REVISTA MEXICANA DE ECONOMÍA Y FINANZAS
Nueva Época
REMEF
(THE MEXICAN JOURNAL OF ECONOMICS AND FINANCE)

Revista Mexicana de Economía y Finanzas
Nueva Época

Volumen 15 Número 3, Julio - Septiembre 2020,
pp.375-394

DOI: https://doi.org/10.21919/remef.v15i3.461

(Recibido: 2/diciembre/2019, aceptado: 25/mayo/2020)

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Competitiveness of Mexican pension funds and regulatory policy

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Abstract

The competitiveness of Mexican mandatory retirement funds and the impact of public debt on returns are evaluated in this essay. Detailed calculations of commissions and rates of return are developed and related to rates paid by federal bills. Fixed effect and SUR regres-sion models are used to measure the impact of public debt on returns. Results show the fol-lowing: (a) these funds are the best savings options available to workers; (b) all providers have converged to similar commissions measured in pesos; (c) historically, returns have been very similar across providers; (d) the risk of significant losses is present due to inadequate diversification; and (e) a heavy public debt induces lower returns. The main public policy recommendations are (a) a lighter public debt and international diversification can improve yields, and (b) workers must be informed of the money value of commissions. Additional research is needed to measure the issues for workers of different wage levels and intensity of participation (given high levels of informality). Detailed calculations of commissions, rates of return, and the impact of public debt are the original contributions of this research.

JEL Classification: H55, O12, O23, G28, J38, O54
Keywords: SIEFORE, AFORE, Mexico, Pension funds, Retirement

Competitividad de los fondos de pensiones mexicanos y política regulatoria

Resumen

Se evalúa la competitividad de los fondos de pensión obligatorios mexicanos y el impacto de la deuda pública sobre los rendimientos. Se calculan detalladamente comisiones y tasas de rendimiento, y su relación con tasas pagadas por bonos federales. Mediante modelos de regresión de efectos fijos y SUR se mide el impacto de la deuda pública sobre los rendi-mientos. Los resultados muestran que: (a) estos fondos son la mejor opción de ahorro dis-ponible para los trabajadores; (b) los proveedores convergieron a comisiones similares medi-das en pesos; (c) los rendimientos son históricamente muy similares entre los proveedores; (d) el riesgo de pérdidas aumenta por una diversificación inadecuada; y (e) una mayor deu-da pública bajo los rendimientos. Recomendaciones de política pública: (i) un menor peso de la deuda pública y diversificación internacional pueden mejorar los rendimientos; (ii) los trabajadores deben ser informados del valor monetario de las comisiones. No se estudian los efectos sobre trabajadores de diferentes niveles salariales o el rol de la informalidad. El cálculo detallado de comisiones, tasas de rendimiento e impacto de la deuda pública, es una contribución original.

Clasificación JEL: H55, O12, O23, G28, J38, O54
Palabras clave: SIEFORE, AFOREs, México, Fondos de pensiones, Jubilación

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Sin fuente de financiamiento para el desarrollo de la investigación

1 Introduction

We study the competitiveness of the Mexican pension funds that operated within the social security system over the 1997 to 2019 period. The criterion of evaluation is the rate of return compared with investment options available to workers and pension funds. We also study whether government indebtedness affects the rate of return.

The rate of return is the primary variable in several domains. Related to the founda-tional goal of any pension system, it affects the value available to pay for retirement, disa-bility, and survivors' pensions. A closely related issue is that national governments usually provide guarantees on minimum pension values, and the rate of return correlates negatively with the contingent public debt (i.e., a weak performance increases the cost of guaranteed benefits). Further, from a general equilibrium view, when governments issue debt that pen-sion funds buy in substantial amounts, pay-as-you-go elements are preserved and capitaliza-tion goals are diminished. These outcomes can affect short- and long-term interest rates (inclusive of inflationary effects) in the macroeconomy.

The purpose of this evaluation is to understand whether pension funds perform ben-eficially, providing workers with a savings vehicle with favorable cost-benefit outcomes. Such an analysis requires purging observed returns from variations due to global market changes (such as safe-asset returns) as well as to the effect of commissions. Volatility may play a role in the evaluation. However, by itself, high variability does not represent a social cost; it may even provide opportunities for higher long-term average returns. However, vol-atility concentrated in specific periods or on specific workers may undermine the goal of making social security a safe vehicle for canalizing labor productivity towards retirement earnings.

Previous research has pointed out to a very high correlation between fund returns net of commissions offered by different managers and to the low and inefficient response of workers to the commission-return packages, but the focus is on after-commissions re-turns. Our research includes detailed calculations of the peso value of commissions, which allows for exact calculations of the value of funds and returns that are affected by commis-sions. Section 2 reviews the general problem and previous literature. Section 3 describes the data and the methods employed, section 4 models the relationship between the return in pension funds and market interest rates, and section 5 presents policy recommendations.

2 Issues and previous literature

Social Security reform established an individual retirement account (IRA) scheme as the primary platform for the pension system that was debated in Latin America between the 1980s and 1990s. The Mexican reformed system began operating in July of 1997, with the first significant money flows entering the fund managers by September of that year. The motivations for reforms included decreasing the fiscal deficits that arose in the old state-managed pay-as-you-go schemes, improving incentives to participate in social security in light of the high informality rates in labor markets across the region, increasing national sav-ings, improving services to workers, reducing the wage gap (the difference between the cash cost of a job for the employer and the cash taken by the worker), eliminating inflexibil-ity in the labor market due to the tie between pension schemes and employment, and im-proving management by placing funds out of the reach of governments, which lends credi-bility to the system (IMSS, 1996 and Camara de Diputados, 2007).

Social security is a scheme of forced savings to solve a common problem (Mulligan and Sala-i-Martin, 1999). Yet, fund management can be decentralized to private fund man-agers. Probably, as Becker (2005) suggested, governance issues motivate reforms. While "there is no magical gain in privatizing" social security because "the services provided by a public agency or a private pension fund are the same," he argued, there

is also no magical gain in privatizing a government steel plant since steel has to be produced, yet there are good reasons to privatize steel." Thus, reforms retained the mandatory saving approach, but they abandoned the public-vertically integrated model to allow private management of funds (although not of the insurance scheme per se). However, the decentralization of fund management is only justified if improved returns are forthcoming.

A primary goal is to provide workers with certainty about the value of their savings, including their investment rates of return. Thus, this evaluation addresses the following questions: How do social security-linked pension funds compare with the investment op-tions available during the period? Is the return on pension funds affected by public debt?

The AFORE fund management corporations were created under the Social Security Law of 1995. SIEFORE are mutual funds managed by an AFORE corporation that re-ceives mandatory retirement savings. Each AFORE manages SIEFOREs in a strict vertical integration framework. Workers cannot choose to invest in a fund not managed by the AFORE, where their account is open. Workers must choose an AFORE, or they are as-signed one by the regulator. Competition between AFOREs should result in similar returns across funds. However, regulation in the Mexican market creates confusion among savers and because competition does not seem to have produced price signals to guide consumers towards better choices (Duarte and Hastings, 2012; Grubb, 2015; Calderon-Colin et al., 2010).

Relatedly, Ramirez and Rochin Ruiz (2014) posited a model in which the AFOREs compete oligopolisti-cally for the business of workers who are not sensitive enough to in-duce a competitive result. De la Torre et al. (2018) found SIEFORE betas to be near unity, which means that, after commissions, returns across suppliers are similar over time. On the other hand, Aguila (2011) argued that workers value their savings at the AFOREs. Conse-quently, they reduce other savings, which means that they assign a shadow rate of return to the funds. Therefore, inelasticity in responding to the relative rates of return does not mean that workers do not value saving or that they do not significantly adjust their behavior to the value of their savings.

In competitive markets, shadow prices and market prices are the same, so achieving adequate price measurements should be a regulatory priority. Using returns on alternative investments as the standard, we examine the efficiency of funds at achieving that goal. Funds face a market with two main risks: interest rates and foreign exchange rates. Since this is a regulated market, the funds may be forced to buy public debt at maturities that may not be demanded otherwise and to buy some private debt that an unregulated fund may not be willing to take.

The issues have macro implications. Data from Banco de Mexico (2019) informs that pension savings are a significant part of the Mexican financial system and are, overwhelm-ingly, the way workers are saving for the long run. In September 2019, commercial banking had deposits from the non-banking private sector of $4.4 trillion, of which only $2.5 trillion came from individuals, most of it through the payroll-debit card channel, while SIEFOREs had deposits for $4.1 trillion. In the insurance industry, total assets were $1.2 trillion, and insurers specialized in pensions had $0.32 trillion (this money originates in transfers from a pension fund to an insurer after a disability or death event).

However, most of the SIEFORE investments are in government debt. 2020 SHCP data show that public debt rose from 1.6 to 9.2 trillion pesos (0.15 to 0.50 trillion dollars) between the September 2008 global financial panic and December 2018. Further, domestic debt as a share of total debt went from nearly zero after the 1994-95 “Tequila crisis” to more than 80% by 2008, and it has fluctuated at around 60% since 2009. The average dura-tion of the debt extended from 33 days in 1997 to more than 2,800 days by 2013 (and has remained in the 2,800-2,900 range since then). Despite the substantial increase in debt, the annual cost of paying it fell from 3 percentage points of GDP in 2000 to 1.9 between 2011 and 2014. The cost rose again to

2.7 by 2019. Low global interest rates and the possibility of selling long-term bonds to the AFOREs played the leading roles in the initial drop in the cost of debt. Yet, by Valentine's day of 2016, the cost of debt began to increase signifi-cantly because the interest rates paid on the public debt increased. Rates on 28-day CETES rose from 3.08 to 6.99% in 18 months, and 1-year rates rose from 3.58 to 7.25. The years following February 2016 brought increased volatility to SIEFORE share prices because the heavy load of long-term bonds means that each interest rate increase generates losses in pension funds. Thus, we investigate the effect of public debt on the real returns of these funds. Martinez-Preece et al. (2019) also found that global economic events affect pension funds and that the SIEFORES have entered an environment of increased risk since October 2008.

The OECD (2015) report on Mexico's pension policy argued that "[n]et returns in SIEFORE compare well with returns on other OECD countries." However, the OECD em-ploys the CONSAR net returns data, which do not correct adequately for the cost of com-missions (CONSAR is the National Commission of the System of Savings for Retirement). The OECD (2015) also argued that the

> . . . investment regime is in accordance with the OECD guidelines . . . As members get older, their pension assets are invested in a more conservative investment regime, with lower exposure to equity and a greater proportion of fixed-income instruments, to reduce the volatility of their returns.

However, while bond returns are less volatile than returns on stocks under certain assump-tions, investing in long-term and low-grade bonds can turn out to be risky. OECD's ana-lysts have found that SIEFOREs are over-concentrated in bills and bonds and have argued that regulations preclude diversification and choice. Mexican pension funds that invest in foreign assets face a restrictive regime. Most OECD countries, by contrast, do not place limits on investment types, and among those that do set limits, Mexico is the most restric-tive. As Martinez-Preece et al. (2019) pointed out, the regulation-to-risk analysis applied by CONSAR is not adequate to measure the mid- and long-term risks that are relevant for holders of pension funds.

Laws and regulations aim to achieve competition through managed mechanisms: the government provides information on net returns to the public, approves fees ex ante, and regulates the worker's choice of provider. There is no policy to facilitate entry, promotional activities are limited, and pricing policies are precluded (for example, two-part pricing). Therefore, the number of providers has shrunk. Indeed, there have been no new providers since 2007 (except one entering through an acquisition), and political negotiations over fee reductions are the primary strategy used to reduce the cost of the system. The regulator em-ploys the next list of criteria to settle decisions on commissions (article 37 of Ley del Siste-ma de Ahorro para el Retiro, SAR): the value of assets, the cost structure, the commissions of other providers, and whatever else the regulator considers pertinent.

Additionally, commissions are approved once per year for all providers simultane-ously. Two peculiar rules in the SAR law are that increases in commissions above the aver-age authorized for other suppliers are not allowed and that providers are not permitted not to apply for a new tariff. If an AFORE does not apply in a given year, it must charge the lowest commission. Thus, the legislation provides a favorable setup for price coordination. The Board also regulates maximum and minimum commissions.

The pension system operates under parameters defined in the social security law that determine the limits of IRA inflows. Contribution rates for retirement are 6.5% of taxable salaries plus a social fee (cuota social). In 2020, that fee was between 4.8 and 4.0% of min-imum wage and was paid by the federal government to workers earning up to the equiva-lent of 15 minimum wages. There is an additional 5% contribution to the "housing sub-account," managed by the National Housing Fund (INFONAVIT), that serves to finance pensions and must be considered in any calculation of the value of the funds available to finance the mandatory retirement account. There is also a 2.5% rate to finance disability and life insurance.

Thus, total contribution rates for retirement are between 16.3 and 11.5% of taxable salary, but five percentage points do not go to the SIEFORE. Also, the housing sub-account can be used to finance the purchase of a home, but a worker using those funds will end up with lower savings than a worker with identical wages not using the housing facili-ty. We will present calculations that include and exclude the housing fund. There is an agency problem because some workers may find that the purchase of a house is partly free since government guarantees on pension values compensate for the funds used.

Another distinctive feature of the system is a notch in the calculations of value: workers registered before July 1997 can choose between the "1973 Law" pension and the "New Law" pension. Under the 1973 pension law, the government appropriates IRA funds in exchange for the pension. Thus, these individuals have an added option value on their savings that induces a moral hazard: workers with access to the benefits of the 1973 law may find it profitable to reduce their contributions or contribution periods if the likelihood of saving enough under the new law is low (because the government will take over those savings). Similarly, the AFORE managing the funds in such a situation knows that losses will be passed to the federal government, so high commissions or risky investment strategies are cost-free for them and their clients.

A detailed consideration of the complexity of the system cannot be pursued due to data limitations. No micro databases link the housing fund, and no public databases link the social security and AFORE records of individuals. To achieve meaningful results, we fo-cused on the results for a worker of average wage contributing to the system since its incep-tion in July 1997.

3 Data and methods

3.1 Data

Our calculations involved the cash flow from payrolls to pension funds, the cost of commissions, and the parameters that define the investment options. They start in Septem-ber of 1997, when the first contribution to the AFORE was made. When applicable, we used the national consumer price index to index for inflation.

Data on SIEFORE share prices (CONSAR, 2019a), interest rates, and exchange rates (Banco de Mexico, 2019) are reported daily. Other data are reported monthly. To match daily data with monthly data, we used the last working day of the month. SIEFOREs have four primary funds, which are indexed from SB1 to SB4 according to the target age group. SB1 is used for workers 60 years and older; SB2 is for those between 46 and 59 years old; SB3 is for those between 37 and 45; and SB4 is for those 36 and young-er. In the first years, there were only SB1 and SB2 funds, and the SB2 funds still held 45% of the assets by 2019. We concentrated on the SB2 funds and on the five firms that have operated since 1997.

The measure of a risk-free asset is the 28-day federal government bill (CETES), which is the more liquid paper in the Mexican market. We also used data for CETES at ma-turities of 91, 182 and 364 days; there were four missing values relatively early in the period for data at 182 and 364 days of maturity, which we filled linearly. The latter issue reflects the hardship that the government faced selling bills at extremely short maturities during the 1990s.

To measure foreign investment opportunities, we used the SP500 index, for which highly liquid investment opportunities are available, including funds traded in the Mexican financial markets.

To model payroll, we used data on monthly taxable salaries reported by the Social Security Institute (IMSS, 2019). Hourly wages are uncommon in the Mexican labor market, as the more usual arrangement is the payment of a salary each day. Thus, taxable salaries are daily salaries adjusted by mandatory benefits, and employers usually pay for weekends and holidays (proportionally for non-full-time workers). Therefore, we multiplied daily taxable salaries by 30.4 to obtain monthly salaries. Taxable salaries are capped at the

equivalent of 25 times the minimum wage. The average taxable salary during the researched period was 4.08 times the minimum.

Data on commissions is available from CONSAR (2019b), which also publishes an index of net return (IRN). Data on returns to housing sub-accounts were taken from IN-FONAVIT (2018, 2019a) and Villagomez (2001). There are 24 AFORE in the CONSAR records. Five have data for the entire period of 21 years and 5 months. Others were short-lived, and four have data for more than 10 years; however, these merged with other firms by 2019. Thus, we had an unbalanced panel, with some entities having 257 observations and one entity having only 172 observations. We had no full data for some of the defunct corporations. The AFORE XXI, the largest one, is the result of a merger; the pre-merger correlation of prices was 0.997, and we consider this as a single corporation for our purpos-es.

3.2 Identification

We are interested in measuring the impact of public debt on the real returns of pension funds. The general strategy is to measure the deviation of returns from a standard and investigate whether it is affected by public debt. We present careful calculations of contributions and net returns. We also needed to purge the returns that SIEFOREs pay from the yields on government debt and the fixed effects of the return in each firm and investigate whether the residual correlates with government debt. We interpreted an affirmative answer as evidence of the public debt causing variations in the real return of the SIEFORE.

From the standpoint of individuals, before the individual becomes eligible for retirement, SIEFOREs' shares are bonds that mature at retirement. Investor-workers have different ages and expected ages of retirement, making it difficult to pin down an average expected maturity for a fund. We model the monthly rate of return of each SIEFORE (r_{it}) as the return on one-year government bills (r_t^g) plus a SIEFORE specific risk premium (L_{it}), as seen in equation 1. We use the one-month bill as the risk-free asset because it is the most liquid in the Mexican market. On the other hand, the return on a government bond of maturity k is formed by the expected return of short-term bonds and a term-specific risk premium L_t^g, as seen in equation 2.

$$r_{it} = r_t^g(k) + L_{it}(k) \tag{1}$$

$$r_t^g(k) = \frac{1}{k}\left[\sum_{j=1}^{k} E_t r_{t+j-1}^g(1)\right] + L_t^g(k) \tag{2}$$

Merging equations 1 and 2, we obtain a relation between the SIEFOREs rates and public debt rates:

$$r_{it} = \frac{1}{k}\left[\sum_{j=1}^{k} E_t r_{t+j-1}^g(1)\right] + L_t^g(k) + L_{it}(k) \tag{3}$$

We obtained short-term rate forecasts and used them to construct the first term on the right side of equation 4, which comes from equation 3 for the terms k and k=1. To forecast, we used two specifications; one is a dynamic model of the 28-day CETES rate, the other is the actual (future) rates. The public debt premium is, thus, estimated as the observed difference $\hat{L}_t^g(k)$:

$$\hat{L}_t^g(k) = r_t^g(k) - r_t^g(1) - \frac{1}{k}i = 1k - 1j = 1kEtrt + jg \tag{4}$$

Putting the pieces together, we reach equation 5. The firm-specific variable, $L_{it}(k)$, is not observable, but it should not be correlated with government debt. It could be different across firms for a variety of reasons, such as lack of competition, differences in the profile of clients that lead to different investment

strategies, slow response of worker-investors to relative returns. Thus, a finding of a significant negative effect of government debt when we add it as a variable in a regression model would support the hypothesis that there is a negative effect of debt on the rate of return on pension funds.

$$r_{it} = \frac{1}{k}\left[\sum_{j=1}^{k} E_t r^g_{t+j-1}(1)\right] + \hat{L}^g_t(k) + L_{it}(k) \tag{5}$$

In summary, the rate of return in a SIEFORE is a function of short-term rates in government bonds plus the risk premium of the k-period bond, and the SIEFORE fixed effect.

To evaluate equation 5, we use SUR and fixed effects models, adding the total public debt as a variable, under the hypothesis that public debt should not affect the results (i.e., should be uncorrelated with returns). The main difference between the two models is that while SUR allows the firm-wise calculation of coefficients and the same-period covariation of errors, the fixed-effect model allows the use of firm-clustered time-related errors but assumes the independence of the errors across entities. The nature of the unobservable $L_{it}(k)$ gives some support to each approach: it makes sense to expect contemporary covariation in unobservable factors affecting returns across firms (which support the use of SUR), but within-firm returns may also have a serial correlation due to slowly changing portfolios. We perform calculations using both approaches, which support the use of a fixed-effects model that allows for a calculation of standard errors that is robust to heteroskedastic mistakes (i.e., within-entity serially correlated errors).

The heuristics are that funds have as floor the return on government bonds and should not do worse than that.

3.3 Scoring the system

This section describes the evolution of the value of pension funds, their real returns, and the way that public debt has interacted with them. We produced detailed estimates of the value of funds for workers who contributed continuously since 1997; future research will address the impact of incomplete labor careers on the value of funds.

The total value of the fund at time t for a worker with a wage and participation his-tory w(t),I(t), in the absence of commissions, is shown in equation 6:

$$V_T(t+1) = [\tau w(t) + \tau_s w_M(t)] I(t) + V_p(t)[1 + r_p(t)] + \tau_h w_M(t) I(t) + V_h(t)[1 + r_h(t)] - C(t) \tag{6}$$

Indexes h and p identify housing and pension funds, T represents their sum, and r refers to the rate of return. Social security tax rates did not change during the period ($\tau = 6.5\%$). The system includes a social fee paid by the federal government to each fund, which we set at a 5.5% rate (τ_s) applied to the inflation-indexed minimum salary wm in July 1997 (adjusted in February of each year). The social fee was made progressive after a 2007 reform, but we do not model that detail. The function $C(t)$ measures the use of the housing fund; it is the result of the flow of credit received and paid, and we do not attempt to model it in detail because public data on its components do not exist.

SIEFORE share prices allow the direct calculation of returns after commissions. Also, CONSAR (2019a) provides a history of AFORE commissions. Between 1997 and 2003, the regulation changed from a relatively free pricing framework to one of stringent control. AFOREs were free to adopt any combination of percent charges on deposits, assets, or real returns. Most had a two-part commission, charging a percentage on assets and a percentage on the flow of new savings. Only one had a commission on real returns. By 2003, commissions on real returns disappeared, and, since 2008, only commissions on asset values have been allowed.

A proposed reform may allow more flexibility in the future.

To calculate the value of the funds after commissions (equation 7), let $cV(t)$ be the percent commission charged on the value of the fund, $cw(t)$ the commission charged on the value of contributions, and $cr(t)$ the commissions charged on real returns. $I_{\pi}(t)$ is an index function that takes the value of unity if real returns are above inflation and otherwise equals 0:

$$V_T(t+1) = [1 - c_w(t)][\tau w(t) + \tau_s w_M(t)] I(t) + V_p(t)[1 - c_V(t)][1 + r_p(t)]$$

$$- c_r(t)[r(t) - \pi(t)] V_p(t) + V_h(t)[1 + r_h(t)] - C(t) \quad (7)$$

Calculations were made for a worker earning the average taxable salary, with depos-its accruing interest beginning the first day of the month after the obligation to contribute is met. These calculations are not exact because deposits can be made up to the 17th of the month and are bimonthly. However, we ignored this variation because the effect is small. When commissions were charged on real returns, we assumed that accruals were monthly and only relevant when returns were positive.

We used data on the five AFORE that have operated continuously. Our calculations represent the AFORE's actual take. The CONSAR Index of Net Returns refers to moving averages of returns after commissions and is not useful for obtaining the calculations pre-sented below. CONSAR information is confusing because it is based on the market prices of the shares of SIEFOREs and not on cash flows entering the system and the part taken by providers. Neither the CONSAR nor the AFORE provides a money value on commissions. The information that the regulatory body offers to consumers is doubly misleading. First, the buyer of a financial service is interested in the return on the full cash amount invested. Second, the consumer is interested in how much money the service costs. Should banks inform them about commissions as a percentage of total deposits or withdrawals during the last three years? Such averages hide the costs of services and confuse consumers.

Figures 1.a and 1.b show the ratio of commissions to monthly contributions as a per-cent of monthly contributions and in money. For the average worker, there is a convergence to a commission on contributions of 20%, or 200 pesos per month (at January 2019 prices).

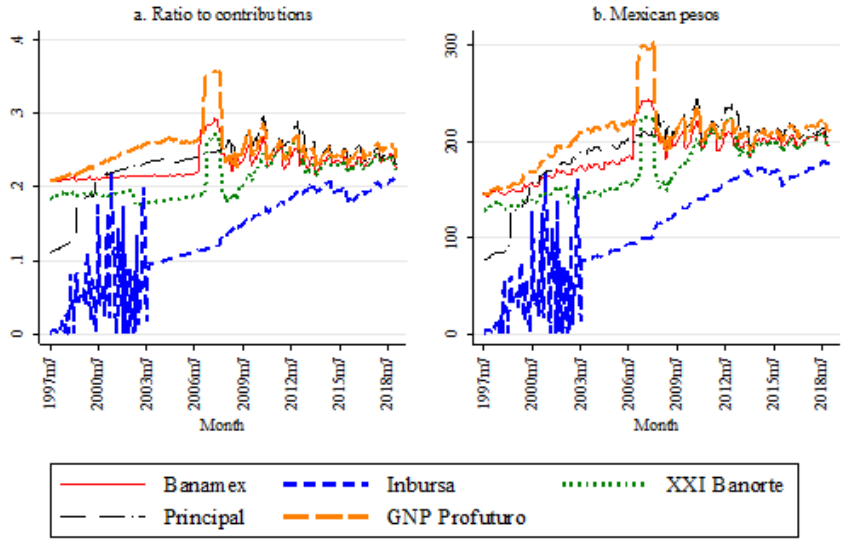


Figure 1. Monthly commissions as ratio to contributions and in money 1997-2019 SB2 funds
Source: Own elaboration

In Figures 2.a and 2.b, we see that regulatory changes forced a substantial conver-gence since 2003. We present data under two frameworks of time to underscore the initial differences and eventual merging of the commissions. In the first months of operations, the AFOREs took up to 20% of assets. By 2002 (5 years after the foundation of the system), most were between 3 and 4% of assets, and by 2012 they had all converged at around 1% (corresponding to approximately one-thousandth of assets per month). Currently, the regu-lator bases policy on a "commissions on assets," a non-stationary series that will be declin-ing for the foreseeable future. This decline will occur because, on average, the de-mographics of the labor force determine average asset growth for several decades (Mexico is a young country and fertility rates are above replacement, so the labor force will grow significantly in the long run). Thus, the regulatory goal of reducing commissions on assets is soft, because improvements are guaranteed even if costs do not fall.

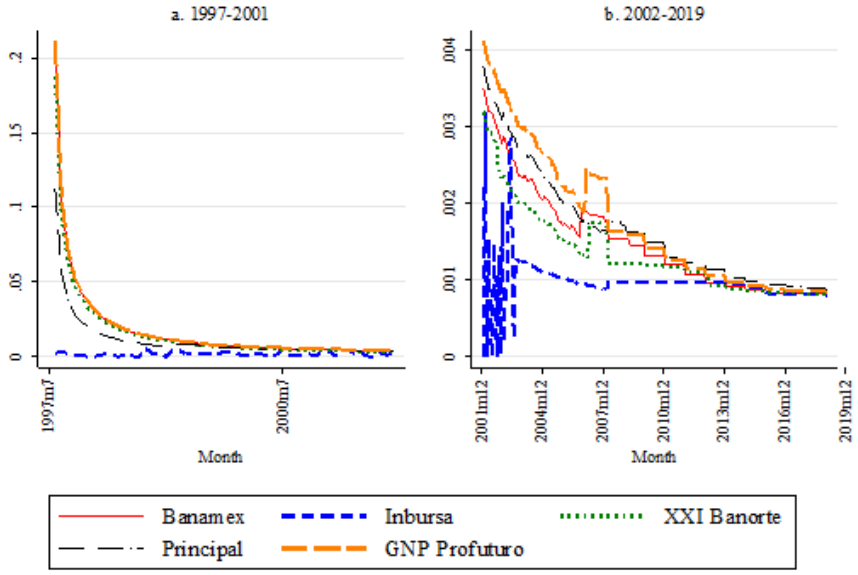


Figure 2. Ratio of total commissions to assets
Source: Own elaboration

The service that the system produces is the value of funds. Considering only the funds managed by the SIEFORE, Figure 3.a shows the value funds that would have ac-crued in the absence of commissions (Equation 6), and Figure 3.b shows the results after commissions (Equation 7). Figure 4.a shows the results with savings including the housing fund, when no mortgage is obtained (Equation 7 using C(t) = 0) and of the retirement fund invested at the largest AFORE; there is more money in the SIEFORE than in the IN-FONAVIT fund because contribution rates are higher for the first. Figure 4.b shows the ratio of values of pension and housing funds adjusted by the percentage of contributions; when the ratio is above 1, it indicates that the cumulated returns in the SIEFORE fund were higher. Conversely, when it was below 1, the housing fund paid higher cumulated returns. During the first ten years, SIEFOREs outperformed the housing fund, but since 2012 the housing fund has taken the lead. As shown in Figure 4, housing fund values are not fully funded; at the end of 2018, total liabilities were $1.132 trillion, but financial assets were only $0.166 trillion. The rest of the money—most of it earmarked for pensions—is to be paid from the INFONAVIT mortgage portfolio. This agency has reported large losses: according to the 2018 financial statement (INFONAVIT, 2018), its book value was $1.28 trillion, but $0.231 trillion was already written-off as unrecoverable, and $0.106 trillion was marked as non-performing. Thus, according to its financial statement, INFONAVIT was short at least $0.174 trillion to pay its "housing sub-account" obligations. In summary, the returns on this component of savings are subject to an idiosyncratic risk because the deci-sion on rates of return is discretionary (see p.

260 of INFONAVIT, 2019b). For example, INFONAVIT decided to set the rate at 8.32% for 2017 but only at 6.38% for 2018, even as 1-year government bonds were moving in the opposite direction (with average rates of 7.12% in 2017 and 8.09% in 2018).

The behavior of $V(t)$ by AFORE depends upon the investment strategies used. Fig-ure 5 shows that the trends and variation of share prices of SIEFOREs were similar for all fund managers except one.

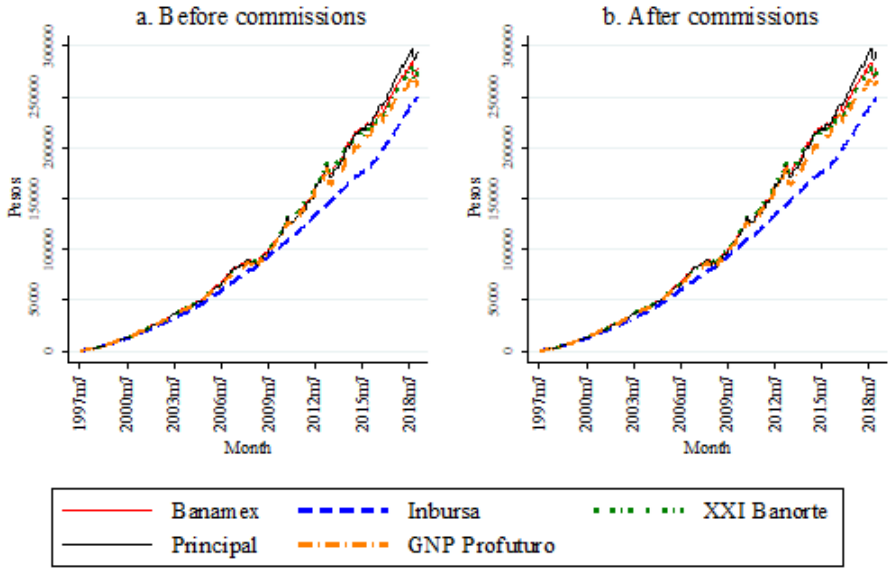
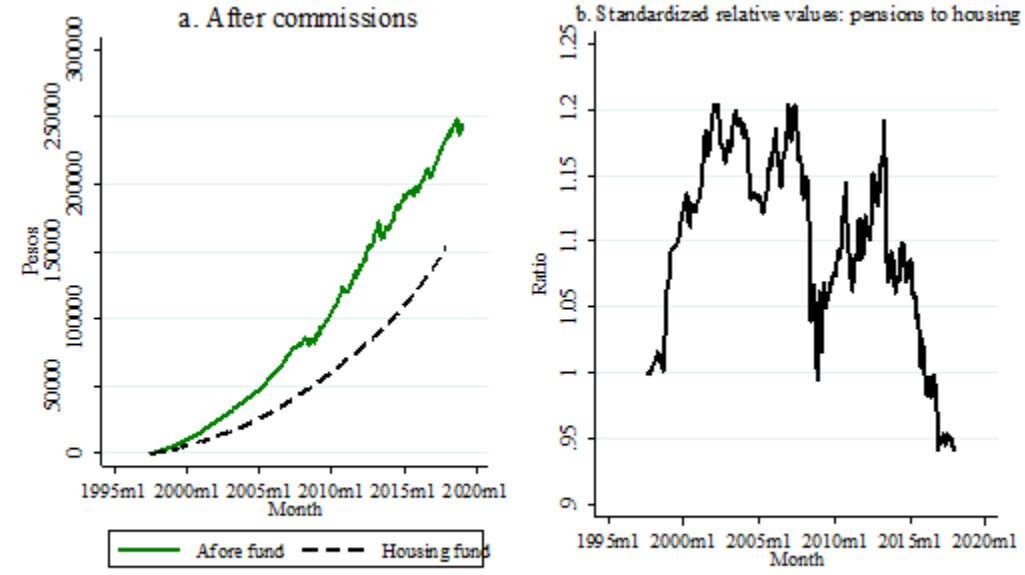


Figure 3. Value of funds SB2 fund and average salary worker

Source: Own elaboration



Note: SB2 fund of largest Afore and average salary worker; standardized values are the value of the fund divided by the rate of contribution.

Figure 4. Values of Afore and Housing funds and ratio of standardized values (pen-sion/housing)

Source: Own elaboration

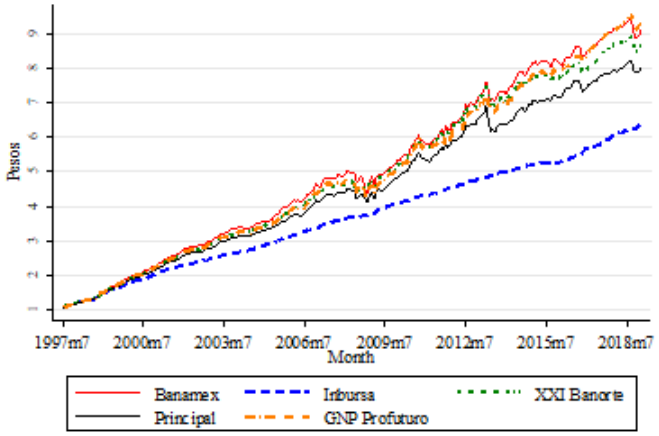


Figure 5. Market price of Siefores 1997-2019
Source: Own elaboration

3.4 Alternative investment strategies

The value of pension funds can be measured from different perspectives. One meas-urement used is the value of savings under the historical commission and investment strate-gies. Another is the historical profiles of the contributions. Alternative measurements are counterfactual since they assume strategies that were feasible but did not take place.

We explored the results of three investment strategies: (a) a historical SIEFORE; (b) Mexican government debt (a risk-free peso strategy); and (c) the SP500 index after chang-ing the inflow to foreign currency monthly (a dollar equity strategy). We have not even considered banking options because the rates were too low. Between 1997 and 2019, aver-age rates in banking deposits maturing at 91 days were 4.3%, compared with 8.4% for CETES of the same maturity (Banco de México, 2019).

The two low-cost counterfactual strategies are to invest in foreign assets and to in-vest in safe national assets. Figure 6 shows the results of investing passively in a large inter-nationally traded index (the SP500) and 28-day CETES. Investing in the SP500 industrial index would have resulted in a lower funds value throughout most of the period, but it would also have yielded significant gains in recent years following the substantial deprecia-tion of the peso and a boom in the American stock market. For investments abroad, contri-butions are exchanged at the interbank dollar rate, and the same rate is used to express the dollar value in pesos. Figure 7 shows the difference between historical values and those arising from the dollar equity strategy. The CETES strategy would have been the loser overall, as is evident in Figure 6. The difference in values yielded by different approaches is not small, ranging in the order of several thousand pesos up or down. The passive strategies under consideration are highly liquid, which means that the relative gains of SIEFOREs are smaller or their losses larger.

Regulation is based upon VaR statistics that cannot be deemed relevant for individ-uals because they measure maximum expected losses over a time scale that is usually much shorter than the retirement horizon. There are two main long-term risks for investments in pension funds in Mexico: the interest rate risk in government bonds and the exchange rate risk. The first risk is small. Given that AFOREs were required to hold most of their assets in such debt (54.7%) in the third quarter of 2019 (CONSAR, 2019b), managers cannot do much wrong. On other investments, the exchange rate risk has not been managed adequate-ly, as demonstrated by the wide variations in Figure 7. Of more concern is that the regula-tion allows "structured" and "securitized" investments authorized by the regulator and fi-nanced almost exclusively by the SIEFOREs (98.6% for structured and 68.0% for securit-ized investments; CONSAR, 2019b, Table 3.5). The result is a

moral hazard that cannot be resolved by regulating portfolios but only by taking the regulator out of the business of au-thorizing investments.

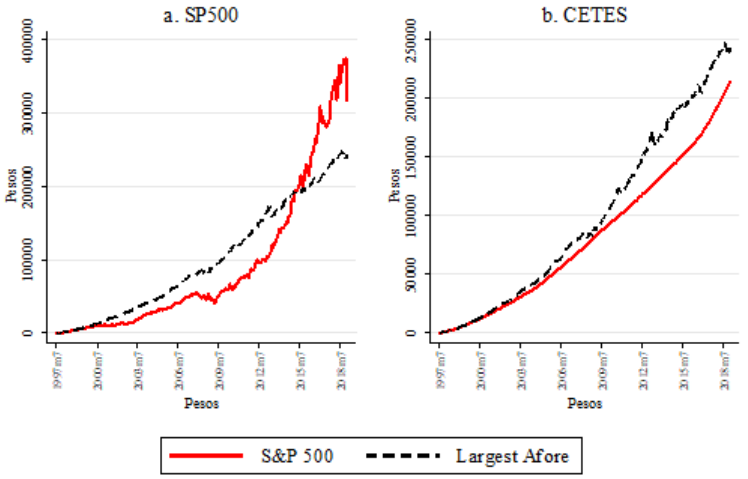


Figure 6. Counterfactual passive portfolios vs Siefore SB2 fund o flargest Afore-Mexican pesos
Source: Own elaboration

The calculations for the passive strategies assume the same costs and commissions as the existing investment strategies and regulations. Likely, passive strategies involve much lower administrative costs. However, AFOREs provide two services: account management and fund management. Account management refers mainly to the realm of customer ser-vice, such as providing account statements, updating information, and providing support to process social security claims. Customer service tends to have fixed costs per worker, and commissions cover those costs. IRAs are not conventional brokerage accounts because AFOREs must manage many of them with small and infrequent deposits. Current regula-tions assume that AFOREs are large enough to diversify the profiles of their clients and impose cross-subsidization because tariffs take a percent of assets regardless of the size of the individual fund.

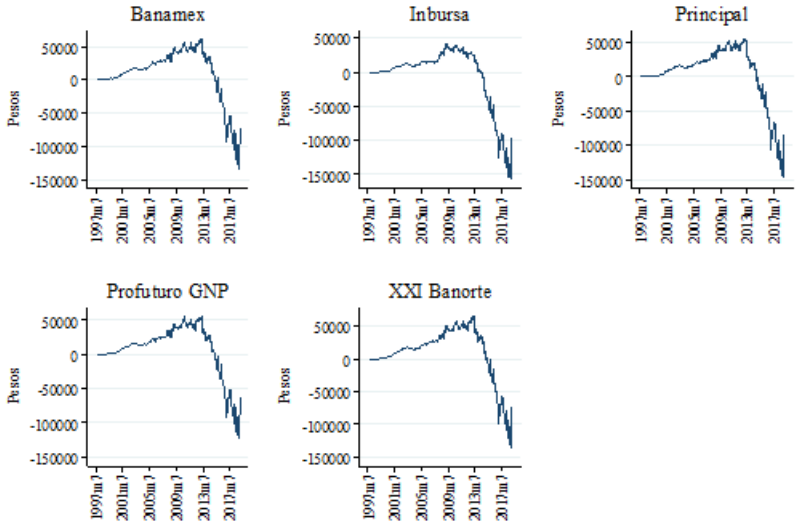


Figure 7. Difference between fund value and international option
Source: Own elaboration

4 Results

This section describes the analysis around interest rates on government debt and pension funds, which is in turn used in the regression analysis.

4.1 Returns on public debt

Forecasts of the short-term interest rates are required to relate returns on pension funds with the spread on interest rates at longer terms and purge entity-specific returns from market-wide returns. Table 1 shows the average real returns of SIEFOREs during three financial moments: the high-interest, 1997-2002 period; the low inflation-stable and declining rates period (2002-2008); and the post-panic near-zero real rates period (2009-2019). Table 1 also shows that the post-2008 volatility was significant, with monthly real returns often above 3% or below -3% during a period when annual real rates in government bills were hovering near zero.

Spreads between short-term and longer-term government bonds have been small and unpredictable: (a) spreads were not higher for longer government debt during the inflation-ary period; (b) spreads became smaller when inflation lowered; (c) during the post-panic period, the yearly gains for investing in one-year Cetes (above 28-day Cetes) were 0.4-0.5%, down from 0.8% during the inflationary period; (d) real one-month losses for invest-ing in long-term Cetes could be higher during the inflationary period; and (e) during the more recent period, one-month losses related to Cetes investment were as high for short-term bonds as they were for long-term bonds (Table 2).

Table 1. Real interest rates paid by SIEFOREs by monetary epoch

AFORE	Monthly average	Std. Dev.	Min.	Max.	Yearly equivalent in percentage rate
September 1997-December 2002: foundation, inflation (64 months)					
Banamex	0.0054	0.0094	-0.0185	0.0276	6.7%
Inbursa	0.0022	0.0043	-0.0134	0.0102	2.6%
XXI Banorte	0.0048	0.0096	-0.0200	0.0246	5.9%
Principal	0.0046	0.0092	-0.0193	0.0266	5.7%
Profuturo GNP	0.0047	0.0083	-0.0177	0.0227	5.8%
January 2002-August 2008: low inflation (68 months)					
Banamex	0.0032	0.0133	-0.0582	0.0335	3.9%
Inbursa	0.0019	0.0041	-0.0129	0.0128	2.4%
XXI Banorte	0.0030	0.0123	-0.0614	0.0269	3.6%
Principal	0.0026	0.0146	-0.0734	0.0345	3.1%
Profuturo GNP	0.0026	0.0122	-0.0612	0.0288	3.2%
August 2009-January 2019: post panic (125 months)					
Banamex	0.0007	0.0190	-0.0658	0.0760	0.8%
Inbursa	0.0000	0.0053	-0.0143	0.0131	0.0%
XXI Banorte	0.0008	0.0167	-0.0440	0.0569	0.9%
Principal	0.0013	0.0184	-0.0539	0.0660	1.6%
Profuturo GNP	0.0003	0.0170	-0.0640	0.0498	0.4%

Source: Own elaboration

Table 2. Monthly Cetes interest rates and spreads by monetary epoch

AFORE	Monthly average	Std. Dev.	Min.	Max.
September 1997-December 2002: foundation, inflation (64 months)				
Spread 91	0.00069	0.00045	-0.00018	0.00177
Spread 182	-0.00043	0.00651	-0.02925	0.00287
Spread 364	-0.00005	0.00664	-0.02925	0.00363
Cetes 28	1.2%	0.5%	0.5%	2.9%
Cetes 91	1.3%	0.5%	0.5%	2.9%
Cetes 182	1.2%	0.5%	0.0%	2.3%
Cetes 364	1.2%	0.5%	0.0%	2.3%
Cetes 28 real	0.43%	0.40%	-0.77%	1.41%
Cetes 91 real	0.49%	0.41%	-0.67%	1.46%
Cetes 182 real	0.38%	0.69%	-2.38%	1.46%
Cetes 364 real	0.42%	0.70%	-2.38%	1.46%
January 2002-August 2008: low-inflation (68 months)				
Spread 91	0.00015	0.00014	-0.00014	0.00056
Spread 182	0.00028	0.00027	-0.00023	0.00115
Spread 364	0.00043	0.00043	-0.00023	0.00173
Cetes 28	0.6%	0.1%	0.4%	0.8%
Cetes 91	0.6%	0.1%	0.4%	0.8%
Cetes 182	0.6%	0.1%	0.4%	0.8%
Cetes 364	0.6%	0.1%	0.5%	0.8%
Cetes 28 real	0.25%	0.33%	-0.44%	1.08%
Cetes 91 real	0.27%	0.33%	-0.43%	1.09%
Cetes 182 real	0.28%	0.33%	-0.41%	1.10%
Cetes 364 real	0.30%	0.32%	-0.40%	1.11%
August 2009-January 2019: post-panic (125 months)				
Spread 91	0.00013	0.00015	-0.00005	0.00158
Spread 182	0.00022	0.00012	-0.00014	0.00066
Spread 364	0.00034	0.00017	-0.00027	0.00084
Cetes 28	0.4%	0.1%	0.2%	0.7%
Cetes 91	0.4%	0.1%	0.2%	0.7%
Cetes 182	0.4%	0.1%	0.2%	0.7%
Cetes 364	0.4%	0.1%	0.2%	0.7%
Cetes 28 real	0.05%	0.37%	-1.21%	1.10%
Cetes 91 real	0.06%	0.37%	-1.17%	1.11%
Cetes 182 real	0.07%	0.37%	-1.15%	1.12%
Cetes 364 real	0.08%	0.37%	-1.14%	1.14%

Source: Own elaboration.

Forecasting $r_t^g\,(1)$ was required to estimate equation 5. We tested two specifications. One assumed perfect foresight and used actual future rates; the other used the forecast from a Box-Jenkins model. For the ARIMA model, the AC and PAC of the 28-day CETES rate series, $r_t^g\,(1)$, suggested using a differenced model with only a one-lag autoregressive term. This, in fact, produces white-noise residuals (Ljung-Box Q-test, 47.63; Prob > chi2(40) = 0.1899). Thus, the short-term real interest rate is highly predictable when using available

information, with only a one-month lag. These projections were used to build the variable in equation 4, which is carried over into equation 5. Figure 8 shows the calculated variables. Equation 2 gives these quantities the interpretation of risk premia (see Hall, Anderson, and Granger, 1992; Clements and Galvão, 2003). Figure 8 conveys that the risk premium in Mexican bonds is minimal (the dotted lines are near zero most of the time).

The considerable risk for pension funds lies in long-term trends that depend upon inflation and global real rates and the exchange rate, and these should be the focus of risk regulation.

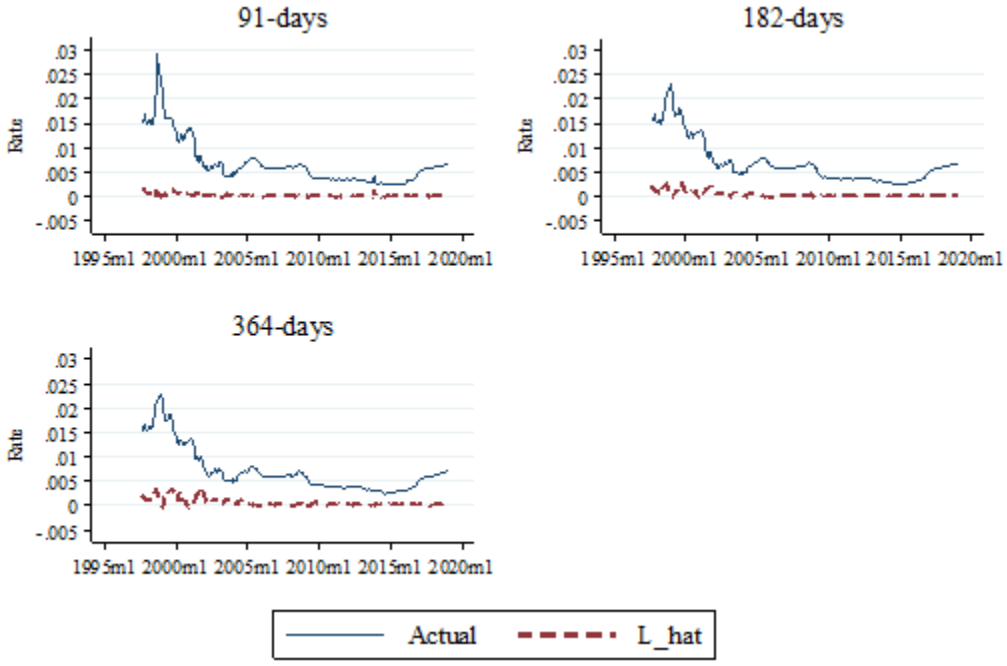


Figure 8. Monthly Cetes rates and risk premium (L_hat)
Source: Own elaboration.

4.2 Regression analysis: the impact of debt

We tested equation 5, which relates spreads in interest rates with short-term rates, using fixed effects models and a SUR model. The estimated equations include or exclude the variable of government debt.

For our first estimation, we used a SUR model that includes the nominal monthly return of each SIEFORE as the dependent variable and the constructed quantities $\hat{R}$ and $\hat{L}$ as regressors (Table 3). This model used data only for the five large corporations that have operated since 1997. The coefficients for $\hat{R}$ and $\widehat{L}$, which measure expected returns and risks, have the expected sign, but they were statistically significant for only one of the five corporations. This result means that regulations to encourage longer-term investments are not relevant for savers. There are, however, significant differences—between 0.30 and 0.63 for $\hat{R}$ and -0.21 to -0.57 for *widehat L*—across corporations. The risk premium predicted with the ARIMA model and the perfect-foresight model yielded different coefficients for the risk variable, but they were not statistically significant. The coefficient for the public debt variable has a negative impact and is statistically significant, at the 90% level, in two cases and at the 95% level in three cases.

A second estimation restricted the coefficients to be the same across firms and allowed for fixed effects (Table 4). These estimates include information on all firms. The coefficient for the 364-day Cetes forecasted rate was in the range estimated by the SUR model for $\hat{R}$ and was statistically significant. The value of

the coefficient for $\hat{R}$ changed when public debt was included in the regression, which suggests that omitting public debt generates bias. The coefficient for $\hat{L}$ changed signs depending upon the inclusion of the public debt variable, but it was not statistically significant. Thus, public debt and risk are related, and public debt reduces returns. We included a dummy, taking the value of unity after September 2008; the coefficient for this post-2008 crisis variable is significant. The regulatory change capping commissions at a percentage of assets took place in 2008, so the post-2008 dummy may have confounded the impacts of the post-crisis environment and regulatory reform. However, the effect is negative, in harmony with the fall in rates shown in Table 2, and contrary to the regulatory goal of improving returns.

To gauge the size of the estimated effects, we calculated the rates of return predicted at 90, 100, and 110% of the value of public debt. Table 5 shows our calculations for the SUR model, and Table 6 shows our results for the pooled model. We consider rates of return around 0.007 (0.7% per month) or yearly rates of 8.7%. In the combined model results, the difference in returns between the 90 and the 110% public debt scenarios was 0.0004873 (0.0070-0.0065) monthly, or 0.0063 (0.63%) per year. Since the mandatory fund assets were \$3,425.5 billion (by May of 2019), the yearly impact between the 90 and 110% scenarios is approximately \$21.6 billion (\$1.13 billion per year at an exchange rate of 19). Between the 90 and 100% debt scenarios, the differences are 0.0026 monthly, or 0.34% yearly, for an impact of \$11.68 billion (\$615 million).

Finally, the SUR and the fixed effect models showed systematic differences in the rate of return paid by different corporations, suggesting the lack of healthy competition in the system. The competition authority ruled in 2015 against a cartel to set limits to the transfer of accounts between providers. The agreement included at least three of the AFORE whose data were used in this research (COFECE, 2015).[2]

Table 3. SUR model of SIEFORE nominal returns

SIEFORE	Variable	Predicted	Perfect foresight
Banamex	364-day Cetes	0.37134	0.51738
	forecasted rate	-0.27762	-0.28889
	Premium in	-0.49398	-0.02045
	long-term	-0.29581	-0.35677
	public debt	-9.68E-07	-6.79E-07
	Public debt	(0.00000)*	0
	Constant	0.00813	0.00637
		(0.00296)**	(0.00321)*
Inbursa	364-day Cetes	0.63567	0.67046
	forecasted rate	(0.06772)**	(0.07260)**
	Premium in	-0.21437	-0.01223
	long-term	(0.07216)**	-0.08966
	public debt	-3.08E-07	-2.53E-07
	Public debt	(0.00000)**	(0.00000)*
	Constant	0.00264	0.00226
		(0.00072)**	(0.00081)**

[2]Breusch-Pagan tests in the SUR model and Hausman tests in the FE model suggest the use of a random ef-fects model. However, estimated coefficients are very similar in RE and FE models.

SIEFORE	Variable	Predicted	Perfect foresight
GNP Profuturo GNP	364-day Cetes forecasted rate	0.3873	0.49965
		-0.27819	-0.29323
	Premium in long-term	-0.57152	-0.15881
		-0.29642	-0.36213
	public debt Public debt	-6.73E-07	-4.66E-07
		(0.00000)**	0
	Constant	0.00699	0.00571
		(0.00296)*	-0.00326
XXI Banorte	364-day Cetes forecasted rate	0.30255	0.43639
		-0.24969	-0.26102
	Premium in long-term	-0.45261	0.03698
		-0.26606	-0.32235
	public debt Public debt	-1.00E-06	-7.61E-07
		(0.00000)**	0
	Constant	0.00854	0.00694
		(0.00266)**	(0.00290)*
Principal	364-day Cetes forecasted rate	0.42385	0.53242
		-0.25093	(0.26361)*
	Premium in long-term	-0.40641	-0.0126
		-0.26737	-0.32555
	public debt Public debt	-8.64E-07	-6.0000064
		(0.00000)*	0
	Constant	0.00696	0.00568
		(0.00267)**	-0.00293
N		255	246
Breusch-Pagan**		1774	1705

* p<0.05; ** p<0.01

Table 4. SIEFOREs returns as a function of expected short rates and risk.

	OLS	FE cluster	OLS	FE cluster	FE	FE cluster
364-day Cetes forecasted rate	0.68205	0.675018	0.509699	0.51081	0.531261	0.527233
	(0.026281)**	(0.027902)**	(0.027095)**	(0.027174)**	(0.038499)**	(0.025323)**
Premium in long-term	0.055903	0.051547	-0.037348	-0.036905	-0.033421	-0.031361
	(0.023268)*	-0.024332	(0.017321)*	-0.017297	-0.033001	-0.017398
public debt Public debt			-1.00E-06	-1.00E-06	-1.00E-06	-1.00E-06
			(0.000000)**	(0.000000)**	(0.000000)**	(0.000000)**
2008 panic						0.000776
						(0.000258)*
Constant	0.002836	0.002886	0.005645	0.005668	0.00539	0.005596
	(0.000366)**	(0.000197)**	(0.000490)**	(0.000378)**	(0.000519)**	(0.000372)**
N	2,126	2,126	2,126	2,126	1,230	2,126
R2 within	0.0441	0.0441	0.0498	0.0498	0.0571	0.0501
R2 between	0.576	0.5759	0.605	0.6052	.	0.6079
R2 overall	0.046	0.046	0.0519	0.0519	0.057	0.0521
RMSE	0.0134	0.0134	0.0134	0.0134	0.0131	0.0134
AFORE FE	NO	YES	NO	YES	YES	YES

* p<0.05 * p<0.01 Cluster: standard errors by SIEFORE.

Table 5. Estimated average impact on nominal SIEFORE return of public debt: at 90, 100 and 110% of actual values of debt.

	Times average of debt	**Margin**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
Banamex	0.9	0.0076	0.0010	7.84	0	0.0057	0.0095
	1	0.0073	0.0010	7.58	0	0.0054	0.0092
	1.1	0.0071	0.0010	7.13	0	0.0052	0.0091
Inbursa	0.9	0.0058	0.0002	23.66	0	0.0053	0.0063
	1	0.0057	0.0002	23.28	0	0.0052	0.0061
	1.1	0.0056	0.0003	22.28	0	0.0051	0.0061
Profuturo GNP	0.9	0.0074	0.0010	7.53	0	0.0055	0.0094
	1	0.0072	0.0010	7.35	0	0.0053	0.0092
	1.1	0.0071	0.0010	6.99	0	0.0051	0.0091
XXI Banorte	0.9	0.0074	0.0009	8.49	0	0.0057	0.0092
	1	0.0071	0.0009	8.16	0	0.0054	0.0089
	1.1	0.0069	0.0009	7.64	0	0.0051	0.0087
Principal	0.9	0.0071	0.0009	7.98	0	0.0053	0.0088
	1	0.0068	0.0009	7.69	0	0.0051	0.0085
	1.1	0.0066	0.0009	7.22	0	0.0048	0.0084

Table 6. Estimated average impact on nominal SIEFORE return of public debt: at 90, 100 and 110% of actual values of debt.

Times average	**Margin**	**Std. Err.**	**Z**	**P>|z|**	**[95% Conf. Interval]**	
0.9	0.0070847	0.0000248	285.21	0	0.007036	0.0071334
1	0.0068213	0.0000213	320.36	0	0.0067795	0.006863
1.1	0.0065974	0.0000605	109.04	0	0.0064788	0.0067159

5 Conclusions

For regulation, the main takeaways of our research are three. First, the weight of public debt on returns has reduced returns and creates a lose-lose situation. Worker-investors lose because returns are lower. The government also loses because minimum pen-sions are guaranteed, and stuffing pension funds with public debt results in higher future taxes and reduces the credibility of the system as a capitalized savings vehicle. Keeping a high percentage of government debt in the portfolios is a double hazard. It sustains the pay-as-you-go elements and makes the government pay redundant commissions to the SIEFOREs for managing debt. Second, risk regulation must focus on the domestic interest rate and foreign exchange risks. While the ancillary use of VaR can be maintained, it should not be considered the main element of risk regulation. Third, regulations on commissions must focus on the peso cost, not on the commission as a percentage of assets. The time se-ries of assets managed is non-stationary and will keep increasing above the growth of the economy for decades because the system is still new. The working population is also young and has above-replacement fertility rates. Thus, targeting lower commissions as a percent of assets is moot; lower values over time is a spurious signal of efficiency. Worker-investors must be informed of the peso cost of the commissions in the short- and long-run (i.e., the results in Figure 1 are informative while those in Figure 2 are spurious).

We did not examine two sources of variation in the results: the age of the individual and her labor force

participation pattern. Long-term trends in financial markets can alter the relative return of strategies. A relevant remaining question regards to what extent those cy-cles affect the expected value of pensions for different cohorts given that retirement age is somewhat inflexible due to regulatory and biological constraints. In Mexican labor markets, informality is prevalent, meaning that, for many, the value of pension savings is affected by individual decisions about the life cycle to work and whether to work in a job that does not involve paying social security taxes.

Finally, we must mention the reform to migrate from the "multi-fund" scheme to a "generational fund" scheme (CONSAR, 2020). Multi-funds were designed for the age of the worker, and individuals were moved to the corresponding fund. With generational funds, workers are assigned to a fund related to their date of birth and will remain at the same fund through life (except if they choose a change). The regulator estimates that this change will reduce commission costs and improve investment strategies enough to raise replacement rates between 2 and 4%. We do not think this reform alters the analysis or con-clusions of this research.

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