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Solvencia de planes de pensiones en universidades públicas de México

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ABSTRACT

The objective of this work is to verify the viability and financial solvency of funds for pension plans in a group of public universities in Mexico. The methodology is of a quantitative nature, by comparing the characteristics of the pension plans, as well as providing with numerical simulations of the value of the fund. The results obtained are that these characteristics are heterogeneous, with only one common element: all the plans are of a defined benefit type and with a pension fund. The contributions vary in a range of 0 to 4%; the retirement age of 60 and 65 years, with 4 universities that do not have this requirement and years of service from 20 to 35 years. The conclusion is that the actuarial cost of these plans is extremely high and that the contribution of external agencies is necessary to guarantee the existence of these plans.

Keywords: pension plans; public universities; solvency; actuarial cost

JEL Code: J08, J26

RESUMEN

El objetivo de este trabajo consiste en comprobar la vialidad y solvencia financiera de fondos para planes de pensiones en un grupo de universidades públicas en México. La metodología que se seleccionó es de tipo cuantitativo, mediante la comparación de las características de los planes de pensiones, así como en la simulación numérica del valor del fondo. Los resultados obtenidos son que dichas características son heterogéneas, con único elemento en común de que todos los planes son de beneficio definido y que cuentan con un fondo de pensiones. Las contribuciones varían en un rango de 0 a 4%; la edad de retiro de 60 y 65 años, con 4 universidades que no cuentan con este requisito y la antigüedad desde 20 hasta 35 años. La conclusión es que el costo actuarial de estos planes es extremadamente alto y que es necesaria la aportación de organismos externos para solventar estos planes.

Palabras clave: planes de pensiones; universidades públicas; solvencia; costo actuarial.

Código JEL: J08, J26

INTRODUCTION

According to Altamirano and others (2018), pension systems are a key element in what is known as the welfare state. These can be defined as social contracts whose primary goal is to provide worthy consumption for senior citizens during the years when generating an income is difficult.

Retirement systems however, still have many obstacles to overcome to satisfy the needs of populations around the world (OCDE, 2017). Many of these challenges are related to gender issues (James *et al,* 2003; CEPAL, 2018), insufficient pensions (OCDE, 2017; CEPAL, 2018) and financial unsustainability due to lack of solvency in the funds (Ponds, Severinson & Yermo, 2012), among others. In Mexico, moderate population aging is expected (CEPAL, 2018) and in accordance with the projections (CONAPO, 2012), in 2050 the population of over 65 will be larger than that under 15 years old. Mexico currently enjoys a demographic bonus, which is why its problems caused by bad planning in matters of social security, especially directed towards senior citizens, are not as visible as can be expected in the future (particularly in the years around 2050). (CEPAL, 2018)

Authors on the subject of pensions explain how the inefficiency of pensions in Mexico is mainly the consequence of a bad transition of the old pension system into the current one, and very low mandatory contributions of 6.5%, when the OECD (2015) advises them to be between 13% and 18%. There is great informality in the country and the retirement system in Mexico finds itself very fragmented (OCDE 2015a; Villagómez, 2015; CIEP, 2017).

PROBLEM AND SUBJECT OF STUDY

The Center for Economic and Budgetary Research (CIEP, 2017) mentions that in Mexico there are more than 1000 retirement systems. Ranging from the mandatory social security schemes such as: the Mexican Social Security Institute (IMSS) and the Social Security and Social Services Institute for State Employees scheme (ISSSTE); to state and parastatal pensions, pensions of state-owned production companies such as the Federal Electricity Commission (CFE) and Petroleos Mexicanos (PEMEX), municipalities and public universities. These pension plans are the ones that together comprise the very fragmented pension system in Mexico (CIEP, 2017; Villagómez, 2015; OCDE, 2015a).

Nowadays the most recent retirement plans are regulated by the National Committee of Retirement Saving System (CONSAR). However, the retirement plans of public, state or

autonomous universities, as well as many other pension plans (state and municipal pensions, etc.) are not regulated by CONSAR. Especially the pension systems for autonomous universities suffer a lack of organization as a consequence of the autonomy denomination.

According to the CIEP (2017), in 2014 the public expenditure generated by autonomous universities was equivalent to 2% of the GDP. The lack of standards to regulate contingent liabilities, the lack of information and transparency in some of the universities, in addition to the reduction of financial resources provided by the government to pay pensions lead to the following questions: Who will meet the costs of these pensions? And who will be most affected by this problem and to what extent? (CEPAL, 2017)

This is why, the purpose of this research study is to prove the viability and financial solvency of defined benefit pension funds, associated with scholars of the autonomous universities in Mexico, comparing the design factors that influence the characteristics of pension plan funds as well as the numeric simulation of the fund value.

The justification for this proposal is that on occasions the insolvency of certain retirement plans in autonomous universities is mentioned by the media (Ramos, 2017; Moreno, 2017; Hernández, 2017), citing poor planning, lack of transparency and even corruption within the autonomous universities. However, the media only mentions the consequences and never analyzes the causes or the status of these pension plans in a technical manner. Therefore, an analysis of this matter from an actuarial and financial point of view is important in order to document this situation and to propose a solution for this problem.

HISTORICAL EVOLUTION

Economic recessions around the world have affected governmental budgets of different member countries of the OECD; specifically with the yield reductions in pension funds as well as in the decrease of contribution rates, increasing the population´s demand for social benefits such as a minimum guaranteed pension. In 2009, the average social expenditure as a percentage of the gross domestic product in OECD member countries increased from 19% in 2007 to 22%. Furthermore, the social expenditure for senior citizens stood at 11%. Other impacts of the global economic crises on pension systems have been the insolvency of the defined benefit pension plans, as well as the incapacity of governments to face the pension payments of the so-called *pay-as-you-go*. Since the 90´s, organizations such as the World Bank and the International Monetary Fund have promoted a multiple-pillar model in which both the public sector and the private sector participate. This model is known as privatized pension systems and with it, the replacement of the public pay-as-you-go systems with a private individual account pension system (Yanqiu & Shih-Jiunn, 2017).

According to FIAP (June, 2019), the main parametric reforms implemented to pension plans by countries in the world between 1995 and June 2019 are the following: 78 countries have increased the contribution rates in their distributive program, 57 raised the age for retirement and 61 have adjusted the formula of benefits to lower the fiscal costs represented by the pension plans. Despite these efforts by different countries to provide a higher income for their population in the retirement stage, in Latin America and the Caribbean only 52.8% of employees are entitled to a pension plan at any given time and in addition, issues of financial sustainability are starting to arise. (Altamirano *et al.,* 2018).

According to the OECD (2015), the greatest challenge regarding pensions faced by the majority of Latin-American and Caribbean countries is the low coverage of pension systems, due to the proportion of employees participating as well as the proportion of elderly receiving some type of pension. Likewise, it is found that as an average in this region only 45% of employees are contributing to or are affiliated with a pension plan.

The majority of pension systems in Latin America and the Caribbean offer benefits that subsidize employees that have participated continuously, given the fact that the contributions of an average employee cannot finance the totality of the pension granted by the pension system. In defined benefit systems, for example, the replacement ratio for an average formal employee who contributes throughout his entire work life represents 65% of the last salary. This means these individuals receive an allowance from the State of 44% approximately. The defined contribution systems grant an average replacement ratio of 40% of the last salary, and this is higher than that of a funded system which represents 27%. Thus, the subsidy is 12 percentage points or 31% (Altamirano *et al*., 2018). Therefore it is necessary to adopt a two-pronged approach in order to decrease the coverage gap, increasing the formal participation and by enabling people to build their own rights to a pension (OECD, 2015).

Mexico is one of the pioneering countries in social security, due to the fact that since the constitution was drafted in 1917, a pension plan is mentioned in article 123. These pensions were the first ones in the country and they were assigned to public employees (CESOP, 2006). In 1925 the pension coverage was extended to parastatal employees after the creation of the Civil Service Pension Act and the General Management of Civil Service Retirement Pensions (CESOP, 2006)

At the beginning pensions were aimed at state-related workers. It wasn´t until 1943 when the first pensions appeared (and social security benefits) for those employees that did not work for the state. These benefits emerge for the first time with the creation of the Social Security Act (IMSS) in 1943. (Cesop, 2006) The pension offered by the IMSS (Mexican Social Security Institute) at that time, was a distributive defined benefit pension system paid by the employee, the employer and the State, in which the employee received a pension that "*on*

occasions, […was…] much more than […the…] that was saved […by the worker…] throughout the course of his work life, financing this difference with public resources (CIEP, 2017, pg. 6)".

In December 1959, the Government Employees Social Services and Security Institute Law (ISSSTE) was created, which is different from the (IMSS), given that the ISSSTE act is for federal government and some federal agency employees while IMSS pensions are for workers in the private sector. The ISSSTE pension is basically for government employees. With the ISSSTE act a new pension system arose where the pension offered by ISSSTE was also PAYG and with defined benefits, similar to what the pension offered by IMSS at the time was. Furthermore, the ISSSTE pension has the same funding issues as the IMSS pension (CIEP, 2017).

These two institutes (IMSS and ISSSTE) were initially distributive pension systems with defined benefits and later evolved into funded systems. Before we address the transition of pension schemes (from defined benefit to defined contribution) it is important to note that the pension system in Mexico is fragmented far beyond the IMSS and ISSSTE, because besides these retirement schemes there are other retirement plans such as: the pensions offered by the Social Security Institute of the Armed Forces (ISSFAM), Petroleos Mexicanos (PEMEX), the Federal Commission of Electricity (CFE), state pensions, municipal pensions, university pensions and so many other pensions of institutions that appeared years before the transition of pensions schemes (CIEP, 2017).

In 1994 the National Commission of the Retirement Savings System (CONSAR) was created, an institution in charge of regulating the current Retirement Saving System (SAR) that was created in 1992 (CONSAR,2015). In 1997, the Social Security Act, currently in force, appears, whereby the pension plan of the institute changes from a distributive system with defined benefits to a funded system with defined contributions. It is in these laws that the most frequently used terminology of the Mexican system (mentioned at the start of this part of the chapter) emerges, being the Retirement Fund Administrators (AFORE) and the Specialized Retirement Fund Investment Companies (SIEFORE). In 2007, the ISSSTE incorporates the same elements of pensions funded with defined contributions as implemented previously by the IMSS (CONSAR, 2015). In the current pension scheme the SAR is the pension system that provides the benefits and services granted by IMSS, ISSSTE and independent workers (CONSAR, 2014).

METHODOLOGY

Some characteristics of funded pension plans such as their design factors and the allocation of assets, are a few of many elements that influence the actuarial model of pension plans

(Booth *et al*., 2005). The three main design factors are contributions, age and benefits, which have the quality of explaining the pension funds in order to be submitted to modeling. For example, Booth and others (2005), when explaining the defined benefit pension plan modeling, sets out a fixed normal retirement age, one benefit per pension (in accordance with the salary) and a contribution rate.

In order to model the behavior of a pension plan, equation (1) is used to project the funds of individual pensions at real value ((Booth *et al*., 2005) in a defined contribution plan.

$$f(T) = f(0) * (1+i)^T + (1-e_1) * \sum_{t=1}^{T} \quad c(t) * (1+i)^{T-t} \qquad (1)$$

Where:
— $f(T)$ is defined as the real value of the fund projection at a moment in time "T".
— $c(t)$ is defined as the real contribution paid at the end of period t.
—i is defined as the real investment return per period.
—T is defined as the amount of periods up to the retirement age.
—e_1 is defined as the commission percentage collected for contributions.

In accordance with the projection focused on defined contribution pensions, the real payment for retirement must be given for the purchase of an annuity, once the balance of the equation (1) is projected. Equation (2) represents the calculation of a pension benefit in accordance with the value in the purchase of any given annuity.

$$Projected\ True\ Pension\ (PRP) = \frac{f(T)}{a_R * (1+e_2)} \qquad (2)$$

Where a_R is defined as the projected value of the annuity at a retirement age R and e_2 is defined as the commission percentage collected for the purchase of the annuity. OECD (2017) uses the replacement ratio equation (3) to measure the efficiency of a defined contribution pension plan.

$$Replacement\ rate = \frac{PRP}{g(S)} \qquad (3)$$

Where $g(S)$ is a function that depends on the salary of the employee and which is used by the OECD (2017) as the average salary of the salary history.

The proposals made by OECD (2015a) to optimize this individual account system (increasing contributions, raising the retirement age, etc.) and some characteristics of the entire Mexican pension system are mainly the fact that there is an opportunity to improve the transition from the old retirement scheme towards the current one (from defined benefits to defined contributions). It also mentions two major problematic areas: informality and fragmentation.

As for fragmentation, it states that it is the existence of special retirement plans, such as those of the federal and local government, universities, Petroleos Mexicanos (PEMEX), etc. and pension plans that belong to pillar one, that complicate the analysis and the regulation of the country´s pension system (OECD 2015; Villagómez, 2015 and CIEP, 2017). Furthermore, the fragmentation of the Mexican pension system also leads to the lack of portability between pillar one pension plans. This issue consists of the fact that the contributors of a pension plan are often unable to take their retirement benefits with them when they change jobs. OECD (2015a) also mentions that the higher the salaries and the faster they rise, the less efficient the Mexican system becomes, since replacement rates of workers may range between 50% and 10%. This is only due to salary differences.

In order to comply with the purpose of this study a quantitative methodology is proposed, focused on numerical exploration and analysis and divided into three principal phases. The first one is to carry out a descriptive and comparative analysis of the characteristics of pension plans in public universities included in this study. The second phase uses the comparative results to carry out numerical simulations and to measure the solvency of these pension funds. The third and last phase combines the collected characteristics and results from the numerical simulations to make recommendations supporting the viability of the pension plans. These phases are described with more detail below.

Descriptive and comparative analysis

During the first stage a documentary and literature review is carried out on the characteristics of pension plans in the principal public universities of the country. This stage is implemented through a search and revision of the group insurance contracts of autonomous universities per state, in order to collect information on the pension plans of each one. The research was based on a cross-sectional time scale with data from 2018 and its subject matter is the pension plans of a group of public universities in Mexico, whose common characteristics are: private or complementary, occupational, mandatory, defined benefit, funded and fixed annuity pension plans.

Numerical simulations

Given the results of the first phase, a pension plan is designed to represent all the plans collected. In order to do this, the average of all the different characteristics of plans is taken into account and an average worker assumed who contributes to a defined contribution pension plan. The numerical simulation of pension funds was carried out based on the following equations: equation (1) is used to project the defined contribution funds, equation (2) serves to disaccumulate pension funds to a real pension and equation (3) to determine a replacement ratio.

As for the projection of the fund value, equation (1) is modified, leading to equation (4) to adapt it to the case of a worker in Mexico accumulating a defined contribution pension fund belonging to the retirement fund. This equation is used to calculate solvency simulations.

$$f(T) = f(0)(1 + i(x))^T(1 - e_s)^T + \sum_{t=1}^{T} \quad c(1 + i(x + t))^{T-t}(1 - e_s)^{T-t} \qquad (4)$$

Where:

—$f(T)$ is defined as the real value of the fund projection at a moment in time

—T is defined as the time to retirement and determined as the seniority mode of the descriptive analysis data.

—$f(0)$ the fund value at the beginning of the projection and which is assumed to be a zero value in this methodology, due to the fact that when the worker starts to accumulate his pension fund, he starts at $0 Pesos.

—$i(x)$ is defined as the real investment return per period, depending on the age of the worker, which are determined as the history average of annual returns per month for the four basic Siefore (Retirement Investment Fund Companies) as of 2018, obtained from CONSAR (National Retirement Savings System Committee), as detailed below. For ages below 36, the return is 7.93%, between ages 37 and 45 it is 7.15%, between ages 46 and 59 it is 6.82% and for ages above 60, it is 6.26%.

—x is defined as the current age of the worker belonging to the fund, and it is determined as the age modality of the descriptive analysis data.

—e_s is defined as the commission percentage on the fund balance, and it is determined assuming the average of balance commissions collected by the AFORE´s of 1.021% (CONSAR 2018).

—c is defined as the average of the percentages of contributions calculated with the data of the descriptive analysis.

With regards to the dissaccumulation of funds, equation (2) was modified to assume a commission of zero for an annuity purchase, resulting in equation (5), which is the one used in this study.

$$Projected\ true\ pension\ (PRP) = \frac{f(T)}{\ddot{a}_R^{(12)}} \qquad (5)$$

Where $\ddot{a}_R^{(12)}$ is defined as the projected value of an advance monthly life annuity at retirement age R, which is calculated with the "Demographic mixed mortality experience" (CNSF, 2016) at an annual rate of 4.53%, which is the average of inflation from the year 2000 to 2017 and which is also used as a salary increase.

Finally, for the calculation stage of the replacement ratio defined in equation (3), for practical purposes a one unit salary is assumed and multiplied by the average of the maximum and

minimum replacement ratio, determined in the descriptive and comparative analysis. The goal is to use the replacement ratio as an auxiliary to measure the solvency of the representative pension plan, where values lower than 100% represent insolvency and higher than 100% represent solvency. This is due to the fact that the incapacity of the pension funds to pay pensions promised to one single worker is being measured. The salary will increase over time at an annual rate of 4.53% in a first scenario and for the purpose of a sensitivity analysis two other arbitrarily selected scenarios of 6% and 8%.

To propose recommendations for the design of a pension plan.
This last phase consists of proposing a series of recommendations that help to improve the viability and solvency of pension plans in universities or agencies with similar pension plans.

RESULTS

When conducting a search for the group insurance contracts of each autonomous university per state in the country, it was determined that it is viable to include only 14 of 33 universities in this study. This is primarily due to two reasons. The first one is that the group insurance contract was not available online, and the second is that the university´s pension plan was entirely contemplated within another state or federal plan. The 14 autonomous universities that were included in this study are: Aguascalientes (UAA), Baja California (UABC), Baja California Sur (UABCS), Campeche (UAC), Colima (UdeC), Guanajuato (UG), Hidalgo (UAEH), Morelos (UAEM), Nayarit (UAN), Nuevo León (UANL), Puebla (BUAP), Querétaro (UAQ), Tabasco (UJAT) and Tamaulipas (UAT).

The categories that were included in the analysis of the characteristics of these plans are: A) Eligibility: the type of staff that is entitled to a pension with the outlined characteristics. B) Pension fund: referring to whether or not there is a pension or retirement fund or trust fund and if there is, its name is given. C) Contributions: whether contributions by the eligible staff or the university itself are contemplated by the university in its collective bargaining agreement. In case they do exist, the amount is given. D) Retirement Modalities: the types of pensions offered by the university are described. E) Requirements to obtain a pension: the requirements to obtain a pension are detailed for each modality mentioned in the previous section. F) Pension amount: the amounts received as pension are detailed in accordance with the modality and requirements described in the previous sections. G) Widower´s and orphan´s pension: the amount and requirements to obtain a widower´s or orphan´s pension are described, if contemplated, in the collective bargaining agreement. H) Bonuses in case of non-retirement: specifies the amounts of the bonuses granted to employees who decide not to retire, once the requirements are met, and if contemplated in the collective bargaining agreement. I) Retirement bonuses: specifies the amounts of the bonuses granted to employees who decide to retire, once the requirements are met, and if contemplated in the collective

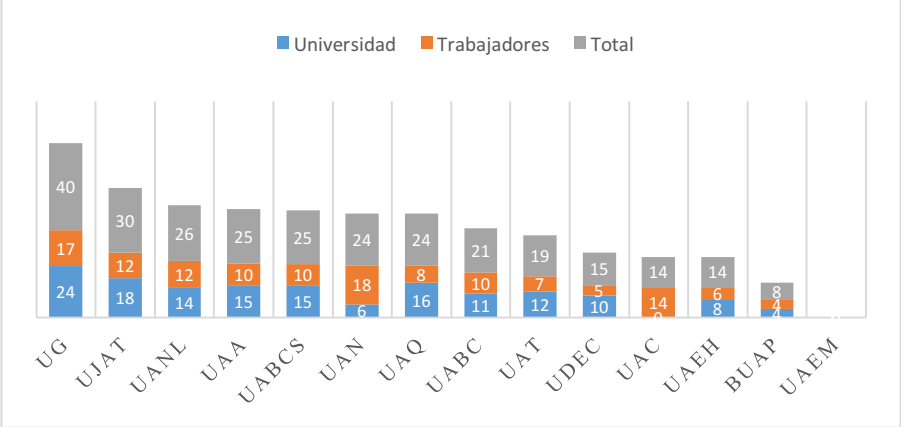
bargaining agreement. J) Increase in the pension amount: describes the way in which the pension will increase with time, in case this increase is contemplated in the group insurance contract. K) Complementarity: referring to whether the pension plan of the university is complemented by any other plan.

Descriptive and comparative analysis

The results obtained only refer to pension plans where the eligibility concerns teachers and scholars of the different autonomous universities per state. In addition, it is important to emphasize that 100% of them are defined benefit pension plans that have a fund or trust fund. The characteristics detailed per aspect in the above, are listed below. Figure 1 shows the amount of the contributions in each one of the universities included in this study. It is important to note that there are two special cases in this category. In the case of the UAC, the contribution depends on the salary received by the employee, the contribution being 2% for the lowest salaries and 14% as a maximum, for which for the purpose of comparison the contribution of 14% was used. Another special case is the UAEM, due to the fact that the amount of the contribution is not specified in the collective bargaining agreement, which is why it was defined as zero.

Figure 1

Amount of the contributions in each one of the universities included in this study



Source: Owm elaboration.

Based on the collected data, it can be seen that the average contribution by the university is 13.1%, while the average contribution by the employees is 9.45%, and the total average contribution was 22.13% (excluding the UAC and UAEM). It is important to state that the university contemplating a higher contribution is the UG with a total of 40% of the salary and the ones with the lowest contribution are the BUAP and the UAEM with 8% and 0%, respectively. The difference between the highest and lowest is 32 percentage points.

Table 1
Requirements for the retirement

University	Requirements	Age	Years of seniority
UAA	Age and years of seniority	65	30
UABC	Age, years of seniority and IMSS pension	65	30
UABCS	Age and years of seniority	65	25
UAC	Years of seniority	-	30
UdeC	Age and years of seniority	65	35
UG	Age and years of seniority	65	30
UAEH	Age and years of seniority	60	20
UAEM	Years of seniority	-	35
UAN	Years of seniority	-	35
UANL	Age and years of seniority	65	25
BUAP	Years of seniority	-	35
UAQ	Age and years of seniority	-	30
UJAT	Age and years of seniority	65	25
UAT	Age and years of seniority	65	30

Source: prepared personally based on information in collective bargaining agreements.

In the previously mentioned heading of retirement modalities, it was found that all universities (except the UAEM) contemplate retirement and early retirement. Table 1 shows the requirements for the retirement of its employees and Table 2, the requirements for early retirement.

Table 2
Requirements for the early retirement

University	Requirements	Minimum Age	Minimum seniority
UAA	Age and years of service	65	20
UABC	Age, years of service and IMSS pension	65	20
UABCS	Age and years of service	65	15
UAC	Age and years of service	50	25
UdeC	Age and years of service	63	20
UG	Age and years of service	65	15
UAEH	Age and years of service	50	20
UAEM	-	-	-
UAN	Age and years of service	65	20
UANL	Age and years of service	60	20
BUAP	Age and years of service	65	15
UAQ	Age and years of service	58.5	20
UJAT	Age and years of service	65	15
UAT	Age and years of service	55	20

* Given the fact that early retirement is based on the sum of age and years of service, the values reflected are based on the assumption of the employee´s preference for the lowest possible seniority.
Source: prepared personally based on information in collective bargaining agreements.

In the results obtained in table 1, it can be seen that the UABCS and UAEH have a requirement for retirement that is based on age and seniority. And likewise that the UAEH is the one that requires the least years of service in order to grant the pension (20 years); followed by the UABS,UANI and UJAT with 25 years of seniority. Another fact to be emphasized is that the UAC, UAEM, UAN, BUAP and UAQ do not have an age requirement for retirement; requirement is only based on a seniority of 30 and 35 years.

Table 2 shows that the UABCS, UG, BUAP and UJAT are the universities where teachers may go on early retirement with only 15 years of seniority. The maximum seniority requirement for this category is 20 years. It is important to state that UABC takes age, seniority and requirements of the IMSS pension into account to grant this early retirement. The UAEM, as mentioned in the above, is the only university that does not have this modality.

Another one of the analyzed categories in the characteristics of these pension plans is the amount of the pension, once teachers have complied with all the previously mentioned requirements. The results can be found in table 3 for both modalities.

Table 3
Replacement ratio

University	Minimum %	Maximum %	Función de salario $g(S)$
UAA	80	100	Weighting of the last salary according to the last ten years of service
UABC	50	100	Last salary
UABCS	60	100	Last salary
UAC	50	100	Average salary for the last ten years
UdeC	60	100	Average salary for the last five years
UG	50	100	Last salary
UAEH	50	100	Career salary average
UAEM	-	100	Last salary
UAN	57.14	100	Last salary
UANL	80	100	Last salary
BUAP	50	100	Average salary for the last five years
UAQ	75	100	Last salary
UJAT	50	100	Average salary for the last five years
UAT	66.65	100	Average salary for the last five years

Source: prepared personally based on information in collective bargaining agreements.

Table 4
Pension bonus

University	For not retiring	For retiring
UAA	Yes	No
UABC	No	No
UABCS	Yes	No
UAC	No	No
UdeC	Yes	Yes
UG	No	No
UAEH	No	Yes
UAEM	No	Yes
UAN	Yes	Yes
UANL	Yes	No
BUAP	Yes	Yes
UAQ	Yes	Yes
UJAT	Yes	Yes
UAT	No	No

Source: prepared personally based on information in collective bargaining agreements.

An important characteristic is that all universities subject to this study show that they grant maximum pensions of 100% of the salary, whether the last salary or the average of the last years. The lowest minimum replacement ratio is 50% and the highest is the one at UAA and UANI. It is worth recalling that, given the fact that UAEM does not contemplate early retirement, the only defined replacement ratio is 100%.

With regards to the widow´s or orphan´s pension, it was found that 6 universities do not contemplate this benefit and that all universities (except the UAC) contemplate increase in the pension amount. The results for the category of retirement and non-retirement bonuses are shown on chart 4. The UABC, UAC, UG and UAT do not seem to have any kind of bonus; while the UdeC, UAN, BUAP, UAQ and UJAT grant both types of bonuses.

The results in the complementarity heading is shown on chart 5. It is shown that 6 of the 14 universities do not contemplate complementarity with mandatory federal pension plans in Mexico such as IMSS. This means that these 6 universities have a pension plan that can be seen as a double pension or a single pension that lies within a state plan.

Table 5
Complementarity in the pension plan

University	Complementarity
UAA	IMSS
UABC	IMSS
UABCS	No
UAC	No
UdeC	IMSS
UG	No
UAEH	IMSS
UAEM	IMSS
UAN	IMSS
UANL	No
BUAP	No
UAQ	IMSS
UJAT	No
UAT	IMSS

Source: prepared personally based on information in collective bargaining agreements.

Numerical simulations

In accordance with the results found in the descriptive analysis of the characteristics of pension plans in the 14 universities under study, the following values are defined for the variables to be used in the calculation of equation (4) as followed:

$c(t)$ =22.13%, which represents the average of the sum of university and employee contributions.
$T = 30$ For being the seniority modality in the retirement requirements.
$x = 35$ Due to the fact that the retirement age modality is 65 years and given that the seniority used to simulate has been established as 30 years, the entry age of the employee is established at 35 years old for the simulations.
$g(S)$ In two scenarios i) the last salary and ii) the average salary over the last 5 years, for being what the majority of the universities define.

Table 6 shows the results of the replacement ratio obtained for an average employee and with the previously mentioned characteristics. The results show it is not possible under any circumstances to achieve 100% of the salary at the time of retirement. This means that universities promise a replacement ratio of 100% but they only manage to pay 67% in the best and 38% in the worst case scenario.

Table 6
The replacement ratio obtained for an average employee (Simulation)

Salary increase	The replacement ratio according with $g(S)$	
	Last salary	Average salary over the last 5 years
4.53%	62%	67%
6%	50%	56%
8%	38%	44%

Source: Own elaboration.

The results of Table 6 are justified by the fact that if we assume an increase of the highest salary and a function of the salary of the last one received, the replacement ratio decreases as it does not have to pay a higher pension with the same fund value. This can be observed in equation (3) where a replacement ratio is calculated based on the fund value in equation (2).

In order to determine which contribution value would lead the replacement ratio value closer to 100%, a sensitivity analysis is carried out with the variable $c(t)$. The lowest contribution percentage (8%), the average contribution (22.13%) and the highest contribution found in the study (31.19%) were used, and two scenarios for the function of salary. The results are shown on Table 7 and 8 based on the last salary received and for the average salary over that last 5 years, respectively.

Table 7
The replacement ratio with diferents contributions (last salary)

Salary increase	The replacement ratio (Last salary)		
	8% Contribution	22.13% Contribution	31.19% Contribution
4.53%	22%	62%	87%
6%	18%	50%	70%
8%	14%	38%	54%

Source: Own elaboration.

Tabla 8
The replacement ratio with diferents contributions (average salary for the last five years)

Salary increase	The replacement ratio (Average salary for the last five years)		
	8% Contribution	22.13% Contribution	31.19% Contribution
4.53%	24%	67%	95%
6%	20%	56%	78%
8%	16%	44%	62%

Source: Own elaboration.

These results show that, the higher the contribution and the lower the increase of salary, the higher the replacement ratio. Thus, a 31.19% contribution and a salary increase of 4.53% manage to reach a replacement ratio of 87% based on the last salary. On the other hand, if the average salaries over the last 5 years is assumed, a replacement ratio of up to 95% can be achieved with a contribution of 31.19%.

That said, in order to reach a replacement ratio of 100%, several numerical simulations were carried out with different scenarios to determine the optimum contribution percentage. The results are shown on Table 9 and it can be seen that the minimum required contribution rate is 32.93%, while the maximum is 57.94%.

Table 9
The optimum contribution in order to reach a replacement ratio of 100%

Salary increase	Optimum contribution	
	Last salary	Average salary for the last five years
4.53%	35.91%	32.93%
6%	44.52%	39.76%
8%	57.94%	49.97%

Source: Own elaboration.

The age and seniority variables also have an influence on the replacement ratio. Therefore, simulations were carried out to determine which replacement ratio would be obtained when setting the entry age at 25 years old and the seniority at 40, as determined by the OECD (2015). The results were that, in the scenario of a 4.53% increase of salary, based on the salary under the two previous scenarios and keeping all other variables the same; the replacement ratio achieved is 89% and 97% respectively. In the following section of this work the recommendations for the design of pension plans, based on the results in this section, are included.

CONCLUSIONS

While it is true that Bismarck designed the first social security program in Germany 120 years ago, making this country the first one in the world to promote the welfare of its workers (OIT, 2009); a lot has happened since, and countries´ mandatory pension plans are migrating from defined benefit to defined contribution ones or individual capitalization. However, the pension plans in universities have not promoted corrective measures to mediate the financial crisis they find themselves in. After reviewing the details of the characteristics of these plans, only 2 of them can be seen to have closed their plan to new members, without offering any other alternative to new employees who entered after the date established by the university.

As far as the rest of the universities are concerned, some of them continue with the same design of plans while others have made reforms to lower the high costs these plans represent. The high costs can be mainly attributed to their design, which from an actuarial point of view is inefficient and costly. This can be concluded after reviewing the characteristics of these plans, among which the contributions made to the plan can be seen to be as low as 8%, and in one of the universities they are null. Another badly planned characteristic is age and retirement seniority. 5 universities do not have an age restriction to obtain a pension and in another the seniority is as low as 20 years, to obtain a pension of 100% of the last salary. These characteristics propitiate the actuarial cost of these plans to be extremely high.

On the other hand, by means of the research conducted in this study, it could be established that, in the case of an average employee in these universities, the pension fund would only be sufficient to pay the employee 38% of their salary (in the worst case). The other 62% of the salary must be absorbed by the state and federal governments, which situation is currently present and which is also the reason why several universities have declared themselves technically bankrupt. This number is much higher than the 31% reported by the Inter-American Development Bank (Altamirano *et al*., 2018) and that was previously mentioned in this document. Furthermore, these findings prove the OECD's recommendation of decreasing the coverage gap, by increasing the formal participation and enabling people to build their own rights to a pension (OECD, 2015b).

Another finding in this study was that in the same case of an average employee, in order to achieve a replacement ratio of 100%, it is necessary to make contributions of 58% of the salary; a situation that strikes employees as illogical. This is why it is emphasized that contributions to universities by external entities such as federal government are necessary in order to afford these pension plans.

Finally, the recommendations that can be made after conducting this study are the following: The first and most important one is that universities need to carry out annual actuarial evaluations to follow-up on costs. In addition to this, it is recommended to adjust the percentage of contribution made to the pension fund with the purpose of ensuring its solvency at all times. Furthermore, to give special emphasis to the replacement ratio offered by the plan, in the sense that it must be complementary to the mandatory plans in Mexico and that literature suggests a replacement ratio of 80% to be appropriate for a person who is retiring.

REFERENCES

Altamirano, A., Berstein, S., Bosch, M., García, M. & Oliveri, L. (2018) *Presente y futuro de las pensiones en América Latina y el Caribe*. Washington: Banco Interamericano de Desarrollo.

Booth, P., Chadburn, R., Haberman, S., James, D., Khorasanee, Z., Plumb, R. H. *et al*. (2005). *Modern Actuarial Theory and Practice*. Estados Unidos: Chapman & Hall/CRC.

BUAP. (2017). *Contrato Colectivo de Trabajo de la Benemérita Universidad Autónoma de Puebla y la Asociación de Personal Académico de la Benemérita Universidad Autónoma de Puebla 2017-2019*. México: Benemérita Universidad Autónoma de Puebla.

CIEP (2017). *Pensiones en México: 100 años de desigualdad*. México: CIEP.

CEPAL (2018). *Panorama Social de América Latina, 2017*. Santiago de Chile: Naciones Unidas.

CONSAR (2014). *¿Cómo funciona operativamente el Sistema de Ahorro para el Retiro?* México: Consar.

CONSAR (2018). *Comisiones vigentes en 2018*. México: Consar.

CONAPO (2012). *Proyecciones de la población de México 2010-2050*. México: CONAPO.

FIAP (June, 2019) *Reformas Paramétricas en los Programas de Pensiones Públicos de Reparto 1995-junio 2019.* FIAP.
Link: https://www.fiapinternacional.org/publicaciones/reformas-parametricas-en-los-programas-publicos-de-reparto/

James, E., Cox, A. & Wong, R. (2003). *The Gender Impact of Pension Reform*. Washington: World Bank.

Moreno, T. (23 de noviembre de 2017). Presupuesto de educación superior baja 74% en 3 años. *El universal*.
Link: http://www.eluniversal.com.mx/nacion/politica/presupuesto-de-educacion-superior-baja-74-en-3-anos

OCDE (2015a). *OCDE Reviews of Pension Systems in México*. México: OCDE.

OCDE (2015b). *Panorama de las pensiones: América Latina y el Caribe*. México: OCDE.

OCDE (2017). *Pensions at a Glance 2017: OECD and G20 indicators*. Paris: OCDE.

OIT (2009). La seguridad social como respuesta a la crisis. *Trabajo* (67). Bruselas: Organización Internacional del Trabajo.

Ponds, E., Severinson, C. & Yermo J. (2012). Deuda implícita de los planes de pensiones del sector público: una comparación internacional. *Revista Internacional de Seguridad Social*, *65*(79), 109.

Ramos, J. (22 June 2017). Existen más de mil sistemas de pensiones "opacos" en el país, muchos de ellos en quiebra. *Dinero en imagen*. Link: http://www.dineroenimagen.com/2017-06-22/88032

UAA. (2018). *Contrato Colectivo de Trabajo UAA-ACIUAA*. México: UAA.

UABC. (2009). *Convenio Reglamentario del Plan de Pensiones por Jubilación de los Trabajadores Académicos de la Universidad Autónoma de Baja California*. México: UABC.

UABCS. (2002). *Contrato Colectivo de Trabajo UABCS-SPAUABCS 2013-2014*. México: UABCS.

UACAM. (2004). *Reglamento de Prestaciones Sociales del Personal Administrativo y Docente de la Universidad*. Recuperado el 3 de julio de 2019 desde: México: UACAM.

UCOL. (2017). *Contrato colectivo de trabajo 2017-2018*. México: UCOL.

UAEMEX. (2018). *Contrato Colectivo de Trabajo UAEH-SPAUAEH. Reglamento de Jubilación del Personal Académico de la UAEH.* México: UAEMEX.

UAG. (2016). *ASPAAUG Contrato Colectivo de Trabajo 2016-2018*. Recuperado el 3 de julio de 2019. México: UAG.

Universidad Autónoma de Morelos (2015). *Contrato Colectivo de Trabajo 2015-2017*. México: Universidad Autónoma de Morelos.

UAN. (2018). *Contrato Colectivo SPAUAN 2018-2019*. México: UAN.

UANL. (2017). *Contrato Colectivo de Trabajo 2017*. México: UANL.

UAQ. (2015). *Contrato Colectivo de Trabajo 2015-2017*. México: UAQ.

UAT. (2017). *Reglamento de pensiones por jubilación para el personal docente de carrera de tiempo completo al servicio de la universidad autónoma de Tamaulipas*. México: UAT.

UJAT. (2017). *Contrato Colectivo de Trabajo 2017-2019*. México: UJAT.

Villagómez, A. (2015). México: un esquema multipilar fragmentado En C. Acuña (coord.) *Cómo fortalecer los sistemas de pensiones Latinoamericanos* (pp. 293-361). Chile: SURA Asset Management.

Yanqiu, Z. & Shih-Jiunn S. (2017) Pension Reforms in the Context of the Global Financial Crisis: A Reincarnation of Pension Privatization through Austerity? En Evans, B. M. & McBride, S. (Ed.), *Austerity. The lived experience*. (pag. 222-245). Toronto, Canadá: University