



# Information theory as a tool to improve individual pensions: The Chilean case



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## HIGHLIGHTS

- Application of techniques developed for statistical physics to economics.
- Analysis of the evolution of individual capitalizations.
- Use of mutability to establish the differences among agencies.
- Use of sensitivity to detect the appropriate instances for actions.
- Examples showing how to increase profits avoiding loses.

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## ABSTRACT

We review the Chilean Pension System (CPS) under an entirely new prism: the fluctuation of the capitalization funds measured by means of information theory, which is achieved by the application of the recently proposed data compressor wzip. We begin by explaining the basics of the CPS at the time we review its economical performance during the period 2003–2012. The share value and its return or profitability are the main indicators used in the introductory analysis. Then we use wzip to recognize regimes of fluctuations of the share values of the different funds and agencies, by means of the indicator known as mutability in a way similar to what mutability achieves in the case of magnetic transitions. It turns out that mutability recognizes the onset of fluctuations of the markets. This fact combined to the variations of returns allows us to define a very sensitive parameter which we call sensitivity. It has been shown that sensitivity is able to anticipate large variations of the share values with several days of advance, thus allowing clients to switch their investments to a safer fund avoiding capital losses. A simulation is conducted to show the huge differences that could have happened during the crises in 2008 and 2011: using information provided by wzip it is possible to obtain better profits and obtain better pensions in the long run.

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## 1. Introduction

The present paper is along the line of applying techniques coming from the physics to economics in what is usually called econophysics. The novelty here is that we incorporate elements of information theory to mediate the relationship between physics and economics as will be explained below. Prior to that it could be interesting for some of the readers to appreciate some landmarks on the road to econophysics to put the present approach in context.

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It is not easy to point out just one single event as the beginning of the relationships between economics and physics, however, the pioneer work of Louis Bachelier on the Theory of Speculation is clearly of prime importance [1]. The fame of the theoretical physicist Ettore Majorana and the strange conditions of his disappearance gave great exposure to his posthumous paper (found by his brother and submitted for publication thereafter) entitled “The value of statistical laws in physics and social sciences” [2]. Linear behavior in economics was well understood, but nonlinear behavior needed from a more holistic approach, which is the idea in the paper “Speculative bubbles, crashes and rational expectations” by O.J. Blanchard [3]. The word econophysics was introduced in 1995 by Eugene Stanley during a Conference in India [4]. Then we arrive to 2005 when the article “Economics: The new physical science?”, by J. Dooyne Farmer, Eric Smith and Martin Shubik, appeared in *Physics Today* [5]. This very quick review intends to show that the relationships between economics and other branches of knowledge have been sought for over a century already and that the tools employed are diverse. In the present paper we hope to introduce one additional technique to econophysics: the introduction of a data compressor to readily recognize different regimes in the price of assets.

The application of information theory techniques to econophysics has been successful in the case of understanding activity of stock markets [6]. The idea comes from the physics of magnetic phase transitions where the transit from a ferromagnetic phase to a paramagnetic phase is preceded by fluctuations in any order parameter (magnetization, site order parameter, correlations) as temperature raises [7,8]. Something similar has been found for the ferromagnetic to spin-glass transition [9,10]. The technique is based on the generation of a time series that is recorded as a vector in a file. Then a data compressor is invoked to compress such a file yielding a coded file whose relative size or “weight” (in bytes) is a measure of the amount of information content of the original file: the more diverse and the more rapidly changes the information content in the sequence of the original file, the less compression is achieved. In this way information theory can help to provide a measure of the agitation or “temperature” of any system described by a time sequence; in the present paper this would correspond to fluctuation or volatility of economic indicators. This is just another application of information theory to a variety of problems in different scientific disciplines [11–13].

The main goal of the present paper is to provide information that can lead the interested clients of the Chilean Pension System (CPS) to search for the appropriate information that can help them to obtain a better pension. An additional goal is to apply the method of information theory that has been successful in other fields [9,7,8,10] to the case of pensions based on personal investments; we will show the advantages that can be obtained from the use of this information.

In the next section we review the basic aspects of the CPS from the point of view of the information useful for the clients who can make decisions along the process: share value variations and profitabilities are presented and discussed. Section 3 brings in the econophysics variables introduced in this paper which are a novelty in the field: compressor *wlzip* is presented and its results are discussed. In Section 4 we end up with a general discussion pointing to bring out the main conclusions of this work.

## 2. Overview of the Chilean pension system

### 2.1. The Chilean pension system

During 2012 the Organization for Economic Cooperation and Development (OECD) produced a report on the situation of Pension Funds in the world, where Chile is vastly mentioned having a prominent status in some of the indicators considered there [14]. Thus, Chile is the world leader when considering the “average annual real net investment return for pension fund” for the period 2001–2010. This can be appreciated in Fig. 5 of the cited report, where Chile tops the bar plot for the decade reaching over 5 positive points; at the same time several countries get negative results. However, the same figure shows that this indicator becomes negative for Chile when considering the period 2007–2011. This quick reversal is one of the reasons of performing this study on the Chilean Pension System (CPS) extending it to a most recent decade 2003–2012.

In the Chilean pension system each person has his/her personal capitalization account through private agencies, so there is no solidary fund or direct state intervention. It assumes each individual knows about investments to take ongoing decisions that could change the possibilities of getting good or bad retirement pensions. Actually, literacy on the system is crucial for taking steps along the good direction [15]. However, most of the people seems to make decisions based on advertisements or propaganda rather than on present facts or actualized knowledge about the CPS.

The original CPS system was put forward in 1981, but it has experienced minor adjustments during the present century. At the time it was pioneer in the world and some other countries have adapted it with some variations. Up to around 2010 clients did not have any independent information about the status of the system. However, during the most recent years some private agencies offer information and assistance to better handle the individual capitalization trying to prevent possible risks as it will be discussed below. This paper tries to offer a new point of view on this subject, using techniques not yet seen in this field, like the understanding of critical phenomena by information theory applied to the characterization of the status of the system.

The CPS is based on an undefined number of private agencies that handle the savings of the registered workers. Employees are automatically discounted from their salaries a proportional contribution, while voluntary savings are also possible (we will not consider this last possibility here). Self-employees were originally excluded from this mandatory saving in the past, but they are progressively being incorporated.

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