Estimating future pension liability of the Mexican Government

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Executive Summary

In this study, we examine the liability of Mexican Government pension funds over the next decades. The calculations take into account the horizon, the rate of disability, the mortality, the separation rate among other things.

We study six pension systems: (1) Private Sector (IMSS), (2) Government workers (ISSSTE), (3) IMSS workers (IMSS-RJP), (4) State Government Pension Funds, (5) National Oil Company (PEMEX) and (6) the Armed Forces (ISSFAM).

Our Findings

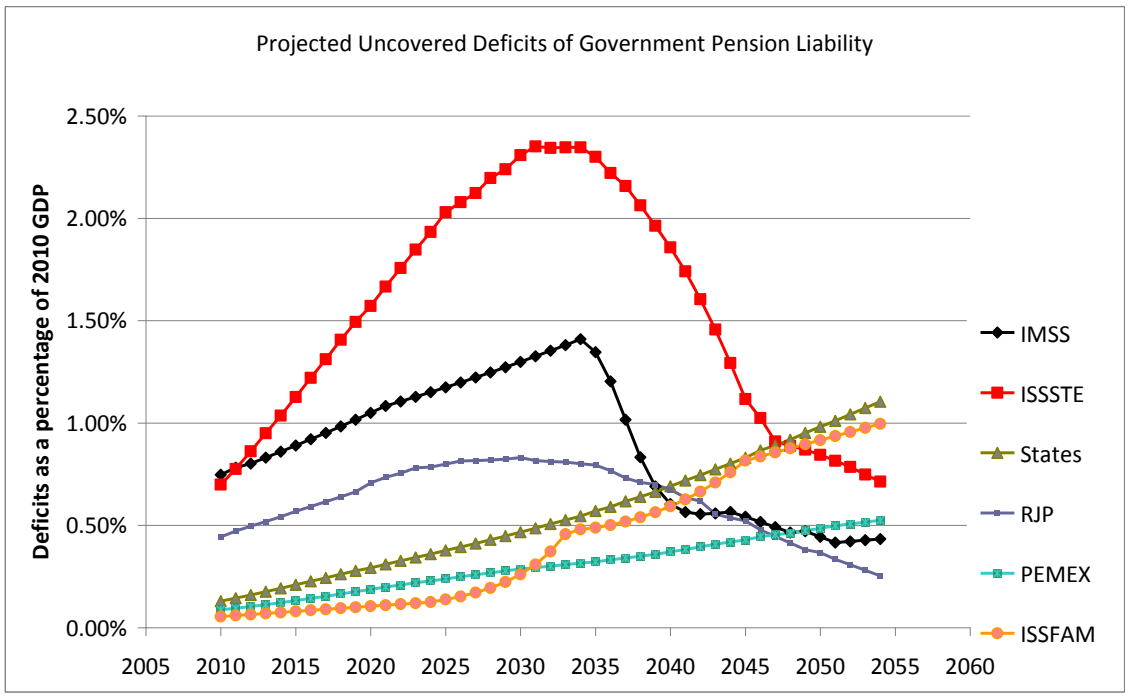
1. We summarize our findings in Figure 1. It exhibits how the pension deficits will evolve up to 2050. The first striking feature is that for the next two to three decades all pension deficits are going to go up whether they have been reformed or not. This is the result of the past promises made to the current retirees as well as future retirees in some of them.

2. For the reformed systems (IMSS, ISSSTE and IMSS-RJP), the liability will start to decline in the late 2020s or in the 2030s. From then on, the liabilities will decline.

3. For the non-reformed pension systems (most state government pension funds, PEMEX and ISSFAM) the deficits will keep on increasing in real terms in the absence of future reforms.

4. The additional military build up (to fight the War on Drugs) and additional benefits authorized to the Armed Forces during 2006-2010 will have a consequence of higher pension liability in another two decades when these men and women start retiring.

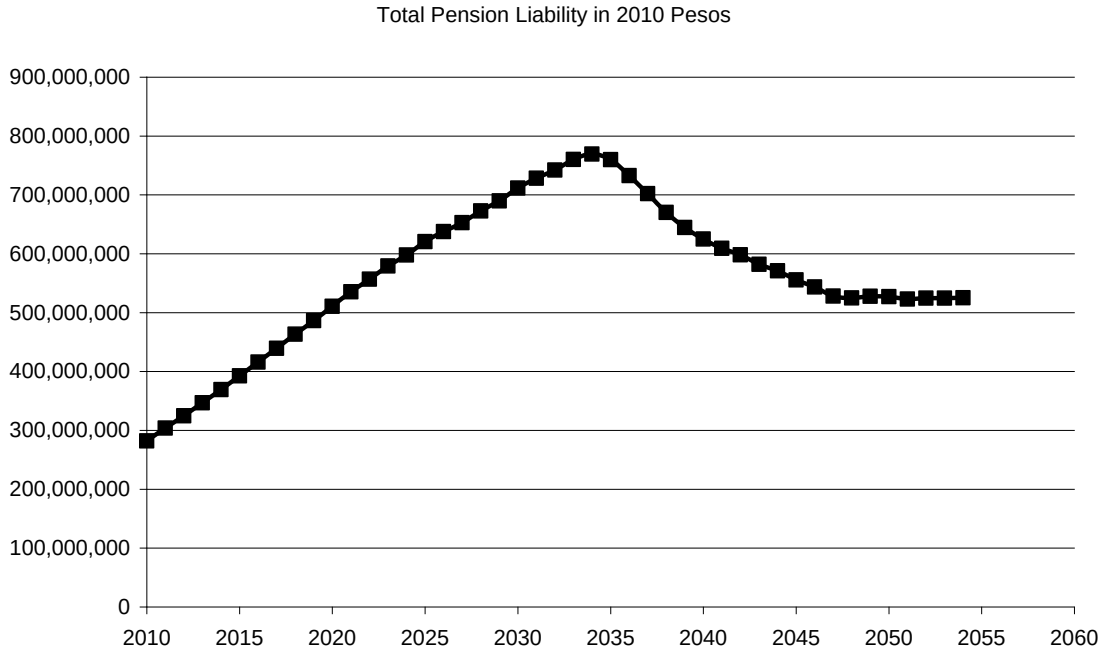
Figure 1: Projected uncovered pension deficit calculated as a percentage of 2010 GDP



5. If we examine the aggregate behaviour of these deficits (see Figure 2), it shows that it will keep growing until 2035 and then it will gradually fall. This decline will be the result of the reform of the three systems that took place between 1997 and 2007. However, the overall decline will not be rapid as the three unreformed systems will keep on adding pension liability at a higher pace.

6. At present the deficit that the government has to finance through taxes (or postponing the liability by issuing government bonds), is about 2 percent of GDP. However, the government tax revenue as a percentage of GDP, including oil revenue, does not exceed 20 percent of the GDP. And this deficit will grow to 6 percent of the 2010 GDP by 2035. Thus, unless the GDP grows substantially or the government revenue increases as a percentage of the GDP, it will create a crunch in the next three decades.

Figure 2: Projected total pension liability calculated in 2010 pesos



7. We summarize the net present value of the total liability of these pension deficits over time. To do that, we need two parameters: (1) Number of years and (2) A discount rate. We use a 40 year projection and different discount rates to calculate the net present value (see Table 1). A standard actuarial practice is to use a (real) discount rate of 3 percent. At 3 percent, the value is 97.32 percent of 2010 GDP.

8. Under all circumstances, the biggest deficit is produced by ISSSTE workers of past, present and future, followed by the private sector workers who are covered under the IMSS and then by the IMSS workers (RJP) themselves.

Table 1: The net present value of the actuarial liability of pension plans with different discount rates and a fixed time horizon of forty years as a percentage of 2010 GDP

Discount Rate	IMSS	ISSSTE	States	RJP	PEMEX	ISSFAM	**Total**
0.00%	37.30%	65.63%	20.36%	26.34%	11.47%	15.21%	**176.33%**
1.00%	31.12%	53.71%	15.82%	21.73%	8.99%	11.44%	**142.80%**
2.00%	26.26%	44.45%	12.45%	18.14%	7.15%	8.71%	**117.16%**
3.00%	**22.40%**	**37.19%**	**9.94%**	**15.33%**	**5.76%**	**6.70%**	**97.32%**
4.00%	19.30%	31.45%	8.05%	13.10%	4.71%	5.23%	**81.83%**
5.00%	16.80%	26.86%	6.60%	11.31%	3.90%	4.12%	**69.59%**
6.00%	14.75%	23.16%	5.49%	9.86%	3.27%	3.30%	**59.82%**
7.00%	13.06%	20.15%	4.62%	8.68%	2.77%	2.67%	**51.95%**
8.00%	11.65%	17.68%	3.94%	7.71%	2.38%	2.19%	**45.54%**
9.00%	10.48%	15.64%	3.39%	6.89%	2.07%	1.82%	**40.28%**
10.00%	9.48%	13.93%	2.96%	6.21%	1.81%	1.53%	**35.91%**

8. This study underestimates the total government liability because of the following entities that were not considered. (1) Development banks (e.g., NAFINSA, Banobras, Banrural). (2) The Central Bank (Banco de Mexico). (3) Courts (e.g., the Supreme Court). (4) State University pension systems. (5) Municipalities.

9. We also estimate a distribution of how our projections vary over time by calculating the lower 5 percent and the upper 95 percent for each year. Discounting at a rate of 3 percent (real), our estimated present value of the total liability varies between 96.19 percent (lower 5 percent) and 104.76 percent (upper 95 percent) of the mean value.

Section 1: **Overview of the Mexican Pension Systems**

The Mexican Government either directly operates or subsidizes various pension systems in Mexico. Some systems such as the pension system of the Mexican Armed Forces are paid for totally by the Federal Government. Others, such as the individual account pension system of the private sector workers are operated by the IMSS. While private pension funds (AFOREs) have been allowed to manage their own pension funds, the Federal Government is contributing 5.5 percent of minimum wage to all formal private sector worker funds. These contributions are financed from general revenue. In addition, it also guarantees a minimum pension indexed (using the consumer price index) to the 1997 level for all the future workers. In State Governments, some have individual accounts but they are subsidized partly by the governments. According to the Office of the Auditor General, there are over 250 different pension schemes either operated directly by the Federal Government or subsidized in one form or another.

The purpose of this study is to calculate the implicit debt of the Mexican Government due to promised pension at different levels of government along with the entities that depend on the government using a common methodology and a common time horizon.

In principle, the methodology is simple: We calculate how much deficit each of these entities have at present and project it forward. There are several assumptions, however, that we need to make. First, we need to take into account demographic changes of the participants in the plan (not just changes in the demographics of the *total* population), future hires, future increases in salary and other benefits, the number of people who will claim disability benefits, the number of people who will leave their jobs and not be able to claim any benefits among others.

It is customary to make projections for one hundred years. However, given that we do not have a very long data history and even less confidence about future benefits (which can be changed at the stroke of a pen), we thought it would be prudent to make projections for no more than 40 years.

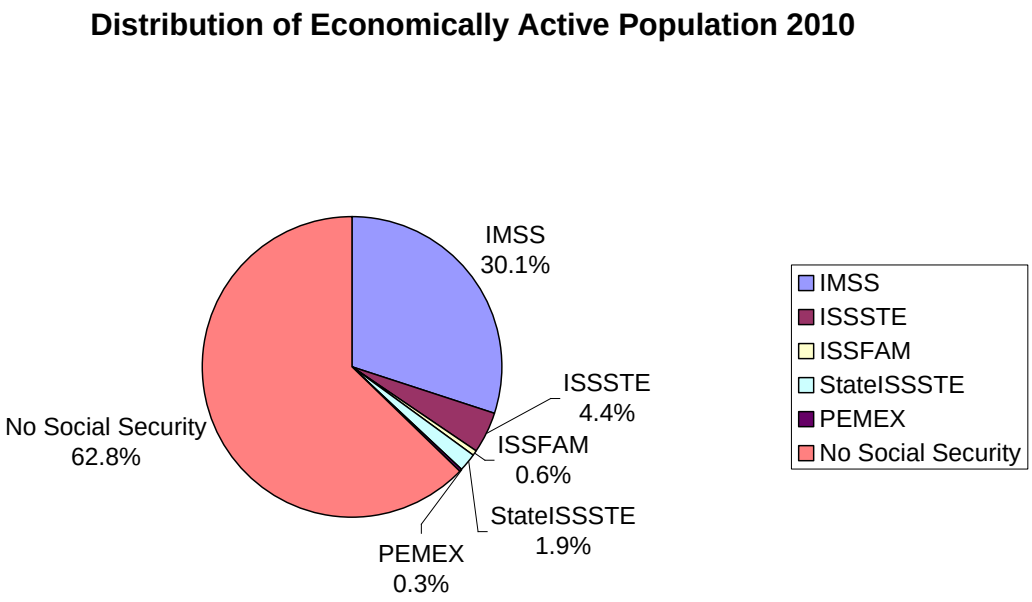
In this study, we focus solely on pension liability. Therefore, we exclude government programs that cover workers' compensation or health or childcare and so on.

Overview of pension coverage of the population by government

Pension coverage became compulsory in Mexico on 31 December 1942, at least by law through the promulgation of the IMSS Law. It was a long way away from getting any significant coverage of the population. It started with a very low coverage of the labor force (less than 3% in 1946). Even in 1952 the coverage of the IMSS was less than 5% of the labor force. In 1958, it was still languishing in the single digits: it covered 9% of the labor force. By 1964, the coverage had reached 18% of the labor force. In 1970, the coverage exceeded 25% of the labor force for the first time. By the turn of the century, IMSS is still far short of covering half of the labor force in Mexico (with about 30% of the labor force). An additional 8 to 10% of the labor force is covered as government employees of various other institutions. This stands in sharp contrast with coverage in more developed countries. For example, in the United States, between 1935 and 1940, the coverage of Social Security went from zero to 63.7%. By 1951, the coverage was 93.7% of the labor force (Myers, 1993, p. 232).

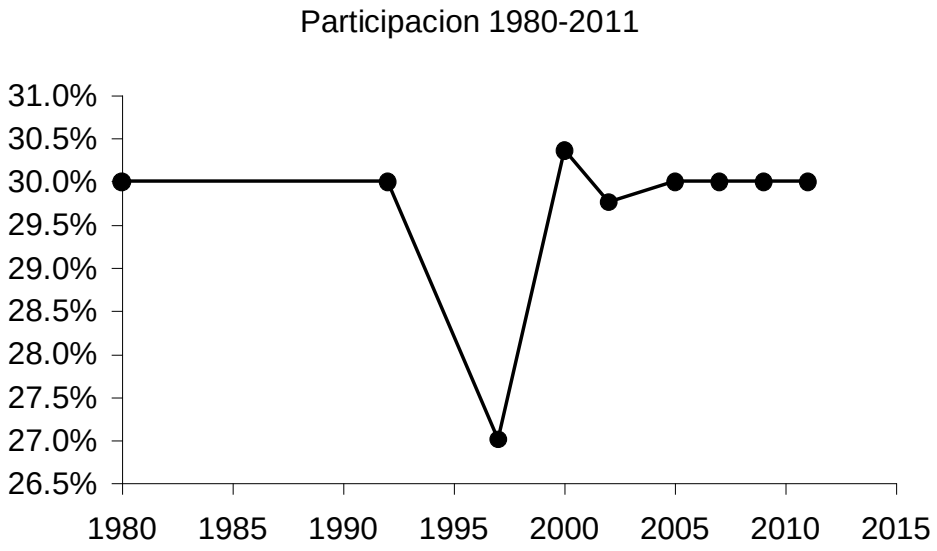
If we examine the economically active population in Mexico in 2010, we find that out of 47 million people, nearly 30 million had no government run social security coverage in the traditional sense. In recent years, there has been some coverage provided by programs like “Seguro Popular” or non-contributory pension plans like “Setenta y Más” but these are ad-hoc programs whose budgets have to be approved on a yearly basis. In other words, less than 40 percent of the workforce has comprehensive social security coverage in the traditional sense.

Figure 3: Coverage of pension schemes in Mexico, 2010



The coverage of IMSS is around 30 percent of the economically active population. This proportion has stayed remarkably constant since 1980 with the exception of the crisis of 1994-95 where the coverage went down to around 27 percent. This fact has strong implications for implicit government debt due to pension obligations: Unless there is a dramatic rise in pension payments, the government liability due to pension is not likely to increase as a proportion of the size of the economic pie.

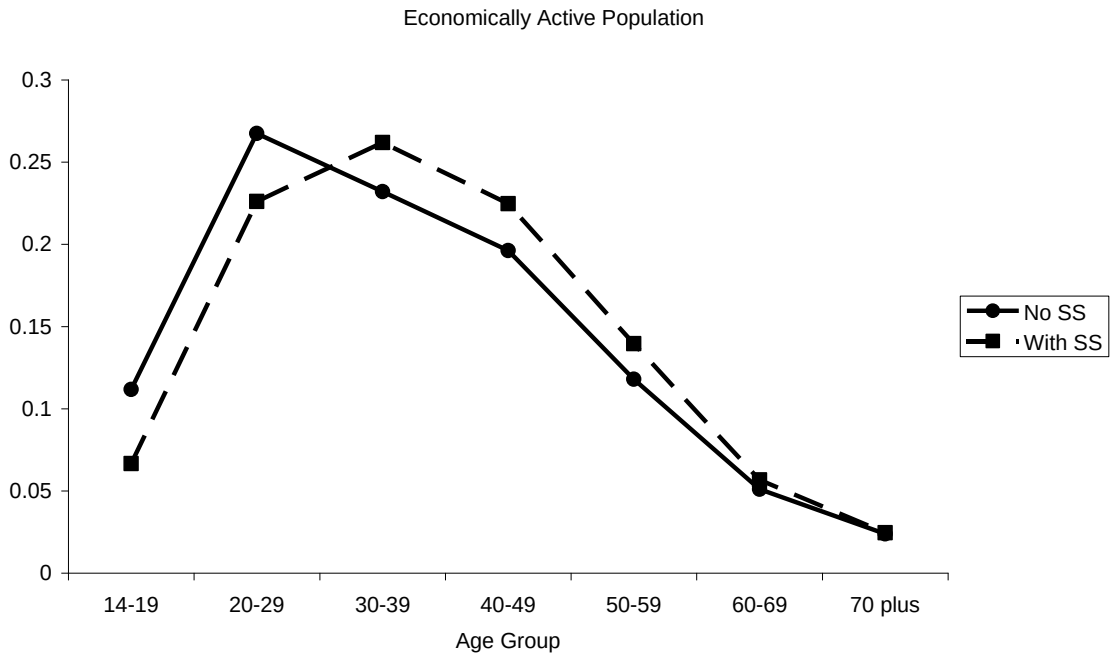
Figure 4: Coverage of IMSS as a proportion of the economically active population



How fast is the economically active population (EAP) growing in Mexico? In a document entitled "Informe Financiero y Actuarial al 31 de diciembre de 2001," the IMSS tackled this question. It examined the EAP growth in the 1950s, 1960s and later. The document then made a projection with three scenarios. In the first, with high growth scenario, the EAP grows at the rate of 2.01 percent per year whereas at the low growth scenario, the EAP grows at the rate of 1.67 percent per year during 2003 to 2023. However, examining the data for past decade, the EAP actually grew at the rate of 1.40 percent per year.

It is well-known that there is a substantial movement of workers between the formal and the informal sectors (see, for example, The Elasticity of Informality to Taxes and Transfers, Jorge Alonso-Ortiz and Julio Leal Ordonez, 2012, working paper). Nevertheless, the movement is not symmetric in terms of age and other characteristics. As a consequence, the distribution of workers in the informal sector tends to be skewed to the left in terms of age – there are more young workers in the informal sector as the following figure shows. Here, we proxy the distributions "with social security" and "without social security" instead of formal and informal sectors.

Figure 5: Population with or without pension coverage



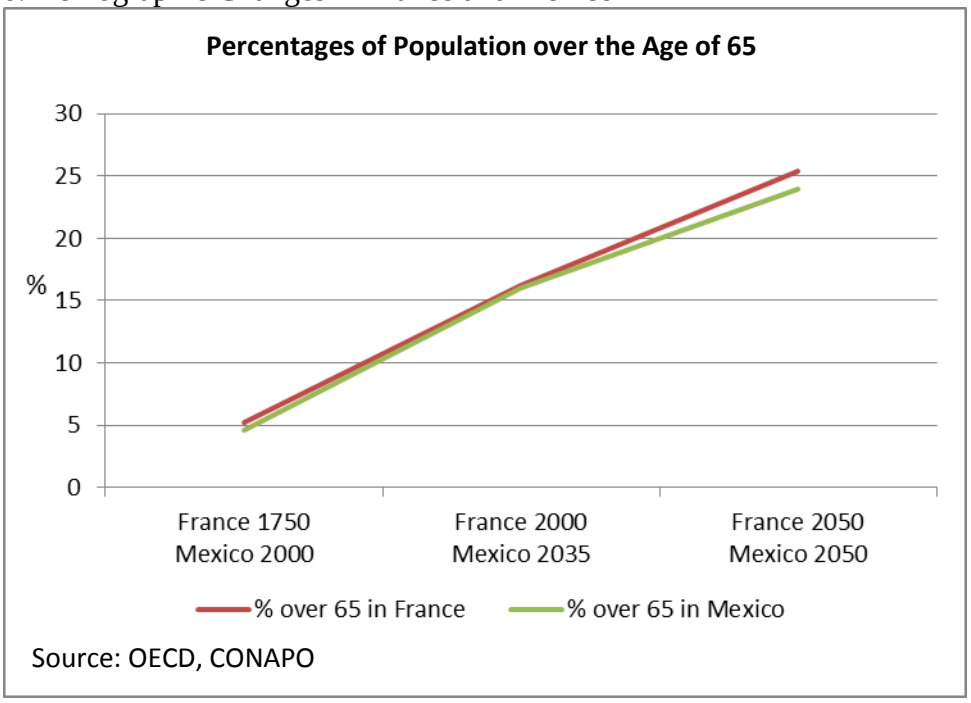
Mexico has operated a pay as you go system of social security for the private sector since 1945. Beneficiaries of a pay as you go system depend strongly on the demographics and economic growth in the formal sector as the informal sector does not generate direct tax revenue. Therefore, an economy with a stagnant private sector that has rising future promises coming from the retirees of the private sector. These unfunded liabilities, combined with stagnant private sector growth, will put pressure on future tax revenue.

Demographic change

When the large scale defined benefit pay as you go system was introduced in Mexico, first in IMSS, then in ISSSTE and other government entities, the retirement age and the benefits were fixed once and for all. The government was reluctant to undertake reform that would invariably mean a reduction in benefits of either the present or the future generations. In some ways, the government did reduce the benefits. It came about by reducing the minimum wage through inflation. We explain that mechanism in the section on IMSS.

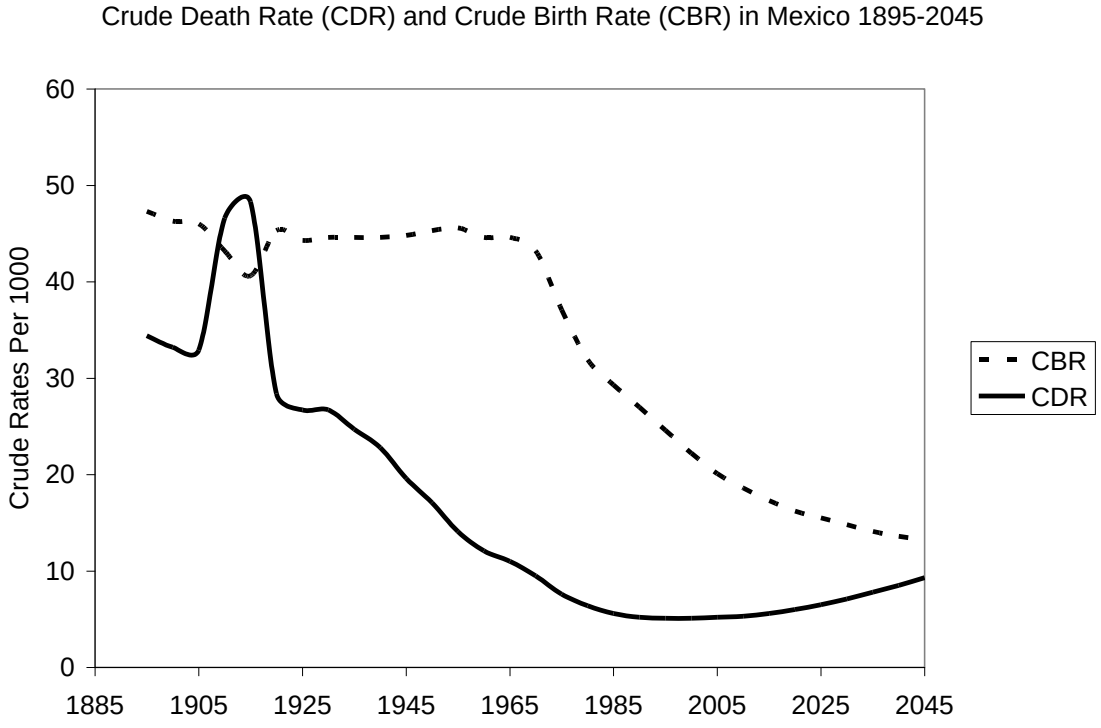
To see what kind of profound changes have taken place in Mexico, consider the following. Figure 6 shows that the demographic transition that France experienced between 1750 and 2050 is being experienced by Mexico between 2000 and 2050. In other words, the demographic transition in Mexico is five times faster. However, Mexican institutions are not keeping up with that pace of change.

Figure 6: Demographic Changes in France and Mexico



The evolution of births and deaths in Mexico has also experienced profound changes. Up until the late 19th century, the total number of births and the total number of deaths did not differ greatly. That meant the population in Mexico rose slowly. However, since the Mexican Civil War of the 1920s, deaths fell dramatically whereas births did not until 1970. This gap produced rapid population growth. However, those rates are in the process of converging. This demographic change is leading to rapid population aging. This process will continue until 2060 or so when the population will stabilize.

Figure 7: Births and deaths in Mexico in a century and a half



Another way to examine the situation is to look at life expectancy at birth and the fertility rate. There has been a steady decline of the total fertility rate and a substantial improvement of life expectancy at birth.

Table 2: Total fertility rate and Life Expectancy at birth

	1970	1990	2010
Total fertility rate	6.5	3.4	2.2
Life expectancy at birth	60.99	71.02	75.70

For retirement problems, life expectancy at birth is not a particularly relevant statistic. A more important number is the life expectancy at retirement. For example, the life expectancy of a male aged 65 in Mexico is 16.8 years and for a female aged 65 is 18.2 years for the year 2000. While the life expectancy has increased, the contribution rate of workers has hardly increased at all while the benefits have not been reduced (except for the inflation impact of reducing the real value of pension benefits).

In summary, the main reason why in the twenty first century various Mexican pension schemes are facing large financial deficits is arising from the population transition that began with the steady decline of the fertility rate from the 1960s. Rising life expectancy also contributed but to a much smaller degree.

Biometric Assumptions

In order to project the future liability we need to have assumptions regarding: (1) The rate at which people leave jobs by age, (2) the rate at which disability occurs by age, and (3) mortality rate by age. These numbers are taken from Circular S-22.2 of CNSF issued in 2009.

Section 2: Literature Review

Implicit Pension Debt (IPD) is a straightforward concept in theory: It is the value of all future liability of the government promises of the past (stock of commitments to future pension outlay). The first mention of IPD was made by Rizzo (1990). Then within a few years it became a standard for the international organizations like the World Bank, the OECD and the International Monetary Fund to refer to the concept of the IPD (see, for example, World Bank, 1995 and Queisser, 1998). In the Mexican context, the first such calculation appears in Grandolini and Cerda (1998).

There are two different definitions of pension liabilities for a *private sector* entity:

(1) Accumulated Benefit Obligation (ABO): the actuarial present value of benefits (vested or unvested) attributed by the pension benefit formula to employee services rendered before a specified date, and based on employee service and compensation prior to that date.

(2) Projected Benefit Obligation (PBO): the actuarial present value as of a date of all benefits attributed by the pension benefit formula to employee service rendered prior to that date.

The ABO differs from the PBO in that it includes no assumptions about future compensation levels (see Holzmann et al., 2004).

Unfortunately neither of these definitions appears to be appropriate for pension systems for the *public sector* that involves at least two generations: the transition generation and the future entrants.

Any calculation of pension liability involves the present value of a set of payments to be made in the future. Thus, it requires two sets of assumptions: (1) Number of years to be considered. and (2) Discount rate to be used. There is no agreed upon choices for these concepts. In theory, the higher the number of years we consider the better. However, as a practical matter, the more years into the future we add, the bigger the uncertainty about the future growth in wages, economic growth, minimum wage etc. that affects our calculation.

We emphasize these two concepts for the following reason: In most other published reports, the present value calculations do not report either the number of years considered or the discount rate (or both).

In our data, we have three entities that have reformed their pension systems (IMSS, IMSS-RJP and ISSSTE). We also have three entities that have not (PEMEX, ISSFAM and the state governments). Therefore, we only consider the generations that are under the defined benefits plans with government liability for the first group and "business as usual" for the other group.

In Mexico, a number of reports are available examining the deficits/surpluses of *current* pension liabilities. For example, a document of the Office of the Auditor General (Secretaría de Hacienda y Crédito Público, Sistema Nacional de Pensiones, Auditoría de Desempeño: 10‐0‐06100‐07‐0115, GB‐022) lists these liabilities.

Unfortunately, it does not explain where the numbers come from. It simply refers to unpublished documents that are not available publicly. Some of the entities referred to (such as the PEMEX) in that document, simply quote pension debt of some specific amounts without any mention of the horizon considered or the discount rate used. This problem is endemic.

In 2011, ISSSTE produced a document called "Informe Financiero y Actuarial, 2011". In Table 25 of that document, a number was reported as the pension debt. Again, no mention of the number of years used for calculating it or the discount rate is mentioned. In the entire document of 144 pages, no discount rate was ever mentioned. In an actuarial report in 2010 (Reporte de Actividades Actuariales al 31 de diciembre 2009 Instituto de Seguridad y Servicios Sociales para los Trabajadores del Estado, August 2010) the ISSSTE report does report the value of actuarial debt with explicit mention of the horizon of evaluation (100 years) and with a specific discount rate (3 percent). In that report, in Table 75 on page 109 it reports a 100 year implicit pension debt of 27.88 percent. This figure is substantially lower than our estimate over a shorter time horizon of 40 years. Since the figures reported do not give substantial details of the workers and the retirees and the assumptions made, it is difficult to determine why their estimate is so much lower. We do note that ever since the ISSSTE has started producing actuarial reports of deficits in the past decade, their projections on the number of retirees have been wrong substantially lower than what eventually occurred. For example, their 2003 Actuarial Report from Hewitt (2003) projected the total number of retirees for 2010 to be 711,981 and the number of workers to be 2,172,131. The actual numbers were 806,781 and 2,247,756 respectively. Thus, the number of workers was underestimated by 3.4 percent and the number of retirees by 13.3 percent. This kind of underestimation is endemic over the last decade.

For IMSS-RJP, on the other hand, a number of actuarial valuations are available publicly (the latest one is "Valuación Actuarial del Régimen de Jubilaciones y Pensiones y Prima de Antigüedad de los Trabajadores del IMSS al 31 de Diciembre de 2010"). These documents do provide a discount rate for calculating the implicit pension debt.

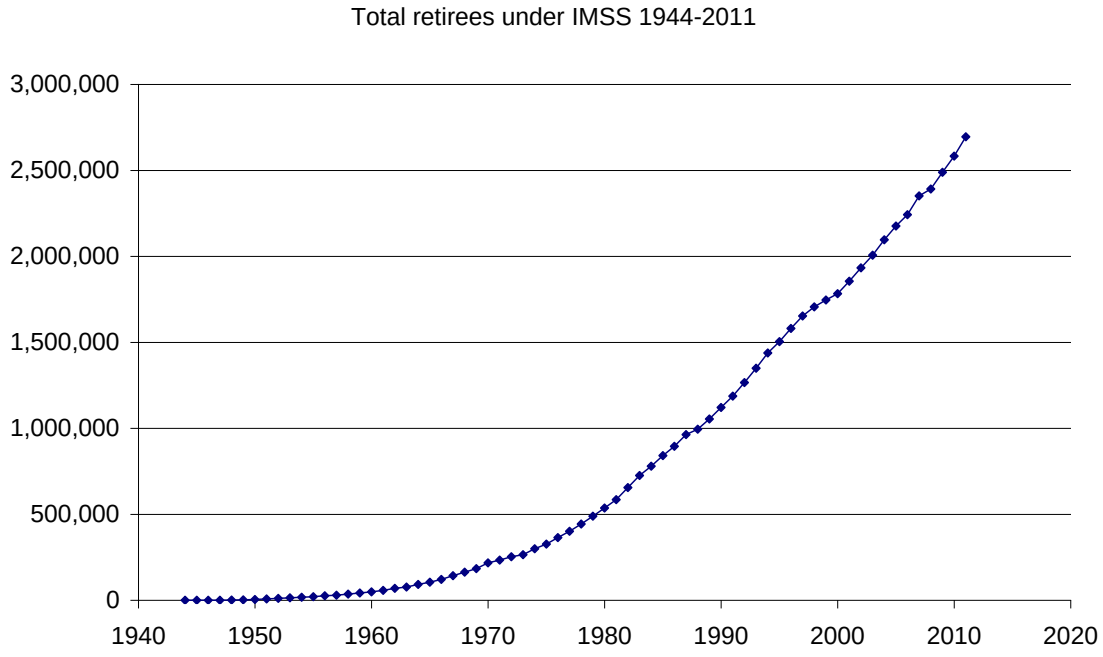
For an overview of the situation of the implicit debt in Mexico, a book was published in July 2012 by Vazquez (2012). Most of the book merely reproduces the reports that we have mentioned above. In a table on page 127 (Cuadro VI.1), the author provides the implicit pension debt liability of a group of public institutions. It merely lists each institution and a figure for implicit debt as a percentage of GDP. It does not give any details of the base year of the GDP used, the discount rate or the number of years used in the calculation. On page 126, the author explains that the information was provided by the institutions themselves and no explanation was given as to how they arrived at these figures. Another book examining the pension situation in 14 states and 38 state universities (Aguirre, 2012). It shows that most of them are still defined benefit plans with contribution rates that fall far short of what is needed to bring them to an actuarial balance in the long run. The author notes that to maintain the current rate of benefits, the contributions have to rise to 30 to 40 percent of the basic salary in the long run.

Section 3: IMSS

IMSS operates the largest pension scheme in Mexico for the private sector. This scheme is considered here separately from the pension scheme operated for the workers of the IMSS (called IMSS-RJP). Private sector workers contribute a portion of their income along with their employers. Retirees are paid from this contribution. The scheme is run by the Federal Government of Mexico.

To understand the implicit debt, it is critical to understand the radical change in the system in 1997. Between the inception of IMSS in 1944 and June 30, 1997, the system operated on a pay as you go scheme with some subsidy from the government. The IMSS operates not just pension, but also healthcare, and childcare among other schemes. There has been a substantial cross subsidy among different schemes operated by IMSS. Therefore, it is not always easy to untangle what exactly is the extent of government subsidy just for the retirement component.

Figure 8: Retirees under IMSS



There are several notable features of this graph. First, the number of retirees has seen explosive growth in the 1970s when double-digit annual growth rates were observed. The growth has slowed considerably over the past two decades to 3 to 4 percent per year.

On July 1, 1997, the new IMSS regime came into effect. Those who joined the private sector on that date or after were given an individual account. They do not contribute to the pay as you go fund. The accounts of all the workers who contributed to the pay as you go fund were also directed to individual funds. The transition generation – those who joined the labor force before the cutoff date but continued to work after that date – will have a choice upon retirement. They can choose to retire under the old scheme (called Ley 73) or they can choose to retire under the new scheme (called Ley 97).

The 1995 law modified various things. It stipulated that people who contribute for 1250 weeks in their lifetime will be eligible for a minimum pension. That minimum pension was pegged at the minimum wage as of July 1, 1997. By law, it is stipulated to rise with the consumer price index (not necessarily how the minimum wage moves over time).

The Role of Minimum Wage

In Mexico, numerous things are indexed to the minimum wage ranging from moving violations, fines imposed on businesses, and even defined benefit pensions. Thus, the minimum wage plays a critical role in determining government expenditure on pension under Ley 73. The relevant Articles of the law read as follows:

"Artículo 75. La cuantía de las pensiones por incapacidad permanente será revisada cada vez que se modifiquen los salarios mínimos, incrementándose con el mismo porcentual que corresponda al salario mínimo general del Distrito Federal.

Artículo 76. Las pensiones de viudez, orfandad y ascendientes del asegurado por riesgos de trabajo, serán revisadas e incrementadas en la proporción que corresponda, en términos de lo dispuesto en el Artículo anterior."

http://www.imss.gob.mx/instituto/normatividad/Documents/4129.pdf

Thus, the "transition generation of workers" – the workers who have been in the formal sector on or before June 30, 1997 or the retirees who draw a pension under Ley 73, the minimum wage is a critical factor. How has the minimum wage evolved over the past four decades? We illustrate that in the following figure:

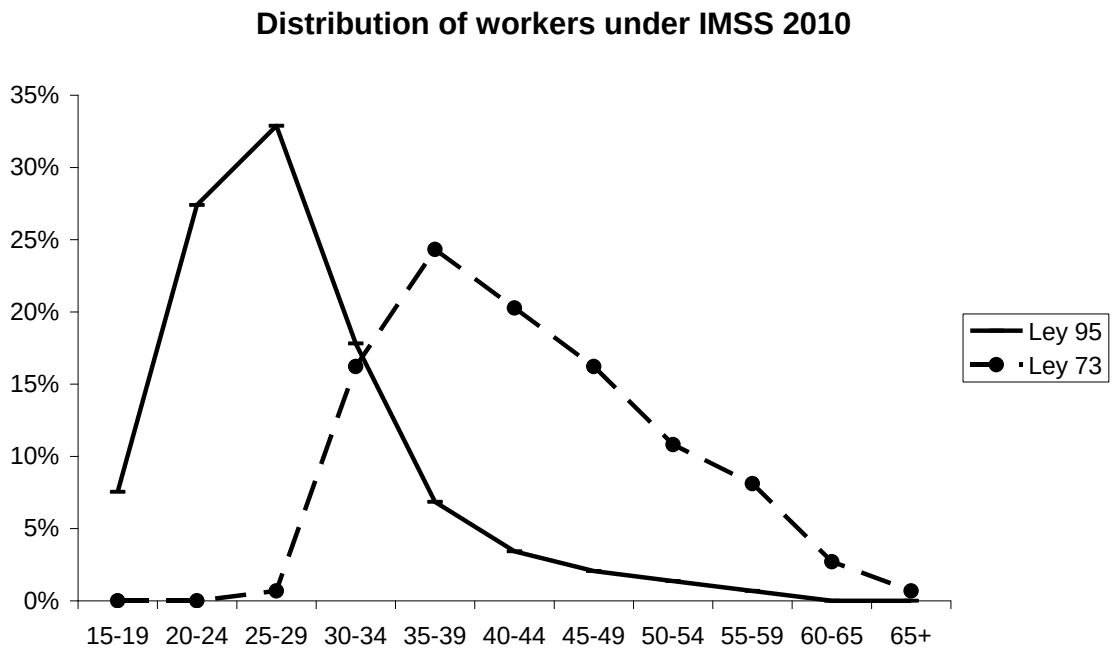
Figure 9: Real Minimum Wage in Mexico

We calculated the value of the minimum wage adjusted for inflation. The index rose to nearly 47 in 1976 – the highest ever in Mexico's history and then started its long climb down to slightly over 10 in 1999. For the next twelve years, it has maintained that value. The minimum wage fell in value between 1976 and 1998 by nearly 80 percent. Thus, during those two decades, pension paid under Ley 73 also fell by 80 percent.

IMSS Retirees: Ley 73 versus Ley 97

With the implementation of Ley 97 on July 1, 1997, the entry of workers into Ley 73 has stopped. The distribution of workers between Ley 73 and Ley 97 in 2010 is as follows:

Figure 10: Distribution of workers



The modal value of workers under Ley 73 is in the 35-39 years age range. Therefore, by 2035-40 the biggest cohort of Ley 73 workers would retire.

Evolution of payment over time

When we examine month by month payment of Ley 73 and Ley 97 of the IMSS, we find the following pattern. First, we note that during 2009-2011, the IMSS pays more than 99.5 percent to the Ley 73 beneficiaries. The rest is paid to the Ley 97 beneficiaries. The reason is simple: Only the widows and orphans and the permanently disabled people have become eligible for payment under Ley 97 as only 15 years have passed since the new law came into effect. In another ten years, we will begin to see the retirees claiming benefits under Ley 97.

The following figures show monthly payments under Ley 73 and under Ley 97 during 2009-2011.

Figure 11: Pension payment under Ley 73

These numbers show the periodicity of the payments. At the end of November, one additional monthly payment (called aguinaldo) is paid to all the retirees. The payments are increasing at an annualized real rate of about 5 percent a year. That increase comes almost exclusively from the rising number of retirees – the real payment per retiree is hardly rising.

Figure 12: Payment under Ley 97

The figure above shows the payment made to Ley 97 beneficiaries every month during 2009-2011. Unlike the benefits of Ley 73, this series does not have any peaks in November.

Choosing between Ley 73 and Ley 97

At retirement, all IMSS workers under Ley 73 will have a choice to retire under the Ley 97 if they want to. Is it worthwhile for them to do so? We do a series of calculations in the tables below to demonstrate that it is almost never worthwhile to choose the Ley 97 option. The Ley 97 might be beneficial if the income of the worker is at the top decile of the workforce and if they work for at least 40 years. Otherwise, the transition generation workers will choose Ley 73 option.

Table 3a Scenario 1: 40 years of service with 10 years in AFORE

Base Salary Monthly	Money in AFORE	Pension (women)	Pension (men)	IMSS pension
$8,000	$92,367	$471	$540	$7,010
$15,000	$173,189	$883	$1,013	$13,116
$25,000	$288,648	$1,472	$1,689	$21,861
$50,000	$405,261	$2,067	$2,371	$22,559
$100,000	$405,261	$2,067	$2,371	$22,559

Assumptions: The rate of return is assumed to be equal to real after fee rate 1997-2010 in the AFORE. The pension per month is taken from the average amount offered by the companies in 2010. Density of contribution is 100 percent.

Table 3b Scenario 2: 40 years of service with 20 years in AFORE

Base Salary monthly	Money in AFORE	Pension (women)	Pension (men)	IMSS pension
$8,000	$273,452	$1,395	$1,600	$7,010
$15,000	$512,723	$2,615	$3,000	$13,116
$25,000	$854,538	$4,358	$5,000	$21,861
$50,000	$1,199,771	$6,119	$7,020	$22,559
$100,000	$1,199,771	$6,119	$7,020	$22,559

Assumptions: The rate of return is assumed to be equal to real after fee rate 1997-2010 in the AFORE. The pension per month is taken from the average amount offered by the companies in 2010. Density of contribution is 100 percent.

Table 3c Scenario 3: 40 years of service with 40 years in AFORE

Base Salary monthly	Money in AFORE	Pension (women)	Pension (men)	IMSS pension
$8,000	$1,198,335	$6,111	$7,011	$7,010
$15,000	$2,246,878	$11,459	$13,146	$13,116
$25,000	$3,744,796	$19,098	$21,910	$21,861
$50,000	$5,257,694	$26,814	$30,761	$22,559
$100,000	$5,257,694	$26,814	$30,761	$22,559

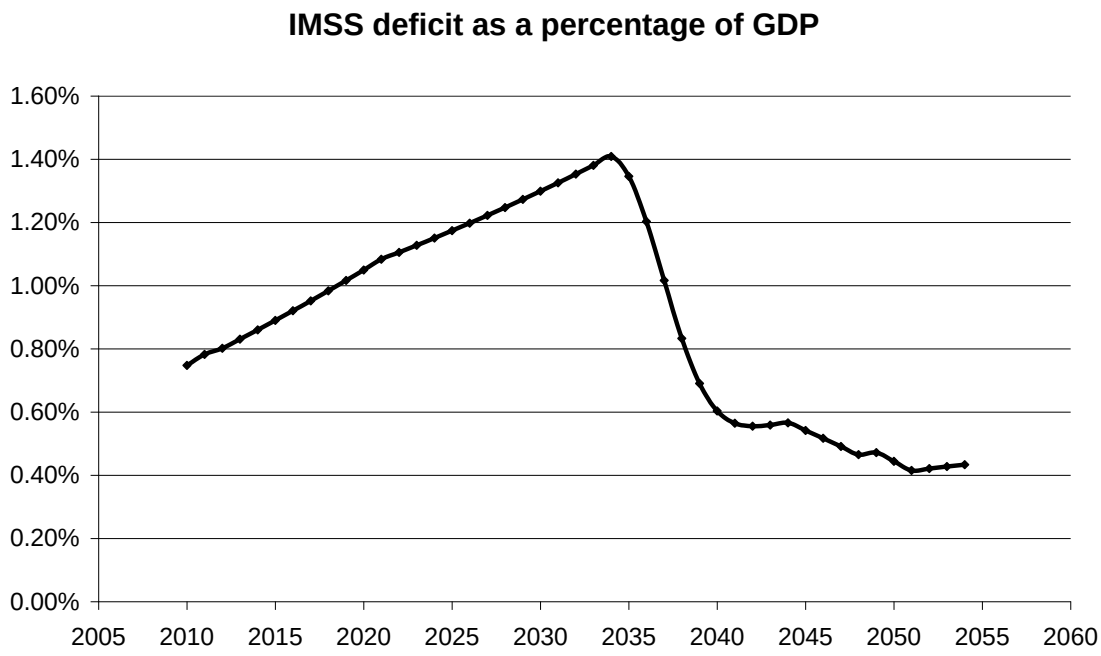
Assumptions: The rate of return is assumed to be equal to real after fee rate 1997-2010 in the AFORE. The pension per month is taken from the average amount offered by the companies in 2010. Density of contribution is 100 percent.

Projection of future costs

We calculate the projected benefits of the retiree into the future with the base year of 2010. We take into account the following factors for Ley 73:

(1) There is no entry into the system since July 1, 1997
(2) People are not leaving the private sector to join the public sector
(3) The disability experience of the future will be the same as that of 2001-2010
(4) The mortality experience of the future retirees will be the same as that of 2001-2010
(5) The rate of wage growth is 1 percent real
(6) The rate of growth of pension paid is the same as the wage growth rate
(7) Those getting less than the minimum salary at retirement will opt for the minimum pension

Figure 13: Projected deficit of the IMSS as a percentage of GDP



There are three reasons why the IMSS will continue to pay benefits to some of the affiliates or their families because those who get benefits for causes other than old age and retirement will continue to be paid by the IMSS: They are the widows, the orphans, and the disabled workers. Thus, for calculating the future liabilities we have to take these people into account.

The old problem in a new bottle

Many people assume that Ley 97 has solved the funding problem of the private sector affiliated with the IMSS. It has not. First, Ley 97 stipulates two sets of government

payments to the future retirees. First, for those who contribute 1250 weeks into the system, the government promises to pay one minimum salary as retirement benefits. Second, the government contributes 5.5 percent of one minimum salary for every contributor to IMSS. Second, the payment to the Ley 73 generation is still being made and the Ley 97 generation is not contributing anything to the retirement of the Ley 73 generation. Where is the money to pay the Ley 73 generation coming from? To see that, we need to examine the portfolio of the AFORE account holders. Every quarter, the CONSAR reports to the Mexican Congress. In that report, it notes the value of the bond held by the AFOREs. If we examine the latest one (INFORME TRIMESTRAL AL H. CONGRESO DE LA UNIÓN SOBRE LA SITUACIÓN DEL SAR, Enero – marzo de 2012) and compare it with the version of a year ago, the value of the long term debt (more than ten years of duration) closely resembles the amount of pension paid to the Ley 73 generation. And this can be tracked for the past three years for which the data is available in the CONSAR website. This means that the only thing that has happened to the implicit government debt is that it has become explicit government debt and the future generation of AFORE holders are carrying them in their portfolio. At some point in the future, when the debt will have to be paid, the future generation will have to pay it. In other words, the promissory notes they carry in their AFOREs will have a zero net value.

Section 4: ISSSTE

The largest pension plan for Government employees is ISSSTE (Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado). This program offers social security for public servants. It includes workers in the Federal Government and many institutions of public education (including public universities).

Old ISSSTE

While a pension system did exist for different types of government workers for two centuries in Mexico, the pension system for all civil servants came into being in 1959. In 1960, when the law came into effect, it covered 129,512 workers and 11,912 retirees. By 1990, ISSSTE covered about 6% of the economically active population.

Contributions: Each worker paid 8% of the basic salary with a cap of 10 minimum salaries. Out of which, 2.75% was set aside for medical services, another 3.5% for retirement benefits and the rest for "other purposes".

Benefits: With 30 years of continuous service, a worker acquired the right to a pension. The pension was equivalent to 100% of the base salary the worker drew immediately prior to retirement (not averaged over five years as in IMSS). Persons with less than 2 times the minimum wage at retirement were given a pension of two times the minimum wage (indexed). This pension did not depend on age. For example, if a worker started with a government job at the age of 20, he became eligible for retirement with 100% base salary at the age of 50. In addition, there was a minimum attachment point (vesting). A worker who worked for 15 years with the government became eligible for 50% base salary pension provided he was 55 years old. The benefits then went up (almost linearly) for additional years of service until it reached 100% with 30 years of service. Disability (physical or mental) benefits were calculated in a similar manner if the worker had worked for more than 15 years. Survivor benefits were also available for the spouse, concubine, children and parents. (In many other countries, parents and concubines do not qualify for such benefits.)

The problem that ISSSTE faced can be simply illustrated by the following table.

Table 4: Workers and Retirees under ISSSTE

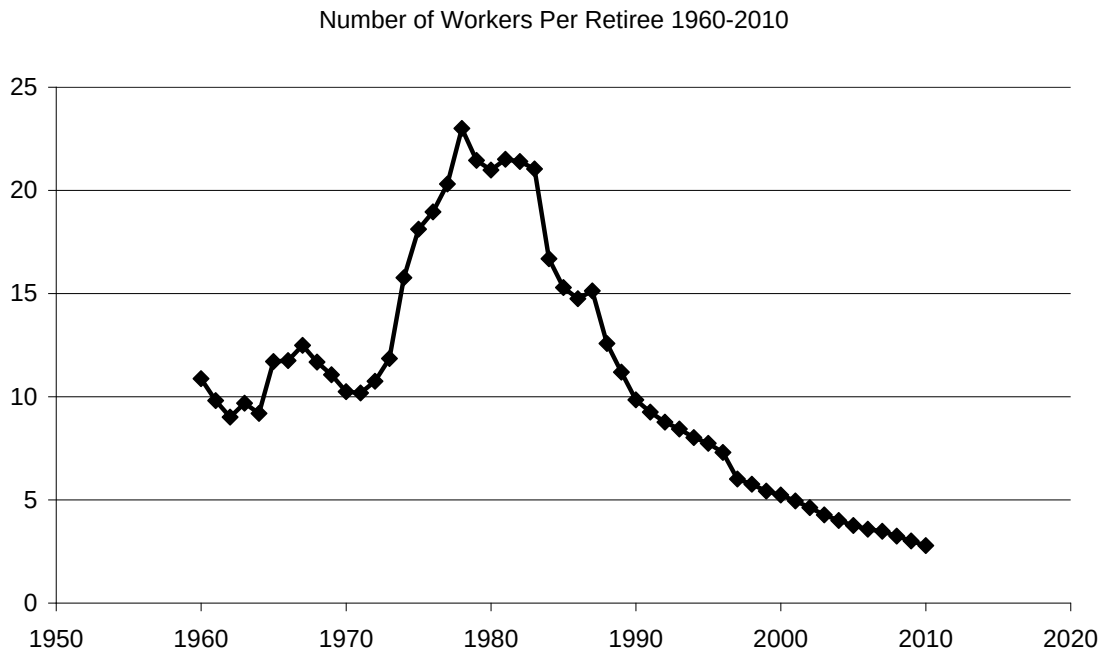
Year	Workers	Retirees	Ratio
1997	1,913,852	318,363	6.01
1998	1,944,772	337,798	5.76
1999	1,989,265	366,707	5.42
2000	2,018,511	385,921	5.23
2001	2,034,981	411,080	4.95
2002	2,041,175	441,970	4.62
2003	2,031,484	476,072	4.27
2004	2,039,719	510,138	4.00
2005	2,058,483	547,318	3.76
2006	2,070,326	578,392	3.58
2007	2,121,098	610,270	3.48
2008	2,162,591	666,654	3.24
2009	2,191,981	729,506	3.00
2010	2,247,756	806,781	2.79

Source: issste.gob.mx

This table shows some extraordinary developments have been taking place for ISSSTE workers. In the past decade and a half, the average growth of members of ISSSTE workers has been in the order of 1.25 percent (during the same period, the Mexican population grew at the rate of slightly over 1 percent). This growth shows that every six years (coinciding with the election of a new administration at the presidential level) the number of workers grew much faster. This growth rate pales in comparison with the growth rate of retirees with pension in the system. It has grown at an average rate of 7.43 percent per year. The number of workers per retiree has gone from 6.01 to 2.79. However, it is not sustainable *indefinitely*, to have this differential of growth of workers and the growth of retirees to continue. To put it differently, the "demographic dividend" for the ISSSTE worker ended in 1978.

It should be noted that this change in worker to retiree ratio has been coming for a long time as the following graph shows. The number of workers per retiree in ISSSTE peaked in 1978 at 23 workers per retiree and from 1988 when the ratio was 15 there has been an continuous decline every single year.

Figure 14: Worker retiree ratio of ISSSTE 1960-2010

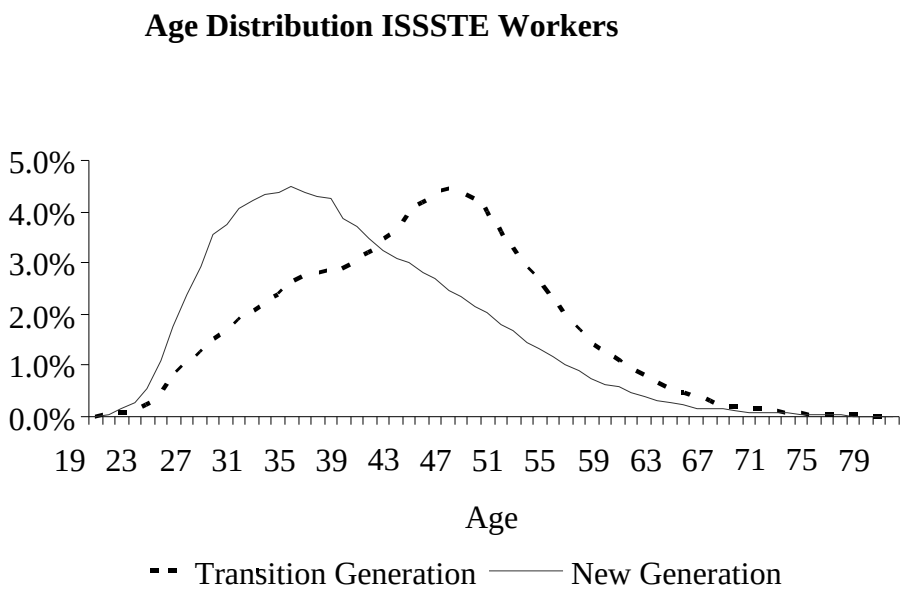


In the past, there have been several proposals for reforming the system. Most workers were afraid that they would lose retirement benefits if they continued working under ISSSTE. This is reflected in the projections made by ISSSTE. For example, 2002 projection for 2010 was 711,981 retirees. But actually it turned out to be 806,781 retirees – a difference of 13 percent. Similarly, the number of workers in ISSSTE for 2010 was projected to be 2,172,131. The actual number was 2,247,756 – a difference of 3 percent.

Reform of 2007

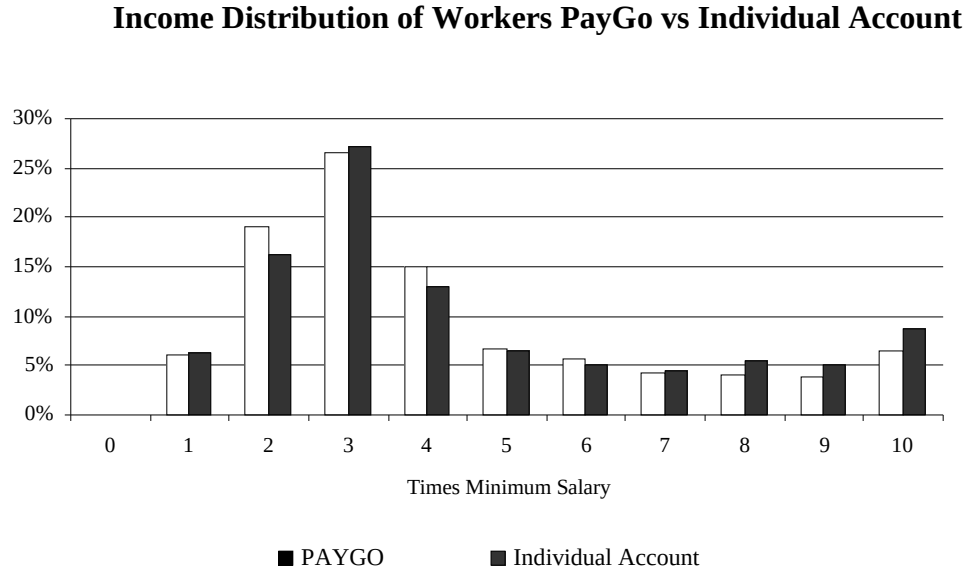
In 2007, the Federal Government decided to modify the regime as follows: All the new entrants will not have access to the old regime of pay as you go pensions. Instead, they will all be entering into an individual account regime very much in the same style as that of Ley 97 of IMSS. Those who were working before the cut-off date, they were given a choice between joining the individual account scheme or stay with the old regime at that point in time. If they chose to switch, they were given a recognition bond. Unlike the transition workers of the IMSS, ISSSTE workers where not given a choice at retirement at a future date. They had to choose the regime between April 1, 2007 and December 31, 2009. Of the 2,072,518 workers at the time, 294,736 workers (just over 14 percent) chose the individual account. In other words, most of them stayed with the old system. The workers who chose the new plan are relatively younger workers as the following graph shows:

Figure 15: Age distribution of two generation of ISSSTE workers



The people who chose individual accounts have higher income as the following graph illustrates.

Figure 16: Income distribution of two generations of ISSSTE workers 2010



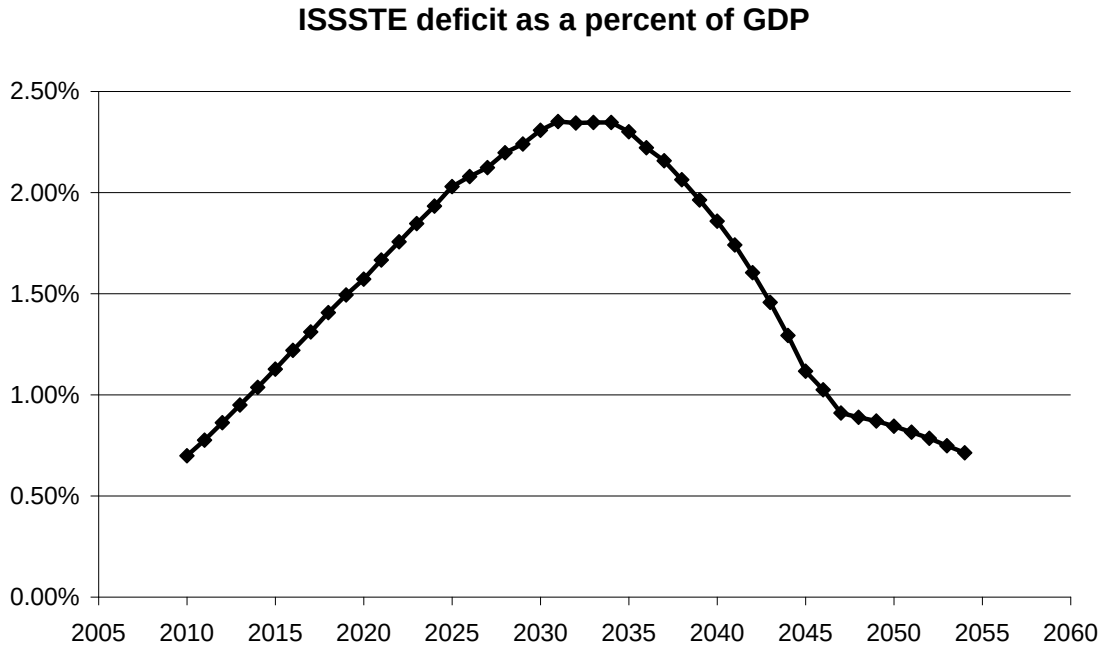
The retirement age is programmed to rise gradually over time. In the appendix, we give the schedules.

Calculating the cost of the transition generation

We use the actual matrix of age and experience of all the workers who stayed in the system. We assume the following:

(1) There is no entry into the system any more
(2) Persons who leave the job permanently will follow the same pattern as the actual experience of 1997-2010
(3) The disability experience of the future will be the same as that of 1997-2010
(4) The mortality experience of the future retirees will be the same as that of EMSSA 2009
(5) The interest rate paid by the recognition bond is 3.5 percent real
(6) The rate of wage growth is 1 percent real
(7) Those getting less than 2 times the minimum salary at retirement will opt for the minimum pension

Figure 17: ISSSTE deficit



Annex: Tables

Retirement benefits for years of service

Table A1

Years of service	% of Base salary
15	50.0%
16	52.5%
17	55.0%
18	57.5%
19	60.0%
20	62.5%
21	65.0%
22	67.5%
23	70.0%
24	72.5%
25	75.0%
26	80.0%
27	85.0%
28	90.0%
29	95.0%
30 or more	100.0%

Retirement benefits for old age

Table A2

Age	% Base salary
60	40%
61	42%
62	44%
63	46%
64	48%
65 or more	50%

Retirement benefits

Table A3

Calendar date	**Minimum age (male)**	**Minimum age (female)**
2010 y 2011	51	49
2012 y 2013	52	50
2014 y 2015	53	51
2016 y 2017	54	52
2018 y 2019	55	53
2020 y 2021	56	54
2022 y 2023	57	55
2024 y 2025	58	56
2026 y 2027	59	57
2028 or over	60	58

Retirement by age and years of service

Table A4

Calendar date	Pensionable age
2010 y 2011	56
2012 y 2013	57
2014 y 2015	58
2016 y 2017	59
2028 or over	60

Retirement for pensionable age

Table A5

Calendar date	Age for retirement
2010 y 2011	61
2012 y 2013	62
2014 y 2015	63
2016 y 2017	64
2018 or beyond	65

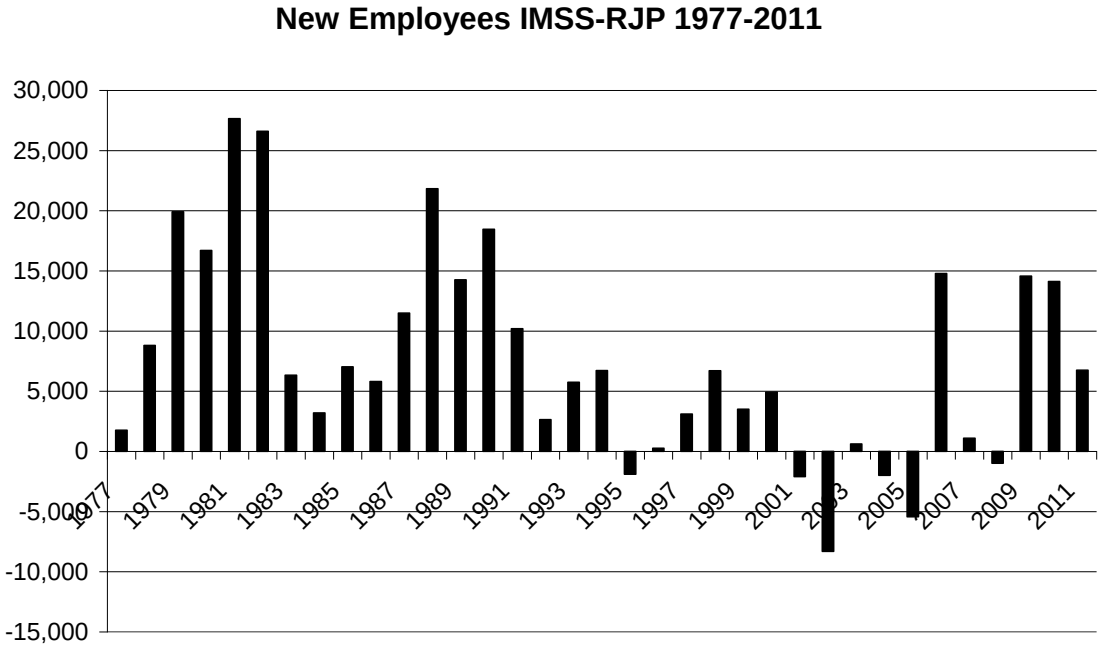
Section 5: IMSS-RJP

IMSS provides retirement benefits, healthcare and childcare to all the formal private sector workers. To provide such services, the IMSS has a nationwide network of offices, hospitals, childcare centers. The employees of the IMSS have had a special regime for their own retirement benefits.

There are several characteristics that set apart the IMSS-RJP regime in terms of retirement. First, it does not have any minimum age of retiring. The only thing that matters is the years of service. The average age of retirement under this regime is 54 years with over 30 percent retiring before turning 50. Not surprisingly, the average number of years of retirement under RJP is 29 years in 2010. The average age of the retirees in RJP is 61 years. Second, the pension amount is determined solely by the last year of service (most other plans take into account multiple years). Third, the pension gets three bonuses (aguinaldos). They add up to 29 percent of the total annual pension (most other plans give a bonus of one month's pension). Fourth, their pensions go up in tandem with the pay of the RJP workers and not just with the consumer price index. Fifth, the contribution of the workers are low for the current workers (at 3 percent of the basic wage). For new workers, the contributions started at 4 percent of the basic wage in 2005 and going up at the rate of 1 percent per year until it hit 10 percent in 2011.

In the following graph, we plot the number of new workers in IMSS-RJP. The number rose continually up until the crisis of 1995. That was the first time in its history, that a small number of permanent employees of the RJP regime ever left or were fired.

Figure 18: Net New Employees IMSS-RJP



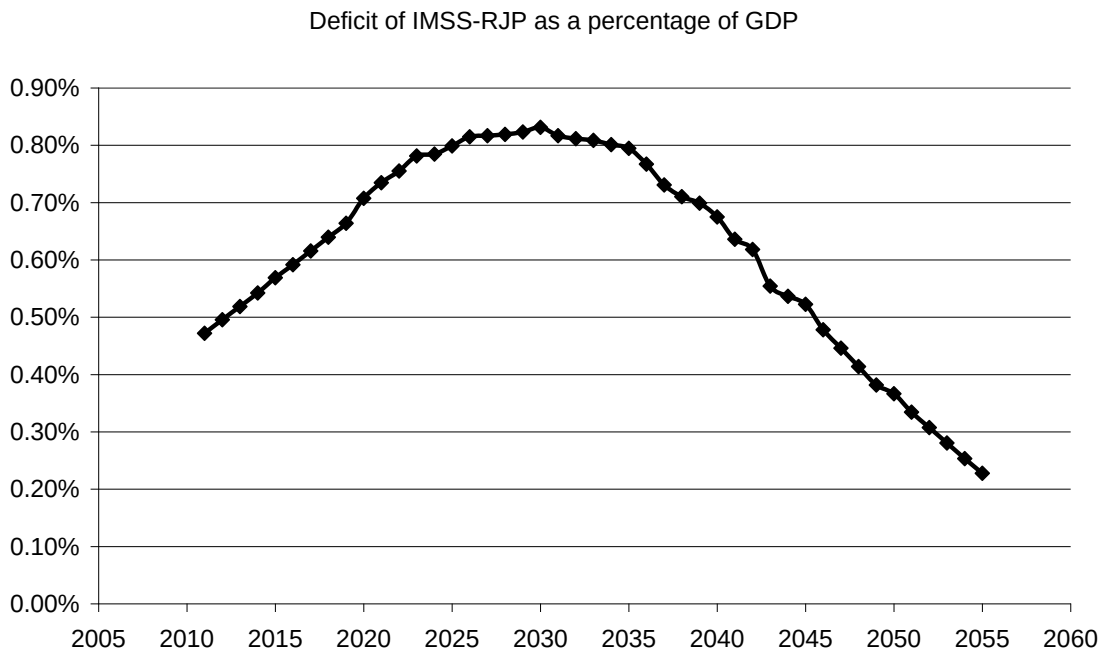
Source: IMSS

Under the current regime of the IMSS-RJP, there were slightly over 200,000 retirees. The total unfunded liability is on the order of 50,000 million pesos a year in 2010.

The RJP regime has been reformed starting in 2004. The law stipulated that the contribution by the workers would go up from 3 percent of salary to up to 10 percent. A large slew of lawsuits were filed against the constitutionality of such a requirement. Most of them have been resolved and the law was largely upheld. There were some setbacks but they are of minor financial consequence.

We calculate the fiscal deficit into the future assuming the regulatory regime change of 2004 is not changed again.

Figure 19: Deficit of IMSS-RJP



Section 6: State Pensions

Mexico has 31 states and one Federal District. The states are: Aguascalientes , Baja California, Baja California Sur, Campeche, Chiapas, Chihuahua, Coahuila, Colima, Durango, Guanajuato, Guerrero, Hidalgo, Jalisco, México, Michoacán, Morelos, Nayarit, Nuevo León, Oaxaca, Puebla, Querétaro, Quintana Roo, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Tlaxcala, Veracruz , Yucatán and Zacatecas. All the states have their own pension schemes for their state government employees.

We solicited information from all the state governments about their pension liabilities. We received varying degrees of response. From the following, we received no response at all: (1) Baja California Sur, (2) Federal District, (3) Hidalgo, (4) Morelos, (5) Nuevo Leon, (6) Quintana Roo, and (7) Tlaxcala.

In a recent report of May 2012, aregional.com has argued that the following states are with high risk of running out of money in the next five years of their pension funds: Baja California, Chihuahua, Tamaulipas, San Luis Potosí, Veracruz, Querétaro, Colima, Tlaxcala, Puebla, Guerrero, Oaxaca, Chiapas, Tabasco, Yucatán y Morelos. It also flagged Durango, Zacatecas, Nayarit, Michoacán and México with medium risk whereas Sonora, Sinaloa, Coahuila, Nuevo León, Guanajuato y Campeche have low risk with Jalisco and Aguascalientes singled out with very low risk. A similar caution was sounded in 2010 by the IMCO (Pensiones estatales: otra bomba de tiempo, http://imco.org.mx/indice_estatal_2010/PDFS/Pensionesestatales.pdf)

The information the states provided to us varied a great deal in terms of quality and detail. Some states provided us with actuarial studies of their states (e.g., Zacatecas). Other states provided with total pension bill for the states for just a few years (e.g., Oaxaca). We have the following data from 24 states that are complete for the years 2007 to 2011. Some states provided data from 2000 or 2001. The states for which include data are: Aguascalientes, Baja California Norte, Campeche, Cuahuila, Colima, Chiapas, Chihuahua, Durango, Guanajuato, Guerrero, Jalisco, México (Estado), Michoacán, Nayarit, Oaxaca, Puebla, Querétaro, San Luís Potosí, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán and Zacatecas.

Table 6: Retirees and average pension of state employees

Year	Retirees	Annual Pension Per person
2007	115,317	$91,713
2008	123,389	$96,120
2009	132,730	$104,071
2010	143,398	$109,996
2011	154,656	$120,500

Note: The pension is calculated in current pesos.

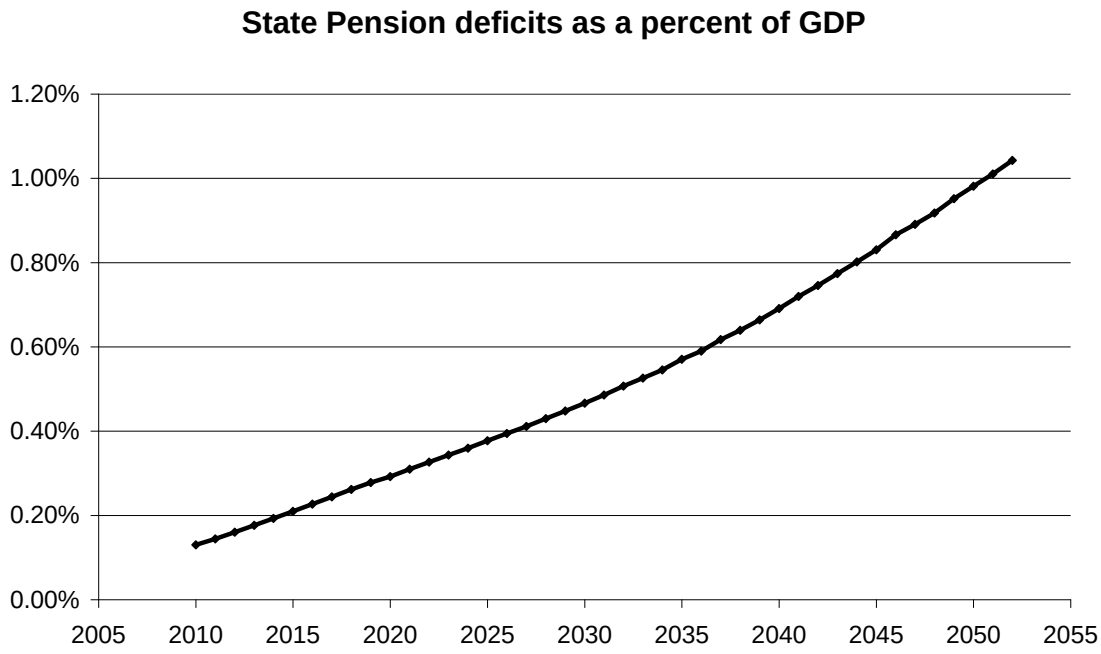
For those states, the average pension is slightly over 100 percent of the salary received by the average worker. The age of the average workers is slightly over 39 years and the age of the average pension recipient is slightly below 64 years.

To calculate the pension liabilities of the 24 states, we assumed that four states that provided with actuarial information can be generalized to all the other states. The rest of the assumptions applied are the following:

(1) The number of state government workers will rise at the same rate as it did between 2007 and 2011.
(2) Persons who leave the job permanently will follow the same pattern as the actual experience of 1997-2010 of ISSSTE
(3) The disability experience of the future will be the same as that of 1997-2010 of ISSSTE
(4) The mortality experience of the future retirees will be the same as that of EMSSA 2009
(5) The rate of wage growth is 1 percent real

Applying the methodology explained earlier, we get the following figure for the implicit debts of the states.

Figure 20: State pension deficits



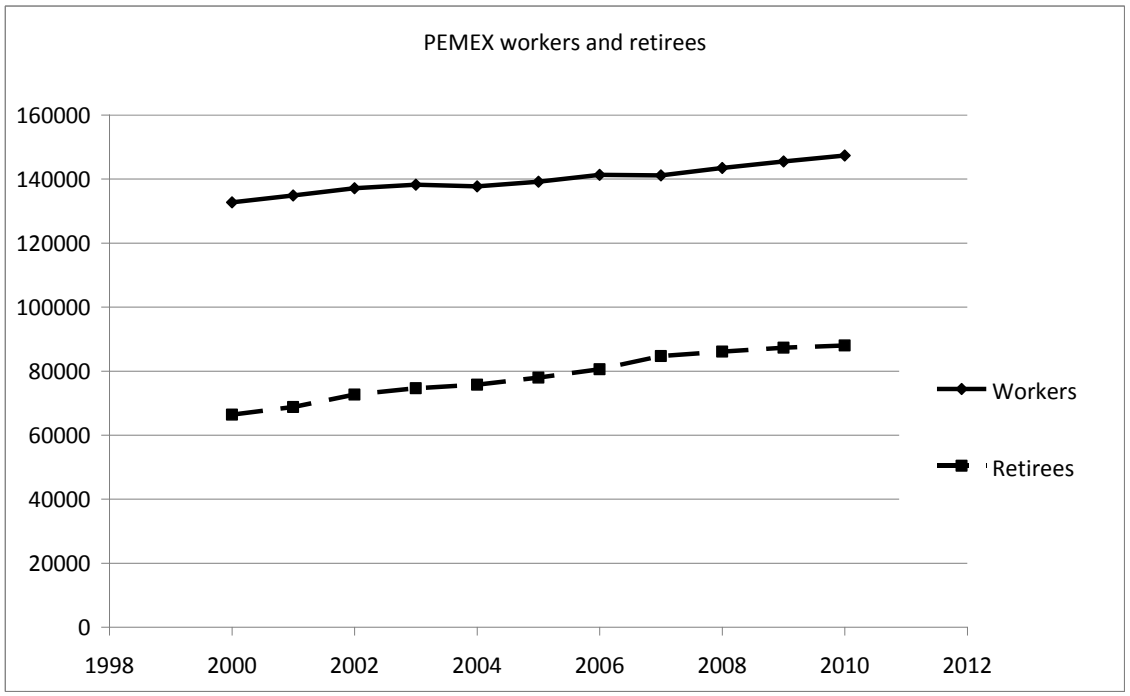
Unlike the IMSS and ISSSTE, where reforms have been instituted to get away from a pay as you go system to funded schemes, most of the states have not instituted such reforms. Thus, the state pension deficits are going to go up over the next forty years unless the states undertake serious reform.

Section 7: Pemex

PEMEX is a state owned oil company. By a constitutional amendment, it was nationalized in 1938. Oil is an important source of government income in Mexico. It provides about a third of total federal government revenue. However, since 2007, Mexican oil production has been declining after reaching nearly 3 million barrels a day it is down to 2.5 million barrels a day (http://www.pemex.com/informes/pdfs/statistical_yearbook_2011.pdf). However, with some more deepwater sources coming into play over the next decade (in 2010, Mexico did not have any deepwater source of oil), some experts believe that it will reach 4 million barrels a day by 2020 (http://bakerinstitute.org/publications/EF-pub-MedlockSoligoScenarios-04292011.pdf).

All of this will have an impact on the number of workers demanded by PEMEX. The evolution of PEMEX workers and the retirees are illustrated in the following graph.

Figure 21

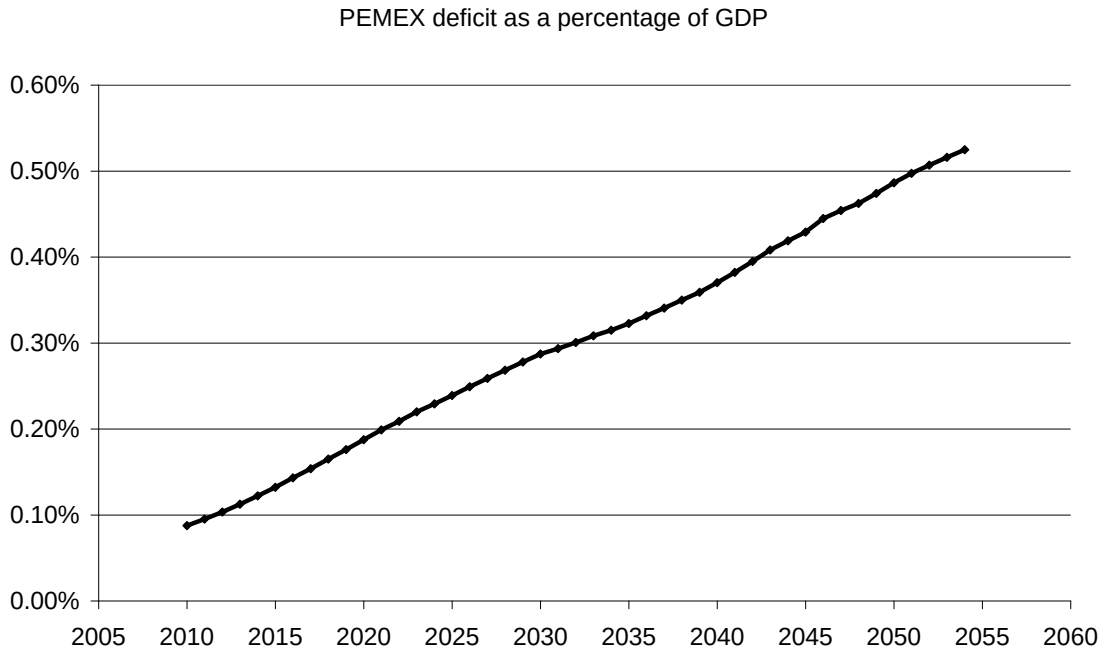


The number of retirees as a proportion of workers is rising over time. PEMEX has two broad classes of workers – those who are directly working in the fields of oil, gas, refineries and other production and extraction processes and the other group are office workers. There are two sets of contracts for the different classes of workers. The field workers have a collective union contract. The office workers do not. Some 40 percent of the workers are office workers and the rest 60 percent are union workers.

The future evolution of the number of retirees will depend on the future evolution of workers. It is difficult to make a prediction about the number of employees in a company whose product is sold in the international market. We can do a mechanical projection based on the number of past employees. However, if we believe that best practices abroad will lead to reform in the sector, there will not be a rise in the number

of workers as in the past. We will assume that the growth rate of the number of workers will be of the order of one percent over the next four decades. We will also assume that the number of years and age of the workers follow the same pattern as the ISSSTE. We will also assume the same wage structure (but not the wage level). These assumptions are needed to make a future projection.

Figure 22: PEMEX deficit



The reason why the numbers are going up so dramatically is that PEMEX has not had any reform of its pension system. At present, the contribution by the workers is minimal and the benefits are high. In 2011, a report was commissioned by the Director of PEMEX proposing a restructuring of existing labor contracts, but this restructuring was never implemented.

Section 8: ISSFAM

In most countries around the world, pension coverage was offered to the military before an other group – especially for disability and survivor benefits. For example, the English and Spanish governments authorized pensions to their veterans in the 17th century. Even more striking, a Naval Pension Scheme was set up in the United States before it had even ratified its Constitution in 1787. These schemes were universal non-contributory.

In the 1920s, the Law of Promotions and Compensation and the Law of Pensions and Retirement were promulgated as a means to regularize military practices in Mexico after the civil war, bring the armed forces under the control of the central government. The three branches of the armed forces provide uniform pay and benefits for equivalent rank and years of service.

As a general rule, a soldier, who works for less than 20 years, is given a lump sum as the following table shows:

Table 7: Compensation for leaving job

Years of service	Months of salary
5 years	6 months
6 years	7 months
7years	8 months
8 years	10 months
9 years	12 months
10 years	14 months
11 years	16 months
12 years	18 months
13 years	20 months
14 years	22 months
15 years	24 months
16 years	26 months
17 years	28 months
18 years	30 months
19 years	32 months

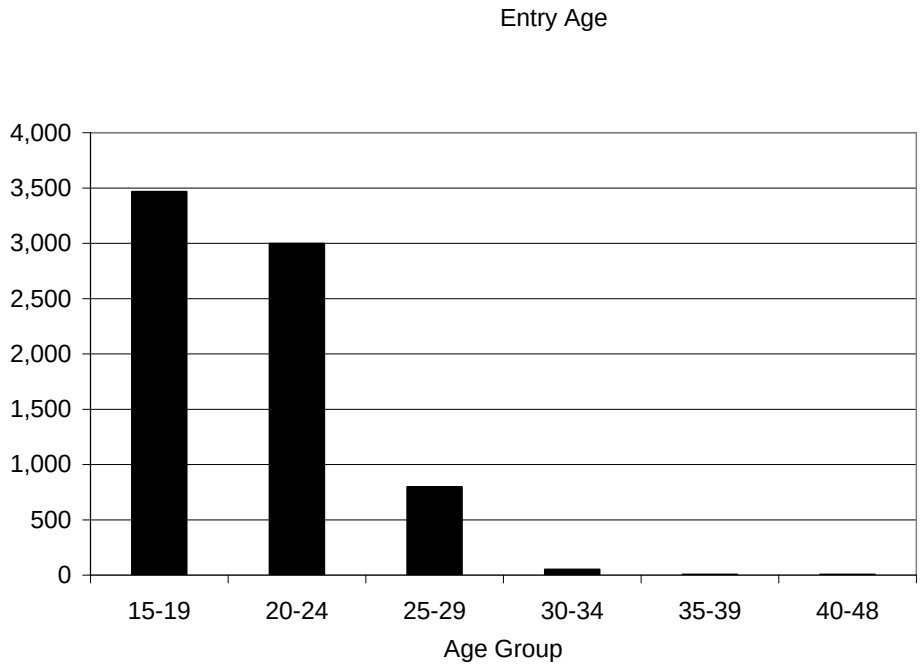
A soldier becomes eligible for a pension only when he or she serves for 20 years. Once a person serves for 20 years, the person is eligible for a pension until death. The pension is typically ranges from 60 percent of the last drawn salary to 100 percent of the last drawn salary once a person serves for 30 years or more.

Unlike other countries in Latin America, Mexican Armed Forces have never played a political role. There have been odd cases of military involvement such as the 1968 student uprising in Mexico City or 1994 uprising in Chiapas. But until the large scale use of the military to fight the War on Drugs of President Calderon, the military has stayed off the streets since the 1920s.

Military service is voluntary in Mexico. The soldiers are paid slightly higher than the minimum wage. The requirement for joining the Armed Forces is primary education and absence of criminal record along with Mexican nationality by birth. It is legal to hold a second job in addition to a regular military job.

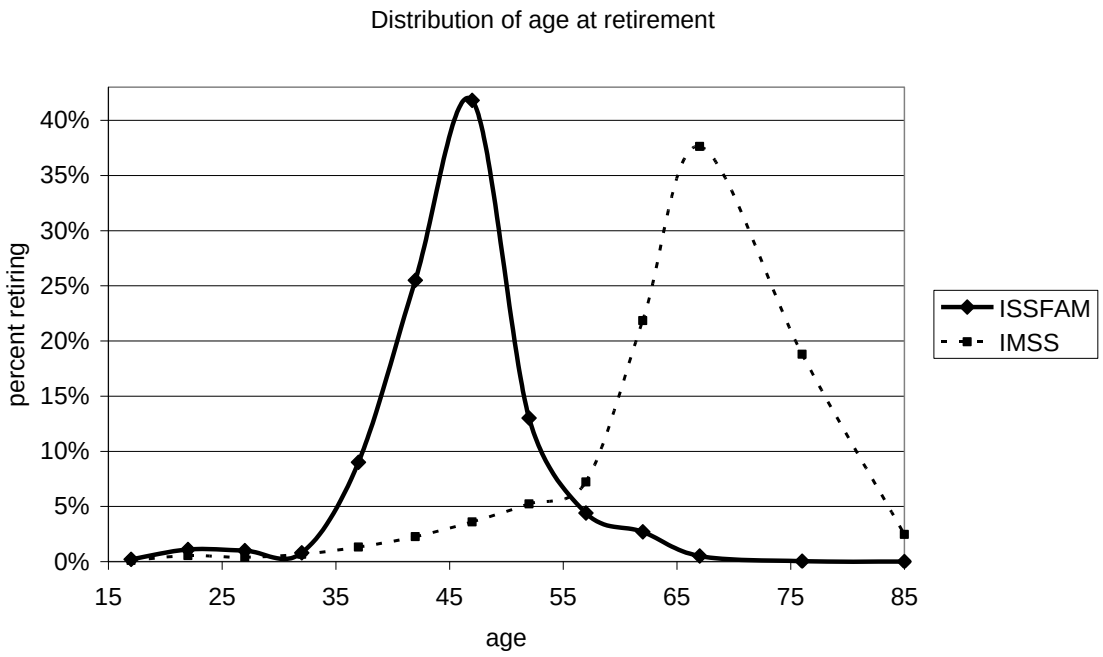
The uniqueness of military jobs makes the retirement pattern very peculiar. Most military service personnel enter before the age of 20.

Figure 23: Entry age distribution ISSFAM



In addition, the military system is extremely rigid in terms of promotion and retirement. Specifically, if a person does not get a promotion by a certain age, he or she is forced to retire from the Armed Forces. Thus, most military personnel retire by the age of 45. Below we contrast the retirement probability with the IMSS data.

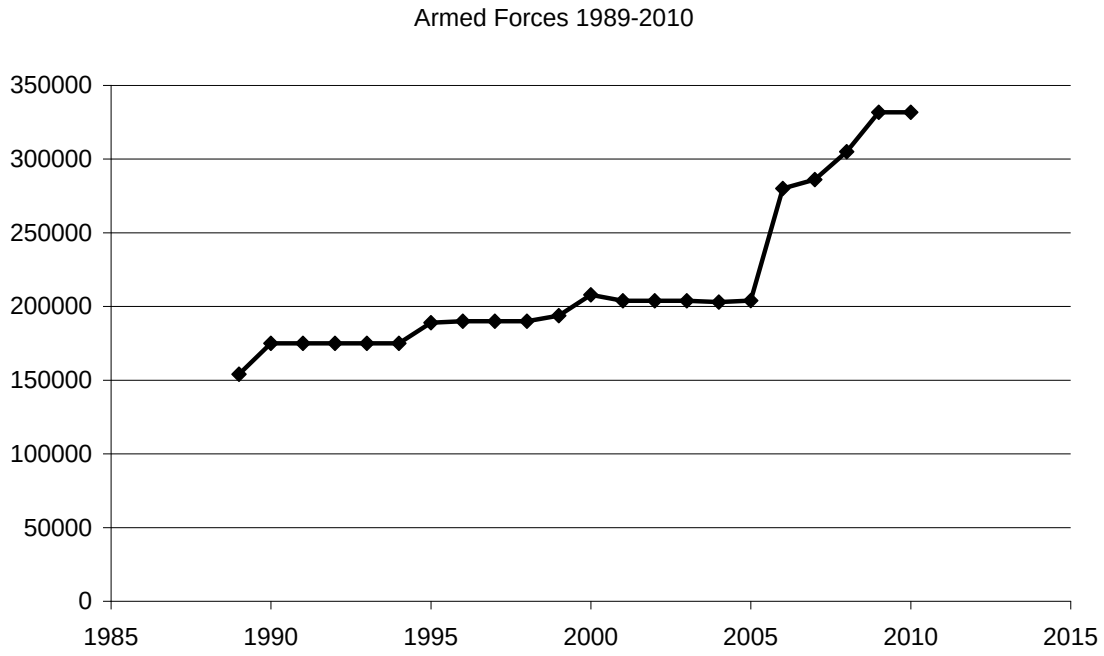
Figure 24: Age at retirement



What the data shows is striking: the onset of retirement is fully 20 years lower for the ISSFAM than the private sector regime. This implies something dramatic for the ISSFAM: the average number of years of service is less than 25 years, but the average number of years spent in retirement is 40 years. This pattern is inverse to that of a person working in the private sector.

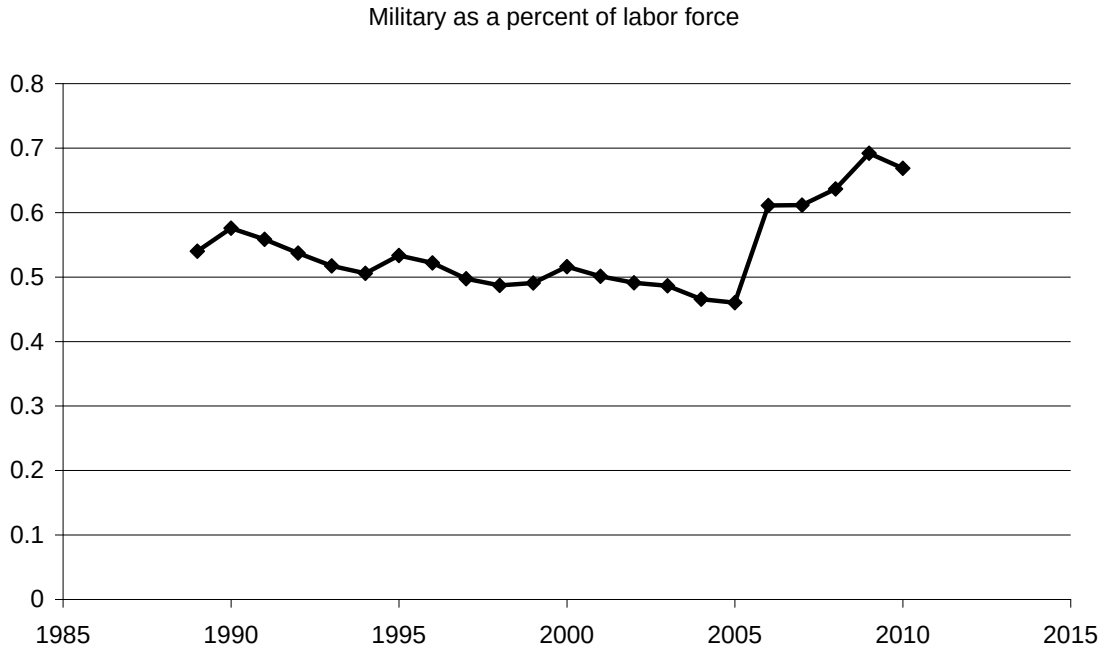
As we noted earlier, under President Calderon, starting in 2006, the military has taken a bigger role in fighting the War on Drugs. The results show up in the total number of personnel in the Armed Forces. There has been a substantial jump in the size with new recruits.

Figure 25: Number of men and women in the Armed Forces



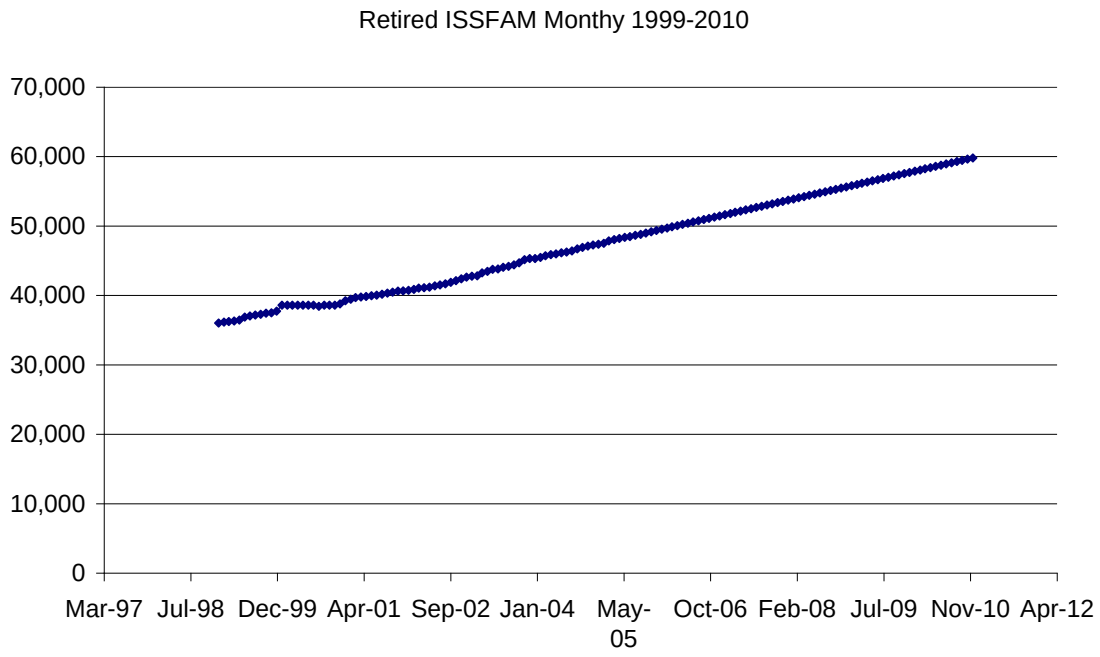
This fact is also reflected in the military as a proportion of the labor force.

Figure 26: Military as a percentage of the labor force



The number of retirees has been going up steadily over the past decade.

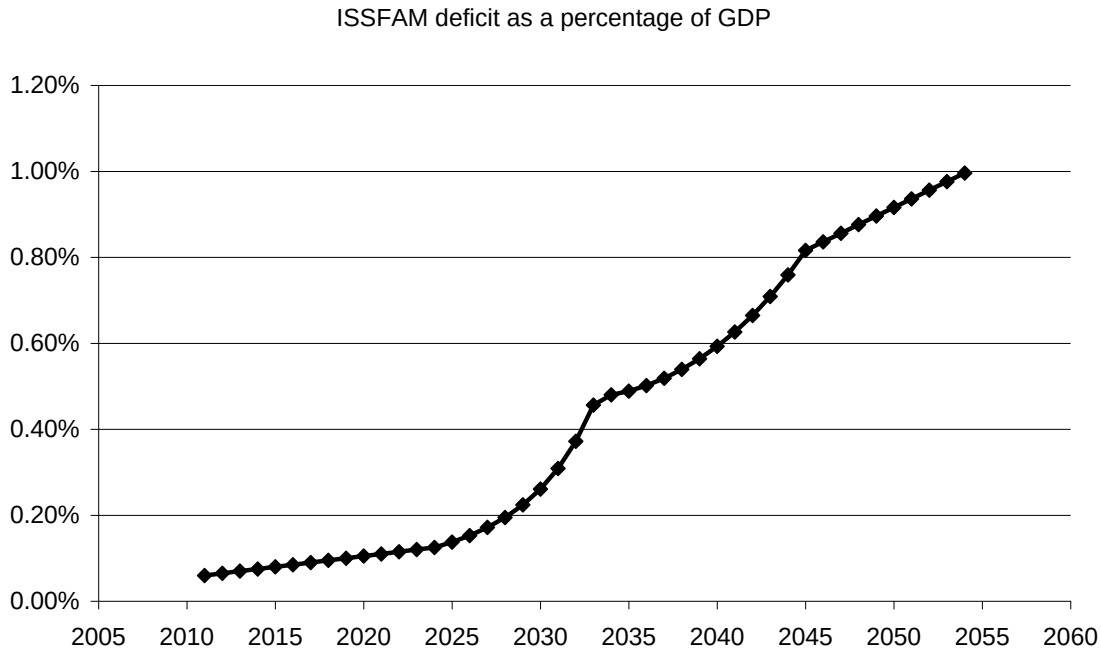
Figure 27: Retired personnel ISSFAM



Unlike the civilian population, military benefits are not tied to minimum wage but the wage of the military. In Mexico, military wages do not rise automatically with the price index. They rise by presidential decrees with the approval of the Mexican Parliament. Monthly average pension received by retired military personnel is slightly less than 10,000 pesos a month in 2010.

If we assume that the rise in the army ranks during 2006-2010 is a one time event and that the long term trend in the Armed Forces resumes the pattern between 1989 and 2005, then we can project the ISSFAM deficit for the next four decades as follows.

Figure 28: ISSFAM deficit as a percentage of GDP



It should be noted that while the rise in the pension deficit for the Armed Forces may seem large by historical standards, it is still smaller than other countries in the region.

Section 9: Concluding Comments

We calculated the implicit pension liability of five federal entities in Mexico. They are calculated using standard actuarial techniques as a percentage of 2010 GDP. It has to be kept in mind that there is a good bit of uncertainty regarding various figures used. For example, wages in the public sector is itself a policy variable. Governments can arbitrarily raise the salary and/or pension benefits by decree. It has done so in the past. For example, the pensions for the Armed Forces were raised substantially in the past few years as well as the level of salary in the Armed Forces. These will have repercussions for the future of pensions in the Armed Forces. Reforms in the IMSS pension regime, IMSS-RJP regime and ISSSTE regime have received legal challenges. Some of these are still in the courts. It is possible that some aspects of these reforms are declared null and void by the courts. In such cases, the cost of reform will go up. For example, in 2011, the Supreme Court declared that the housing account money (INFONAVIT) cannot be used as a part of the benefit that the Secretary of Finance used for authorizing benefits under new pension law. That decision alone increased the cost of the reform by several percentage points of the GDP.

Perhaps it is also worth keeping in mind that the pension debt does not have to be paid at any given year. Instead, it will be paid over the next decades. Therefore, we can reasonably expect that the GDP will also rise during that time. In 1960, the population of Mexico was 37 million. In 2010, it has grown to 112 million – a rise by a factor of three. During the same period, the real GDP *per capita* has risen by a factor of 2.6. As a result, the absolute size of the economy has grown by a factor of 8. Hence, a debt of 80 percent of GDP in 2010 will become 10 percent of GDP if the economy keeps growing as it did in the past fifty years if measured in terms of the GDP of 2060.

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Appendix A: Estimating the distribution of future cost of pension

Here we explain how the fiscal cost of ISSSTE has been calculated in our model. For the other systems, it is done in a similar fashion. The pension calculation is done using the standard methodology (see, for example, Winkelvoss, 1993). However, because of the existence of the social quota and the minimum pension guarantee, the formulas had to be modified.

For calculating the fiscal cost of ISSSTE, we calculate the following components.
FC = PJR + B + CPMG

Where
FC = Fiscal cost.
PJR= Actuarial present value of the pension liability in a pay as you go system.
B = Present value of the recognition bond.
CPMG = Present value of the minimum pension guarantee.

To calculate PJR

Consider a worker who is at age x, retiring at age r.
Worker aged x has a wage of w(x) which gets adjusted by an experience factor of t years, g(t). Thus, the wage of a worker aged x with t years of experience is given by $w(x)g(t)\ \ a<x<r$ where a is the age at which a worker starts in the system.

The retirement benefit is calculated by using a factor *f* so that the projected benefit for a worker at retirement with t years of experience is given by:
$f \cdot w(r) \cdot\ g(t)$

The contribution required by the terminal reserve method at time t is calculated as ${}^{T}P(t)$. It is the present value of future retirees who get to age r. Let $\ddot{a}_r$ denote the present value of an (anticipated) annuity at age r.

Let $l(r,t\text{-}r+a)dt$ be the total number of workers who have achieved the age r during t and t+dt. Therefore, we can write the reserve as follows:
${}^{T}P(t)= f\, w(r)g(t)\, l(r,t\text{-}r+a)dt\ \ \ddot{a}_r$

For our purposes, we construct a matrix L that runs on two dimensions: years of service and age. For each worker, we have information along those two dimensions. Each entry of the matrix is given by $l(x_i , y_j)$ where x_i the age and y_j is the years of experience. For our data, x_i takes values between 18 and 85 years and y_j takes values between 0 and 55.

We express all the salaries in terms of multiples of minimum salary denoted by a variable k. Tus, a worker aged x_i and years of service y_j with an income *k* times the minimum salary will be denoted by $w_k(x_i , y_j)$ con $k = 1,2,3,\ldots,16$ y with a growth in salary by a factor $g(t)= (1+\Delta w)^t$.

The pension adjustment factor (*f*) is 100% at age *r* is equal to $(x_i + (30 - y_j))$ for men and $(x_i + (28 - y_j))$ for women.

Finally, the actuarial present value of all the workers who get to the required number of years (AR) to get the benefit at time t is calculated as follows:

$$^{T}P(t)= \sum_{K=1}^{16} \sum_{i=18}^{85} \sum_{j=0}^{55} w_k(x_i , y_j)\ (1+\Delta w)^{(r-yi)}\ l(x_i , y_j)\ \ {}_{AR-yj|}\ddot{a}_{xi}$$

Where ${}_{AR-yj|}\ddot{a}_{xi}$ is equivalent to a deferred annuity by AR – y_j that represents the years left for the workers to complete 30 years for men and 28 years for women.

To calculate B

The bond is valued using UDIS (an inflation indexed bond) for the transition generation. This is the explicit debt that the government acknowledges. Note that for the transition generation in IMSS, no such explicit recognition takes place. The value of B is calculated as follows:

$$B = (12 + A)\cdot w \cdot f \cdot \cdot V^{z-x}$$

Where
A = Annual "Bonus" called Aguinaldo
w = Base salary (at the time of the switch over)
f = Factor of adjustment according to Article 63 y 83 of the ISSSTE Law
x = Current Age
y = Number of years served at the time of the switch over
z = Age at retirement, that is calculated as follows

$$z = \begin{cases} x \quad if \quad x > 55 \\ \min(55, x + (30 - y)) \quad if \quad x \le 55 \end{cases}$$

and

$$V^x = \left(\frac{1}{1+i}\right)^x$$

i = interest rate to calculate the discount factor.

For determining the value of the bond, we construct the age versus experience matrix M, where each element $m(x_i , y_j)$ represents a person of age x_i and experience y_j . x_i takes values between 18 y 85 years and y_j takes values between 0 and 55 years.

Thus the worker of age x_i and experience y_j with income $w_k(x_i , y_j)$ will be entitled to:
$B_{i,j} = m(x_i , y_j) \cdot (12+a) \cdot w(x_i) \cdot f \cdot V^{z-xi}$

To calculate CPMG

The minimum pension is calculated as follows:

$CPMG = Max\{0, PMG – MC\}$
Where
PMG = Minimum guaranteed pension.
MC = Amount the worker has accumulated in the individual account. The method of calculating MC is explained below.

The *PMG* is equivalent to 3,034.20 pesos per month in 2007 and adjusted according to the consumer price index (INPC) over time. To calculate MC, we have assumed that the

rate of return is the same as the average historic return of the basic AFORE (SIEFORE Number One) and charged a fee of one percent of the balance (the actual charge of the PENSIONISSSTE during 2007-2011).

To calculate MC

Contributor	% of base wage
Employer	5.175%
Employee	6.125%
Social Quota	5.50%[1]

For the worker aged *x* and *y* years of experience, balance in the account is given by

$$MC = (11.30\% * SBC * \mathrm{I}\ddot{a}_{\overline{x:z|}}) + CS$$

Where

MC = Present value of the balance calculated at the time of retirement
SBC = Base Salary
$\mathrm{I}\ddot{a}_{\overline{x:z|}}$ = Increasing temporal annuity
CS = Social Quota

where

$$\mathrm{I}\ddot{a}_{\overline{x:z|}} = \sum_{K=0}^{z-1} (1+r)^k (1+\Delta w)^k v^k {}_k p_x$$

And Δw is the rise in wage and ${}_k p_x$ is the k year survival probability of a worker aged x. Note that the survival probability here refers to survival in the ordinary mortality sense multiplied by the resignation and the firing of the employees.

The value of the social quota:

$$CS = 5.5\% * SM97 * 360 * I\ddot{a}_{\overline{x:z|}}$$

$$I\ddot{a}_{\overline{x:z|}} = \sum_{K=0}^{z-1} (1+\inf)^k v^k {}_k p_x$$

On the other hand, minimum guaranteed pension is calculated as follows

$$PMG = 12 * 3{,}034.20 * {}_{AR-y}\left| I\ddot{a}_{\overline{x:z|}} \right.$$

$${}_{AR-y}\left| I\ddot{a}_{\overline{x:z|}} \right. = \sum_{K=0}^{z-1} (1+\inf)^k v^k {}_k p_x$$

[1] Percent of minimum wage in Mexico City, adjusted upward with the consumer price index.

Appendix B: The projection with uncertainty

Our projections shown in the main text is the result of the mean of a set of simulations done with our population projected into the future. We have therefore calculated the upper 95 percentile of our distributed future paths along with the lower 5 percentile. In what follows, we report these numbers over time. The variability is generated by calculating the variability of the population in IMSS and ISSSTE over time.

Figure B1: Total Pension Liability of the six entities with distribution of uncertainty

Figure B2: Pension Liability of IMSS with distribution of uncertainty

Figure B3: Pension Liability of ISSSTE with distribution of uncertainty

Figure B4: Pension Liability States with distribution of uncertainty

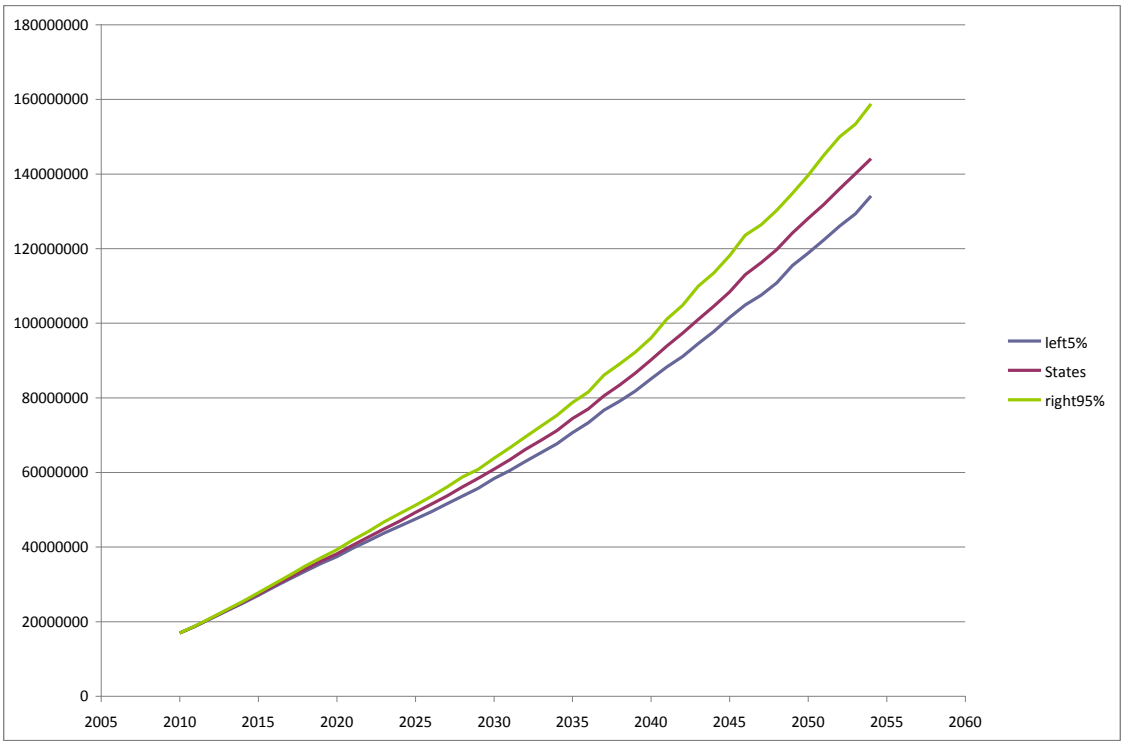

Figure B5: Pension Liability of RJP-IMSS with distribution of uncertainty

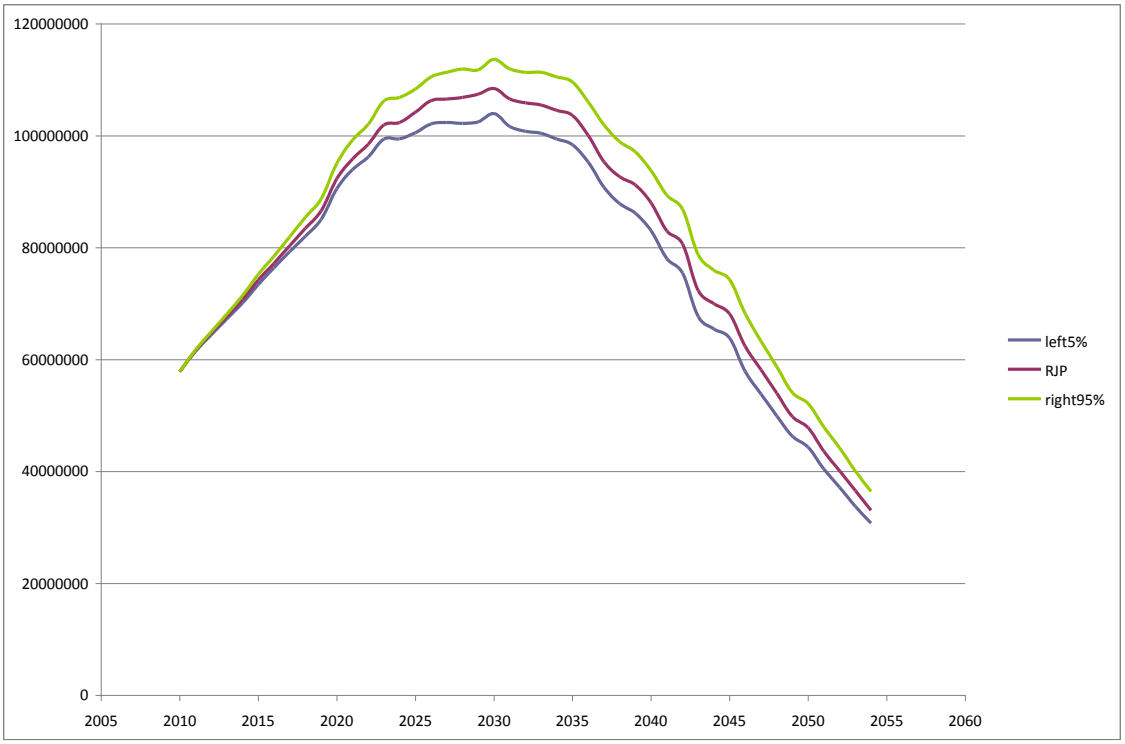

Figure B6: Pension Liability of PEMEX with distribution of uncertainty

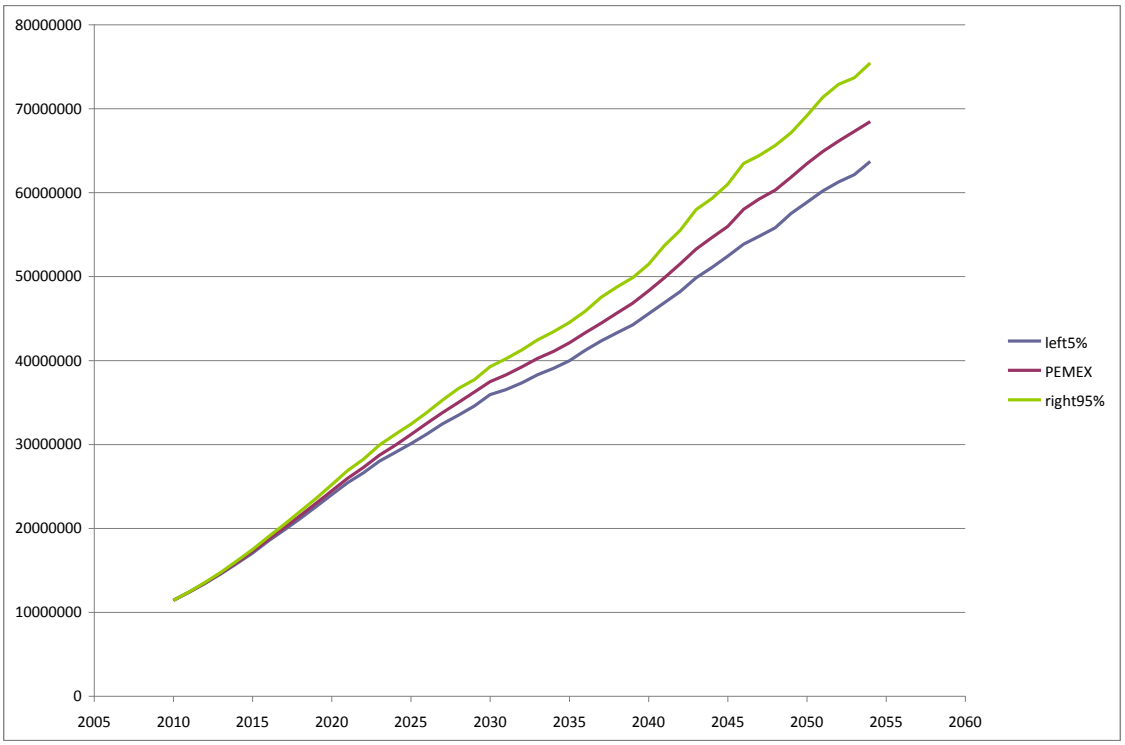

Figure B7: Pension Liability of ISSFAM with distribution of uncertainty