd if he would have made an investment without knowing the other investors' decisions, but does not make that investment when he finds that others have decided not to do so. Alternatively, he herds when knowledge that others are investing changes his decision from not investing to making the investment. Throughout our research, we did not encounter any methodology for herding effect that would be applicable for the emerging market with a very limited amount of data as is the case with Croatia. Some of the encountered methodologies required more in-depth data. For instance, Avery and Zemsky (1998) consider the impact accuracy of the information investors have prior to making an investment. For our study, we could not collect any data regarding the information pension fund managers have prior to making an investment so we did not find methodology proposed by Avery and Zemsky (1998) appropriate for our research. Another example of a non-correlative methodology is a well-known herding methodology, the LSV measure, developed by Lakonishok, Shleifer and Vishny (1992). The latter was designed to search for herding effect among institutional investors in the developed markets and particularly for the stock markets so we did not find it suitable as well. Therefore, we decided to tailor the methodology for herding effect to our needs and, to the best of our knowledge, we believe this is the first work that adopts the proposed methodology.

We conducted the analysis only for category B funds, in the period from 2003 to the end of 2014. As mentioned before, we did not find any methodology regarding the herding effect suitable for our study and therefore we needed to define herding in the context of Croatian pension funds. We defined herding as an act of rebalancing a particular fund on the asset class level after the fund was in the position in which its asset allocation would deviate significantly from asset allocations of all other funds and the fund performed poorly.

In order to search for herding effect, we also applied the decomposition of pension funds into the following asset classes: domestic equity, foreign equity, domestic bonds, foreign bonds and money market. In furtherance of exploring possible evidence of herding, we tested if there were previously any non-random associations between the poor relative performance of a particular fund (a fund "being near activation of the guarantee deposit") and the magnitude of the deviation of its portfolio structure from the market portfolio. Market portfolio was the asset-weighted structure of all pension funds, named "the *MIREX Portfolio*". To detect empirical evidence of herding we used Fisher's exact test. Fisher's exact test is a nonparametric statistical test used to test the null hypothesis that no non-random associations exist between two variables, against the alternative that there is a non-random association between the variables. Fisher's exact test provides an alternative to the chi-squared test for small samples, or samples with very uneven marginal distributions. Unlike the chi-squared test, Fisher's exact test does not depend on large-sample distribution assumptions, and instead calculates an exact p-value based on the sample data. Fisher's exact test is considered valid for samples of any size.

The herding effect methodology relies on some assumptions. Firstly, in Fisher's exact test, we set the significance level at 5%. We assumed a 3 percentage points above the guaranteed return as a trigger for a fund manager to consider the fund he or she manages to be near activation of guarantee deposit. We stated that a fund deviates significantly from the structure of all other funds with its own portfolio structure if its deviation is larger than average deviation, in absolute terms.

Firstly, in order to assure valid inputs for Fisher's exact test, it was necessary to define formally the *MIREX Portfolio*. Equations (11) and (12) describe the process of defining the *MIREX Portfolio*.

$$aa_i := \sum_{j=1}^{4} a_i f_j \, , i = 1, \dots, 5 \tag{11}$$

$$MIREX\ Portfolio := \left(\frac{aa_i}{\sum_{i=1}^{5} aa_i}, \dots, \frac{aa_5}{\sum_{i=1}^{5} aa_i} \right) \tag{12}$$

Where, $a_i f_j$ denotes the value of an asset class i in a fund j at the end of each month. Simply put, the *MIREX Portfolio* is the cumulative asset-weighted structure of all pension funds.

Secondly, we needed to define two binary variables. For each fund, we defined variables V_1 and V_2 in the following manner:

V_1 $:=$ Asset allocation of a particular fund deviates significantly from the asset allocation of the *MIREX Portfolio*,

V_2 $:=$ A particular fund is near activation of the guarantee deposit.

In order to assign values to each variable, we needed to precisely define, in a quantitative manner, variables V_1 and V_2. Therefore, we defined a $1x5$ matrix of monthly asset allocation for each fund, approach similar to the one used for identifying the *MIREX Portfolio*. Formally, equation (13) explains the process.

$$saa := \left(\frac{a_1}{\sum_{i=1}^{5} a_i}, \dots, \frac{a_5}{\sum_{i=1}^{5} a_i}\right) \tag{13}$$

Where, $a_i, i = 1, \dots, 5$ denoted a value of an asset class a_i in a certain month for a particular fund. Since we obtained monthly data from a ten-year period, we had 120 matrixes for each fund and the same number of matrixes for the *MIREX Portfolio,* totalling 600 matrixes. For each month, we observed the sum of the absolute values of the difference between the weight of each asset class in a particular fund and the weight of the same asset in the *MIREX Portfolio*. Namely, equation (14) describes the computed mapping.

$$D := \sum_{i=1}^{5} |MIREX\ Portfolio\ (1, i) - saa(1, i)| \tag{14}$$

We denoted the above-defined mapping with the letter *D* and observed its values. We decided to treat *D* as an indicator of funds' deviations from the structure of the *MIREX Portfolio*. The minimum value of *D* during the period covered by our study occurred at 2.19%, while the maximum value was almost 30%. The average value of above-defined mapping was 12.89%. Thus, we established a setting for the definition of variable V_1 in the following manner: if a mapping *D* in a current month, for a particular fund, exceeds its average value the value assigned to variable V_1 is one, otherwise it is zero.

Once we defined variable V_1 we needed to precisely define variable V_2, i.e. to state what it meant for a fund to be "near activation of the guarantee deposit". The idea on defining variable V_2 was intrinsically simple. We denoted with α_t NAV per share of a particular fund or Mirex value and calculated returns in the following manner, explained by equations (15) and (16).

$$r_t := \sqrt[3]{(\alpha_t / \alpha_{t_0})^{\Delta_t}} - 1 \tag{15}$$

$$\Delta_t := \frac{d_{t_e} - d_{t_0}}{d_t - d_{t_0}} \tag{16}$$

Where d_{t_0} represented the beginning of a three-year period, d_t was the current month and d_{t_e} was the end of a period. Using this method, we were able to obtain 120 "three-year annualised" returns for each fund as well as returns for Mirex. Afterwards, we reduced the "three-year annualised" returns of Mirex by 3 percentage points. Three percentage points were considered to be an appropriate buffer because they represented half of the discount encompassed for actual calculation of the guaranteed return. If the return of a fund for a particular month, calculated in this manner, was below the return for Mirex, calculated in the same manner, discounted by 3 percentage points we assigned value 1 to the variable V_2 or 0 otherwise.

It is important to remind that the regulation defining the circumstances triggering the activation of the guarantee deposit had changed over the ten-year period. Nevertheless, variable V_2 was defined considering current conditions. Since no significant changes were made to the ordinance from 2007 onwards, we found it appropriate to encompass the entire period using the above-described method.

After having precisely defined variables and their values, it was possible to create a $2x2$ contingency table for each fund. We summed up the number of times the following events took place:

a) Fund deviates significantly from the structure of a theoretical *MIREX Portfolio* with its own portfolio structure and the fund is near activation of the guarantee deposit.

b) Fund deviates significantly from the structure of a theoretical *MIREX Portfolio* with its own portfolio structure and the fund is not near activation of the guarantee deposit.

c) Fund does not deviate significantly from the structure of a theoretical *MIREX Portfolio* with its own portfolio structure and the fund is near activation of the guarantee deposit.

d) Fund does not deviate significantly from the structure of a theoretical *MIREX Portfolio* with its own portfolio structure and the fund is not near activation of the guarantee deposit.

Finally, we could precisely define the hypothesis for Fisher's exact test. Formally, we set the following hypothesis:

$H_0 \coloneqq$ There are no non-random associations between variables V_1 and V_2 , i.e. there are no non-random associations between funds significantly deviating from the structure of the *MIREX Portfolio* and being near activation of the guarantee deposit.

Hypothesis H_1 stated there is an association between the aforementioned variables. Again, we used the mathematical software to conduct the test, to see if it would reject a null-hypothesis H_0 at the 5% significance level.

6.2 Results

After conducting Fisher's exact test, the null-hypothesis was rejected for the PBC-B fund. For the other three category B funds, the test did not reject the null-hypothesis. Hence, at the 5% confidence level, the test showed there was a non-random association between the PBC-B fund deviating significantly from the structure of the *MIREX Portfolio* and the fund being near activation of the guarantee deposit. These results suggest that there could be some evidence of herding. The result was rather anticipated, because the PBC-B fund has a relatively small market share and experienced relatively low returns in the past.

7. Conclusion

Croatia, like many other countries, introduced mandatory defined contribution pension plans in the form of privately managed pension funds. Since the investment risk in such pension schemes is transferred to the fund members, return guarantees of some form are often embedded in the product in order to gain support for the pension reform. Return guarantees are neither cheap nor intrinsically risk free. Furthermore, they necessarily affect, directly or indirectly, the expected return of investments. Croatian mandatory pension fund members are currently entitled to a relative return guarantee limited to the amount of a guarantee deposit funded by fund management companies and 50% of their share capital.

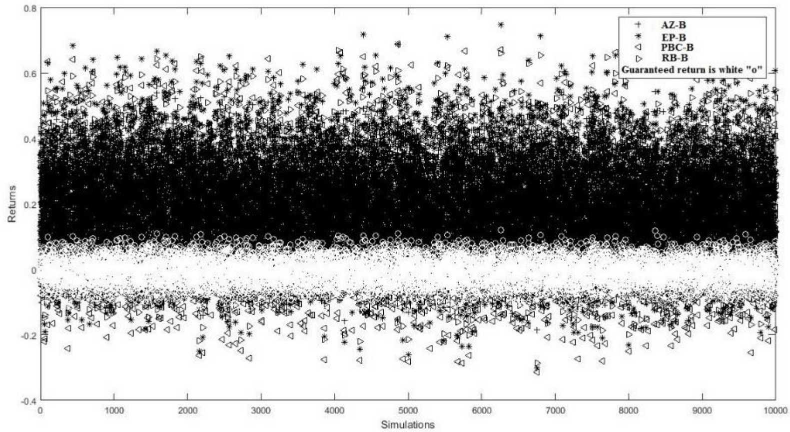
The scope of our study was to examine possible effects of the guarantees on the management of pension funds. Although the outlook on the subject from the perspective of our research was limited due to the scarcity of the data and changes in regulation, simulations that we have conducted indicate that the probability of activating the guarantee scheme is quite low, below 8% in all business-like cases. Moreover, the threat of immediate activation of the guarantee could be further reduced by aligning the underperforming fund's portfolio with the investment strategy of competitors. Although we have found some evidence suggesting the existence of herding among Croatian mandatory pension funds, as most funds were never even close to activating the guarantee scheme and the funds lack sufficient history, evidence is inconclusive.

Even though the presented methodology has some limitations and therefore should be regarded as a preliminary evidence, we believe there is space for further research and improvement. Most importantly, since the relative return guarantee does not protect fund members from a general adverse situation on capital markets, it might be advisable to discard it in parallel with a reduction in the management fee.

We believe that the main value added of a relative return guarantee is that it incentivizes pension companies to reduce operational risks and non-systematic market risks. Secondly, the activation of the guarantee scheme would probably have a serious negative financial impact on pension companies, particularly if a category B fund was to underperform. Therefore, the methodology presented in this paper could also be used as an internal risk management tool by pension companies and further elaborated to accommodate for the specific needs of particular companies.

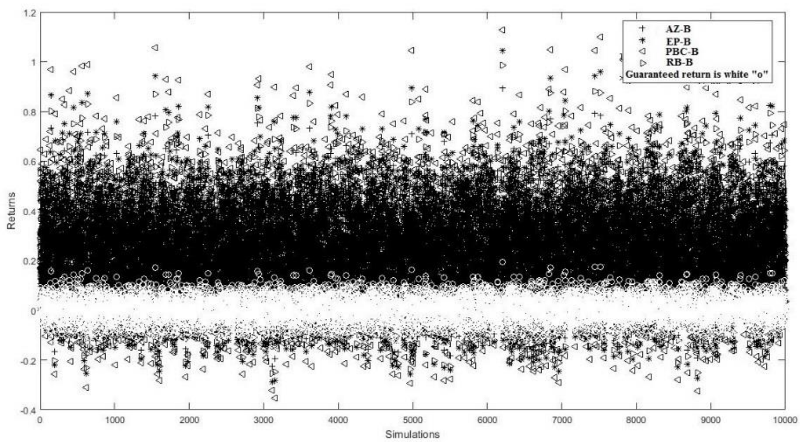
APPENDIX

Figure A1 Example of simulations that use yearly returns of the funds as inputs



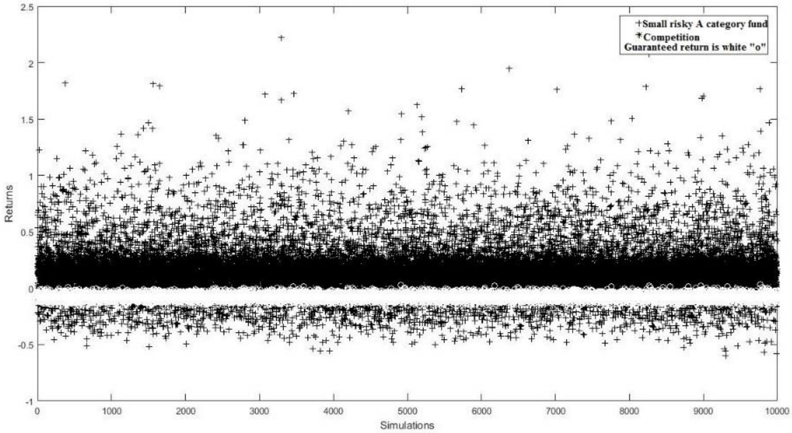
Source: Authors' algorithm

Figure A2 Simulations that use yearly returns of benchmark indices, i.e. asset class proxies as inputs



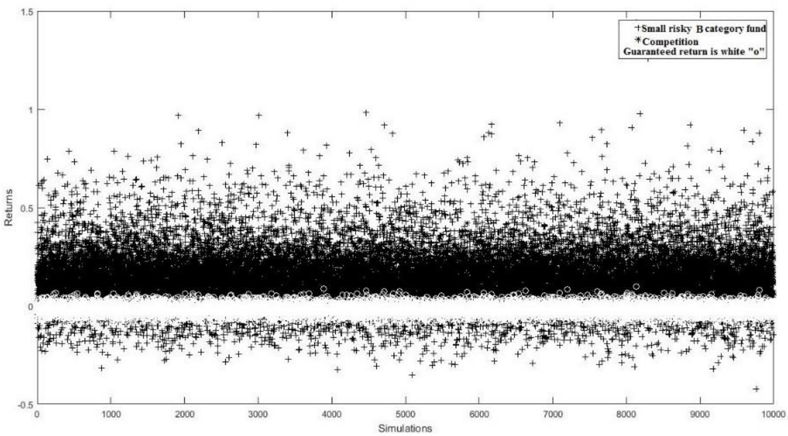
Source: Authors' algorithm.

Figure A3 Simulations that use monthly returns of benchmark indices for a small aggressive category A fund



Source: Authors' algorithm.

Figure A4 Simulations that use monthly returns of benchmark indices for a small aggressive category B fund



Source: Authors' algorithm.

REFERENCES

Antolín P, Payet S, Whitehouse E R, Yermo J (2011): The Role of Guarantees in Defined Contribution Pensions. *OECD Working Papers on Finance, Insurance and Private Pensions,* no. 11.

Avery C, Zemsky P (1998): Multidimensional Uncertainty and Herd Behaviour in Financial Markets. *American Economic Review,* 88:724-748.

Bikhchandani S, Sharma S (2000): Herd Behaviour in Financial Markets: A Review. *IMF Institute Working Paper,* wp/00/48.

Burtless G (2007): International Investment for Retirement Savers. Historical Evidence on Risk and Returns. *Centre for Retirement Research at Boston College*, CRR WP 2007-5.

Clark G L, Urwin R (2010): Innovative Models of Pension Fund Governance in the Context of the Global Financial Crisis. *Pensions,* 15(1):62-77.

Deelstra G, Grasselli M, Koehl P-F (2004): Optimal Design of the Guarantee for Defined Contribution Funds. *Journal of Economic Dynamics and Control*, 28(11):2239-2260.

Grande G, Visco I (2010): A Public Guarantee of a Minimum Return to Defined Contribution Pension Scheme Members. *Banca d'Italia Working Papers,* no. 762.

Holzmann R, Palmer E, Robalino D, editors (2012): Nonfinancial Defined Contribution Pension Schemes in a Changing Pension World: Vol. 1, Progress, Lessons and Implementation. Washington, DC: World Bank.

Lachance ME, Mitchell OS (2002): Guaranteeing Defined Contribution Pensions: The Option to Buy-Back a Defined Benefit Promise. *NBER Working Paper,* no. 8731.

Lakonishok J, Shleifer A, Vishny R (1992): The Impact of Institutional Trading on Stock Prices. *Journal of Financial Economics,* 32:23-43.

Mahayni J, Schlögl E (2003): The Risk Management of Minimum Return Guarantees. *Discussion Paper 18/2003*. *Bonn Graduate School of Economics, Department of Economics.*

Matek P, Radaković M (2015): Is active management of mandatory pension funds in Croatia creating value for second pillar fund members? *Financial Theory and Practice,* 39(3):245-278.

Pennacchi G G (1999): The Value of Guarantees on Pension Fund Returns. *The Journal of Risk and Insurance,* 66(2):219-237.

Walliser, J (2003): Retirement Guarantees in Mandatory Defined Contribution Systems. In: Mitchell, O S, Smetters K (eds.): *The Pension Challenge: Risk Transfers and Retirement Income Security*. Philadelphia, Pension Research Council Press.

World Bank (2005): Guarantees – Counting the Cost of Guaranteeing Defined Contribution Pensions. *World Bank pension reform primer series*. Published online: January 1st, 2005: http://documents.worldbank.org/curated/en/2005/01/6259019/guarantees-counting-cost-guaranteeing-defined-contribution-pensions.

HANFA (Croatian Financial Services Supervisory Agency) (2005-2014): *Monthly Reports*.

Croatia. *Zakon o obveznim i dobrovoljnim mirovinskim fondovima* (Act on Mandatory and Voluntary Pension Funds), 1999. Zagreb. Narodne novine 49/99, 63/2000, 103/2003, 177/2004, 71/2007, 124/2010, 114/2011, 51/2013.

Croatia. *Zakon o obveznim mirovinskim fondovima* (Act on Mandatory Pension Funds), 2014. Zagreb: Narodne novine 19/14, 93/15).