# EUROPEAN MASTER IN LAW AND ECONOMICS



# Nudging on Heaven's Door: A Quantitative Analysis of the Effects of Financial Regulation on Welfare

**Keywords:** Behavioral Law & Economics, Behavioural Finance, Asset Allocation, Default Option, Pension Funds.

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#### <u>Abstract</u>

This is the first paper that studies the economic impact of the default option in pension funds in Latin-America. A stochastic model was developed to replicate investments conditions under the Peruvian Private Pension Funds System in a timehorizon of 42 years. The returns of the asset classes used by the pension funds were generated through a non-parametric bootstrapping process. Six scenarios were created to analyze the potential outcomes of the model and ten thousands iterations per scenario were executed to have robust results. Results showed a clear difference between the fund that maximizes welfare in the long term and the default option. As long as an overwhelming percentage (99,2%) of active affiliates younger than 30 years old maintain their funds in the clearly inefficient default option, it is theorized that Peruvian authorities would have the opportunity to "nudge" young affiliates to a welfare maximizing fund by simply changing the default option. The value of the default option was quantified. For the average affiliate, a change in the default option should imply an expected benefit that (depending on market conditions) would be in a range of 35,28% and 88,4% in accumulated wealth in their retirement accounts. This increase in accumulated wealth would take place facing negligible levels of additional risk (as high as 1,62%). Such an increase in accumulated wealth is absolutely important in developing countries where citizens hardly can rely on the government to cover their most basic needs.

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# 1. Introduction

Sometimes people need to make some crucial decisions on their lives and sometimes, some of those decisions imply a deep analysis of complex economic factors. One of the complex and critical decisions that people face in welfare systems with defined-contributions schemes is to elect the asset allocation of their pension funds. If real humans were close to the "Homo Oeconomicus" archetype, such a choice would not be a problem, the optimal decision would be always chosen with no effort. However, real humans depart a lot from such a paradigm. Motivation for this thesis was to try to quantify the economic impact that the setting of the default of option in Peruvian pension funds may have in future welfare. **To the best of my knowledge, this is the first paper that studies the economic impact of the default option in pension funds in Latin-America.** 

The aim of this thesis is to investigate the potential tangible benefits that a minimal change in financial regulation may bring to the Peruvian welfare system. I claim that the current pension funds regulation in Peru is only reasonable if it is analyzed under the traditional "Homo Oeconomicus" paradigm. I claim that a change in regulation that may recognize, the limitations of the "Homo Oeconomicus" model, and that "nudges" citizens to welfare maximizing scenarios, should bring critical and tangible benefits to future Peruvian welfare.

In this line of though, the research question of this thesis will be: **Could a minimal change in Peruvian financial regulation have a tangible impact in Peruvian welfare?** My hypothesis is that a change in the default option in the frame of the Peruvian Private Pension Funds System should bring a substantial increase in Peruvian welfare, measured as the additional accumulation of wealth in retirement funds at no significant risk.

In order to answer the aforementioned research question, in chapter 2, Peruvian Private Pension Funds System will be analyzed. After briefly describing its origins and present situation, I will focus on its mandatory investments limits, age restrictions and default options.

In chapter 3, the theoretical framework, I will briefly described what are definedcontributions pension funds and I will focus on their optimal asset allocation strategies. Later, I will discuss the "Homo Oeconomicus" model, the status quo bias and the so-called "default effect". Finally I will make a review of "Nudge Theory" as a valid alternative to overcome departures from the "Homo Oeconomicus" paradigm.

Chapter 4 will describe the model created to provide the quantitative information required to answer the above-mentioned research question. First, emphasis will be given to the characteristics of any stochastic model. Then, a complete description of the model particularly designed for this research will be offered. Such a model will try to replicate the Peruvian Pension Funds System considering: a) contribution rates, b) administration fees, c) portfolio rebalancing, d) changes in wages that recognize increases in productivity e) density of contributions according to unemployment rates, and f) increases in wages connected to the natural economic growth that the country has exhibited in the last 25 years. Later, official information concerning the historical asset allocations, and current legal investment limits of the Peruvian private pension funds will be used to model theoretical replications through the use of potential scenarios. To replicate the returns from the asset classes used by the pension funds, data will be collected from time series that will represent the returns of Peruvian and International financial markets. Then, estimations of potential returns of those asset classes will be generated through a non-parametric bootstrapping process. Finally, the aforementioned random returns will be appropriately combined to simulate the returns from the pension funds in a time horizon of 42 years in conditions that represent the Peruvian Private Pension Funds System. This procedure will be repeated ten thousand times per each one of the accumulated wealth and risk taken during the process.

In Chapter 5 I will summarize the empirical results obtained in the stochastic model described in the previous chapter and I will offer an interpretation of them.

Chapter 6 will discuss the limitations of the study and some potential suggestions for further research.

Finally, in chapter 7, I will offer a brief summary of the paper, and some overall conclusions.

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# 2. The Peruvian Private Pension Funds System

## 2.1. Appearance and Reform

#### 2.1.1. The Appearance of the Peruvian Private Pension Funds System

Despite the extreme economic and political turbulences during the eighties, Peru always had a state-run compulsory old age pension system on a pay-as-you-go basis. However, by 1990, hyperinflation was unchallenged and achieved an unparalleled 7481% (Kiguel & Liviatan, 1995, p. 382), the country was broken and in the middle of a subversive war. In this state of desolation, at the beginning of the 1990's, an aggressive programme of macroeconomic stabilization took place. The goal was to correct the deep and persistent fiscal deficits, to cut the hyperinflation spiral and to reduce the shortage of foreign currency. In addition, long-term measures were taken to liberalize the economy and gain access to international financial markets while strengthening domestic financial markets. (Segura, 2015, p. 404). In this context, in 1992, after the total economic collapse suffered during the 1980's and *"as an integral component of the structural reforms implemented since 1990, Peru introduced a fully-funded private pension system"* (Kane, 1995, p. 1)

The Peruvian "Private Pension System" (SPP by its name in Spanish) is a definedcontribution system that works using an individual capitalization account (CIC by its name in Spanish) instead of the conventional public pay-as-you-go-system. In the SPP, the affiliate makes <u>mandatory</u> contributions to his own individual pension fund, which is managed by a specialized firm called "Pension Fund Administrator" (AFP by its name in Spanish). The AFP invests the affiliate's contributions and charges him with a fee for the professional management of his fund (Lavigne, 2013, p. 13). In addition, a second fee is charged to cover the affiliate in case of disability and to cover his survivals in case of death. When the affiliate turns 65 years old, the AFP pays him a retirement pension from his contributions plus any generated profits. (Decreto Ley N° 25897, 1992).

However if the accumulated wealth at retirement is below survival standards, additional sources of income would be required by the affiliate after turning 65 years old, i.e. a part-time job or some economic support from his family. The appearance of the SPP did not close the open public system. Any worker has the chance to choose the SPP or the open public system. A brief comparison of the 2 systems is provided in Annex 1.

#### 2.1.2. The Reform of the System and the New Type of Funds

The SPP suffered a few extra modifications during the 1990's, however, in 2003, a structural change was conceived. From the beginning of the SPP, every AFP offered a heavily regulated unique type of fund. However, in 2003, the so-called "Multi-funds Reform" forced every AFP to offer a fund with a lower risk-return profile called "Type 1 fund"; and the chance to offer an additional type of fund with a high risk-return profile called: "Type 3 Fund". The original fund became the "Type 2 Fund" (Ley N° 27988, 2003). The multi-funds reform took place because the original type of fund "*imposed too much risk on the old affiliates and offered moderate returns to the young*".. (Carranza & Moron, 2008, p. 355). Therefore, the extra funds were launched to give to the affiliates the opportunity to choose between different options that may suit better their risk-return profile. The main difference between the types of funds is that each

fund is legally constrained by different maximum limits to invest in debt, equity and other kinds of assets (Bernal, Muñoz, Perea, Tejeda, & Tuesta, 2008, p. 41).

The next major reform to the SPP came in 2012. This reform had two main objectives to achieve: first, the reduction of the fees charged by the AFP and secondly the extension of the coverage to include more citizens (Guillén & Mosqueda, 2013, p. 8). However, those goals were not the only ones that the reform had. After the 2008 crisis, it was understood that a new ultra conservative fund should be available. This idea was materialized in the type 0 fund. To keep minimum volatility, investments limits in risky assets in this fund were severely hardened (Ley N° 29903, 2012).

# 2.2. Investment Limits, Age Restrictions and Default Options

With the new fund, the legal investments limits became as shown in table 1.

	Type of fund				
Investment	Type 0	Type 1	Type 2	Type 3	
Short-Term Debt Securities or Cash	100	40	30	30	
Debt Securities	70	100	75	70	
Equity Securities		10	45	80	
Derivatives		10	10	20	
Alternative Investments			15	20	

Table 1: Maximum investment limits per type of fund in percentages.

Source: (Ley N° 29903, 2012) Own elaboration

The multi-funds regulation also has age restrictions and default options to access the different types of funds (Rozinka & Tapia, 2007). They are summarized in table 2.

	Type of fund				
Age (in years)	Туре 0	Type 1	Type 2	Туре 3	
65 or more	By default	By request	By request	Forbidden	
60 –65	By request	By default	By request	Forbidden	
Less than 60	By request	By request	By default	By request	

Table 2: Allocation of affiliates to the different types of funds considering their age

# Source: (Ley N° 29903, 2012) Own elaboration

The simultaneous reading of table 1 and table 2 shows that the young affiliates are automatically enrolled in the type 2 fund which has a limit in equity investments of 45% (the limit exists with the intention to reduce the risk of the fund) while the affiliates keep the right to switch to a different fund (at will) until they are 60 years old.

It must be said that if current legislation is analyzed from a traditional perspective (where the "Homo Oeconomicus" stands) the default option does not play a role at all. However, from a behavioural law and economics perspective, if the "Homo Oeconomicus" paradigm does not stand, affiliates may simply get stuck in the default option chosen by the legislator or the policy-maker for decades. In that case, the role of the legislator or policy-maker when defining the default option becomes decidedly substantial. However, the enormous economic impact (in terms of future welfare) related to the setting of a particular default option for a pension fund may be clearly visible for the average man only at retirement.

# **3. Theoretical Framework**

The theoretical framework displayed in this chapter will briefly described what a defined-contributions system is as a previous step to analyze the best strategies of asset allocation for defined-contribution pension funds as discussed by the specialized literature. The aim of such a review is to understand what economic theory has said about optimal assets allocation for portfolios with long horizons of time. Later, in order to understand why, in real life, allocations of assets may differ from what it is expected by traditional economic theory, a comparison between the "Homo Oeconomicus" model and the average man will be offered. Analysis will center in how the extensive use of heuristics leads to systematic and predictable biases in decision-making processes. Emphasis will focus in explaining the status quo bias and the so-called "default effect" because they are particularly relevant for this research. Finally, modern "Nudge Theory" will be revised as an alternative way to regulate complex issues considering the realistic flaws detected in the "Homo Oeconomicus" model.

## **3.1. Defined-Contribution Pension Funds**

Defined Contribution Systems started in the U.S. during the seventies "...as a mechanism for executives to defer bonuses. Even today, some DC vehicles are still called savings plans; and for many years the standard default was money market funds or guaranteed investment contracts (GICs)". (Cohen, Ezra, & Furlan, 2011, p. 26). However, nowadays, defined-contribution plans are quite popular around the world because they "...establish a clear linkage between contributions, investment

performance and benefits; support enforceable property rights; and may be supportive of financial market development." (The World Bank, 2008, p. 3)

The most important advantage of a defined-contribution system is that it is fully funded, it does not create fiscal problems and it gives incentives to workers to make important contributions because, under normal circumstances, a clear relation between the sum of the contributions and the amount of the future pension should exist (Guillén & Mosqueda, 2013, p. 12). However, if the defined-contribution funds are "...compared to defined benefit plans they can subject participants to financial and agency risks as a result of private asset management, the risk of high transaction and administrative costs, and longevity risks unless they require mandatory annuitization" (The World Bank, 2008, p. 3)

## **3.2. Applied Investments Theory on Pension Funds**

"Asset allocation is generally defined as the allocation of an investor's portfolio across a number of "major" asset classes". (Sharpe, 1992, p. 7) Where "major" asset classes are typically equity, bonds, bills, cash, etc. Financial literature does not offer an indisputable optimal asset allocation for pension funds. However, most successful asset allocation strategies are divided in 2 broad categories. The first one comprehends strategies which maintain a constant asset allocation until retirement. In the second category stand the so-called "life-cycle" strategies which change the asset allocation of the fund accordingly to the age of the employee. Nobel laureate Robert J. Schiller (2006) tested six different asset allocations for pension funds. Three of them were life-cycle portfolio strategies that invested a large percentage of the funds in equity until employees were 29 years old. From that age, the concentration of equity gradually fell as reaching retirement. Differences among the 3 life-cycle portfolio strategies lied on how they varied their equity shares passing from 90% to 40% in the "Aggressive" case, from 85% to 15% in the "Baseline" scenario and from 70% to 10% in the "Conservative" fund. The other 3 asset allocations strategies did not have a life-cycle basis but fixed equity concentrations of 100%, 50% and 0%. Strategies were tested using U.S. data from 1871 to 2004. Results showed that funds with 100% of their assets invested on equity provided optimal results.

Antolín et al (2010) tested 24 different asset allocations. The first 4 were fixed portfolio strategies with different concentrations of equity: 0%, 20%, 50% and 80%. The next 4 were path-dependent dynamic risk budget strategies that modified their concentration of assets according to certain risk budgets<sup>1</sup> using 4 different initial equity concentrations: 20% 40% 60% and 80%. The last 16 strategies were different versions of life-cycle strategies. All the 24 strategies were tested using data from 1954 to 2008 from Germany, Japan and the U.S.. Results showed that life-cycle strategies had better outcomes in relatively short investment periods as 20 years. However, for remarkably long periods (around 40 years) life-cycle advantages tended to disappear. The study concluded that, for the same exposure to risk, funds with high equity exposure switching to bonds prior retirement tended to have a better relative performance

<sup>&</sup>lt;sup>1</sup> Where the higher the risk budget, the more aggressive the fund.

Bassu and Drew (2010) tested 22 different asset allocation strategies in Australia. The study comprehended 17 fixed weight strategies that emulated 17 of the top Australian pension funds, 3 life-cycle strategies and 2 hypothetical strategies including a fund which invested 100% of assets in equity. They used Australian data from 1900 to 2004 to test the funds. Results showed that asset allocations with moderate equity concentration were systematically overcome by funds with very aggressive equity concentration (approaching the 100% of equity).

Cannon and Tonks (2013) used data from Australia, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the U.K. and the U.S. Their results showed, among other findings, that 100% equity strategies usually performed better than 50% equity – 50% bonds and 100% bonds strategies. Life-cycle strategies were the optimal ones in a few countries.

Manor (2017) discussed the most efficient asset allocation that could be implemented in a pension system in Israel. In order to do so, fifteen different strategies were tested Findings showed that the efficient strategies had an initially high percentage of equity, which was gradually decreasing. They showed that an initial high concentration of equity was mandatory to obtain reasonable pensions but that equity should be reduced prior retirement to prevent losing the accumulated funds.

The analysis of the optimal asset allocation for pension funds in the literature has shown different authors using different asset allocations strategies and different sets of data to test them. However, there is wide consensus in the fact that at least at initial

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stages, a high percentage of equity is required to achieve the best potential pensions. Nevertheless, the average asset allocation in pension funds is quite different. The next sections of the theoretical framework focus on the differences between the "Homo Oeconomicus" and the average man to explain why real behaviour is not as expected.

# 3.3. The "Homo Oeconomicus" Archetype

"Homo Oeconomicus" (economic man) is a Latin expression which, as acknowledge by Savona (2006), lacks undisputable consensus regarding its date of appearance or its author. However, this research has found as its first published use an extract from the work of Charles Devas from 1883, referring to it as: *"homo oeconomicus, or the dollarhunting animal."* (Devas, 1883, p. 27). Beyond the fact that there is no academic consensus regarding the appearance of the phrase (in Latin) or who coined it, it is a fact that the notion of *"Homo Oeconomicus"* existed quite before the work of Devas. Even an early delineated version of it could be depicted from Hobbes masterpiece: Leviathan (1651). However, the full concept and an entirely distinguishable image of the *"Homo Oeconomicus"* belongs to the theory developed by the 19<sup>TH</sup> century classical economists.

In words of John Stuart Mill: "...Political Economy presupposes an arbitrary definition of man, as a being who invariably does that by which he may obtain the greatest amount of necessaries, conveniences, and luxuries, with the smallest quantity of labour and physical self-denial with which they can be obtained in the existing state of knowledge.". (1836, p. 16) In the same line of thought, Mill insists on a similar vision of a man as "... a being who desires to possess wealth, and who is capable of judging

the comparative efficacy of means for obtaining that end." (1844, p. 97) These two quotes, offer a reasonable view of the "Homo Oeconomicus" as it was originally conceived in the 19<sup>th</sup> century. The 21<sup>ST</sup> century concept of the "Homo Oeconomicus" has not dramatically changed, but extended, the 19<sup>th</sup> century vision of it. According to Mullainathan & Thaler (2001), the three key features exhibited (today) by the "Homo Oeconomicus" are: first, unbounded selfishness; secondly, unbounded willpower; and thirdly, and particularly important, unbounded rationality. These three key features of the "Homo Oeconomicus" are the assumptions in which mainstream economics models rely on. However, these assumptions keep being challenged by behavioural economics.

#### **3.3.1. Unbounded Selfishness**

The first key trait of the "Homo Oeconomicus" is unbounded selfishness. A clear view of that feature is exhibited by someone who "...acts on the basis of preferences that are self-regarding --excluding such intrinsic values as altruism, fairness, and vengeance--..." (Bowles & Gintis, 2000, p. 1414).

From the opposite perspective, bounded selfishness, refers to the fact that *"Behavioral economists have documented ways in which individuals may instead act out of concern for others or based on conceptions of fairness, reflecting vengeful as well as altruistic motives"* (Robinson, Hammitt, & Loomis, 2011, p. 5). As discussed by Frey (1997), real life retreats from the "Homo Oeconomicus" because human motivation is not only concerned about monetary incentives. Intrinsic motivation may lead people to execute contributions to charitable organizations as anonimous donations or pro-bono work.

#### **3.3.2.** Unbounded Willpower

The second key trait of the "Homo Oeconomicus" is unbounded willpower. It implies that "...humans boast full (complete) self-control..." (Karbowski, 2016).

*Contrariu sensu,* bounded willpower, in words of Jolls, Sunstein, & Thaler means that "*…human beings often take actions that they know to be in conflict with their own long-term interest"* (1998, p. 9). Robinson & Hammitt, share a similar perspective. For them, bounded willpower, implies to acknowledge "*…that our incomplete self-control may cause us to engage in behaviors we know we will regret."* (2011, p. 1410) From a practical perspective, if human beings had unbounded willpower, all the New Year's resolutions concerning future diets would be 100% successful.

#### **3.3.3. Unbounded Rationality**

The most important feature exhibited by the "Homo Oeconomicus" and lacking in the average man is unbounded rationality. It was Nobel laureate, Herbert Simon, one of the first economists to pay attention to the unrealistic level of rationality attributed to men by economists: "*This man is assumed to have knowledge of the relevant aspects of his environment which, if not absolutely complete, is at least impressively clear and voluminous. He is assumed also to have a well-organized and stable system of preferences, and a skill in computation that enables him to calculate, for the alternative courses of action that are available to him, which of these will permit him to reach the highest attainable point on his preference scale." (Simon, 1955, p. 99) Consequently, Herbert Simon, already during the fifties, advocated for a change in the paradigm of unbounded rationality: "We shall explore possible ways of formulating the* 

process of rational choice in situations where we wish to take explicit account of the "internal" as well as the "external" constraints that define the problem of rationality for the organism" (1955, p. 101).

The idea of incorporating imperfect or bounded rationality to economic models has prospered since those days. In this line of thought, Conlisk (1996) found four clear arguments for that. First, the patent empirical evidence concerning the importance of bounded rationality. Secondly, the success achieved when describing economic behavior after incorporating bounded rationality. Third, the arguments that consider unbounded rationality, in spite of their historical transcendence, are too extreme to be unqualified. Fourth, the cognitive process required in order to make a good decision is not cost free and economics needs to collect all the costs involved in any process.

From the analysis made until here, it should be said that the "Homo Oeconomicus" model definitely is what a "model" means: an abstraction to the end that complex issues become manageable. In this sense it serves all kinds of applications, but the newly emerging experimental approaches show its limits as part of the regular dynamics of progress in research. As Nobel laureate Paul Samuelson used to say: "Funeral by funeral, theory advances."

## *3.3.3.1.* Heuristics, a challenge to the unbounded rationality assumption

According to Nobel laureate Daniel Kahneman (2011) humans make decision in two different ways (dual process theory) relying in two different models of cognition called System 1 and System 2. On the one hand, System 1 functions in an automatic,

effortless, fast, intuitive and unconscious way. On the other hand, System 2 is conscious, slow, controlled, deliberate and effortful. Most decisions people make are irrational because they are done in a fast and intuitive way (using System 1) while relying on mental shortcuts called heuristics (Tversky & Kahneman, 1974). Heuristics are rules of thumb used in order to make decisions but not trying to find the optimal solution to a problem but the first option that may reach a personal threshold (Gigerenzer, 2008).

#### 3.3.3.2. Heuristics and Cognitive Biases

The clear problem of heuristics when making decisions according to Tversky & Kahneman (1974) is that their use leads to predictable cognitive biases. Lieder et al (2013) describe cognitive biases as systematic errors that appear in judgments and decision-making processes. Hammond et al (1998) refer to cognitive biases as sets of mental flaws that harm our logical reasoning, which we cannot completely eradicate Many biases have been identified as emanating from certain heuristics, i.e. at least 6 cognitive biases can be identified as emanating from 2 heuristics as shown in Table 3.

	Bias	Description	Emanating Heuristics
1	Ease of recall	Individuals judge events that are more easily recalled from memory, based on vividness or recency, to be more numerous than events of equal frequent instances, which are less easily recalled.	Availability Heuristics
2	Retrievability	Individuals are biased in their assessments of the frequency of events based on how their memory structures affect the search process.	Availability Heuristics
3	Insensitivity to base rates	When assessing the likelihood of events, individuals tend to ignore base rates if any other descriptive information is provided - even if it is irrelevant.	Representativeness Heuristics
4	Insensitivity to sample size	When assessing the reliability of sample information, individuals frequently fail to appreciate the role of sample size.	Representativeness Heuristics
5	Misconceptions of chance	Individuals expect that a sequence of data generated by a random process will look "random", even when sequence is too short for those expectations to be statistically valid.	Representativeness Heuristics
6	Regression to the mean	Individuals tend to ignore the fact that extreme events tend to regress towards the mean on subsequent trials.	Representativeness Heuristics

Table 3: Biases and Emanating Heuristics

Source: (Caputo, 2013)

In general terms, a several number of biases have been extensively studied by the specialized literature, as shown in table 4. However, this research is particularly interested in the Status-Quo Bias and the related Default Effect<sup>2</sup>

N	Bias	Study
1	Framing	Neale and Bazerman (1985); Bazerman, Magliozzi and Neale (1985); Neale, Huber and
		Northcraft (1987); Bottom and Studt (1993); Chang, Cheng and Trotman (2008)
2	Fixed-pie error	Thompson and Hastie (1990); Gelfand and Christakopoulou (1999); Mumpower, Sheffield,
		Darling and Miller (2004); Larrick and Wu (2007); Traavik (2011)
3	Self-serving	Thompson and Loewenstein (1992); Babcock, Loewenstein, Issacharoff and Camerer (1995);
		Babcock, Wang and Loewenstein (1996); Gelfand, Higgins, Nishii, Raver et al. (2002);
		Kriss, Loewenstein, Wang and Weber (2011)
4	Anchoring	Ritov (1996); Whyte and Sebenius (1997); Kristensen and Garling (2000); Wilson (2012)
5	Emotional bias	Gladwin and Kumar (1987); Kramer, Newton and Pommerenke (1993)
6	Overconfidence	Neale and Bazerman (1985); Kramer, Newton and Pommerenke (1993)
7	Incompatibility error	Thompson and Hastie (1990)
8	Intergroup bias	Lewis (2011)
9	Relationship bias	Reb (2010)
10	Status quo	Korobkin (1998)
11	Toughness bias	Heifetz and Segev (2004)

**Table 4: Brief list of Cognitive Bias** 

Source: (Caputo, 2013)

# 3.4. The Status Quo Bias and the Default Effect

## 3.4.1. The Status Quo Bias

According to Reeson & Dunstall (2009), the status quo bias challenges the assumption that humans always behave as "utility maximizers" who easily choose the option that suits them the best if such an option is available. Their research shows that the old habits and a natural human trend to inertia and procrastination usually lead men to the maintenance of the status quo even if it is not the optimal alternative.

Beyond the problem of procrastination (bounded willpower), Samuelson & Zeckhauser

(1988) explain that there are three great classes of reasons that help to understand the

<sup>&</sup>lt;sup>2</sup>Part of the literature includes the default effect as a particular case of the status quo bias. Another segment of the literature refers to them as independent but related factors.

maintenance of the status quo. The first group of reasons denies the existence of any bias at all. In this case, rational decision-making would take place when people are facing identical settings, when transition costs are overwhelming, or when there is uncertainty regarding the decision-making setting. In these cases, maintaining the status quo can be the rational option. For example, mankind could achieve important benefits from speaking a plane universal language i.e. Esperanto; however, the transition costs associated with such a change may be overwhelming.

The second set of reasons discussed by Samuelson & Zeckhauser (1988) that explain the status quo bias are cognitive misperceptions. Here, the idea of loss aversion plays a role because the status quo becomes the reference point, so any loss measured from the status quo, just as in the "endowment effect" (Thaler, 1980), feels as extremely more important than any gains from it.

The third group of reasons analyzed by Samuelson & Zeckhauser (1988) is psychological commitment. Here different factors play important roles. First factor is the desire to justify sunk costs. Second factor is regret avoidance because, in words of Kahneman & Tversky: *"regret associated with failures to act is often less intense than the regret associated with the failure of an action"* (1981, p. 173). This means that potential negative outcomes associated with a change of the status quo are perceived as more painful than the same negative outcomes if they come from the status quo.

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## 3.4.2. The Default Effect or Default Bias<sup>3</sup>

The default effect implies that in situations where an election needs to be performed, people exhibit a hyperbolic preference for the default option (regardless the content of it (Camerer, 2000). Johnson & Goldstein (2003) have identified three critical reasons that make a default option to have an orotund influence in decision making. First, average people in charge of decision making tend to perceive default options as recommendations or guidelines made by the policy-makers. Secondly, because making any choice implies some level of effort, while, accepting the default option implies no effort. Third, because defaults tend to be seen as the status quo (as explained before).

Neuroscience has also studied the default effect. Yu et al (2010), used magnetic resonance imaging to evaluate the impact that emotions have on people keeping the default option. Results showed *"an anticipatory somatic signal in the insula as a potential mechanism for loss aversion and a ventral striatal mechanism associated with default selection encompassing the same area as winning, implying that selecting the default might be rewarding in itself"* (Yu, Mobbs, Seymour, & Calder, 2010, p. 14706).

Researchers have also conducted experiments concerning the impact of the default effect. Human lives literally depend on organ donations, so in order to test the impact of the default option in such a critical topic an experiment was conducted by Johnson & Goldstein (2004). They elaborated a survey asking people if they would be organ donors using three varying defaults. In the first scenario, people were requested to imagine that they had moved to a different state where the default option was <u>not</u> to

<sup>&</sup>lt;sup>3</sup> Part of the literature refers to the default effect as the default bias. Part of the literature includes the default effect in the status quo bias. This research treats them independently.

be a donor while keeping the opportunity to "opt in" the "donor status" at any time. In the second case or "opt-out" situation, the default rule was to be an organ donor, so they were asked to "opt-out" if necessary. The third case, the neutral one, offered no default. People were forced to choose to be a donor or not. Results showed almost no difference in the number of potential organ donors between the second scenario (optout) and the third scenario (neutral). However, positive answers (to be a donor) in the "opt-in" scenario appeared around just half of the other cases. As it is shown in figure 1, the default option played a quite relevant role in the decision-making process.



Figure 1: Percentage of potential donors by scenario

Source: (Johnson & Goldstein, 2004)

In a different environment, in a so-called natural quasi-experiment, changes in the automobile insurance law in the US, allowed Johnson et al (1993) to analyze the impact of the default option in the car insurance market. The States of New Jersey and Pennsylvania, both introduced cheaper car insurance rates by reducing the potential suing rights in case of an accident, however, they did it in different ways. On the one hand, New Jersey settled the lower price option as the default option and allowed its citizens to switch to the full suing rights by paying the full price. Around 20% of them

did it. Pennsylvania, on the other hand, settled full rights as the default option allowing people to "opt out" from the full rights. Approximately 75% of Pennsylvanian drivers kept the full rights. Johnson et al (1993) propose the idea that New Jersey is a reasonable counterfactual for Pennsylvania. If that assumption were accepted, 55% of Pennsylvanian drivers would have full insurance just because it was the default option. In that case, the value of the settling of the default option would have reached the amount of USD 200 millions (in insurance premia).

### **3.5. Nudge Theory**

The review of "Nudge Theory" should offer interesting ideas to overcome the decisionmaking problem in particularly complex topics with high impact for the average man.

#### 3.5.1. Choice Architecture, Nudges and Default Options

The term choice architecture "reflects the fact that there are many ways to present a choice to the decision-maker, and that what is chosen often depends upon how the choice is presented" (Johnson, et al., 2012, p. 488). To understand this concept, its creators, Thaler and Sunstein (2008), propose the case of the manager of a school cafeteria who has found out that the place where food is exhibited has a relevant effect on what it is bought by the students, becoming cognizant of how the "choice architecture" influences consumption.

The most important thing about the previous example is that now the manager has become a "choice architect" and must decide if she wants to maximize profits or the consumption of healthy products. Therefore, she has the chance to "nudge" the students. For Thaler & Sunstein a nudge is an " aspect of the choice architecture that alters people's behaviour in a predictable way, without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates." (2008, p. 6) "Nudges are ways of influencing choice without limiting the choice set or making alternatives appreciably more costly in terms of time, trouble, social sanctions...." (Hausman & Welch, 2009, p. 126) "A nudge is a function of the choice architecture that alters people's behaviour in a predictable way (1) that is called for because of cognitive boundaries, biases, routines, and habits in individual and social decision-making and which (2) works by making use of those boundaries, biases, routines, and habits as integral parts of the choice architecture." (Hansen, 2016, p. 170)

There exist different types of nudges or interventions, including changing the order of alternatives, required waiting periods to offset the trend to perform careless decisions, alternatives to undo unfortunate decisions, required provision of information and specially the accurate use of default options (Baron & Wilkinson-Ryan, 2018)

There are many different types of default options. They include: simple defaults, where there is only one default for all the decision-makers; random defaults, where the particularly chosen default option is elected (at random) for experimental purposes; forced choice, where a service or product is not delivered by default until a choice is performed; and sensory defaults, which change according to the user, as in web pages that automatically modify their language depending on the visitor (Johnson,

et al., 2012). However, this research focuses in the use of default options which rely on the use of the default effect (see section 3.4.2.) in favour of a decision-maker.

#### 3.5.2. Default Options as Nudges for Pension Funds

Pension funds have become a relevant ground for the use of default options as nudges. Madrian & Shea (2001) analyzed the impact of a change in the 401(k)<sup>4</sup> plan of a publicly traded company operating mainly in the U.S. health sector. Since April 1<sup>st</sup> 1998 the company they analyzed switched its default option to automatic enrollment while the employees conserved the right to "opt out" of the default plan at any time. The research studied the enrollment level before and after the changed in the default option arriving to 2 major findings. First, the enrollment in the 401(k) plan significantly increased after the change in the default option. Secondly, that employees hired under the new default framework massively kept both the default asset allocation (allocated entirely to a money market fund) and the default contribution rate (3%) in spite of the fact that previous employees had hardly ever chosen this combination. The study concluded that the change was mainly attributable to the fact that employees understood the default option as recommendation and to inertia.

Beshears et al, (2009) studied the effect of a change in a default option related to the enrollment and contributions to a pension fund plan in a medium-sized company in the U.S. chemical industry. This company changed its default option twice in less than one year. In December 2000 the company implemented automatic enrollment as the default option for new hires with a contribution rate of 3%. Then, in October 2001, the

<sup>&</sup>lt;sup>4</sup> The 401 (k) plan is a retirement plan in the U.S. that allows employees to invest pre-tax dollars in a retirement account.

company changed again the default option to a contribution rate of 6% for the new hires (people hired after October 2001). Results showed that when the default option implied automatic enrollment the participation rate grew to 95%. Such a percentage represented a difference of 35% if counted after 3 months of being hired and of 25% after if counted after 24 months of tenure as shown in figure 2. In addition, from the group of people hired under the 6% default option, the percentage of people who kept the default option was absolutely significant. Results are shown in figure 3. It is quite clear that the default option has a significant impact in pension funds decisions.



Figure 2: Default Participation and Tenure

Source: (Beshears, Choi, Laibson, & Madrian, 2009)



**Figure 3: Default Participation and Contribution Rates** 

Source: (Beshears, Choi, Laibson, & Madrian, 2009)

# 4. Methodology and Data

## 4.1. Aim of the Empirical Study and Election of the Model

The aim of the empirical study delineated in this chapter is to supply the quantitative information required to compare the potential accumulation of wealth and risk taken by the "Type 2 Fund", a balanced fund which works as the default option in the Peruvian Private Pension Fund System (see section 2), and the "Type 3 Fund", the high-equity fund of the system.

Such a quantitative analysis could be done using deterministic models or stochastic models. Deterministic models main feature is that they use non-random values as parameters and therefore produce a unique result. On the other hand, stochastic models forecast a myriad of possible outcomes as solutions which are weighted by different probabilities (Taylor & Karlin, 1998, p. 2). In this line of thought, a stochastic model reduces the uncertainty that appears when required parameters are random variables by offering different possible solutions that reflect the potential values or distributions of those parameters. Statistical moments can be obtained from the outcomes, including the mean, the mode, the variance and a whole probability density distribution. (Renard, Alcolea, & Ginsbourger, 2013, p. 136)

Considering that in defined-contribution pension funds the accumulated wealth that affiliates achieve at retirement depends on profits that come from financial assets which exhibit unpredictable results (random variables); then, a stochastic approach becomes the most reasonable way to model pension funds. Therefore, this research will focus in such a type of model as detailed ahead.

## 4.2. A Non-parametric Model of Financial Returns

The returns obtained in financial markets are hardly normal (Bohumil, 2014), and finding the appropriate distribution that best fit them may go from "Stable Paretian" distributions (Mandelbrot, 1963) to a "...subordinated stochastic process generated from a mixture of combinations of distributions" (Affleck-Graves & McDonald, 1989, p. 892). This theoretical disagreement generates practical problems when developing a financial model because if the model relies on disputable assumptions or parameters, it generates important doubts concerning the results of the whole study. Therefore, the returns of the asset classes required to replicate the "Type 2 Fund" and the "Type 3 Fund" have been obtained using non-parametrical estimations through a bootstrapping process. It must be said too that in line with the methodology proposed by Basu & Drew (2010), the mean and standard deviation of the asset class returns are assumed to be not only invariant through time but also time independent.

## 4.3 Fees, Contributions and the Labour Environment

To simulate conditions in the SPP, administration fees charged by the AFP were settled on 1,22% of the accumulated funds per year. However, they are discounted in a monthly (proportional) basis. It must be said that the 1,22% annual fee is the current fee in the SPP and in the model it has been maintained constant in real terms for the whole accumulation period. Contribution rates are maintained in the historical rate of 10% of the salary. Contributions are understood as mandatory and as automatically discounted from the payroll of any employee on a monthly basis, so the employee has no chance to decide if he wants to perform the contributions or not.

Contributions depend on wage. The wage of the average worker from 18 to 25 years it has been estimated around PEN<sup>5</sup> 980.00 in 2018 (Instituto Nacional de Estadística e Informática - INEI, 2017). The remuneration is assumed to grow 67% when the affiliate turns 25 years old, and finally to increase by 8% at age 45 (Instituto Nacional de Estadística e Informática - INEI, 2017). Additionally, wages are assumed to grow at a 6% rate in nominal terms, which is completely independent of the age of the worker and perfectly in line with the growth exhibited in the last official available information 2007-2016 (Instituto Nacional de Estadística e Informática - INEI, 2017). Density of contributions is understood as a function of the unemployment rate. The higher the unemployment, the lower the chances to make contributions to the retirement fund. Unemployment rate is estimated in 10,8% until the affiliate is 25 years old, severely decreasing to 3,3% when he turns 25, and to be maintained at those levels until he is 45 years old. From that age, unemployment finally drops to 1,7% until he is 60 years old (Instituto Nacional de Estadística e Informática - INEI, 2017). Voluntary or extraordinary contributions to the fund have not been considered in the model.

## 4.4. Investments Constraints in Pension Funds

In order to execute the replication of both, the "Type 2 Fund" and the "Type 3 Fund", their fundamental investment constraints required to be identified (Ley N° 27988, 2003) (Ley N° 29759, 2011). The next investments constraints were carefully incorporated in the process of replication of the aforementioned pension funds:

<sup>&</sup>lt;sup>5</sup> PEN: Peruvian Currency

## 4.4.1. General Legal limits

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rable	э.	General	investment	IIMILS

General Investments Limits by issuer		
a) The sum of assets issued or guaranteed by the Peruvian		
State		
b) The sum of assets issued or guaranteed by the Peruvian	30%	
Central Bank		
c) The sum of a) and b)		

Source: (Ley N° 27988 , 2003) Own elaboration

## 4.4.2. Specific Legal Limits

They were applied in both replicated funds in a different way as shown in table 6.

	Type of Fund		
Investment	Type 2 (%)	Type 3 (%)	
Short-Term Debt Securities or Cash	30	30	
Debt Securities	75	70	
Equity Securities	45	80	
Derivatives	10	20	
Alternative Investments	15	20	

Table 6.: Investment limits per type of fund in percentages

Source: (Ley N° 29903, 2012) Own elaboration

#### 4.4.3. Foreign Investments Limits

Calculations for the replication of funds have been done considering that pension have not only a legal limit of 50% on foreign investments, but also an operative limit of 50% on foreign investments which is in line with the last rate approved by the Peruvian Central Bank (Banco Central de Reserva del Perú, 2018) as shown in figure 4



Figure 4: Foreign Investments Limits in the SPP: September 2008 – September 2018

Source: Adapted from Banco Central de Reserva del Perú (2018)

# 4.5 Official Data from Historical Asset Allocation

Official public information regarding the asset allocation of both the "Type 2 Fund" and the "Type 3 Fund" was collected from the official Peruvian source (Superintendencia de Banca, Seguros y AFP, 2018). Official information has been reorganized, consolidated, and summarized in table 7

	Type 2 Fund		Type 3	Fund	
	Amount in		Amount in		
	thousands	% of the	thousands	% of the	
	of PEN	fund	of PEN	fund	
Peruvian Fixed-Income	51.049.042	44,73%	2.097.274	8,90%	
Peruvian Variable-Income	13.281.756	11,64%	7.034.841	29,87%	
Peruvian Traditional Mutual					
Funds	994.572	0,87%	63.404	0,27%	
Total Peruvian Invesments	65.325.369	57,23%	9.195.520	39,04%	
Foreign Fixed-Income	2.198.346	1,93%	241.995	1,03%	
Foreign Variable-Income	3.684.270	3,23%	1.485.619	6,31%	
Foreign Traditional Mutual					
Funds	43.133.904	37,79%	12.740.948	54,09%	
Total Foreign Investments	49.016.520	42,94%	14.468.562	61,42%	
Transitory Accounts	-194.899	-0,17%	-108.541	-0,46%	
TOTAL	114.146.991	100,00%	23.555.542	100,00%	

Table 7: Composition of the funds by December 29, 2017

Source: (Superintendencia de Banca, Seguros y AFP, 2018) Own elaboration In Table 7, investments per fund were summarized in 2 wide categories: Peruvian investments and foreign investments. Then, each category was subdivided by the asset classes effectively present on them. Foreign investments in the "Type 3 Fund" clearly exceed the 50% of the fund. This is only possible because the limits on foreign investments work for the assets managed by each AFP as a whole and not per fund. Considering that the "Type 2 Fund" (which is the oldest and clearly the largest fund) invests abroad less than the operative limit, there is an opportunity to invest more than 50% of the assets of the "Type 3 Fund" overseas. Investments done by each AFP were analyzed and such a strategy was unvarying in each one of them.

## **4.6.** Data Required for the Replication of Asset Classes

From the classification shown in table 7, appropriate proxies were designated to represent actual asset classes present in both funds in the most reasonable way. General criterion used to find appropriate proxies was that proxies should display public, free, available information for reasonably long periods of time. For variableincome proxies, continuous time series of 20 and 68 years were found and included in the model. In the case of fixed-income proxies, relevant fixed-income indices were harder to find because fixed-income indices that rely on truly liquid fixed-income assets have not been in the market for equally extensive periods of time. However, fixed-income assets exhibit less volatility than their variable-income counterparts, so the impact that shorter time series may have in the model is moderate. Therefore, fixed-income time series ranging from 10 to 14 years were included in the model. It must be said that in all cases, time series revealed nominal returns so they were transformed into real returns using the Consumer Price Index (CPI) for U.S. time series (Bureau of Labor Statistics, 2018) and the Peruvian "Indice de Inflacion" for the Peruvian time series (Instituto Nacional de Estadística e Informática - INEI, 2017). Each one of the financial index used as proxies of the asset classes identified in table 7 are discussed ahead.

#### 4.6.1. Foreign Variable-Income

The chosen proxy for foreign equity was the "Standard & Poor's 500 Index". This is probably the most important stock index in the world. It is a capitalization-weighted index which represents 500 of the largest publicly-traded companies in the U.S. As most of the foreign investments in Peru are executed in the U.S. market, the S&P 500 is the most natural choice to simulate those kinds of investments. The enormous advantage of the S&P 500 is that long time series of data are available. Monthly time series from the last 68 years (1950-2018) were compiled (Yahoo Finance, 2018) and included in the model.

#### 4.6.2. Peruvian Variable-Income

Peruvian financial markets look small when compared to U.S. markets in terms of market capitalization, breadth, depth and other recognizable attributes. Data regarding Peruvian variable-income is definitely not as abundant as in the case of the U.S. markets. Nevertheless, indexes tracking the most important stocks in the Lima Stock Exchange (BVL by its name in Spanish) do exist. One of the most representative Peruvian stock indices is the "Indice General de la Bolsa de Valores de Lima", renamed in 2015 as "S&P/BVL Peru General Index". Monthly time series from the last 20 years

(1998-2018) of the mentioned index were found (Yahoo Finance, 2018) and used as a proxy for Peruvian equity.

#### 4.6.3. Foreign Fixed-Income

The general criterion to represent investments in foreign fixed-income assets is that they must represent liquid debt securities with investment grade, different maturities and issuers (including government and corporate issuers). The "iShares Core U.S. Aggregate Bond ETF" is a well-recognized American ETF that fits these characteristics. Monthly time series from the last 14 years (2014 - 2018) were collected and used in this research (Yahoo Finance, 2018).

#### 4.6.4. Peruvian Fixed-Income

More than half of the Peruvian fixed-income identified in table 7 are represented by bonds issued by the Peruvian Government. Therefore, the most representative index to replicate this category was the "S&P Peru Sovereign Bond Index" which comprehends Peruvian sovereign debt issued in PEN with different maturities. Monthly time series from the last 10 years (2008-2018) were found and used as a proxy for Peruvian Fixed-Income. (S&P Dow Jones Indices, 2018)

#### 4.6.5. Traditional Mutual Funds

In table 7, the most significant category is "Foreign Traditional Mutual Funds". This category displays exceptional weights equivalent to the 37,79% and 54,09% of the "Type 2 Fund" and the "Type 3 fund" respectively. This category, in essence, contains hundreds of mutual funds which invest in thousands of securities. It would be

preposterous to use one proxy for such a category considering that the "Type 2 fund" and the "Type 3 fund" fund have different limits to equity and debt so, the composition of the mutual funds chosen for each type of pension fund should be different to fit those limits. To appropriately represent the "Foreign Traditional Mutual Funds" category, its weight in each fund was reassigned directly to their underlying asset classes: foreign equity and foreign debt.

In the case of the category "Peruvian Traditional Mutual Funds" which represents the 0,87% and 0,27% of the type 2 and type 3 respectively. Their weights have also been reassigned to their underlying assets. In this line of thought, results will be presented showing three alternative versions of each fund. Further details regarding the scenarios in each fund are given in section 5.

# 5. Results

In this chapter I will discuss the results obtained after running the stochastic model developed for this thesis (as described in the previous chapter). First, I will explain why the results are presented through three alternative versions of the type 2 fund and through three alternative versions of the type 3 fund. Then, I will summarize the results individually obtained after running ten thousands simulations per each one of those six different scenarios. Later, I will make a comparative review of the results obtained in the aforementioned six scenarios analyzing both the return and the risk faced by them. Finally I will offer a general interpretation of my results.

## 5.1. Three Alternative Scenarios per type of Fund

The 3 alternative versions of the type 2 fund and the three alternative versions of the type 3 fund have been developed because the official public information regarding the asset allocation of pension funds in Peru shows two particular investment categories which do not represent a unique asset class but a "combination" of asset classes. Those investment categories are: "Foreign Traditional Mutual Funds" and "Peruvian Traditional Mutual Funds". The first one basically represents a set of foreign equity and foreign debt, while the second one represents a set of Peruvian equity and Peruvian debt securities. The problem of official reports presenting information in this way is that they lack a transparent delimitation of the percentages of the funds devoted to a particular asset class, making potential replications (for academic purposes) ineffective.

Therefore, the six scenarios shown in this chapter, exhibit the potential results in terms of return and risk achieved by 10.000 simulations after the reassignment of the categories "Foreign Traditional Mutual Funds" and "Peruvian Traditional Mutual Funds" to their underlying assets in 3 hypothetical alternative scenarios per type of fund resembling positions with maximized equity, balanced equity and minimized equity. In this way, the results of the 6 scenarios revealed in this chapter try to compensate the natural deficiency in the official information. This is especially true considering that a category as "Foreign Traditional Mutual Funds" is absolutely material to determine the potential return and risk taken by both types of funds because it represents 37,79% of the "Type 2 Fund" and 54,09% of the "Type 3 Fund". Although the category "Peruvian Traditional Mutual Funds" only represent the 0,87% and the 0,27% of the "Type 2 Fund" and of the "Type 3 Fund" fund respectively, from a qualitative perspective it offers the same challenge.

It should be clear that the equity maximizing and the equity minimizing scenarios try to represent the widest range of possibilities regarding the use of mutual funds, while the balanced scenario try to represent an intermediate position. The actual positions chosen by the AFP for both funds should stand somewhere in the middle.

It must be said that in all the scenarios the assets officially committed to "Foreign Traditional Mutual Funds" were reassigned to foreign equity and to foreign fixedincome, while the assets officially represented in the "Peruvian Traditional Mutual Funds" category where always reassigned to Peruvian equity and to Peruvian fixedincome.

# 5.2. Results per Scenario

Table 8 shows the results obtained after running ten thousands simulations per each one of the next six different scenarios. The histograms representing the distributions of each one the scenarios are included as annexes. (From annex 2 to annex 7).

		-				
					Standard	
	5%	50%	Mean	95%	Deviation	95%-5%
F2 Maximized						
Equity	250.377	382.818	399596	607.294	110.989	356.917
F2 Balanced	248.875	344.887	354055	489.408	74.544	240.533
F2 Minimized						
Equity	230.546	305.038	310523	410.556	55.562	180.010
F3 Maximized						
Equity	246.330	514.115	585039	1.173.308	306.875	926.978
F3 Balanced	245.790	440.198	478951	849.529	193.739	603.739
F3 Minimized						
Equity	221.712	372.381	400056	665.564	144.620	443.852

Table	8:	Results	per	Scen	ario
I GOIC	υ.	ILC JUILD	PCI	30011	

Own elaboration

# 5.3. Comparative Analysis of Expected Returns

In this section I will analyze and compare the results produced by the alternative scenarios of both funds in terms of Expected Return.

## 5.3.1. Maximized Equity Scenarios

Under an equity maximization policy by the AFPs, results show after 42 years of contributions, that the expected return of the "Type 3 Fund" clearly would outperform the expected return of the "Type 2 Fund". A change from the "Type 2 Fund" to the "Type 3 Fund" at enrollment would imply an expected increase of 46.41% in real PEN. If median returns are preferred for the analysis of returns, the "Type 3 Fund" still would outperform the "Type 2 Fund" in a 34,30% in real PEN. As an additional fact, it should be said that the potential for appreciation of the type 3 fund is even more

significant showing an increase of 93,20% at the 95<sup>th</sup> percentile. Table 9 and Figure 5 offer a summary of the abovementioned analysis.

	50%	Mean	95%
F2 Maximized Equity	382.818	399.596	607.294
F3 Maximized Equity	514.115	585.039	1.173.308
Difference	131.297	185.443	566.014
Difference (%)	34,30%	46,41%	93,20%

**Table 9: Differences in Maximized Equity Scenarios** 

**Own Elaboration** 





Own elaboration

## 5.3.2. Balanced Scenarios

Under a policy of use of Mutual Funds with equal distribution of debt and equity by the AFPs, the expected return of the "Type 3 Fund" clearly would outperform the expected return of the default option (the "Type 2 Fund"). A change from the default option to the type 3 fund at enrollment would imply an expected increase of 35,28% in real PEN after 42 years. If median returns were preferred for the analysis of returns, the "Type 3 Fund" still would outperform the "Type 2 Fund" in a 27,64% in real PEN. The potential appreciation of the "Type 3 Fund" would be even more significant showing an increase of accumulated wealth equal to 73,58% at the 95<sup>th</sup> percentile. Table 10 and Figure 6 offer a summary of the abovementioned analysis.

	50%	Mean	95%
F2 Balanced	344.887	354.055	489.408
F3 Balanced	440.198	478.951	849.529
Difference	95.311	124.896	360.121
Difference (%)	27,64%	35,28%	73,58%

**Table 10: Differences in Balanced Scenarios** 



#### **Figure 6: Balanced Scenarios**

**Own elaboration** 

#### 5.3.3. Minimized Equity Scenarios

Under a policy of use of mutual funds with minimized equity by the AFPs, the expected return of the "Type 3 Fund" still would outperform the expected return of the default option. In this case, a change from the type 2 fund to the type 3 fund at enrollment would imply an expected increase of 28,83% in real PEN after 42 years. If median returns were preferred for the analysis of returns, the type 3 fund still would outperform the default option by a 22,08% in real PEN. The potential appreciation of the type 3 fund would be more significant showing an increase of 62,11% at the 95<sup>th</sup> percentile. Table 11 and Figure 7 offer a summary of the abovementioned analysis.

	50%	Mean	95%
F2 Minimized Equity	305.038	310.523	410.556
F3 Minimized Equity	372.381	400.056	665.564
Difference	67.343	89.533	255.008
Difference (%)	22,08%	28,83%	62,11%

**Table 11: Differences in Minimized Equity Scenarios** 

**Figure 7: Minimized Equity Scenarios** 



**Own elaboration** 

#### 5.3.4. Non-consistent Policies

If the AFPs would decide to implement investment policies whose use of mutual funds would depend on the type of fund, then the number of comparisons would increase. Considering that in essence the type 3 fund is a high-equity fund and that the default option is, in essence, a balanced fund, then a comparison between a "Type 3 Fund" with a maximized equity position and the "Type 2 Fund" with balanced equity is absolutely reasonable to expect. In such a case, a change at enrolment from a balanced "Type 2 Fund" to a "Type 3 Fund" with an aggressive concentration of equity in its mutual funds should represent an increase in the expected return of 65,24% after 42 years of contributions. In this line of thought, Table 12 shows the change in the

expected return that should take place if there is a switch from each one of the 3 possible scenarios considered for the "Type 2 Fund" to each one of the three possible scenarios considered for the "Type 3 Fund".

Table 12: Gains in expected returns gained by switching from the alternative versions
of the default option to the alternative versions of the "Type 3 Fund"

	F3 Maximized	F3	F3 Minimized
	Equity	Balanced	Equity
F2 Maximized Equity	46,41%	19,86%	0,12%
F2 Balanced	65,24%	35,28%	12,99%
F2 Minimized Equity	88,40%	54,24%	28,83%

Own elaboration

It must be said that because of the essence of the "Type 3 Fund" as a high-equity fund and the "Type 2 Fund" as a balanced fund, a fairly implausible (but still theoretically possible) scenario would be a change from a "Type 2 Fund" with equity maximization to a "Type 3 Fund" with equity minimization. Even in this case (which is an oxymoron), the "Type 3 Fund" would outperform any scenario of the default option.

# **5.4.** Comparative Analysis of Risk

When discussing defined-contribution pension funds, the real risk that citizens face is to receive low pensions after the accumulation phase (at retirement). Therefore, the most appropriate indicator of risk corresponds to the worst potential outcomes at a certain level of significance (Antolín, Payet, & Yermo, 2010). In line with the literature, this research will use the 5<sup>th</sup> percentile of the distribution of each scenario as its measure of risk. Other traditional indicators of risk are poor predictors of the potential lowest outcomes after continuous contributions for extremely long time horizons. In this line of argument, this research has found that exist a weak correlation (p=0,2172) between the standard deviation of the six studied scenarios and the lowest outcomes

of their distributions (defined at the 5<sup>th</sup> percentile) These findings confirm that the standard deviation is a poor predictor of risk for retirement funds. This data has been

summarized in table 13 and figure 8

Table 13: Correlation Coefficient between the Standard Deviation and the Lowest Outcomes at the 5<sup>th</sup> Percentile

	5th percentile	Standard Deviation
F2 Maximized Equity	250.377	110.989
F2 Balanced	248.875	74.544
F2 Minimized Equity	230.546	55.562
F3 Maximized Equity	246.330	306.875
F3 Balanced	245.790	193.739
F3 Minimized Equity	221.712	144.620
<b>Correlation Coefficient</b>	0,2172	

Own elaboration





Own elaboration

However, as theoretically expected, the standard deviation is an excellent measure of the dispersion of the distribution. For example, when checking the range of outcomes between the 5<sup>th</sup> percentile and the 95<sup>th</sup> percentile, the standard deviation works as an almost perfect predictor of such a range ( $\rho = 0.9997$ )

	95% - 5%	Standard Deviation	
F2 Maximized Equity	356.917	110.989	
F2 Balanced	240.533	74.544	
F2 Minimized Equity	180.010	55.562	
F3 Maximized Equity	926.978	306.875	
F3 Balanced	603.739	193.739	
F3 Minimized Equity	443.852	144.620	
Correlation Coefficient	0,9997		

 Table 14: Correlation Coefficient of the Standard Deviation and the Range of

 Outcomes: 95<sup>th</sup> Percentile - 5<sup>th</sup> Percentile

Figure 9: Standard Deviation vs. Range of Outcomes 95<sup>th</sup> Percentile - 5<sup>th</sup> Percentile



Own elaboration

Understanding the 5<sup>th</sup> percentile of returns after 42 years of accumulation as the appropriate measure of risk for this research I will analyze the risk faced by each one of the scenarios under analysis.

The analysis of the 6 scenarios shows that in terms of risk (as defined) for every set of alternative versions, the funds with maximized equity actually got the less unfavourable results, closely followed by their balanced counterparts leaving the minimized equity versions behind. The rationale for these apparently counterintuitive results is that after 42 years of returns, the relatively higher expected returns associated with equity have an important impact not only on the expected return, but are strong enough as to positively impact the lowest outcomes at the 5<sup>th</sup> percentile, making the equity maximized funds safer alternatives than their balanced counterparts. A ranking of the 6 scenarios from the safest one to the riskiest one at the 5<sup>th</sup> percentile is shown ahead in table 15.

	5th percentile		
F2 Maximized Equity	250.377		
F2 Balanced	248.875		
F3 Maximized Equity	246.330		
F3 Balanced	245.790		
F2 Minimized Equity	230.546		
F3 Minimized Equity	221.712		

Table 15:	Ranking	of scenarios	s by risk
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Own elaboration

Table 15 also shows that risk differences in the first four scenarios are negligible. In the first four scenarios, the lowest outcomes at the 5<sup>th</sup> percentile stand between PEN 245.790 and PEN 250.377 showing a range of just PEN 4.587 (which implies a maximum change of -1,83%). Nevertheless, risk differences are not negligible when considering the Minimized Equity version of the "Type 3 Fund". However, as it has already been stated, it should be clear that although theoretically possible such a scenario it is highly implausible because in essence, the type 3 fund is a high-equity fund. These findings have been summarized in table 16

Table 16: Percentual changes in risk faced if switching from	n the alternative sets of
the "Type 2 Fund" to the alternative sets of the "Type 3 Fund	"

			/ 1
	F3 Maximized Equity	F3 Balanced	F3 Minimized
	PEN 246.330	PEN 245.790	Equity PEN 221.712
F2 Maximized			
Equity PEN 250.377	-1,62%	-1,83%	-11,45%
F2 Balanced			
PEN 248.875	-1,02%	-1,24%	-10,91%
F2 Minimized		,,	
Equity PEN 230.546	6,85%	6,61%	-3,83%

# 5.5. The Risk-return Trade-Off

After having analyzed the returns and the risk potentially faced by each change of scenario, it is necessary to analyze the risk-return trade-off among them. In figure 10, the axis of ordinates shows the expected return of the scenarios and the horizontal axis shows the risk incurred by them. It must be noted that the horizontal axis has been inverted, so the scenarios at the left are the safest ones and the ones to the right are the riskiest ones. The objective of this figure is to claearly visualize the efficiency of the scenarios.



Figure 10: Risk-return Trade-off

Own elaboration

Analysis of figure 10 is absolutely significant. It shows that the Minimized equity scenarios are inefficient and that from the remaining 4 scenarios, as long as the differences in risk are negligible, the impact of the expected returns becomes absolutely substantial.

## 5.6. Interpretation of Results

The findings of my research show that in a 42 years period of investments in the frame of the Peruvian Private Pension Funds System, funds representing high-equity concentrations outperformed their balanced and low-equity counterparts. In terms of expected return differences were absolutely substantial as shown in tables 8 and 12; and in terms of risk, understanding risk as the potential worst scenarios of accumulated wealth at the 5<sup>th</sup> percentile, differences were negligible as shown in table 8 and 16. Therefore, the analysis of the risk-return trade-off was profoundly favourable to the type 3 fund as clearly shown in figure 10. In this line of thought, the type 3 fund should be preferred by rational affiliates at enrollment. It is actually the case that the youngest affiliates have the longest time horizon and they may even hedge any negative initial outcomes with extra work (Gomes, Kotlikoff, & Viceira, 2008). However, official information regarding the number of active affiliates per type of pension fund in Peru tells a different story. Peruvian official sources shows that from the pool of affiliates younger than 30 years old, more than 99,2% of them take part of the "Type 2 Fund", and when considering affiliates of all ages, more than 90% of them are still in the "Type 2 Fund". (Superintendencia de Banca, Seguros y AFP, 2018)

So, how the information regarding the number of affiliates per fund can be explained at the light of the results of my model? My overall interpretation is that despite the fact that in terms of risk-return trade-off the "Type 3 Fund" outperforms the default option; the impact that bounded rationality has on most affiliates completely offset the advantages of the "Type 3 Fund" Particularly in developing countries, bounded rationality may be exacerbated because of path-dependency issues. The link between path dependency and bounded rationality in Peru can be clearly understood if we analyze Peruvian results on the Programme for International Student Assessment - PISA. PISA is an OECD programme which was created in 1997 with the aim to evaluate 15 years old students competencies in different areas of knowledge as reading comprehension, mathematics, science and (recently) financial education. Competencies evaluated in the frame of PISA are of particular interest because "The assessment focuses on young people's ability to apply their knowledge and skills to real-life problems and situations" (Anderson, Lin, Treagust, Ross, & Yore, 2007, p. 592). In the last edition of the test in December 2015, Peruvian students exhibited terrible reading comprehension and mathematical skills. From 69 countries or territories, Peru ranked 62<sup>nd</sup> in Reading Comprehension, and 61<sup>st</sup> in Mathematics (Organisation for Economic Co-operation and Development - OCDE, 2018). In the test concerning financial literacy, Peru ranked 14<sup>th</sup> of 15 participating countries or territories. (Organisation for Economic Co-operation and Development - OCDE, 2018). For a population that hardly understands what it reads, with poor mathematical skills and with little understanding of the most basic daily-life financial concepts, it is hard to believe that they will be in reasonable capacity to forecast and evaluate the potential trade-off between the risk and return that the asset allocation of the different type of pension funds in Peru may imply. Even informative campaigns would be meaningless if the target public cannot understand the content of the information. Therefore, in these circumstances, the assumption of rationality when choosing a pension funds is very hard to sustain for the masses.

In these conditions, it is even easier to assume that the default effect may play a hyperbolic role in the election of a pension fund. In this line of interpretation affiliates would get massively affected by the default effect because, as discussed in the literature review, people tend to perceive a default option as a recommendation or guideline made by the policy-maker; or because of the fact that making any choice implies some level of effort, while, accepting the default option implies no effort at all (Johnson & Goldstein, 2003); or simply because, as neuroscientist explain, selecting the default option activates the same areas in the brain than winning (Yu, Mobbs, Seymour, & Calder, 2010).

After the default option (the "Type 2 Fund") is accepted, the status quo bias plays a huge role too. As Reeson & Dunstall (2009) argue, old habits and a natural human trend to inertia and procrastination usually lead men to the maintenance of the status quo. In addition, "regret avoidance" also would lead to the maintenance of the status quo because potential negative outcomes associated with a change of the status quo are generally perceived by decision makers as more painful than the same negative outcomes if they come from the status quo (Kahneman & Tversky, 1981). This last idea is particularly powerful in the case of the election of a pension fund with a high concentration of equity because particularly in the short-run, the natural volatility of a high-equity fund may "scare" affiliates if they experiment what Benartzi & Thaler (1995) have called Myopic Loss Aversion.

## 5.7 Quantification of the value of the default option

If people in the Peruvian SPP get stuck in a default option<sup>6</sup> which does not maximize welfare in the long term; then, a switch in the setting of the default option from the "Type 2 Fund" to a more efficient fund as the "Type 3 Fund" should bring tangible benefits to the huge majorities. In this line of argument, the expected value of a change in the default option should be understood as the expected change in future accumulated wealth that should experiment the average affiliate if he is automatically enrolled in the "Type 3 Fund" instead of being automatically enrolled in the "Type 3 Fund" instead of being automatically enrolled in the "Type 2 Fund".

In order to quantify the value of the default option, it must be remembered that, in essence, the "Type 3 Fund" was conceived by Peruvian authorities as a high-equity fund (see section 2.1.) and that the "Type 2 Fund", in essence, was conceived as a balanced fund (see section 2.1.) Therefore, it should be noted that the "Type 3 fund with Minimized Equity" It is a useful scenario only to illustrate the theoretical inferior limit of the fund but implausible in practice because, as mentioned before, the "Type 3 Fund" is in essence a high-equity fund. So, the scenario "Type 3 Fund with Minimized Equity" cannot be understood as a valid picture for the quantification of the impact of a change in the default option.

Regarding the "Type 2 Fund", as this fund is in essence a balanced fund, depending on the circumstances of the market it could be biased to equity or to debt. Therefore, the three alternative versions of the "Type 2 Fund" fund should be considered as possible.

<sup>&</sup>lt;sup>6</sup> The type 2 option became the default option just because of historical reasons as explain in section 2.1.

In addition, it must be said that there is not a conceivable reason to assume that, simultaneously, the "Type 2 Fund" (a balanced fund) could be taking an aggressive high-equity position while the "Type 3 Fund" (a naturally high-equity fund) would be taking just a balanced position. Therefore, it also seems implausible to consider that a change in the default option in real life may be similar to a switch from what in the model is a "Type 2 Fund" with maximized equity to a "Type 3 Fund" with balanced equity. That possibility should be discarded too.

Having all previous considerations in mind, and relying in the expected returns found per each relevant scenario, the potential increase in future accumulated wealth can be estimated as an increase in accumulated wealth between 35,28% and 88,4%. This range of values represents all the possible combinations of scenarios described in table 17.

		-
	F3 Maximized Equity	F3 Balanced
F2 Maximized Equity	46,41%	
F2 Balanced	65,24%	35,28%
F2 Minimized Equity	88,40%	54,24%

Table 17: Potential value of the change in the default option

Own elaboration

The risk involved in the change in the default option should be considered as negligible (as high as 1,62%) and in some cases may imply a reduction in risk as shown in table18

	<u>0</u>	
	F3 Maximized Equity	F3 Balanced
	PEN 246.330	PEN 245.790
F2 Maximized Equity PEN 250.377	1,62%	
F2 Balanced PEN 248.875	1,02%	1,24%
F2 Minimized Equity PEN 230.546	-6,85%	-6,61%
F2 Minimized Equity PEN 230.546	-6,85%	-6,61

Table 18: Potential increase in risk due to a change in the default option

Therefore, a significant finding of this research is that a switch in the default option from the "Type 2 Fund" to the "Type 3 Fund" considering a period of 42 years of investments should imply an increase in future accumulated wealth in the range of 35,28% and 88,4% while facing a negligible increase in risk (which should be as high as 1,62%).

It should be clear that in this kind of situations, as the "Homo Oeconomicus" paradigm simply does not stand, and the default option plays a major role when choosing the asset allocation of the pension funds, the role of the legislator or policy-maker when defining the default option becomes exceptionally substantial. Therefore, important but complex decisions as the asset allocation of the pension funds become a golden opportunity for the policy-makers to "nudge" their citizens into welfare maximizing paths.

# 6. Limitations and Further Research

The first natural limitation of the present study is that a main assumption is that the system will be maintained until the affiliated is able to retire and that his funds will not be nationalized as in the Argentinian case. Unfortunately, in Latin-America this kind of policies are relatively usual.

A second limitation is that results correspond to the average employee in the current SPP who performs periodical contributions to his fund. People in the open and public pay-as-you-go system are obviously excluded from this analysis as well as people who perform activities in black markets or non-formal sectors because they do not perform contributions to the SPP.

An important condition for the model to hold is that contributions are performed for 42 years. If the investment horizon gets significantly reduced, the risk-return trade-off may vary substantially. Clearly, the model may not hold for an affiliate that for any circumstances may enroll at age 45. In addition, If in the future the SPP changes its investments limits, the model may not hold and it should be adjusted to this end.

Last but not least it should be said that the model implies investments until the affiliate turns 60 years and not until retirement (at 65 years old) because when the affiliate turns 60 years old, he cannot maintain his funds in the type 3 fund. The analysis of the convenience of this measure has been out of the scope of the present paper but it is open for a further research. Finally, I must say that this paper compared the existing funds. A further paper should evaluate how to improve the existing funds.

# 7. Summary and Conclusions

Motivation for this thesis was to try to quantify the economic impact that the setting of the default of option in Peruvian pension funds may have in future welfare. **To the best of my knowledge, this is the first paper that studies the economic impact of the default option in pension funds in Latin-America.** 

The research question in this paper was: "Could a minimal change in Peruvian financial regulation have a tangible impact in Peruvian welfare?" My hypothesis was that a change in the default option in the frame of the Peruvian Private Pension Funds System should bring a substantial increase in Peruvian welfare, measured as the additional accumulation of wealth in retirement funds at no significant risk.

I did an empirical analysis to verify my hypothesis. I elaborated a stochastic model to replicate the Peruvian Pension Funds System considering: a) contribution rates, b) administration fees, c) portfolio rebalancing, d) changes in wages that recognize increases in productivity in three different age segments: from 18 to 25, from 25 to 45 and from 45 to 60, e) density of contributions according to the unemployment rates for the aforementioned age segments, and f) increases in wages connected to the natural economic growth that the country has exhibited in the last 25 years. Later, official information concerning the historical asset allocations, and current legal investment limits of the Peruvian private pension funds were used to model the present asset allocation in six potential scenarios. To replicate the returns from the asset classes used by the pension funds, data was collected from time series that represented the returns of Peruvian and International financial markets. Then,

estimations of potential returns of those asset classes were generated through a nonparametric bootstrapping process. Finally, the aforementioned random returns were appropriately combined to simulate the returns from the pension funds through 42 years in conditions that represent the Peruvian Private Pension Funds System. This procedure was repeated ten thousand times per each one of the six scenarios that were constructed in order to simulate potential distributions of the accumulated real wealth and risk taken during the process.

Results were in line with the specialized literature. **First main finding** was that in terms of expected returns, scenarios that simulate the highest concentrations of equity notoriously outperformed the ones with lower equity concentrations. **Second main finding** was that in terms of risk, understood as the lowest outcomes of accumulated wealth at the 5<sup>th</sup> percentile, the extra risk taken by the high-equity scenarios compared to the balanced scenarios was negligible. Explanation of such a finding relies on the fact that the additional returns usually associated with high equity concentrations, in a lapse of 42 years, are important enough as to offset the higher standard deviation also usually associated with high-equity concentrations. **Third main finding** was that scenarios with minimized equity were the ones with the lowest outcomes at the 5<sup>th</sup> percentile.

Nevertheless, the merits of the scenarios with high equity concentrations for the long term (as found in my research for the Peruvian Private Pension Funds System) are not in line with the behaviour actually exhibited by the (presumably rational) Peruvian decision makers. According to Peruvian official information regarding the number of

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active affiliates per type of pension fund, from the pool of active affiliates who are younger than 30 years old, more than **99,2%** of them are in the "Type 2 Fund" (a balanced fund which because of historical reasons became in the default option), instead of in the "Type 3 Fund" (a high-equity fund); and when considering affiliates of all ages, more than 90% of them are still in the default option.

So, how the information regarding the number of affiliates per fund can be explained at the light of the results of my model? My overall interpretation is that despite the fact that, in the long term, the expected return of the "Type 3 Fund" (the Peruvian high-equity fund) should largely outperform the "Type 2 Fund" (the default option) while facing a negligible increase in risk (around 1%); **particularly in the Peruvian case**, **path dependency issues related to well-documented poor low comprehension reading standards**, **reduced mathematical skills and humble knowledge of daily-life elementary financial concepts<sup>7</sup> exacerbate the problem of bounded rationality in decision-makers**. Under these circumstances, they get massively affected by the default effect when choosing the asset allocation of their pension funds and later they continue in the same fund due to a combination of the status quo bias, inertia and procrastination. Therefore, the "Homo Oeconomicus" paradigm simply does not stand and the role of the legislator or policy-maker when defining the default option

So, what would be the overall answer to the original research question: "Could a minimal change in Peruvian financial regulation have a tangible impact in Peruvian

<sup>&</sup>lt;sup>7</sup> As reported by the OECD

welfare?" The answer would be affirmative. Implications of this research show that considering a period of 42 years of investments a switch in the default option from the "Type 2 Fund" to the "Type 3 Fund" should bring an increase in future accumulated wealth in the range of 35% and 88% while facing a negligible increase in risk, (which would be as high as 1,62%). An increase of the accumulated wealth in such a percentage has enormous consequences in welfare for affiliates in a developing country where public facilities can hardly satisfy the daily needs of their citizens. Therefore, the recommendation of public policy of this thesis to Peruvian authorities is that the default option should be changed from the "Type 2 Fund" to the "Type 3 Fund" while giving the chance to the affiliates to "opt out" of it if they want. If Peruvian authorities do so, they would be "nudging" the affiliates of the SPP to a welfare maximizing fund.

# **Bibliography**

- Decreto Supremo Nº 01-65-TR. (1965, January 22). Peru.
- Decreto Ley N° 19990. (1973, April 30). Diario Oficial El Peruano.
- Decreto Ley N° 20530. (1974, February 27). Diario Oficial El Peruano.
- Decreto Ley N° 21021. (1974, December 17). Peru.
- Decreto Ley N° 25897. (1992, December 06). Peru.
- Decreto Ley N° 25967. (1992, December 07). Peru.
- Ley N° 27988 . (2003, June 03). Peru.
- Ley N° 29759. (2011, July 21). Diario Oficial El Peruano.
- Ley N° 29903. (2012, July 19). Diario Oficial El Peruano.
- Affleck-Graves, J., & McDonald, B. (1989). Nonnormalities and Tests of Asset Pricing Theories. Journal of Finance, 44(4), 889-908.
- Anderson, J., Lin, H.-S., Treagust, D., Ross, S., & Yore, L. (2007). Using Large-Scale Assessment Datasets for Research in Science and Mathematics Education: Programme for International Student Assessmeent (PISA). *International Journal of Science and Mathematics Education*, 591-614.
- Antolín, P., Payet, S., & Yermo, J. (2010). Assessing Default Investment Stragetegies in Defined Contribution Pension Plans. OECD Publishing.
- Bachelier, L. (1900). Theory of Speculation.
- Banco Central de Reserva del Perú. (2018, July 29). Nota Informativa: BCRP ELEVA EL LÍMITE DE INVERSIÓN EN EL EXTERIOR DE LAS AFP A 50%.
- Baron, J., & Wilkinson-Ryan, T. (2018). Conceptual foundations: a bird's-eye view. In J. Teitelbaum, & K. Zeiler (Eds.), *Research Handbook on Behavioral Law and Economics* (pp. 19-44).
- Baron, J., Beattie, J., & Hershey, J. (1988). Heuristics and Biases in Diagnostic Reasoning. *Organizational Behavior and Human Decision Processes*, 88-110.
- Barr, A., & Packard, T. (2003). Preferences, constraints, and substitutes for coverage under Peru's pension system. The World Bank.
- Basu, A., & Drew, M. (2010). Appropriateness of Default Investment Options in Defined Contribution Plans: Australian Evidence. *Pacific-Basin Finance Journal, 18*(3), 290-305.
- Benartzi, S., & Thaler, R. (1995). Myopic Loss Aversion and the Equity Premium Puzzle. *The Quarterly Journal of Economics*, *110*(1), 73-92.
- Bennyhoff, D. (2008). *Time Diversification and Horizon-Based Asset Allocations*. The Vanguard Group.
- Bernal, N., Muñoz, Á., Perea, H., Tejeda, J., & Tuesta, D. (2008). A look at the Peruvian Pension System Diagnosis and Proposals. BBVA.
- Bernoulli, D. (1738). Specimen Theoriae Novae de Mensura Sortis. *Commentarii Academiae Scientiarum Imperialis Petropolitanae, V*, pp. 175-192.
- Bernoulli, D. (1954). Exposition of a New Theory on the Measurement of Risk. *Econometrica*, 22-36.
- Beshears, J., Choi, J., Laibson, D., & Madrian, B. (2009). The Importance of Default Options for Retirement Saving Outcomes: Evidence from the United States. In J. Brown, J. Liebman, & D. Wise (Eds.), Social Security Poliy in a Changing Environment (pp. 167-195). University of Chicago Press.
- Bodie, Z. (1995). On the Risk of Stock in the Long Run. *Financial Analysts Journal*, 51(3), 68-76.
- Bodie, Z., Merton, R., & Samuelson, W. (1992). Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model. *Journal of Economic Dynamics and Control, 16*, 427-449.
- Bohumil, S. (2014). The Puzzle of Financial Market Distribution. *Ekonomický casopis, 62*, 709-727.
- Bowles, S., & Gintis, H. (2000). Walrasian Economics in Retrospect. *The Quarterly Journal of Economics*, *115*(4), 1411-1439.
- Bureau of Labor Statistics. (2018, August 12). Consumer Price Index. Retrieved from https://www.bls.gov/cpi/
- Camerer, C. (2000). Prospect theory in the wild: Evidence from the field. In D. Kahneman, & A. Tversky (Eds.), *Choices, Values and Frames* (pp. 288-300).
- Cannon, E., & Tonks, I. (2013). The value and risk of defined contributions pension schemes: International evidence. *Journal of Risk and Insurance, 80*(1), 95-119.

- Caputo, A. (2013). A literature review of cognitive biases in negotiation processes. *International Journal of Conflict Management*, 374-398.
- Carranza, E., & Moron, E. (2008). The Peruvian Pension Reform: Ailing or Failing? In S. Kay, & T. Sinha, Lessons from Pension Reform in the Americas. Oxford University Press.
- Cohen, J., Ezra, D., & Furlan, T. (2011). Australia's Defined Contribution System: Lessons We Can Learn (and Teach). *Benefits Quarterly*, 26-30.
- Conlisk, J. (1996). Why Bounded Rationality? Journal of Economic Literature, XXXIV, 669-700.
- Devas, C. (1883). Groundwork of Economics. London: Longmans, Green & Co.
- Fama, E. (1965). The Behavior of Stock-Market Prices. The Journal of Business, 34-105.
- Fama, E. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, *25*(2), 383-417.
- Fisher, K., & Statman, M. (1999). A Behavioral Framework for Time Diversification. *Financial Analysts Journal*, 88-97.
- Frey, B. (1997). Not Just for the Money. An Economic Theory of Personal Motivation. Edward Elgar Publishing.
- Gigerenzer, G. (2008). Why Heuristics Work. *Perspectives on Psychological Science, 3*(1), 20-29.
- Gomes, F., Kotlikoff, L., & Viceira, L. (2008). Optimal Life-Cycle Investing with Flexible Labor Supply: A Welfare Analysis of Life-Cycle Funds. *American Economic Review*, 98(2), 297-303.
- Gonzáles, C. (2004). Incorporación y desincorporación en el régimen de pensiones del Estado a la luz de la jurisprudencia constitucional. In *Estudio sobre la jurisprudencia constitucional en materia laboral y previsional* (pp. 187-257). Lima: Academia de la Magistratura.
- Guillén, J., & Mosqueda, R. (2013, January June). Pay as you Go System versus Fully Funded Pension in Peru. *Ecos de Economía*(36), 5-19.
- Hammond, J., Keeney, R., & Raiffa, H. (1998). The Hidden Traps in Decision Making. *Clinical laboratory management review : official publication of the Clinical Laboratory Management Association / CLMA, 13*(1), 39-47.
- Hansen, P. (2016). The Definition of Nudge and Libertarian Paternalism: Does the Hand Fit the Glove? *European Journal of Risk Regulation*, 7(1), 155-174.
- Hausman, D., & Welch, B. (2009). Debate: To Nudge or Not to Nudge. *Journal of Political Philosophy*, *18*(1), 123-136.
- Hobbes, T. (1651). Leviathan.
- Instituto Nacional de Estadística e Informática INEI. (2017). Perú: Evolución de los indicadores de empleo e ingresos por departamento, 2007-2016.
- International Federation of Pension Fund Administrators FIAP. (2010). Description and Analysis of the Multifund Systems in the Latin American and Eastern European Pension Systems. Santiago.
- Jagannathan, R., & Kocherlakota, N. (1996). Why Should Older People Invest Less in Stocks Than Younger People? *Federal Reserve Bank of Minneapolis Quarterly Review, 20*(3), 11-23.
- Johnson, E., & Goldstein, D. (2003). Do Defaults Save Lives? Science, 1338-1339.
- Johnson, E., & Goldstein, D. (2004). Defaults and Donation Decisions. *Transplantation, 78*(12), 1713-1716.
- Johnson, E., Hershey, J., Meszaros, J., & Kunreuther, H. (1993). Framing, Probability Distortions, and Insurance Decisions. *Journal of Risk and Uncertainty*, 35-51.
- Johnson, E., Shu, S., Dellaert, B., Fox, C., Goldstein, D., Häubl, G., et al. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, 487-504.
- Jolls, C., Sunstein, C., & Thaler, R. (1998). A Behavioral Approach to Law and Economics. *Coase-Sandor Institute for Law and Economics Working Papers, 55.*
- Kahneman, D. (2011). *Thinking, Fast and Slow.* New York: Farrar, Straus and Giroux.
- Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-292.
- Kahneman, D., & Tversky, A. (1981). The Psychology of Preferences. *Scientific American*, 160-173.
- Kahneman, D., Knetsch, J., & Thaler, R. (1990). Experimental Tests of the and Endowment Effect and the Coase Theorem. *Journal of Political Economy, XCVIII*, 1325-1348.
- Kane, C. (1995). Peru: Reforming the Pension System. The World Bank.
- Karbowski, A. (2016). Discussion on the Social Rate of Discount: from Sen to Behavioural Economics. *Economics and Sociology*, *9*(2), 46-60.

- Kiguel, M., & Liviatan, N. (1995). Stopping Three Big Inflations: Argentina, Brazil, and Peru. In R. Dornbusch, & S. Edwards, *Reform, Recovery, and Growth: Latin America and the Middle* (pp. 369-414). University of Chicago Press.
- Kőszegi , B., & Rabin, M. (2006). A Model of Reference-Dependent Preferences. *Quarterly Journal of Economics*, 121(4), 1133-1165.
- Kőszegi , B., & Rabin, M. (2007). Reference-Dependent Risk Attitudes. *American Economic Review*, *97*(4), 1047-1073.
- Kritzman, M. (1994). What practicioners need to now about... time diversification. *Financial Analysts Journal, 50*(1), 14-18.
- Lavigne, M. (2013). Social protection systems in Latin America and the Caribbean: Peru. United Nations.
- Lieder, F., Griffiths, T., & Goodman, N. (2013). Burn-in, bias, and the rationality of anchoring. In P. Bartlett (Ed.), Advances in Neural Information Processing System 25: 26th Annual Conference on Neural Information Processing Systems 2012.
- Madrian, B., & Shea, D. (2001). The Power of Suggestion: Inertia in 401(K) Participation and Savings Behavior. *The Quarterly Journal of Economics, CXVI*(4).
- Malkiel, B. (1973). A Random Walk Down Wall Street: The Time-tested Strategy for Successful Investing. New York: W. W. Norton & Company.
- Mandelbrot, B. (1963). The Variation of Certain Speculative Prices. *The Journal of Business*, *36*(4), 394-419.
- Manor, M. (2017). Efficient life cycle investment strategies in defined contribution pension plans in Israel. *Journal of Insurance, Financial Markets and Consumer Protection, 26*(4), 47-66.
- Mill, J. (1836). On the Definition of Political Economy; and on the Method of Philosophical Investigation in that Science. In *The London and Westminster Review* (pp. 1-29).
- Mill, J. (1844). Essays on Some Unsettled Question on Political Economy.
- Mullainathan, S., & Thaler, R. (2001). Behavioral Economics. In *International Encyclopedia of SocialSciences* (pp. 1094-1100). Pergamon Press.
- Nisbett, R., & Ross, L. (1980). Human Inference: Strategies and Shortcomings of Social Judgement. New Jersey: Prentice-Hall.
- Olivera, J. (2016, First Semester). An Assessment of a Proposed Multi-Pillar Pension Reform in Peru. *Apuntes, XLIII*(78), 9-40.
- Organisation for Economic Co-operation and Development OCDE. (2018). *PISA 2015 Results in Focus.* Secretary-General of the OECD.
- Palacios, R., & Whitehouse, E. (1998). The Role of Choice in the Transition to a Funded Pension System. The World Bank.
- Pereda, J. (2007). Estimación de la Frontera Eficiente para las AFP en el Perú y el Impacto de los Límites de Inversión: 1995-2004. Banco Central de Reserva del Perú.
- Pollner, J., & Lasaga, M. (2003). *Peru's Private Pension System: An Analysis of its Evolution, Current Market Structure and Recommendations for Reform.* The World Bank.
- Rabin, M. (2000). Risk Aversion and Expected-Utility Theory: A Calibration Theorem. *Econometrica, 68*(5), 1281-1292.
- Reeson, A., & Dunstall, A. (2009). Behavioural Economics and Complex Decision-Making Implications for the Australian Tax and Transfer System.
- Renard, P., Alcolea, A., & Ginsbourger, D. (2013). Stochastic versus Deterministic Aproaches. In *Environmental Modelling. Finding Simplicity in Complexity.* John Wiley & Sons.
- Robinson, L., & Hammitt, J. (2011). Behavioral Economics and Regulatory Analysis. *Risk Analysis*, *31*(9), 1408-1422.
- Robinson, L., Hammitt, J., & Loomis, J. (2011). Behavioral Economics, Distribution, and Benefit-Cost Analysis.
- Rofman, R. (2007). Pension Reform and the Development of Pension Systems: An Evaluation of World Bank Assistance. The World Bank.
- Rozinka, E., & Tapia, W. (2007, January). Survey of Investment Choice by Pension Fund Members. OECD WORKING PAPER ON INSURANCE AND PRIVATE PENSIONS(7).
- Rubin, P., & Paul, C. (1979). An Evolutionary Model of Taste for Risk. *Economic Inquiry, XVII*(4), 585-596.
- Samuelson, P. (1963). Risk and Uncertainty: A fallacy of Large Numbers. Scientia, 98, 108-113.
- Samuelson, P. (1969). Lifetime Portfolio Selection By Dynamic Stochastic Programming. *The Review of Economics and Statistics*, 239-246.
- Samuelson, P. (1994). The Long Term Case for Equities and How It Can Be Oversold? *Journal* of *Portfolio Management*, 21(1), 15-24.

- Samuelson, W., & Zeckhauser, R. (1988). Status Quo Bias in Decision Making. *Journal of Risk* and Uncertainty(1), 7-59.
- Savona, P. (2006). On the Definition of Political Economy and on the Method of Investigation Proper to It: Reflections on the Bicentennial of the Birth of John Stuart Mill. Roma: Luiss University Press.
- Schiller, R. (2006). Life-cycle personal accounts proposal for Social Security: An evaluation of President Bush's proposal. *Journal of Policy Modelling*(28), 427–444.
- Schmeidler, D. (1989). Subjective Probability and Expected Utility without Additivity. *Econometrica*, *57*, 571-587.
- Segura, A. (2015). Some Thoughts on Fiscal Policy. In A. Santos, & A. Werner (Eds.), *Peru, Staying the Course of Economic Success.* International Monetary Fund.
- Sharpe, W. (1992). Asset allocation: Management style and performance measurement. *The Journal of Portfolio Management, 18*(2), 7-19.
- Simon, H. (1955). A Behavioral Model of Rational Choice. *The Quarterly Journal of Economics*, 69(1), 99-118.
- Spierdijk, L., & Bikker, J. (2012). Mean reversion in stock prices: implications for long-term investors. *Journal of Investment Strategies*, 2(1), 91-102.
- Starmer, C. (2000). Developments in Non-expected Utility Theory: The Hunt for a Descriptive Theory of Choice under Risk. *Journal of Economic Literature, 38*, 332-382.
- Superintendencia de Banca, Seguros y AFP. (2018). Retrieved 06 01, 2018, from Superintendencia de Banca, Seguros y AFP Web site: http://www.sbs.gob.pe/estadisticas/sistema-privado-de-pensiones
- Szpiro, G. (1986). Measuring Risk Aversion: An Alternative Aproach. *Review of Economics and Statistics, 68*, 156-159.
- Taylor, H., & Karlin, S. (1998). An Introduction to Stochastic Modeling (3rd ed.). Academic Press.
- Thaler, R. (1980). Toward a Positive Theory of Consumer Choice. *Journal of Economic Behavior and Organization*(1), 1124-1131.
- Thaler, R., & Sunstein, C. (2008). *Nudge: Improving Decisions About Health, Wealth and Happiness.* New Haven: Yale University Press.
- The World Bank. (2008). The World Bank Pension Conceptual Framework. The World Bank.
- Tiede, L., & Ponce, A. (2011). Ruling Against the Executive in Amparo Cases: Evidence from the Peruvian Constitutional Tribunal. *Journal of Politics in Latin America, 3*(2), 107-140.
- Tuesta, D. (2011). A review of the pension systems in Latin America. BBVA.
- Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science, 185*, 1124-1131.
- Tversky, A., & Kahneman, D. (1992). Advances in Prospect Theory: Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty, V*, 297-323.
- Yaari, M. (1987). The Dual Theory of Choice Under Risk. Econometrica, 55, 95-115.
- Yahoo Finance. (2018, August 2). Yahoo Finance Business Finance, Stock Market, Quotes, News. Retrieved from https://finance.yahoo.com
- Yu, R., Mobbs, D., Seymour, B., & Calder, A. (2010). Insula and Striatum Mediate the Default Bias. *The Journal of Neuroscience*, 14702-14707.

Sector	National Pension System (SNP) Private	Pension System (SPP)
Funding	Worker (13%) System funded by the public treasury.	Contribution to the CIC (10%); Worker commission (about 1.95%)
	contributions and collective capitalization	Insurance premium (1.06%) Individual capitalization system with State guarantee after 20 years of contribution (minimum pension)
Management	Social Security Office (ONP) Intensive use of outsourcing in its	Pension Funds Administrators (AFP) Decentralized collection
	main activities	Coverage for disability and survival pensions is subcontracted Advertising spending
Coverage	Dependent workers: computsory Independent workers: voluntary	Dependent workers: compulsory Independent workers: voluntary
Benefits	Retirement, disability, survival, death Determination of the benefits in function of legal regulations General rule: 65 years old and 20 years of contribution Maximum limits are applied	Retirement, disability, survival, death Individual capitalization system with guarantee of minimum pension when 65 years old and 20 years of contribution Retirement modalities and fund type in function of risk
Source: Alvaro Vidal en el Perú y reform (LC/L.3444), Santiago for International Coop	Bermúdez, Cuadros Luque, Fernando y Ch las de la protección social asociadas: U o, Chile, Economic Commission for Latin A eration (GTZ), 2012.	istian Sanchez Reyes (2012), "Flexibilización laboral a balance tras 20 años", Políticas Sociales series incrica and the Caribbean (ECLAC)/German Agency

Annex 1: Main differences between the SNP and the SPP



Annex 2: Histogram of the Type 2 Fund with Maximized Equity

Own elaboration



Annex 3: Histogram of the Type 2 Fund with Balanced Equity



Annex 4: Histogram of the Type 2 Fund with Minimized Equity

Own elaboration



Annex 5: Histogram of the Type 3 Fund with Maximized Equity



Annex 6: Histogram of the Type 3 Fund with Balanced Equity



Annex 7: Histogram of the Type 3 Fund with Minimized Equity

Own elaboration

