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Economic Analysis

Long-term returns and replacement rates in Mexico's pension system

Overview

BBVA Research[1]

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In this work I analyze the relevance of considering a range of elements related to the investment process to evaluate the long-term returns of Pension Funds and the possible impact of these on the replacement rates of participants in a Pension System. The analysis focuses on Mexico for three reasons: 1. Its Pension System was not greatly affected in relative terms by the 2008 financial crisis; 2. The long-term returns of the Pension Funds (Siefore) in the System are considered a key variable in determining the pensions of participants; and 3. It was one of the first OECD countries to introduce a life-cycle scheme into its pension model.

The main result of this research is that the Mexican model of Siefores with diversified portfolios can offer reasonable returns over the longer-term, although it is not a control variable for the Pensions System. Once this limitation has been recognized, the only certain way that a pension or its replacement rate can be improved is to move towards higher contribution densities and to maintain appropriate contribution rates. If this is done, it is still possible to achieve additional improvements in pensions due to greater than expected returns. One route for achieving this is to increase the share of equity instruments in pension portfolios, which from a more wide-ranging perspective may also strengthen the Pension System as this alternative may also help to offset in part situations of low contribution densities by participants.

2: I would like to say thank you to Adolfo Albo and David Tuesta in the BBVA Economic Research Department and to Francisco González Almaráz in Afore Bancomer for the discussions we had about various points in this research. Their comments helped me to expand the horizons of this study and to strengthen the analysis it contains. I would also like to thank Alberto Herrera and my colleagues in the Global Trends Unit: Javier Alonso, Jasmina Bjeletic, Soledad Hormazábal, María Claudia Llanes and Ivonne Ordoñez for their support and very valuable observations. Any errors or omissions which remain in this work are entirely my responsibility.

1. Introduction[3]

At the end of 2008, the world experienced one of the worst financial collapses in history. What began in 2007 as an apparent solvency problem that only affected the subprime mortgage sector in the U.S. turned in the second half of 2008 into a global financial crisis, with prices for the main asset classes plummeting and an economic recession that the world is still trying to overcome.

In this context, two facts related to pension funds should be highlighted. Firstly, these institutional investors have proved to be a highly important stabilizing factor for economies at times of crisis. With a long-term investment horizon and diversified investment portfolios they have been able to maintain liquidity for markets, companies and productive projects. For more details, see BBVA (2009).

Secondly, the financial crisis also had an immediate negative impact on the profitability of pension funds. According to the OECD (2009), the real returns of pension funds in OECD countries fell by 17.4% on average in 2008.

The aim of this document is to draw some lessons from the financial crisis for pension fund investments and to evaluate some of the potential long-term implications for participants in terms of future replacement rates measured by the ratio of their pension to their last salary. This evaluation uses Mexico as the main reference, as its pension system was one of the least affected by the crisis. Another reason for choosing Mexico is that in the months before the financial collapse, the system incorporated a life-cycle structure into its pension model. In the future this may be useful in keeping long-term investment risks in check and maintaining reasonable levels of return.

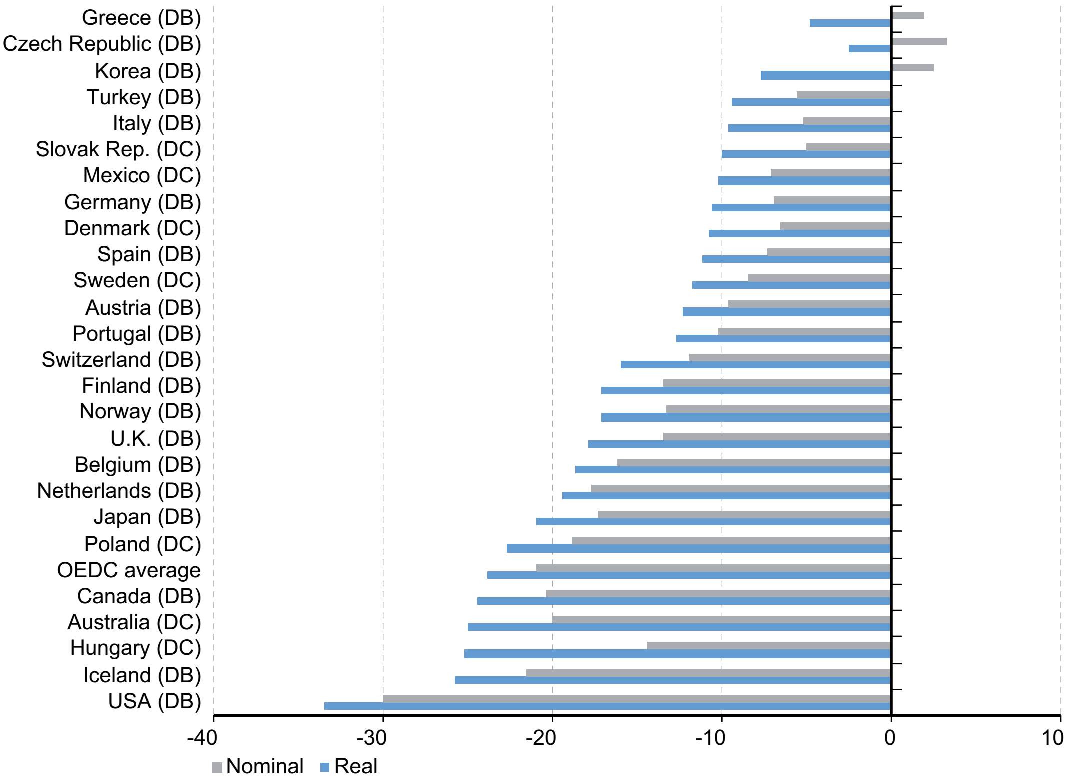
3: This document is an enhanced version of the analysis in Herrera, Carlos A. (2009), incorporating: a) fuller coverage of fixed income assets; b) an increased number of simulation exercises (1,000 compared to 250); c) an increased number of investment horizon cases for Siefores; and d) possible areas for reform of the investment regime for Siefores in Mexico.

2. Some lessons from the financial crisis

One of the main lessons of the financial crisis is that the volatility of security markets may affect all pension systems, regardless of their pension model. For example, using OECD pension systems as a reference, it can be seen that the fall in asset prices generated negative returns in systems using both defined-contribution and defined-benefit schemes, and combinations of the two. As can be seen in Chart 1, all pension systems in OECD countries recorded negative returns in real terms in the period January-October 2008.

Chart 1

Real and Nominal Returns in OECD's Pension Systems, Jan-Oct 2008



Note:The most important Pension Plan in each country is indicated by assets/ GDP (DB): Defined Benefit Pla and (DC): Defined Contribution Plan.
Source: BBVA Research with data from OECD (2008)

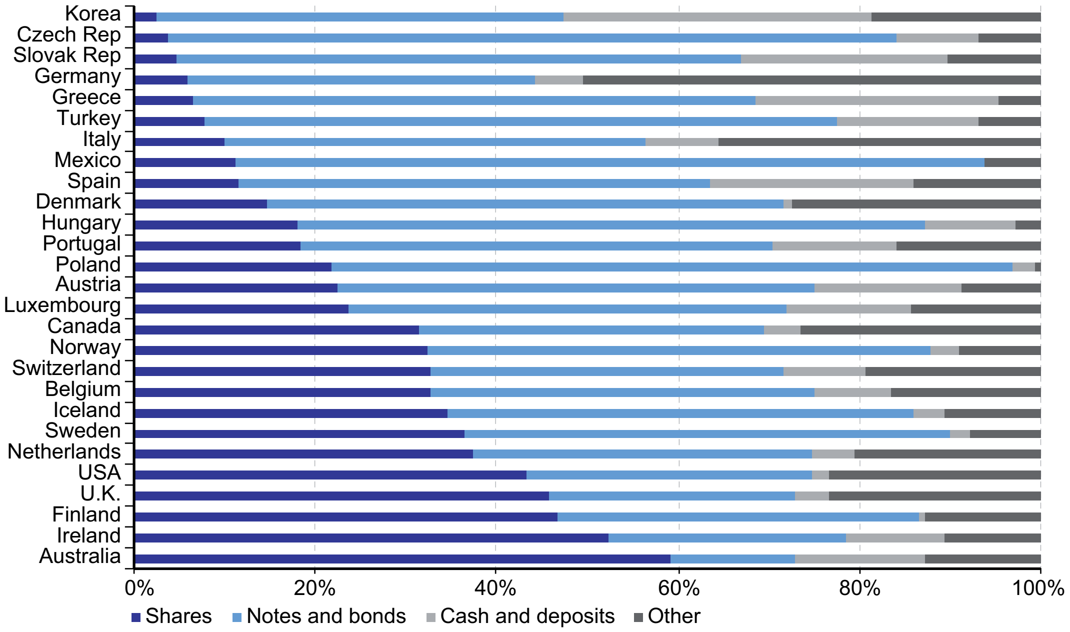
Nevertheless, Chart 1 also reveals differences in the effects of the crisis. For example, there were negative returns of between 33% and 25% in real terms in Ireland and the United States, but of less than 5% in Korea and Greece; on another side, the negative performances of Germany and Mexico were around 10%.

What factors can explain this difference in the performance of the pension systems in the crisis? According to a number of studies, the performance of investments depends on various elements within the investment process, such as the choice of asset classes, the time horizon considered and the specific moments at which resources are invested or withdrawn. On this point we can refer, for example, to studies by Brinson *et al*. (1991), Butler and Domian (1991) and Ibbotson and Kaplan (2000).

In terms of asset classes, Chart 2 illustrates that pension funds in OECD countries have diversified portfolios, but the main investments are in equity (shares and share indices) and fixed-income (notes and bonds) instruments. When we consider these asset classes, we must ask ourselves whether either of them explain in particular the different performance of investments by pension funds during this financial crisis.

Chart 2

Pension Systemas & Asset Allocation (2008 or last available data)



Source: OCDE, Global Pension Statistics

The evidence shows that the impact of the crisis on pension fund portfolios was not focused on a single asset class. Using the information available at the close of 2007 as a source of reference for the assignment of pension fund assets in periods previous to the crisis and then comparing their performance during the crisis, we can see mixed results in terms of the possible relation between assignment of assets and the returns generated by the funds.

It is true that countries with higher investment in equity also recorded higher losses when compared with a similar level of investment in fixed-income instruments. For example, Table 1 shows the cases of Greece, Italy, Portugal and Holland. However, this does not necessarily appear to indicate that fixed-income investments are “safe” in themselves, since countries with a very high share of this asset class in their portfolios also registered a broad range of losses. This was the case, for example, with Hungary, the Czech Republic and Mexico, where at least 66% of the total portfolio was assigned to fixed income instruments.

Table 1

Asset Allocation and Returns in Pension Systems (Selected assets)

Country	Equities, % of total (2007)	Notes and bonds, % of total (2007)	Real return, Jan-Oct 2008
Korea	0.2	58.5	-2.5
Greece	5.4	37.2	-4.7
Czech Rep.	5.9	75.2	-4.8
Italy	10.1	37.2	-9.5
Slovak Rep.	8.6	49.2	-9.7
Mexico	13.1	82.5	-10.0
Germany	0.1	25.8	-10.1
Denmark	30.7	50.8	-10.5
Spain	19.0	65.1	-10.8
Sweden	29.5	51.6	-11.2
Austria	35.1	44.4	-11.7
Portugal	25.3	36.6	-12.4
Switzerland	15.7	24.4	-12.6
Finland	46.8	39.9	-16.0
U.K.	29.6	21.9	-17.2
Norway	32.5	55.2	-17.1
Belgium	9.3	7.6	-17.9
Netherlands	40.3	35.0	-18.7
Poland	34.6	61.0	-20.9
Canada	28.9	23.6	-23.9
Australia	25.3	NA	-24.4
Hungary	14.0	66.8	-25.0
Iceland	34.3	46.2	-25.2
USA	46.7	16.4	-25.8
Ireland	66.3	18.5	-33.4

NA: No Available

Source: BBVA Research with data from OCDE (2008) and OCDE, Global Pension Statistics

However, some countries with very similar assignment of assets between fixed income and equity obtained very different results, as can be seen in the case of Austria, Iceland, Spain and Hungary. The above leads us to think that following the financial crisis we should not talk of classes of assets that are really “safe” (fixed-income) or “risky” (equity). In other words, an important lesson from the crisis is to remember that all financial assets may be volatile in their returns and that the performance of investments is not only explained by the assignment of assets, but also by other factors both internal and external to the investment process. Such factors could include the design and regulatory framework of the investment regime in which the funds operate.

To identify the relevance of each of the above factors in the performance of OECD pension fund investments we would have to carry out detailed analysis on a country-by-country basis. However, whilst an analysis of this kind is outside the scope of this document, Mexico has been chosen here as the main and most significant case study for three reasons:

1. Its pension system was relatively unaffected by the financial crisis.
2. It has reformed its pension system and has moved form a defined-benefit to a defined-contribution scheme. Thus the long-term returns that pension funds in the system may generate can be identified as key for the participants’ retirement pensions.
3. Mexico was one of the first OECD countries to introduce a life-cycle scheme into its pension model in order to generate reasonable returns with more limited risks for participants.

3. Mexico's pension system

Mexico reformed its main pension system (IMSS) in 1994, moving from a defined-benefit to a defined-contribution scheme. As a result, since 1997 the IMSS pension scheme has used a system of defined contributions to individual capitalized accounts, which are administered by private companies known as Afores in the SAR (Sistema de Ahorro para el Retiro – Retirement Savings System). In the IMSS pension scheme the value of the pension to the member depends on the amount accumulated in their individual account; however, the system guarantees a pension equivalent to a minimum salary indexed to inflation for members who meet certain age and contribution requirements.[4]

The design of the Afore industry within the SAR retirement savings system has developed gradually from a situation in which each Afore managed a single type of investment fund (called a "Siefore") for its participants (1997 to 2004), which in turn focused on fixed-income government instruments, to a new model based on a family of basic Siefore (Siefore Básicas or SBs) funds with more diversified investment portfolios. The change to this multi-fund model began in 2005 with two funds: fund 1 for people aged over 56 and fund 2 for people under 56. Fund 2 also, for the first time, made it possible to invest retirement funds in equity instruments, subject to two restrictions: 1) such investments were limited to 15% of fund assets; and 2) investment was only permitted through structured capital protected notes based on share indices.

In March 2008 the number of pension funds in each Afore increased to five Basic Siefores and the life-cycle basis of their operation was made explicit. In other words, as participants grow older their pension assets are invested with lower exposure to equity and a greater proportion of fixed-income instruments to reduce the volatility of their returns. Thus the maximum exposure to equity under this investment regime is 30%, but this only applies to Basic Siefore 5 (SB5), which is for participants aged under 26. As the participants grow older they gradually move to Siefore SB4, SB3, SB2 and finally SB1, which does not have any exposure to equity. (See Table 2). One characteristic of the family of funds under the life cycle model in Mexico is that members may not have pension resources in more than one such fund, and members may only change to Siefores with a more conservative portfolio than that automatically assigned for their age.

Table 2

Siefore's investment regime
(Maximum investment limit by asset classes and old-age of affiliates)

	Siefore (Pension Fund)				
	SB1	**SB2**	**SB3**	**SB4**	**SB5**
Asset classes, % of total de assets					
* Equity (stock indices)	0%	15%	20%	25%	30%
* Fixed Income	100%	100%	100%	100%	100%
* Foreign instruments	20%	20%	20%	20%	20%
* Asset-backed securities	10%	15%	20%	30%	40%
* Structured Notes	0%	5%	10%	10%	10%
* Trusts[1]	0%	5%	5%	10%	10%
Risks, %					
Limit for Value at Risk (VAR)	0.60%	1%	1..3%	1.60%	2%
Old-age structure, years					
Old-age of affiliates	>= 56	46 a 55	37 a 45	27 a 36	<= 26

1: Real state and Infraestructure trusts
Source: BBVA Research with data from CONSAR´s Rule 15

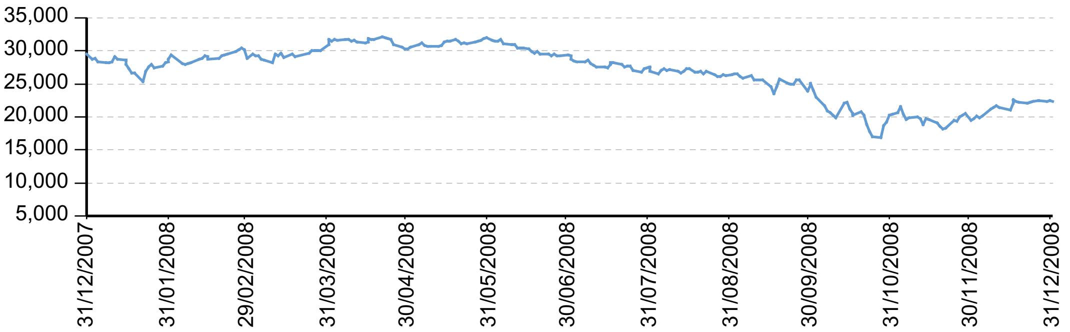
4: For more detail on the reforms of the pension system in Mexico, refer, for example, to Albo *et al*. (2008).

A) Short-term impact of the crisis and government reaction

Mexico's stock market fell significantly during the worst periods of the crisis. For example, the stock market registered major falls of 8.4%, 18.1% and 36.3% in June, August and October 2008, compared with its pre-crisis high on April 21 of 32,095 points (see Chart 3). However, the biggest impact of the financial crisis on the Siefore portfolios did not result from falls in equity markets, but from downward adjustments in the price of fixed-income instruments, particularly long-term ones.

Chart 3

Mexican Stock Market in 2008 (Indice de precios y cotizaciones (IPC), points)



Source: BBVA Research with data from Bolsa Mexicana de Valores

Table 3 shows the significant share of fixed-income instruments in Siefores in 2008. With regard to the period of financial crisis and its impact on the Siefore portfolio, CONSAR (2009) reports that in mid-2008 greater risk aversion on the part of shareholders was translated into a credit squeeze and thus temporary adjustments in interest rates. It also shows that the increase in the prices of goods and foods (in the domestic market) also put pressure on the monetary authorities to increase reference interest rates to avoid a resurgence of inflationary spirals. It was this increase in interest rates, particularly long-term rates, which led to fixed-income instruments in the Siefore portfolios recording losses, according to the valuation at market prices used by the Afores.[5]

Table 3

Siefore and Asset Allocation in 2008 (% of total of the portfolio)

Beginning of Multifunds model with 5 Siefore (April-2008)

	SB1	SB2	SB3	SB4	SB5	System
Equity	-	11.3	14.6	18.3	20.4	14.5
Domestic	-	5.2	7.1	9.4	11.9	7.3
Foreign	-	6.1	7.5	8.9	8.5	7.2
Fixed Income	100.0	88.7	85.4	81.7	79.6	85.5
Domestic	92.0	82.6	79.5	75.8	73.9	79.4
*Corporate	18.0	16.0	15.8	16.1	16.4	16.1
*Government	74.1	66.7	63.7	59.7	57.5	63.3
Foreign	8.0	6.0	5.9	5.9	5.7	6.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Pre-Crisis Situation (June-2008)

	SB1	SB2	SB3	SB4	SB5	System
Equity	-	12.0	15.6	19.5	22.6	15.5
Domestic	-	6.1	8.2	10.6	13.2	8.3
Foreign	-	5.8	7.5	8.9	9.4	7.2
Fixed Income	100.0	88.0	84.4	80.5	77.4	84.5
Domestic	91.6	81.6	78.1	74.2	71.3	78.0
*Corporate	19.0	17.1	16.4	16.5	16.2	16.7
*Government	72.6	64.5	61.7	57.7	55.2	61.3
Foreign	8.4	6.5	6.3	6.3	6.1	6.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

Continues on next page

5: Under this system, a loss/gain occurs when the valuation of an investment portfolio at market prices shows a value that is lower/higher than the value registered at a previous valuation date. These losses/gains are frequent in investment management because of price changes in different asset classes. They do not represent an actual loss/gain, unless there is an actual settlement of any of the securities in the investment portfolio in the markets.

Table 3 (Cont.)

Siefore and Asset Allocation in 2008 (% of total of the portfolio)

End of year

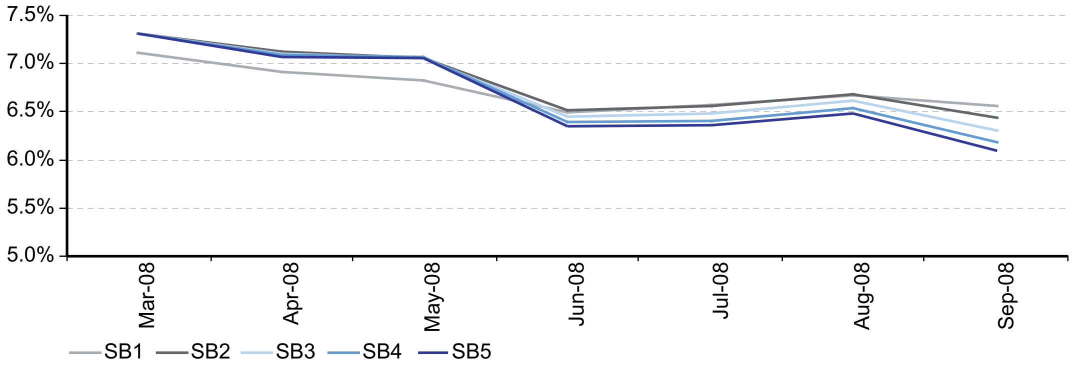
	SB1	SB2	SB3	SB4	SB5	System
Equity	-	7.8	11.4	14.2	16.5	10.6
Domestic	-	4.3	6.3	7.9	9.6	5.9
Foreign	-	3.4	5.1	6.3	6.9	4.7
Fixed Income	100.0	92.2	88.6	85.8	83.5	89.4
Domestic	95.3	87.1	83.1	79.9	77.4	83.9
*Corporate	12.7	15.3	15.8	16.4	17.1	15.6
*Government	82.6	71.8	67.3	63.5	60.3	68.3
Foreign	4.7	5.2	5.5	5.9	6.1	5.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: BBVA Research with data from CONSAR

Based on the above, in September 2008 the system registered an average real fall in its historical return of 95 basis points compared with the level at the start of the five Siefores model. (See Chart 4). Given this situation, and to protect workers' assets, the financial authorities and the regulator (CONSAR) adopted a series of actions in secondary regulation.

Chart 4

Annual real historic return in Siefore (Annualized monthly variation, %)



Source: BBVA Research with data from CONSAR

According to Calderon (2009), the following were the most important measures designed to prevent greater deterioration in Siefore portfolios:

1. In October 2008 additional rules were introduced to allow an investment strategy determined by the Investment Committee to be maintained in the face of extreme market volatility. In order to do this, Siefores have to present CONSAR with a special portfolio restructuring program to allow a better handling of investments during the temporarily adverse conditions.

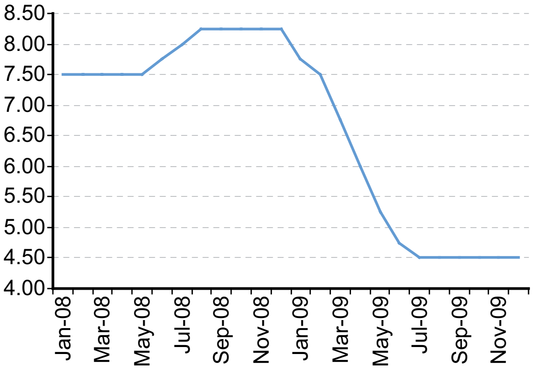
2. In December 2008 the transfer of workers from one Siefore to another (for reasons of age) was temporarily suspended to prevent the sale of securities in unfavorable conditions for retirement savings. For the same reason, the funds' operating rules were modified to ensure that the collection flows of the Afores matched the settlement of transfers.

3. In addition, the Siefores were temporarily allowed to limit their value-at-risk (VaR) under the regulations to avoid hasty sale of instruments held in portfolios which could lead to greater losses.

The measures outlined above, together with a new cycle of falling interest rates under domestic monetary policy (see Chart 5), and also accompanied by a more favorable stock market performance, resulted in Siefore losses being cancelled out over 2009, proving to be a short-term phenomenon, as can be seen in Chart 6.

Chart 5

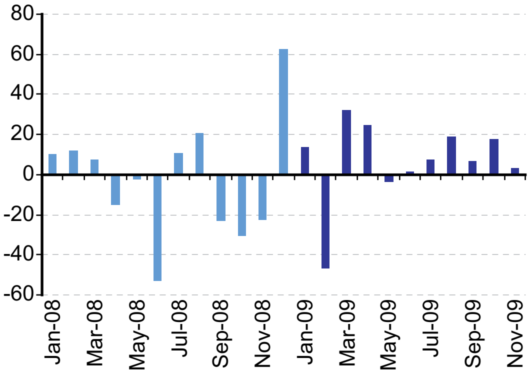
Targeted interest rate by Banco de Mexico (% end of period)



Source: BBVA Research with data from Banco de Mexico

Chart 6

Returns net of fees, (Thousand of million of pesos)



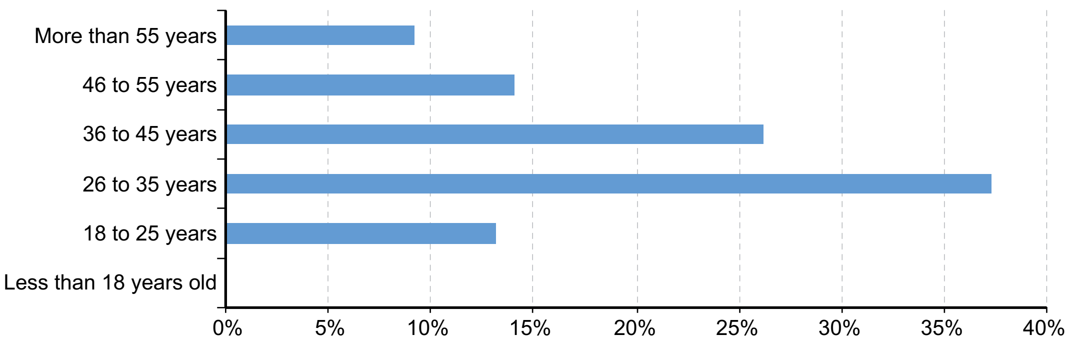
Source: BBVA Research with data from CONSAR

However, the above does not mean that there may not be a return to losses for the Siefores, because, as has been indicated, all financial returns are volatile. However, an assessment of the possible impact of this volatility on pension assets should take into account the investment horizon and asset investment regime.

In terms of the investment horizon, the resources in the SAR retirement savings system have a clear long-term perspective, as their aim is to finance a pension at the end of a worker's active working life. If we consider the current age distribution of SAR participants and that the retirement age in Mexico is 65, it is clear that most of the pension resources will be needed between 20 and 47 years in the future, as 76.7% of the participants are now between 18 and 45 years of age6. (See Chart 7).

Chart 7

Distribution of SAR accounts by old-age group, %



Source: BBVA Research with data from CONSAR

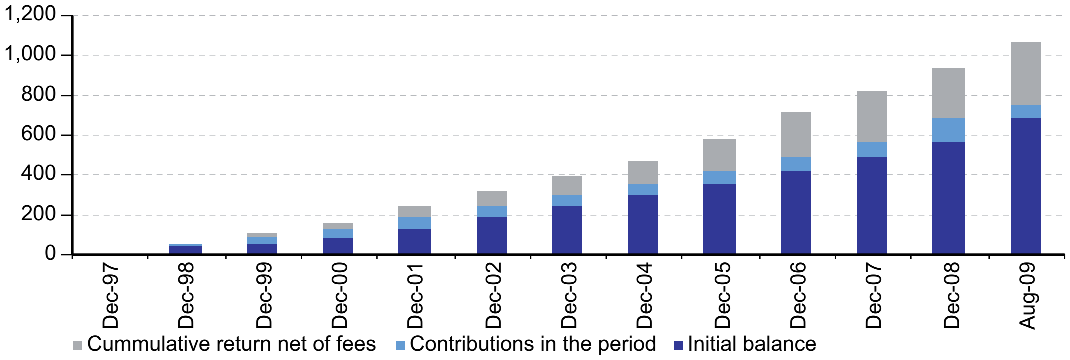
6: In Mexico, people who are now over 45 years of age will probably not use the defined-contribution scheme for their retirement pensions, as the reform of the IMSS pension system in 1994 stipulated that workers who were active until a day before the reform ("transition" workers) could choose between the old defined-benefit and the new defined-contribution schemes, whichever was more favorable for their retirement benefits. Thus the impact of an event such as the financial crisis of 2008 would be practically nil in Mexico for people who are currently over 45 years of age and for transition workers in general.

B) The return for Siefores over a long-term retrospective perspective

Given that Siefores have a long-term investment horizon, the performance of their investments should be assessed by long-term measures and not according to possible short-term losses/gains. For example, if the balance of funds managed by the Afores within the SAR is broken down into accumulated contributions and returns net of fees between 1997 and 2009, we see that the net accumulated return expanded soundly under this long-term period. (See Chart 8).

Chart 8

Breakdown of SAR balance funds (Thousand of million pesos)



Source: BBVA Research with data from CONSAR

In addition to the investment horizon, the investment regime to which pension resources are subject influences expected return and possible volatility, as it determines the type of instruments and asset classes in which the scheme may participate. A valuation of possible returns for Siefores should thus necessarily take into account its investment regime.

In relation to the above, it should be remembered that until 2004 the investment regime of the Siefores focused on fixed-income investments (particularly government instruments). This helped limit the portfolio volatility of the single fund compared with alternative equity investments. To give an example: Table 4 compares historical equity and fixed-income returns for Mexico, using the Mexican stock price index (IPC for its Spanish initials) and the interest rate of 28-day Treasury Certificates (CETES for its Spanish initials) as indicators for each type of security respectively.[7] The table also includes inflation (measured by the Consumer Price Index CPI) as a reference for purchasing power.

7: The Federation's Treasury Certificates (CETES) have 28-day, 91-day, 182-day and 364-day issues. The longest historic series data for such issues corresponds to 91 days CETES, for which the Bank of Mexico has statistical information from January 1978; however, the average monthly CETES 28 day rate is considered to be the nominal risk free rate and is available from September 1982. See Bank of Mexico (2009). Other fixed income instruments for longer terms have gradually been added to the Mexican public debt market. For example, Bondes in January 1994, Udibonos in January 1996, and fixed rate bonds from January 2000, in particular the latter which, because of their terms of 10, 20 and 30 years can be considered an appropriate area for pension fund investment, are relatively recent additions to the Mexican markets: January 2000 (10 year Bond), January 2003 (20 year Bond) and October 2006 (30 year Bond). As a result, the CETES 28 day rate is considered to be the most representative for fixed income instruments for retrospective long-term analysis.

Table 4

Equity & Fixed income in Mexico

	Equity	Fixed-income	Inflation
	Indice de precios ycotizaciones (IPC) Nominal annual return, %	Interest rate (CETES 28 days) Nominal annual return, %	General Consumer Price Index (CPI), Annual % change
1981	-36%		
1982	-22%	44%	107%
1983	250%	59%	88%
1984	65%	NA	60%
1985	177%	62%	66%
1986	321%	87%	108%
1987	124%	96%	167%
1988	100%	70%	75%
1989	98%	45%	20%
1990	50%	35%	31%
1991	128%	19%	19%
1992	23%	16%	12%
1993	48%	15%	8%
1994	-9%	14%	7%
1995	17%	48%	55%
1996	21%	31%	28%
1997	56%	20%	16%
1998	-24%	25%	19%
1999	80%	21%	13%
2000	-21%	15%	9%
2001	13%	11%	4%
2002	-4%	7%	6%
2003	44%	6%	4%
2004	47%	7%	5%
2005	38%	9%	3%
2006	49%	7%	4%
2007	12%	7%	4%
2008	-24%	8%	7%
Geometric mean	IPC	CETES	Inflation
97-04	21%	16%	11%
82-08	48%	30%	31%
Arithmetic mean	IPC	CETES	Inflation
97-04	24%	14%	9%
82-08	61%	30%	35%
Standard deviation	IPC	CETES	Inflation
97-04	38%	7%	6%
82-08	82%	26%	42%
Excess nominal return over inflation per unit of risk*	IPC	CETES	
97-04	0.37	0.63	
82-08	0.32	-0.18	

*Difference between the arithmetic mean return in IPC (CETES) and inflation during the period of reference then divided by the standard deviation of IPC (CETES).
NA: No available. For computation of arithmetic mean, geometric mean and standard deviation it was used as working assumption the average interest rate between 1983 and 1985.
Source: BBVA Research with data from Banco de Mexico and Bolsa Mexicana de Valores

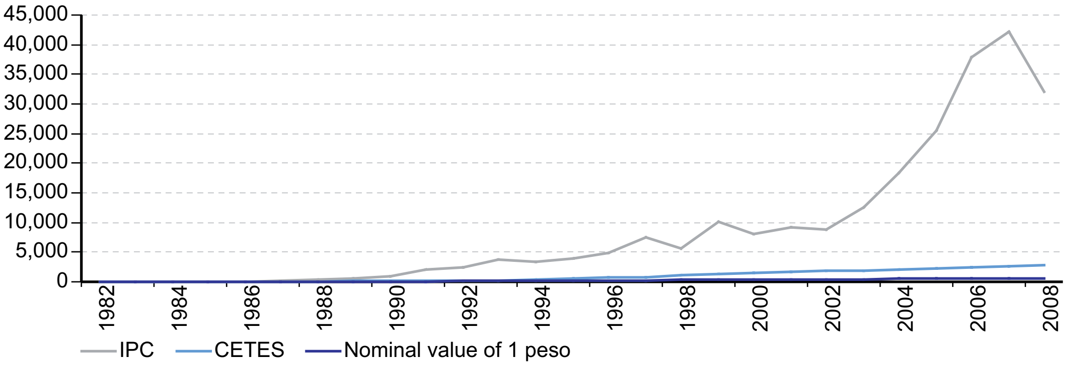
For the 1997-2004 period, in which the investment regime of the single fund focused on fixed-income, the arithmetical average of the annual returns for CETES was 14%, and their average volatility in terms of standard deviation was 7%. In contrast, the arithmetical average of the annual return of the IPC was 24%, with a volatility of 38%. Thus the CETES recorded lower volatility than the IPC, but also a lower nominal return. Was it therefore reasonable to concentrate the investment of the single fund on fixed-income instruments during this time? The answer is yes, when we also take into account inflation during the period. For example, the nominal return of CETES in excess of inflation per unit of risk was greater than the IPC (see Table 4).[8]

However, over a longer-term investment horizon, as is the case with pension funds, an excess concentration of investment in short-term fixed-income may limit potential fund returns. For example, in Table 4 we see that over a longer period of time (1982-2008) the geometric average of the IPC returns is much greater than that of the CETES. This reflects their greater potential contribution to the returns of pension funds.[9]

What about risk? The Mexican experience indicates that investments in equity may be attractive in terms of their nominal returns in excess of inflation per unit of risk. As can be seen in Table 4, when an extensive investment period is considered, such as 1982-2008, investment in the IPC may have recorded a return in excess of inflation per unit of risk that is in excess of that of CETES. Thus there are signs that the impact of investment in equity on the return of a portfolio may be positive, even taking into account volatility, and that this class of security should not be absent from pension fund portfolios. As can be seen in Chart 9, over a long-term horizon the value of one peso investment in the IPC compared with an alternative short-term investment in CETES may give a significant premium above the inflation rate (nominal value of 1 peso), even assuming that there are no reinvestment risks in the fixed-income instrument.[10]

Chart 9

Value of 1 peso invested in IPC vs CETES, 1982-2008 (1982 = $1.00)



Source: BBVA Research with data from Banco de Mexico and INEGI

Given the above, the move of the investment regime of the Siefores towards a family of funds that incorporate equity in a diversified portfolio under a life-cycle scheme represents very significant progress towards extending alternatives for future returns and pensions for participants. How high might returns be under this new model, and to what extent is volatility limited? This subject is analyzed in more detail in the following section.

8: In this study, investment risk is only measured by its volatility, or the standard deviation of its returns. In turn, the nominal return in excess of inflation per unit of risk is similar to the performance measure known as the Sharpe ratio, which is a broad measure of the nominal return of an investment in excess of the risk-free rate per unit of risk (standard deviation). See Sharpe et al. (1999). The calculation employed in this document uses the inflation rate rather than the risk-free rate to value excess return.
9: The geometric average is a measure which provides a weighted return for the investments over time and does not take into account possible variations in the managed assets. It is thus used widely to value the performance of financial investments. See Bodie et al. (2004).
10: Note that in Table 4 there is no information for 1984, as there was no issuance of 28-day CETES in that year. These possible gaps in the issue of instruments imply a reinvestment risk for fixed-income instruments, in addition to others such as credit or default risk. In the case of CETES no credit risks are considered to exist.

C) Siefore returns in a long-term perspective

Although historical experience may offer some insights for investment questions, it is very important to bear in mind that these signs do not represent a guarantee of any kind of possible future performance. Because of the above, for forward evaluation of Siefore investments we have to take into account a variety of different scenarios covering the possible performance of prices for the different classes of assets that make up their portfolios under the forecast investment regime.

One way of presenting possible scenarios for the future behavior of prices of financial assets is to carry out simulation exercises. Therefore, in this document we use the Monte Carlo Simulation technique to project the prices of the main Siefore asset classes: fixed income and equity with a range of investment horizons from 1 to 50 years.[11]

i) Model for the long-term dynamics of financial asset prices

In this study, the prices of the main asset classes –fixed income and equity- are modeled as random variables using a multiplicative model with the following general characteristics:[12]

$$P_T = P_0 e^{gT}$$

The model indicates that the price of a financial asset at a time t = T is equal to the price of the asset at the time t = 0 increased exponentially at a rate "g" over a T year horizon.

As a result, the behavior of the price of the financial asset depends ultimately from the behavior of "g". One widely used hypothesis in the financial sector for the possible behavior of "g" is that it behaves as a random variable (rv) with a normal probability distribution and constant average and variance.

The relevance of "g" being an rv and having a normal probability distribution is that when we take the logarithm of the financial asset prices these also behave as an rv, but with a lognormal probability distribution. This lognormal distribution makes it possible to capture at least three characteristics of the prices of financial assets:

1. Prices are always positive.
2. At all points in time, prices are uncertain as they are affected by the variance of "g".[13]
3. Price changes are continuous.

In the multiplicative model, the value of "g" is obtained by applying logarithms on both sides of the equation:

$$Ln\,(P_T) = Ln\,(P_0) + gT$$

$$Ln\left(\frac{P_T}{P_0}\right) = gT$$

$$g = \frac{1}{T}\,Ln\left(\frac{P_T}{P_0}\right)$$

The rate "g" is therefore a rate of return annualized over a time horizon from 0 to T. In this context, "gT" may be interpreted as an accumulated growth rate which also has a normal probability distribution.

According to a number of researchers, such as Luenberger (1998) and Hull (2008), the variable "gT" follows a stochastic pattern described as Geometric Brownian Motion (GBM) or Wiener process "dzt". Under this hypothesis, any random variable "x" exhibits a dynamic over time given by a stochastic differential equation of the type:

$$dx_t = vdt + \sigma dz_t$$

Where

$$dz_t = \varepsilon_t \cdot \sqrt{dt}$$

With $\varepsilon_t \sim N\,(0,1)$

11: Note that in Table 4 there is no information for 1984, as there was no issuance of 28-day CETES in that year. These possible gaps in the issue of instruments imply a reinvestment risk for fixed-income instruments, in addition to others such as credit or default risk. In the case of CETES no credit risks are considered to exist.

12: An alternative way of specifying the model would be additive. However, a specification of this type would not lead to a lognormal distribution for asset prices, which, as we mention later in this document, enables us to capture various relevant characteristics. For more details of these alternative specifications and their limitations, refer to Luenberger (1998).

13: It should be noted that when the variance has the value "zero", the multiplicative model is sufficiently general to simulate the price of a fixed income asset, in which the rate of interest is determined a priori for a particular term, as might occur in the case of "zero coupon" bonds.

This equation in turn has an analytical solution given by the equation:

$$x_t = vt + \sigma z_t$$

Therefore, under the hypothesis of GBM for "gT", prices would behave in the form:

$$P_T = P_0 e^{vT+\sigma dz}$$

Where "gT" is distributed as a normal rv with constant average and variance:

$$gT \sim N\,(vT,\ \sigma^2 T)$$

The change over time in the price of the asset behaves as follows:

$$Ln\left(\frac{P_T}{P_0}\right) = vt + \sigma dz_t$$

$$dLn(P_t) = vt + \sigma dz_t$$

This behavior could be expressed equivalently in terms of P(t) as follows:

$$\frac{dP_T}{P_t} = \mu dt + \sigma dz_t$$

Where

$$\mu = v + \frac{1}{2}\sigma^2$$

Following Luenberger (1998), the previous stochastic process for the price of a financial asset may in turn be extended to the case of an asset in a portfolio with "n" assets, in such a way that the price of the i-th asset where i=1, 2, 3,…n is given by a behavioral equation as follows:

$$\frac{dP_i}{P_i} = \mu_i dt + \sigma dz_i$$

With covariance:

$$Cov\,(dz_i,\ dz_j) = \sigma_{ij}\,dt,$$

Based on the above, the change in price for each asset i, at an instant of time t, has a lognormal probability distribution with an expected value and variance given by the following equations, respectively:

$$E\left[\ln\left(\frac{dP_i(t)}{P_i 0}\right)\right] = vt = (\mu_i - \frac{1}{2}\sigma^2)t$$

$$Var\left[\ln\left(\frac{dP_i(t)}{P_i 0}\right)\right] = \sigma_i^2 t$$

A portfolio with "n" assets is built by assigning a weight w(i) to each asset i=1, 2, 3,…n where the sum of all the weights w(i) is equal to 1. As a result, the instantaneous rate of change of a value in a portfolio V is given by the equation:

$$\frac{dV}{V} = \sum_{i=1}^{n} w_i \frac{dP_i}{P_i} = \sum_{i=1}^{n} w_i \mu_i dt + w_i \sigma dz_t$$

Where the variance in the stochastic term dz(t) is given by:

$$E\left(\sum_{i=1}^{n} w_i dz_t\right)^2 = E\left(\sum_{i=1}^{n} w_i dz_i\right) E\left(\sum_{j=1}^{n} w_i dz_t\right) = \left(\sum_{i,j=1}^{n} w_i w_j \sigma_{ij} dt\right)$$

Therefore, for a lognormal portfolio V(t), the expected value of its return and its variance are given by the following equations:

$$E\left[Ln\left(\frac{dV}{V}\right)\right] = vt = \sum_{i=1}^{n} w_i \mu_i t - \frac{1}{2}\sum_{i,j=1}^{n} w_i w_j \sigma_{ij} t$$

and,

$$\sigma^2(t) = \sum_{i,j=1}^{n} w_i w_j \sigma_{ij} t$$

Where "v" gives the annualized growth rate of the portfolio's value and is a function of the assignment of assets through the w(i).

$$v = \frac{1}{t} E\left[Ln \left(\frac{dV}{V} \right) \right]$$

Furthermore, it should be stated that if the multiplicative model makes it possible to capture the individual behavior of some fixed income instruments, in this study it was decided to built an index or weighted average of interest rates for instruments with differing maturities. The current share of each of these instruments in the Siefore portfolios is used to weight this index.

However, the construction of an interest rate index also requires simulation of the behavior of the interest rate curve over time. In order to do this, a working hypothesis is used in which the prices of fixed income assets over differing terms are proportional to the prices of short-term instruments, and that all the volatility in the prices comes from the volatility of the short-term instruments.

A functional form which is compatible with such a hypothesis is given by the Ornstein-Uhlenbeck behavior equation for short-term rates r(t) cited by Vasicek (1977), which is specified as:

$$dr = \alpha (\gamma - r)\, dt + \sigma dz$$

$$\text{with } \alpha > 0$$

It should be noted that this equation contrasts with the Wiener process used in modeling equity, as it defines stationary behavior for the rv. As a result, in this equation the term "α(γ-r)" represents a force which takes the process towards its average long-term value gamma "γ". The value of alpha "α" is known as the velocity of reversion to the mean.

Vasicek (1977) demonstrated that it is possible to construct an interest rate curve for different terms based on the Ornstein-Uhlenbeck equation through calculation of prices for "zero coupon" bonds using equations which are only dependent on the alpha and gamma parameters:

Vasicek's starting point is that the performance of any bond at a time t and with maturity of T is given by an internal rate of return in t, which is an inverse function of its price.

$$R(t,T) = -\frac{1}{T} Ln\,(P(t,\, t + T)) \text{ with } T > 0$$

Based on the above, the short-term interest rate is defined as an instantaneous rate when t tends to zero.

$$r(t) = R(t,\, 0) = \lim_{T \to 0} R(t,\, T)$$

Vasicek demonstrated that the price of a bond with a maturity of T is given by a specific functional form:

$$P(t,T,r) = exp\left[\frac{1}{\alpha}\; 1 - e^{-\alpha(T-t)}\; (R(\infty) - r) - (T - t)\, R(\infty) - \frac{\sigma^2}{4\alpha^3} (1 - e^{-\alpha(T-t)})^2 \right] \text{with } t \leq T$$

Where, R(∞) represents the performance of a bond with a very long term maturity (when T tends to infinity).

$$R(\infty) = \gamma + \frac{\sigma}{\alpha} - \frac{1}{2}\; \sigma^2 / \alpha^2$$

Based on these equations, Vasicek demonstrated that the interest rate structure for different terms can be calculated using the equation:

$$R(t,T) = R(\infty) + (r(t) - R(\infty)) \frac{1}{\alpha T} (1 - e^{-\alpha T}) + \frac{\sigma^2}{4\alpha^3 T} \;(1 - e^{-\alpha T})^2 \text{ with } T \geq 0$$

For the purposes of applying this theoretical framework to the Mexican experience, 28 day CETES and the Mexican stock market's IPC stock price index are used to represent short-term fixed income and equity instruments, respectively. The time periods considered in estimating the parameters which feed the models were January 1981 to November 2009 for the IPC and January 2001 to November 2009 for 28 day CETES.[14]

14: For the IPC the longest historic data series available in the Bank of Mexico's statistics was used, whilst for 28 day CETES the period used for reference was taken to begin when it was considered that there was price and financial stability. This was based on an assumption that from this time there would be institutional conditions which would be sufficient to assume that the future behavior of interest rates in Mexico would be compatible with this scenario: a) a central bank with long-term inflation objectives; b) a fiscal responsibility law for the public sector budget; and c) a floating exchange rate.

The time horizon considered in simulating the possible behavior of fixed income and equity assets and Siefore portfolios was 50 years. Such a time period is sufficiently long to cover the investment horizon of a participant who makes successive use of all the Siefores in Mexico. 1000 simulations were run for the various models. This number was based on current regulations for calculating VaR, which consider that 1000 simulation scenarios are sufficient to achieve representative references for the long-term investment scenarios of the Siefores.[15]

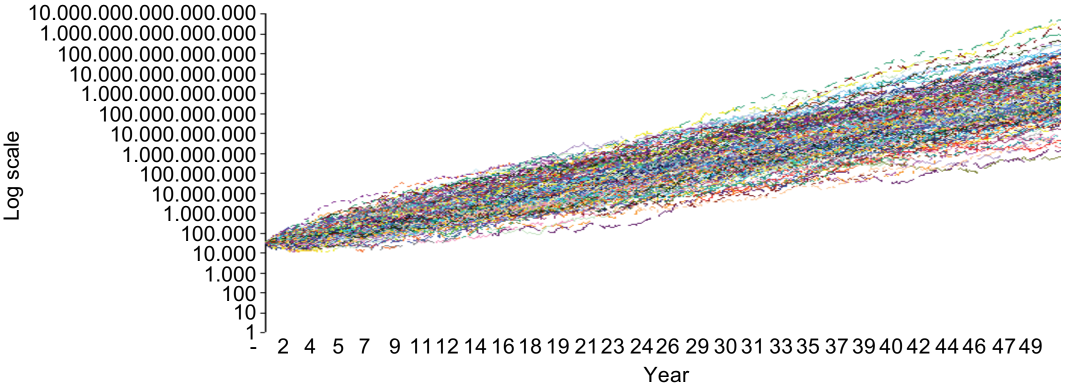
ii) Results

a) Equity instruments

The multiplicative model used to simulate equity asset prices makes it possible to expect such prices to display random paths over time, which should lead to a widening range of possible results as the investment horizon lengthens. See Chart 10.

Chart 10

Equity projection (IPC) in a horizon of 50 years (Based on a 1,000 simulation paths)

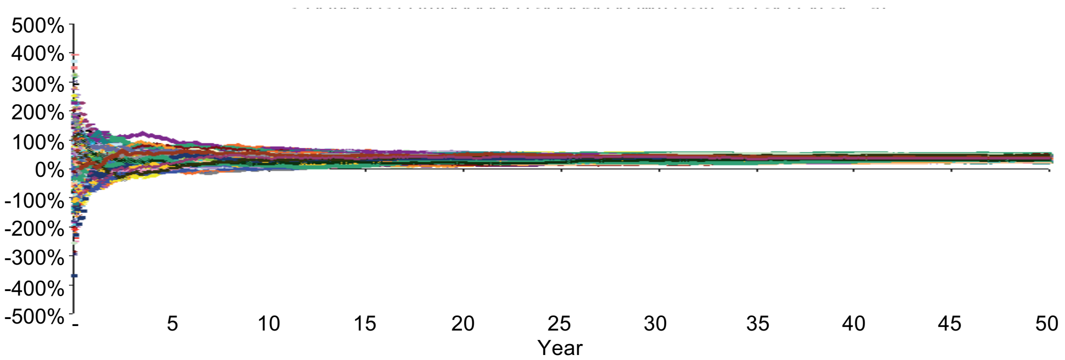


Source: BBVA Research

Based on the above, it is also possible to expect that the performance of equity instruments will lie within a range of values. However, when the calculation of such performance explicitly considers the investment horizon by using a compound annual growth rate between the start of the period and the end of the investment, it can be seen that the longer the investment horizon, the lower seems to be the dispersion of possible performance, as shown in Chart 11.[16]

Chart 11

Equity retruns along different time horizons (Compound annual growth rate during the t-year period, %. Based on a simulation of 1,000 price paths)



Source: BBVA Research

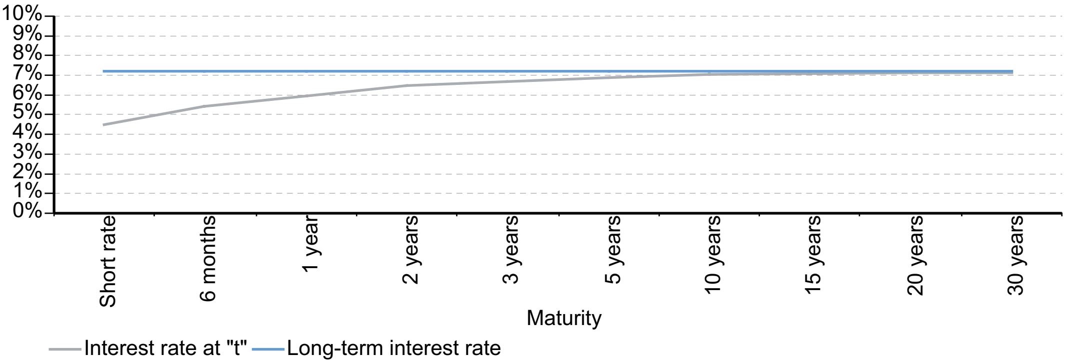
15: See CONSAR CIRCULAR 15-22, modifications to the general rules establishing the investment regime to which specialist pension funds investment companies are subject. Published in the Official Bulletin of the Federation, June 15, 2009.

16: A compound annual growth rate represents the interest rate at which a present value would grow to a future value over a specific period of time. The formula which underlies this calculation is CAGR= (VF/VP)^(1/n)-1, where FV is the future value, VP is the present value and n is the number of years. An equivalent expression with continuous compounding interest is Ln (VF/VP)*1/n, which represents an annualized growth rate of return during the n-year period.

b) Fixed income securities

For fixed income assets, the methodology used by Vasicek makes it possible to simulate the behavior over time of short-term interest rates (28 day CETES), and to use this behavior to estimate an interest rate or yield curve for each point in time. Chart 12 illustrates one possible yield curve at a moment "t". Observe that due to the assumption of reversion to the mean which is implicit in the Ornstein-Uhlenbeck equation, as the investment horizon lengthens, the interest rates tend towards a long-term level.

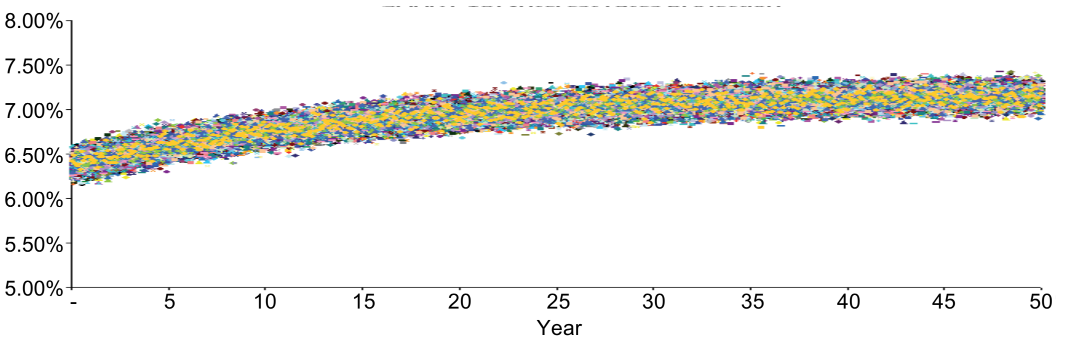
Chart 12
Yield curve at time "t", %



Source: BBVA Research

As mentioned in the theoretical section, having a yield curve for each point in time in turn makes it possible to calculate the average weighted interest rate for the various fixed rate instruments with different maturities in which the resources of the various Siefores are invested. Chart 13 illustrates the behavior of this average over 1000 simulations for investment horizons of between 1 and 50 years. The results also show, as expected, a range of possible interest rates which can be obtained for each investment horizon.

Chart 13
Interest rates projection (Based on 1,000 simulation paths)



Source: BBVA Research

c) Siefores

Once the potential return paths for the fixed income and equity instruments are known, we can simulate the returns on Siefore portfolios for different allocations of fixed income and equity instruments over different investment horizons. However, in the simulation, we should take into account two elements: 1) portfolios should be rebalanced for the assignment of fixed income and equity instruments in order to ensure that they always comply with the investment regime for each Siefore. Refer to Chart 2 for the investment regime for each Siefore, particularly with regard to equity; and 2) as the participant ages, the resources should automatically move from one Siefore to the next in the life-cycle scheme. As a result, there are at least 5 relevant investment horizons for resources in the SAR retirement savings system defined by the transition between the Siefores a) from SB5 to SB1, b) from SB4 to SB1, c) from SB3 to SB1, d) from SB2 to SB1 and e) in SB1.[17]

17: In all simulation exercises we assume that the participant joins each Siefore at the minimum age established for that investment regime. In SB5, it is assumed that the minimum age to join the Pension System is 18.

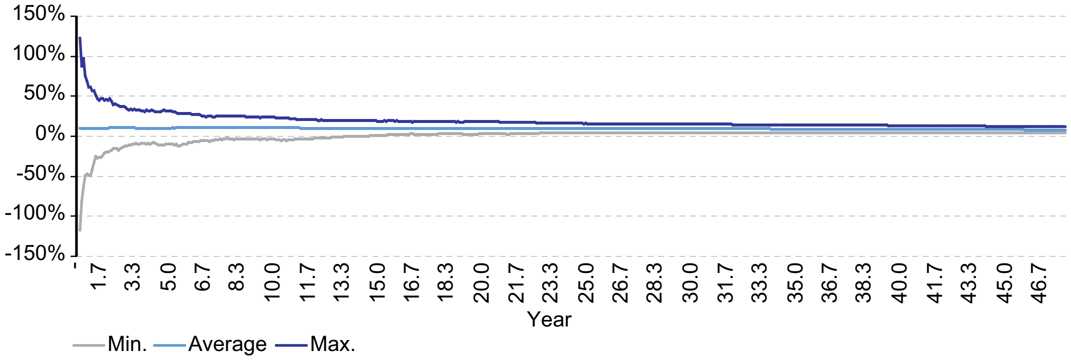
We will now describe the main results in terms of gross returns and volatility arising from simulating the Siefore portfolios under the current investment regime and using fixed income and equity as the main asset classes. The results have been adjusted for inflation to obtain rates of return in real terms. This adjustment was made using a working hypothesis of a constant annual inflation rate of 3.5%, which is consistent with the Bank of Mexico's long-term range of 3%, +/- one percentage point.

1. Investment horizon from SB5 to SB1

In the case of a participant who moves through all the Siefores in turn (SB5 to SB1), the results of the simulation exercises reveal that, in this long-term investment horizon, the life-cycle scheme allows the portfolio return to be stabilized within a range and also for its volatility to be reduced to an extremely significant extent. (See Charts 14 and 15, respectively).

Chart 14

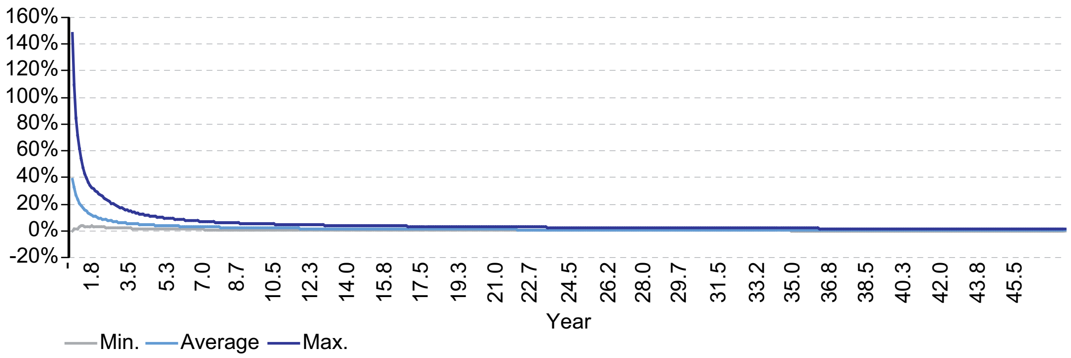
Simulation of returns in time horizon from SB5 to SB1 (Annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)



Source: BBVA Research

Chart 15

Simulation of volatility in time horizon from SB5 to SB1 (Volatility in annualized real rate of return at each year, %. Based on 1,000 porfolio simulations)



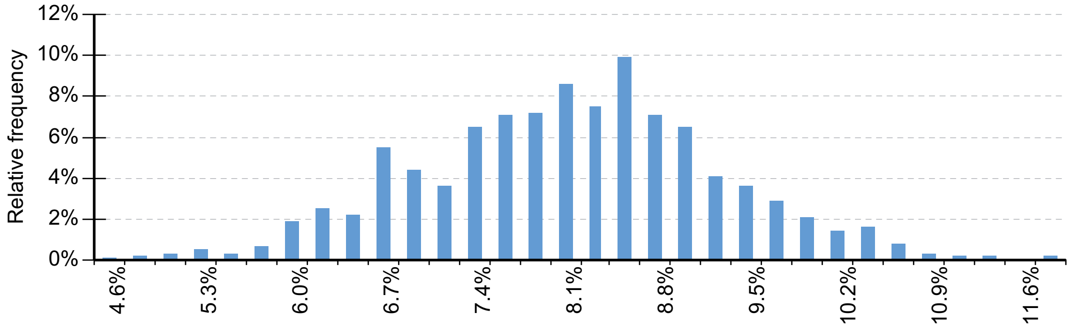
Source: BBVA Research

As a result, towards the end of the 47 year projection period, the real gross returns on the Siefore portfolio are distributed approximately as a normal probability distribution, with an average of 8% and a standard deviation of 1.2% (See Chart 16). Therefore, under the current investment regime, the SAR would tend in principle to offer a real return in the range 5.7% to 10.3% to participants who pass through Siefores SB5 to SB1.[18]

18: This range uses two standard deviations from the mean in a normal distribution and groups together 95.44% of the probability in the distribution of returns under consideration.

Chart 16

Real return distribution in time horizon from SB5 to SB1 (Compound annual growth rate at year 47, %)



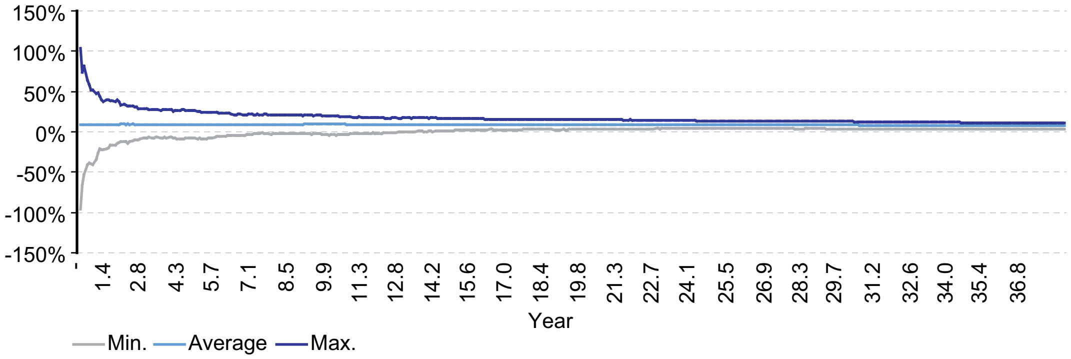
Source: BBVA Research

2.Investment horizon from SB4 to SB1

In the case of a participant who passes successively from Siefore SB4 to SB1, the simulation exercises show that over this 38 year investment horizon, the life-cycle scheme would stabilize the returns on the portfolio within a range and would significantly reduce its volatility. (See Charts 17 and 18, respectively).

Chart 17

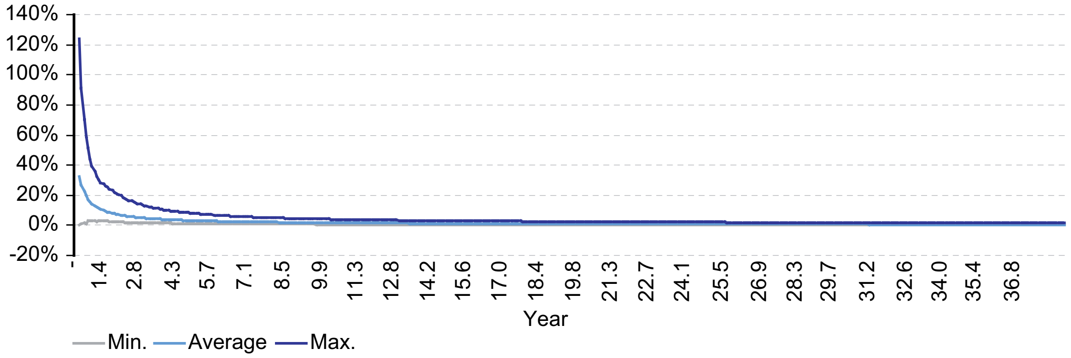
Simulation of returns in time horizon from SB4 to SB1 (% Annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)



Source: BBVA Research

Chart 18

Simulation of volatility in time horizon from SB4 to SB1 (Volatility in annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)

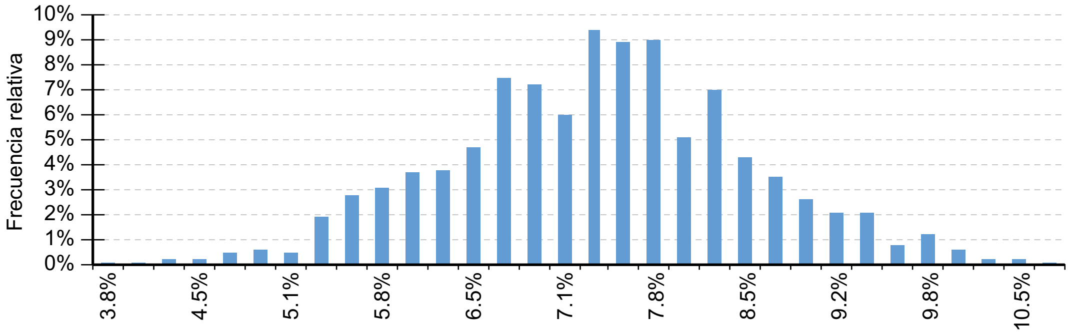


Source: BBVA Research

Towards the end of the 38 year projection period, the real gross returns on the Siefore portfolio are also distributed approximately as a normal probability distribution, with an average of 7.3% and a standard deviation of 1.1% (See Chart 19). Therefore, under the current investment regime, the SAR would tend in principle to offer a real return in the range 5.0% to 9.5% to participants who pass through Siefores SB4 to SB1.

Chart 19

Real return distribution in time horizon from SB4 to SB1 (Compound annual growth rate at year 38, %)



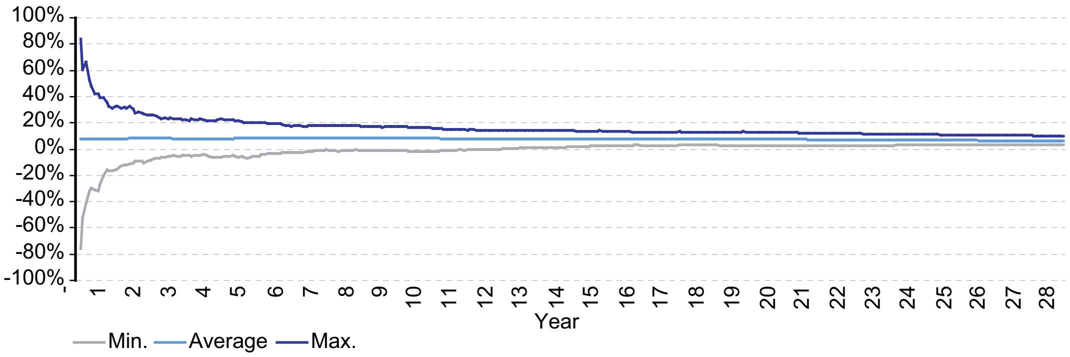
Source: BBVA Research

3. Investment horizon from SB3 to SB1

In the case of a participant who passes successively from Siefore SB3 to SB1, the simulation exercises show that over this 28 year investment horizon, the life-cycle scheme would stabilize the returns on the portfolio within a range and would significantly reduce its volatility. See Charts 20 and 21, respectively.

Chart 20

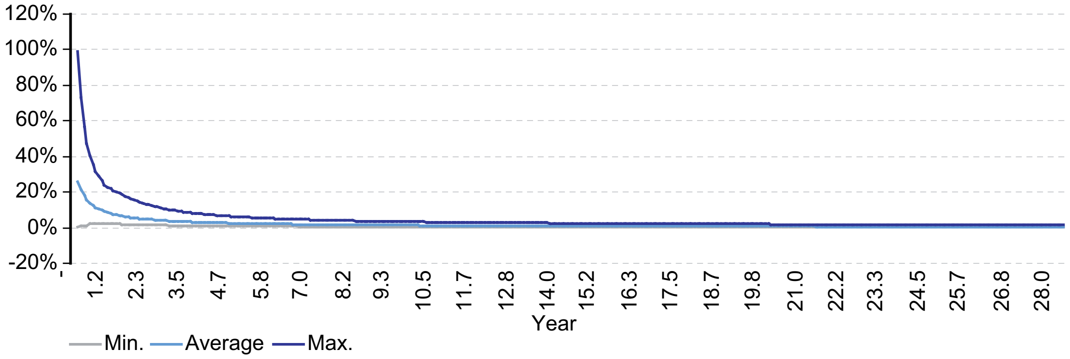
Simulation of return in time horizon from SB3 to SB1 (Annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)



Source: BBVA Research

Chart 21

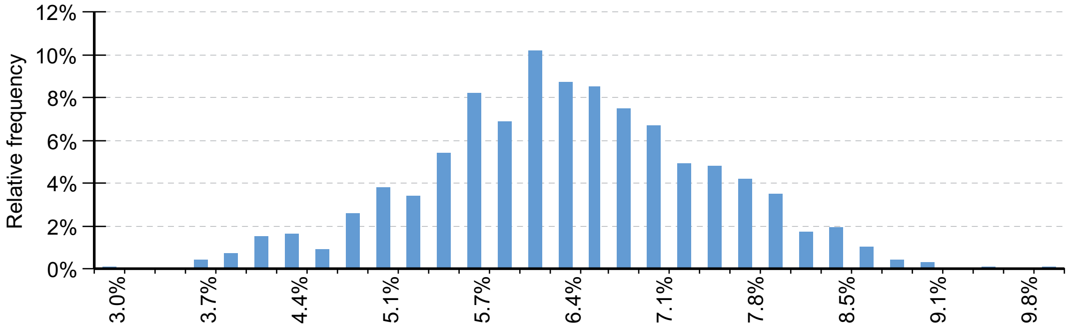
Simulation of volatility in time horizon from SB3 to SB1 (Volatility in annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)



Source: BBVA Research

Towards the end of the 28 year projection period, the real gross returns on the Siefore portfolio are also distributed approximately as a normal probability distribution, with an average of 6.3% and a standard deviation of 1.1% (See Chart 22). As a result, under the current investment regime, the RSS would in principle have the capacity to give participants who pass from Siefore SB3 to SB1 real returns in a range of 4.2% to 8.4%.

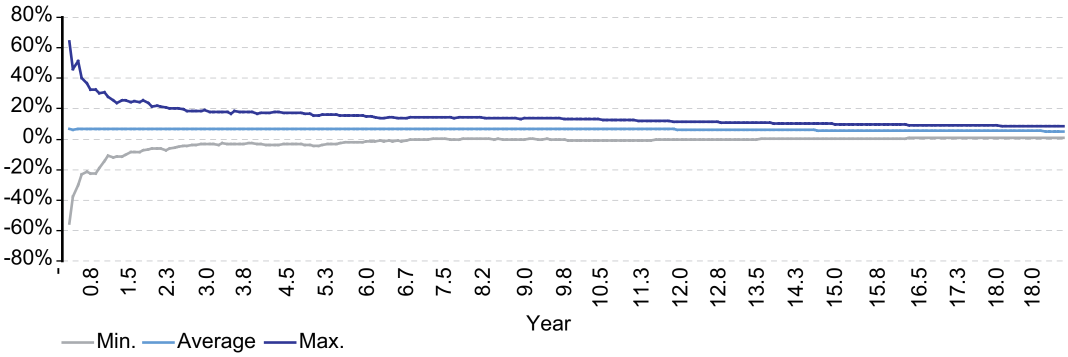
Chart 22
Real return distribution in time horizon from SB3 to SB1 (Compound annual growth rate at year 28, %)



Source: BBVA Research

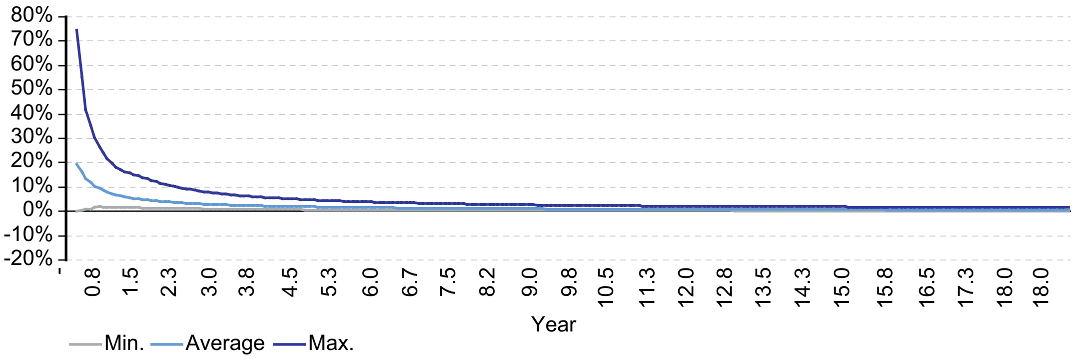
4. Investment horizon from SB2 to SB1
In the case of a participant who passes successively from Siefore SB2 to SB1, the simulation exercises show that over this 19 year investment horizon, the life-cycle scheme would stabilize the returns on the portfolio within a range and would significantly reduce its volatility. (See Charts 23 and 24, respectively).

Chart 23
Simulation of returns in time horizon from SB2 to SB1 (Annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)



Source: BBVA Research

Chart 24
Simulation of volatility in time horizon from SB3 to SB1 (Volatility in annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)

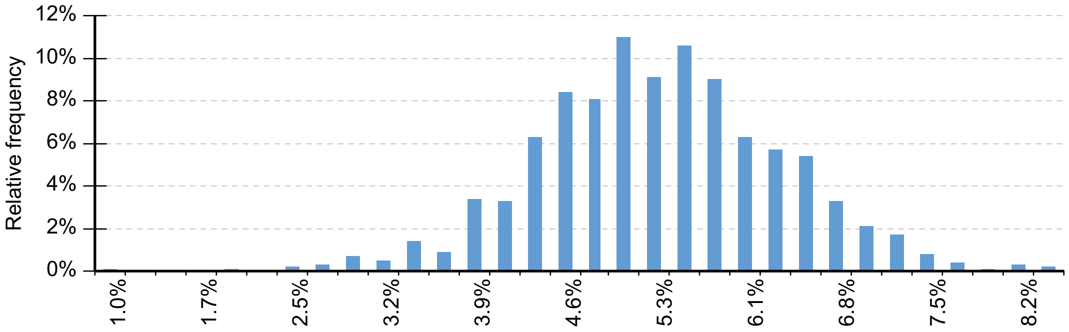


Source: BBVA Research

Towards the end of the 19 year projection period, the real gross returns on the Siefore portfolio are also distributed approximately as a normal probability distribution, with an average of 5.2% and a standard deviation of 1.9% (See Chart 25). Therefore, under the current investment regime, the SAR would tend in principle to offer a real return in the range 3.3% to 7.2% to participants who pass through Siefores SB2 to SB1.

Chart 25

Real return distribution in time horizon from SB2 to SB1 (Compound annual growth rate at year 19, %)



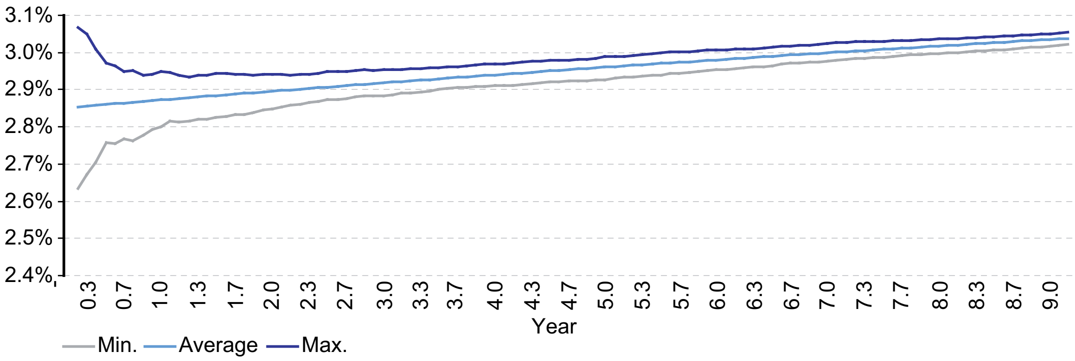
Source: BBVA Research

5. Investment horizon in SB1

In the case of a participant in Siefore SB1, the simulation exercises show that over this 9 year investment horizon, the life-cycle scheme would stabilize the returns on the portfolio within a range and would significantly reduce its volatility. See Charts 26 and 27, respectively.

Chart 26

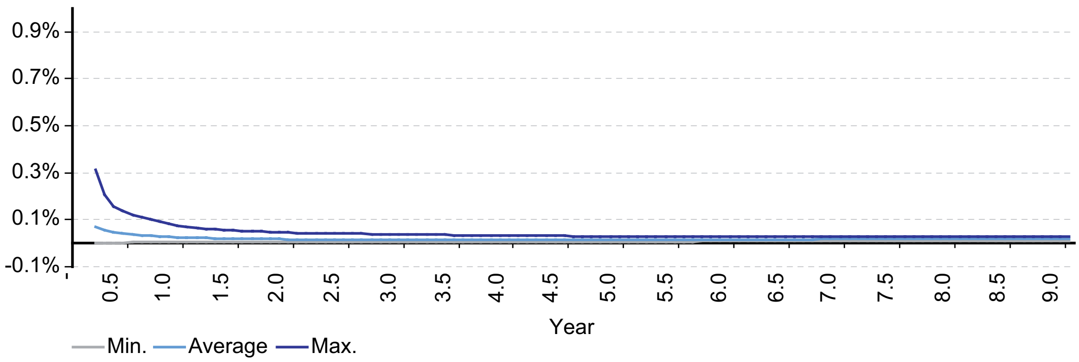
Simulation of returns in time horizon of SB1 (Annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)



Source: BBVA Research

Chart 27

Simulation of volatility in time horizon of SB1 (% Volatility in annualized real rate of return at each year, %. Based on 1,000 porfolio simulations)

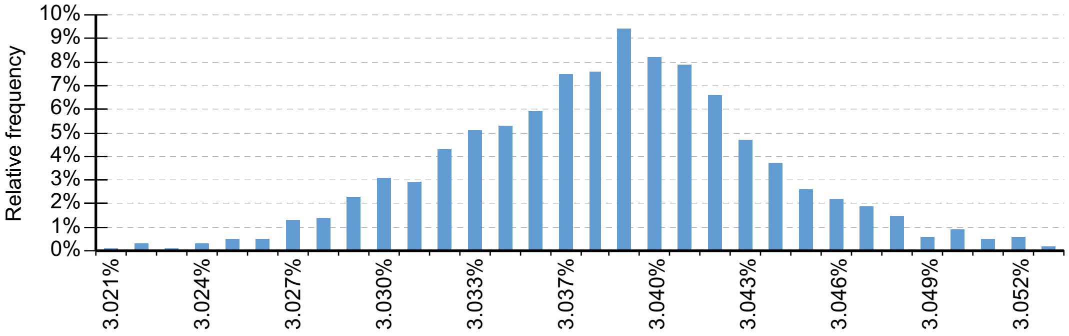


Source: BBVA Research

Towards the end of the 9 year projection period, the real gross returns on the Siefore SB1 portfolio are also distributed approximately as a normal probability distribution, with an average of 3% and a standard deviation of 0.01% (See Chart 28). Therefore, under the current investment regime, the SAR would tend in principle to offer a real return in the range 3.03% to 3.05% to participants in Siefore SB1.

Chart 28

Real return distribution in time horizon of SB1 (Compound annual growth rate at year 9, %)



Source: BBVA Research

The simulation exercises indicate that the returns are clearly differentiated according to the path that a participant may make through the various Siefores. In general, it can be seen that the longer the time horizon for the investment (for example, SB5 to SB1) the higher the rates of return, which in turn implies greater exposure over time to equity instruments.

These results suggest that the Mexican Siefore model with a diversified portfolio including equity instruments in different proportions throughout the participants' lives may represent an attractive long-term option for obtaining reasonable returns with relatively limited risks.

D) Replacement rates

With reasonable levels of return, the question then arises: what level of pensions will there be for participants in terms of their possible final salaries or replacement rates? However, the answer does not depend only on the investment horizon and the returns that the pension system may record, but also on the contributions and contribution densities that individuals have invested in the system (IMSS) throughout their active working lives.

In the case of Mexico, the rate of obligatory contribution to the IMSS pension system (6.5%) is below the average in Latin America, and is even below that of the obligatory contribution rate under the ISSSTE pension system as reformed in 2007 (11.3%).[19] The lack of stability in formal employment and the significant participation of the informal labor market in the country have also led to contribution densities that are very varied in the IMSS pension system.

Given the above, an assessment of the pensions that may be paid under the IMSS pension system based on the returns provided by the SAR retirement savings system has to take into account that we cannot talk of representative individuals within the pension system. They have to be distinguished at least by contribution density or frequency of contributions if we are to calculate the possible replacement rates that the system may provide within any range of returns.

To illustrate the possible replacement rates that could be provided by the IMSS pension system based on a range of real gross returns in the SAR such as those presented in the previous section, in this section we consider four groups or types of participants based on their contribution density: Group A (96%), Group B (76%), Group C (44%) and Group D (15%): In each case the number in brackets indicates the proportion of time that the worker has contributed to their formal pension plan within their active working life. A greater level of formality in employment may also be identified with a greater contribution density, and the reverse would be the case for greater employment informality.

19: In terms of contributions in Mexico, it is important to note that the IMSS pension system also includes a social payment made by the state per day of contributions that depends on the worker's income. The ISSSTE pension system also includes a social payment, but it does not depend on income levels, and there is an option to increase the worker's contribution with a corresponding co-payment by the state depending on the worker's voluntary contributions. For more details see Albo et al. (2008).

In addition, it is also necessary to consider that there are differing groups of participants depending on age, and that these have differing investment horizons. For illustrative purposes, on this occasion we have chosen participants who move successively from Siefore SB4 through to SB1, which was the largest group of participants in the SAR retirement savings scheme in September 2009 (35.9% of the total). Thus the replacement rates which can be obtained for this group of participants, based on an average real gross rate of return of around 7%, a long-term fee over balance of 1% per annum, and a contribution rate of 6.5% (plus social payment) and their possible contribution density group - are: (A) 43%, (B) 34%, (C) 20% and (D) 7% respectively. (See Table 5).

Table 5

Replacement rates over last salary for affiliates with time horizon from SB4 to SB1 (Real rate of return, %)

Contribution rate	Density of contribution	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%
6.5%														
	A	13%	16%	19%	23%	28%	35%	43%	54%	69%	88%	112%	144%	185%
	B	10%	12%	15%	18%	22%	27%	34%	43%	54%	69%	89%	114%	146%
	C	6%	7%	9%	10%	13%	16%	20%	25%	32%	40%	51%	66%	85%
	D	2%	2%	3%	4%	4%	5%	7%	9%	11%	14%	17%	22%	29%
7.5%														
	A	15%	18%	21%	26%	32%	39%	49%	61%	78%	99%	126%	162%	209%
	B	12%	14%	17%	20%	25%	31%	39%	49%	62%	78%	100%	128%	165%
	C	7%	8%	10%	12%	15%	18%	22%	28%	36%	45%	58%	74%	96%
	D	2%	3%	3%	4%	5%	6%	8%	10%	12%	15%	20%	25%	33%
8.5%														
	A	16%	20%	24%	29%	35%	44%	55%	68%	87%	110%	141%	180%	232%
	B	13%	16%	19%	23%	28%	35%	43%	54%	69%	87%	111%	143%	184%
	C	8%	9%	11%	13%	16%	20%	25%	31%	40%	50%	64%	83%	106%
	D	3%	3%	4%	4%	6%	7%	9%	11%	14%	17%	22%	28%	36%
9.5%														
	A	18%	22%	26%	32%	39%	48%	60%	76%	95%	121%	155%	199%	256%
	B	14%	17%	21%	25%	31%	38%	48%	60%	76%	96%	123%	157%	203%
	C	8%	10%	12%	15%	18%	22%	28%	35%	44%	56%	71%	91%	117%
	D	3%	3%	4%	5%	6%	8%	9%	12%	15%	19%	24%	31%	40%
10.5%														
	A	20%	24%	29%	35%	43%	53%	66%	83%	104%	133%	169%	217%	280%
	B	16%	19%	23%	27%	34%	42%	52%	65%	83%	105%	134%	172%	221%
	C	9%	11%	13%	16%	20%	24%	30%	38%	48%	61%	78%	100%	128%
	D	3%	4%	4%	5%	7%	8%	10%	13%	16%	21%	26%	34%	44%
11.5%														
	A	22%	26%	31%	38%	46%	57%	71%	90%	113%	144%	184%	236%	303%
	B	17%	20%	25%	30%	37%	45%	56%	71%	90%	114%	145%	187%	240%
	C	10%	12%	14%	17%	21%	26%	33%	41%	52%	66%	84%	108%	139%
	D	3%	4%	5%	6%	7%	9%	11%	14%	18%	22%	29%	37%	47%
12.5%														
	A	23%	28%	33%	41%	50%	62%	77%	97%	122%	155%	198%	254%	327%
	B	18%	22%	26%	32%	40%	49%	61%	76%	97%	123%	157%	201%	259%
	C	11%	13%	15%	19%	23%	28%	35%	44%	56%	71%	91%	116%	150%
	D	4%	4%	5%	6%	8%	10%	12%	15%	19%	24%	31%	40%	51%

Assumptions for computing replacement rates:
Density of contribution: A 96%, B 76%, C 44%, D 15%; Income level of affiliates: 4 minimum wages; Real wage growth rate, % annual: 1.50%;
Fees over balance (long-term average, %): 1.0%.
Source: BBVA Research based on Albo et al (2007)

The results in Table 5 reflect various aspects of what is a complex reality. Firstly, the replacement rates for individuals may vary depending on the real levels of return at the end of their active working life. However, as shown by the simulation exercises, the real rate of return may not be a control variable in any pension system, because, although the probability of a certain expected value occurring may be influenced by the investment regime, and its volatility limited by an appropriate system of risk management, in the end it will always be an uncertain or unknown variable with a range of possible values.

Secondly, although the return is not a control variable in a pension system, there are variables that could be control variables and play a key role in the replacement rates of participants. For example, the results shown in Table 5 reveal that regardless of the real level of return, participants with greater contribution densities (As and Bs) can always achieve greater replacement rates than those with lower contribution densities (Cs and Ds). Thus, measures that promote formal employment relations always have a positive effect on the pension from the point of view of the pension system.

Thirdly, the results also show that a low rate of contributions into the system also translates into low replacement rates. For example, Table 5 shows that for any contribution density group and level of return, the replacement rates may always be increased as the contribution level increases. Measures that can promote higher contributions (obligatory and/or voluntary) into the system will always result in higher pensions, regardless of the rate of return. It can also not be ruled out that the positive effect of greater contributions may, in turn, be reinforced by a higher than expected rate of return.

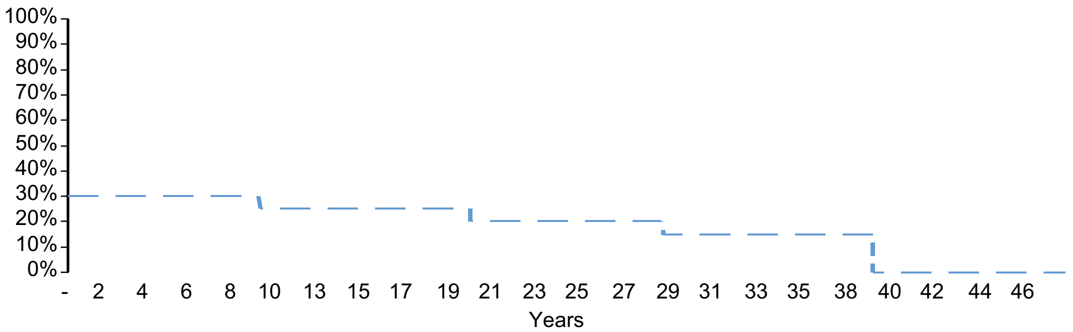
Whilst remembering these points, it is also worth asking whether it is possible to increase expected returns. In this context, simulation exercises indicate that the expected value of the returns in the SAR retirement savings scheme increases with the length of the investment horizon; however, under the Siefore life-cycle system this basically happens because of the greater exposure that participants have to equity instruments when they are younger. It is therefore worth analyzing whether it is worth having greater exposure to equity assets under the life-cycle model in order to increase the expected returns of the Siefore. This analysis is reported in the next section.

E) Investment regime and expected returns

The current investment regime includes maximum exposure to equity instruments of 30% in SB5, which decreases in successive Siefore portfolios until reaching 0% in SB1. In terms of exposure to equity, this represents a stepped path over time of the type illustrated in Chart 29.

Chart 29

Siefore's exposure in time to Equity (% of total net assets)



Source: BBVA Research

Starting from this path, increased exposure to equity may be achieved in three ways: 1) by increasing the time of exposure to the asset in each Siefore, but without changing the percentage share; 2) by increasing the percentage share of assets in each Siefore, but without changing the current periods of exposure; or (3) by increasing both the percentages and times of exposure to equity. For illustrative purposes, we will now explore some of the many possible structures.[20]

20: It is worth noting here that the alternative structures examined aim to change the current life-cycle structure in the Siefores as little as possible, so as not to increase transaction and administration costs for the portfolios significantly and, at the same time, to facilitate comparison with the current stepped exposure structure. However, although other exposure structures could also be proposed which are concave or linear, the possible transaction and administrative costs of these would have to be evaluated at some time.

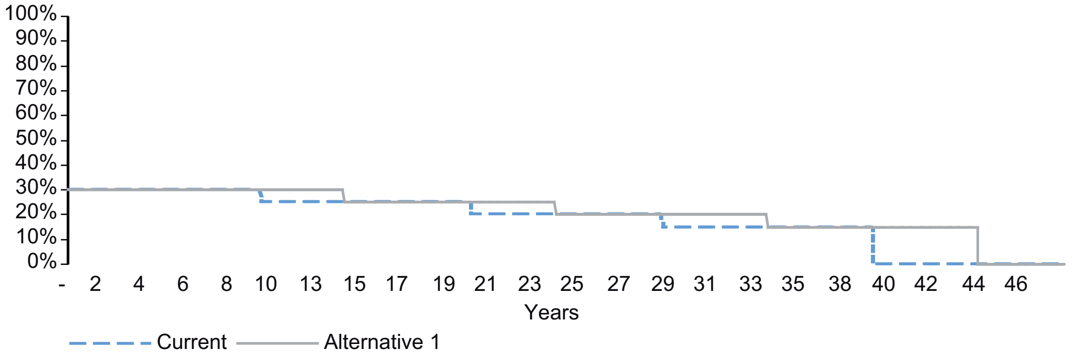
1. Increasing the time of exposure to equity, but without changing the current percentages.

The first alternative for increasing exposure to equity involves lengthening the amount of time spent in each Siefore under the current investment regime; this would also have a stepped exposure structure, but with longer "steps".

There is no rule for determining how long the steps should be; however, one possible starting point might be increasing exposure more for the youngest participants. Based on these criteria, Chart 30 illustrates the case of extending the time in SB5 from 9 to 13 years; the time in SB4 from 10 to 11; and the time in SB3 from 9 to 10; whilst there is no change in SB2 and the time in SB1 is reduced by 3 years.

Chart 30

Siefore's exposure in time to Equity (% of total net assets)

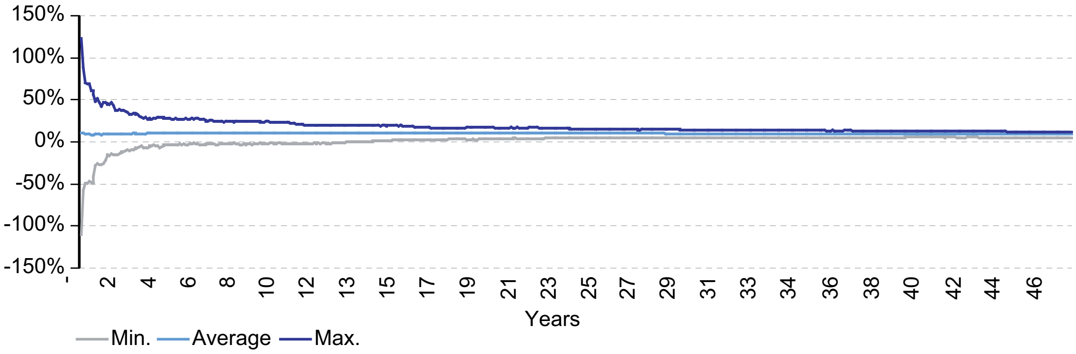


Source: BBVA Research

In a structure of equity exposure such as that shown in Chart 30, the return over the horizon from SB5 to SB1 continues to have the same pattern as in the previous simulation. In other words, there will be lower dispersion of the returns the longer the time horizon. See Chart 31

Chart 31

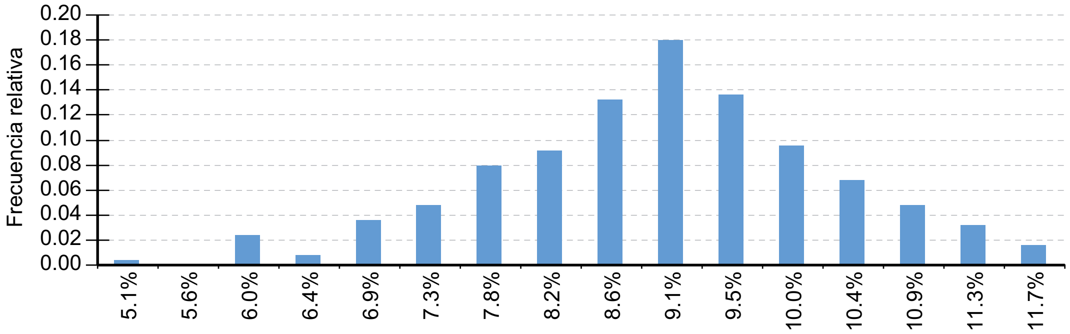
Simulation of returns in time horizon from SB5 to SB1
(Annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)



Source: BBVA Research

However, the increased exposure to equity increases the average expected returns towards the end of the projection period from 8.0% to 8.8% with a standard deviation similar to that in the current structure (1.2%). With this new level of average returns, and considering two standard deviations, the possible range of results for returns for the horizon SB5 to SB1 increases from one of 5.7% to 10.3% to one of 6.3% to 11.3% with 95% probability. See Chart 32.

Chart 32
Real return distribution
in time horizon from SB5 to SB1 (Compound annual growth rate at year 47, %)



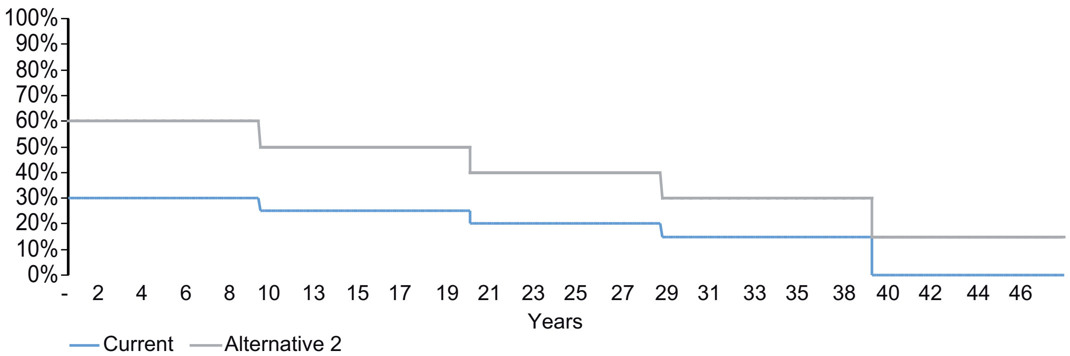
Source: BBVA Research

2. Increasing the percentage of equity, but without changing current exposure periods.

The second alternative for increasing exposure to equity consists of directly increasing the share of equity in each of the Siefore portfolios, without changing the time the participants spend in each of these.

Chart 33 illustrates the possible case of doubling the share of equity in Siefores SB5, SB4, SB3 and SB2, and having a 15% share in SB1.

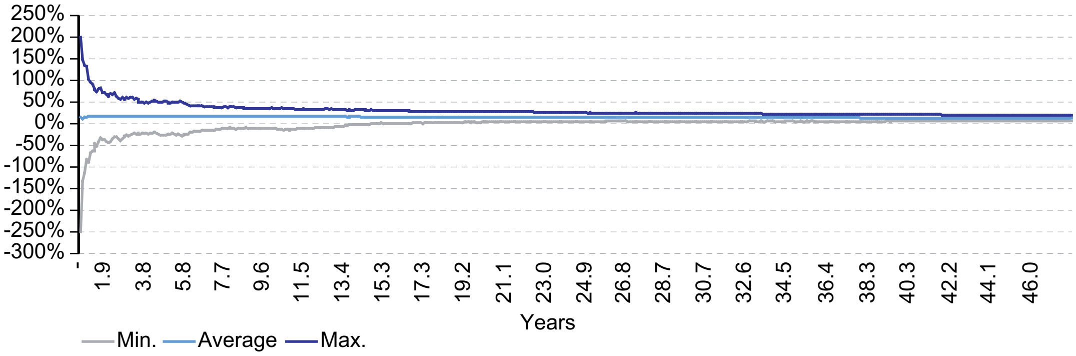
Chart 33
Siefore's exposure in time to Equity (% of total net assets)



Source: BBVA Research

In a structure of equity exposure such as that shown in Chart 33, the return over the horizon from SB5 to SB1 continues to have the same pattern as in the previous simulation. In other words, there will be lower dispersion of returns the longer the time horizon. See Chart 34.

Chart 34
Simulation of returns in time horizon from SB5 to SB1
(Annualized real rate of return at each year, %. Based on 1,000 portfolio simulations)

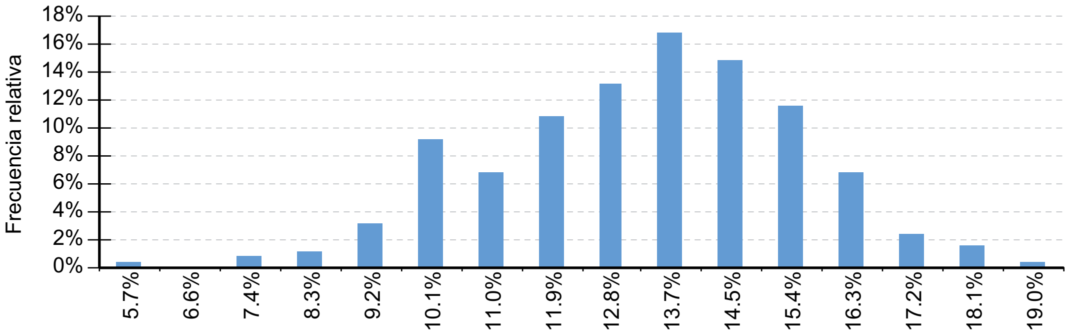


Source: BBVA Research

The increased exposure to equity increases the average expected returns towards the end of the projection period from 8.0% to 12.8%, but the standard deviation is now 2.3% compared to 1.2% in the current structure. With these new levels for average returns and volatility, and once again considering two standard deviations, the range of possible returns over the horizon SB5 to SB1 increases from one of 5.7% to 10.3%, to one of 8.3% to 17.3% with 95% probability. See Chart 35.

Chart 35

Real return distribution in time horizon from SB5 to SB1 (Compound annual growth rate at year 47, %)



Source: BBVA Research

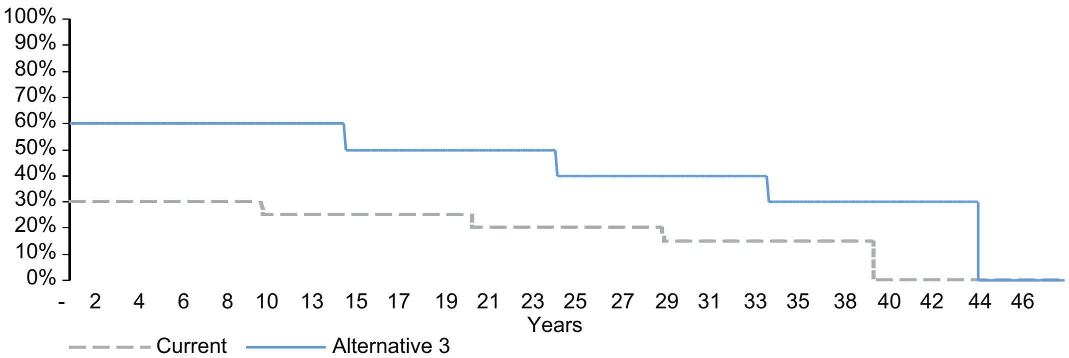
3. Increasing the percentage share of, and the time of exposure to, equity.

The third alternative for increasing exposure to equity consists of increasing the share of equity in each of the Siefore portfolios and also increasing the time of exposure.

Chart 36 illustrates the possible case in which the share of equity in Siefores SB5, SB4, SB3 and SB2 is doubled, whilst the time of exposure is extended as described in alternative 1; however, no equity is included in SB1, and the time in this Siefore is reduced.

Chart 36

Siefore's exposure in time to Equity (% of total net assets)

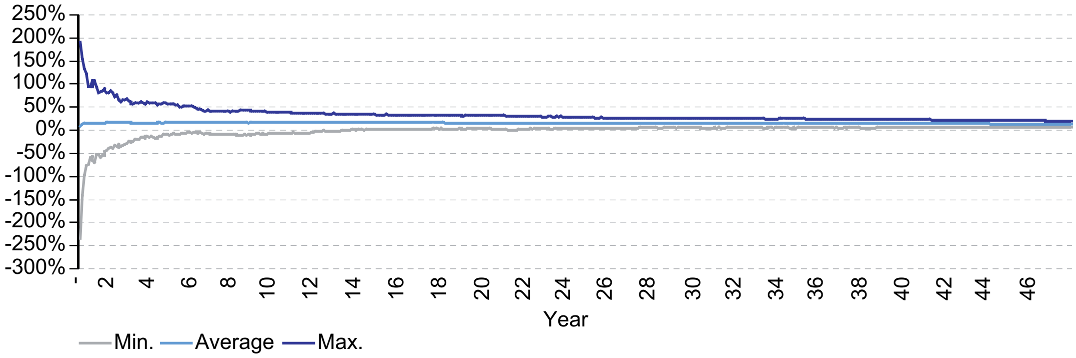


Source: BBVA Research

Once again, the returns over the horizon SB5 to SB1 continues to have the same pattern as in the previous simulation exercises. In other words, there will be lower dispersion of the returns the longer the time horizon. See Chart 37.

Chart 37

Simulation of returns in time horizon from SB5 a SB1
(Annualized real rate of return at each year, %. Based on 1,000 porfolio simulations)

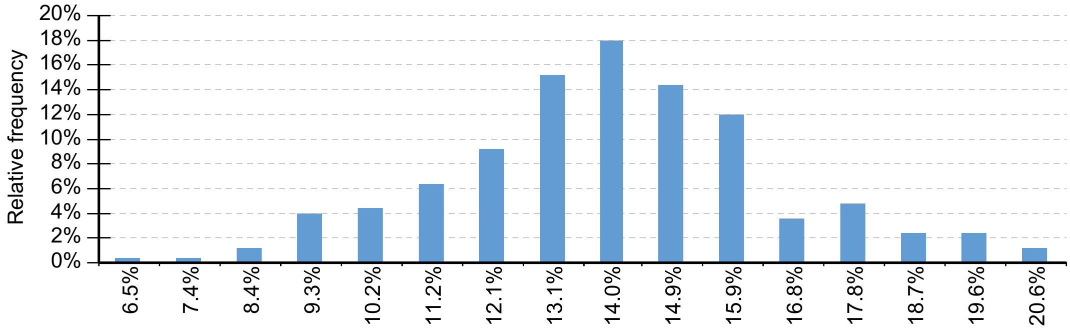


Source: BBVA Research

However, the increased exposure to equity through both the share of equity and the time of exposure further increases average expected returns towards the end of the projection period from 8.0% to 13.5%, but the standard deviation is now also 2.5% compared to 1.2% in the current structure. With these new levels of average returns and volatility, and once again considering two standard deviations, the range of possible results for returns over the horizon SB5 to SB1 increases from one of 5.7% to 10.3% to one of 8.5% to 18.6% with 95% probability. See Chart 38.

Chart 38

Real return distribution
in time horizon from SB5 to SB1 (Compound annual growth rate at year 47, %)



Source: BBVA Research

These alternatives illustrate an upside bias in expected returns as the exposure to equity increases. However, with the exception of alternative 1, in which reorganization of times of exposure to equity can lead to increased expected returns with the same level of volatility, in the other two alternatives considered here, increased returns are accompanied by increased volatility.

4. Conclusions

The financial crisis of 2008 highlighted the importance of pension funds as factors of stability in the markets. However, it also provided a number of lessons and implications for the pension systems.

The first lesson from the crisis was that the volatility of financial markets may affect all pension systems, regardless of their pension scheme (defined-benefit, defined contribution or a mixture of the two). The above reminds us that all investments are volatile in their returns and that their different performances in extraordinary circumstances such as the 2008 crisis is not only the result of a specific assignment of assets, but also of the design of the investment scheme and the regulatory framework.

This working document has used the Mexican experience to illustrate the relevance of considering a variety of elements associated with the investment process when assessing the performance of pension fund returns.

Firstly, the investment horizon should be long-term to put any short-term performance into a more appropriate context. The Mexican experience illustrates, for example, that the losses recorded in 2008 were a temporary phenomenon and from a long-term point of view the returns for the Afore in the pension system continue to expand soundly.

Secondly, the investment regime has a significant influence on potential returns and their volatility. In this context, the Mexican experience indicates that the changes in the investment regime of the Siefores towards more diversified portfolios including equity has been very positive and has significantly extended the chances of improving returns.

Thirdly, the incorporation of life-cycle schemes into the operation of pension funds may provide an attractive alternative for limiting volatility and improving future returns. Simulation exercises for the case of the Siefores in Mexico illustrate that in a long-term perspective, the life-cycle scheme may significantly limit volatility and offer a reasonable range of gross returns for participants.

With reasonable levels of return, the key question in any pension system is what level of pensions will there be for participants in terms of their possible final salaries or replacement rates? However, the answer does not depend only on the investment horizon and the returns that the pension system may record, but also on the contributions and contribution densities that individuals have invested in the system throughout their active working lives.

With regard to the above, an important implication of the analysis of pension fund investments is that their gross return is not a control variable. Although the return of a pension fund may be influenced and its volatility limited by the investment regime, it will always be an uncertain variable that will be located in a range.

Thus variables such as the contribution density and the contribution rate may influence the replacement rate in a more certain and long-term extent. This does not mean that special care and attention should not be paid to the investment regime, but rather that once its limitations are recognized, the only certain way of improving a pension or its replacement rate, particularly under defined-contribution schemes, is to progress towards higher contribution densities and through maintaining appropriate contribution rates. Once this is achieved, additional improvements through greater than expected returns cannot be ruled out.

The simulation exercises in this work reveal that it is possible to have higher expected returns through having increased exposure to equity. It is therefore clear that this asset class should not be absent from pension fund portfolios.

Events such as the financial crisis of 2008 highlight the importance of not turning back in reforming and maintaining the strength of the pension system. To the extent that various structural and financial challenges faced today by many pension systems in the world may finally be solved, whether through parametric adjustments or changes in the pension model, pension systems will also be better prepared to confront any contingency in the future.

In regard to the above, perhaps one of the main structural challenges to be faced by pension funds in developing countries will be to increase the density of contributions by participants as, irrespective of the level of return in the pension system, the lower the density of contributions by the participant, the lower the replacement rate, as this document has shown.

However, the results in this working document for long-term returns for the pension system may be useful in illustrating the appropriateness of implementing overall reform. For example, although our simulation exercises show that higher expected returns are accompanied by increased volatility when the share of equity instruments in the portfolios is increased, the probability of having positive profitability is very high in all cases. Therefore, starting from this result, and taking a more broad view of the pension system, it may be worth considering having a greater share of equity instruments in pension portfolios in order to have the possibility of partly offsetting the low density of contributions by participants, which otherwise would most certainly lead to low replacement rates.

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