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Using Expected Geometric Values to Calculate the Cost of Interest in Hyper-inflationary Environments: the Case of Venezuela

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Abstract

It is of vital importance to explore the relationship between pensions and inflationary levels because this forms a link between social policy and economic development in the context of Venezuela's challenging economy and its impact on the development of pension systems. With such rampant inflation, companies must adjust the rates of salary increases to avoid a significant decrease in the purchasing power of income from defined benefit plans. Our research seeks to find the possibility of using an average geometric rate of future interest rates expressed as an expected value to discount obligations. Consequently, the cost of interest associated with the actuarial liability of the Benefit plans increases substantially in the next fiscal period to the actuarial valuation, sometimes compromising its sustainability over time. In order to minimize this problem, two scenarios for calculating the interest rate are proposed to smooth out this volatile effect; both are based on a geometric average with the expectation of working life or with the duration of the obligations. We are careful to use a reasonable interest rate that is not so high as to compromise the cash flow, resulting in skewed annual results of the companies. Our research seeks to find the possibility of using an average geometric rate of future interest rates expressed as an expected value to discount obligations. We formulate and actuarially evaluate two different scenarios, based on job expectations and Macaulay's duration, of the obligations that allow the sustainability of the plan in an environment of extremely high inflation. To illustrate the impact of the basic annual expenditure of the period, the results of an actuarial valuation of an actual Venezuelan company were utilized. Despite some companies adjusting their book reserves increasingly through a geometric progression, the amounts associated with the costs of interest would be huge in any such adjustment pattern. Therefore, we suggest adoption of one of the alternatives described in the research.

Keywords: Actuarial liabilities, Social security, Projected benefit, Macaulay duration

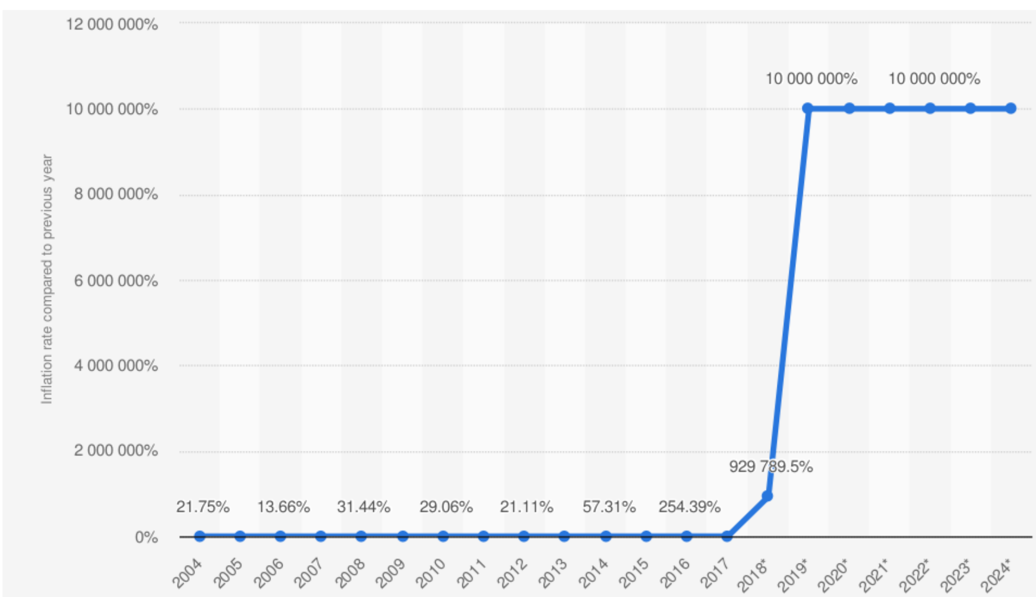
1. Introduction

Hyperinflation is a very high rate of inflation.[1] It is often caused by a government printing enormous amounts of new money to pay for its expenses. Subsequently, this out-of-control increase in prices causes the country's currency to rapidly decrease in value, resulting in shortages of necessary goods. Under this scenario, the citizens characteristically begin hoarding goods, creating a vicious circle in which they become even more expensive and scarce, money practically becomes worthless, and a domino effect of financial institutions going bankrupt begins, ultimately causing the collapse of the country's economy.

Despite being home to the world's largest oil reserves, Venezuela is facing a situation such as that described above. The average inflation rate in Venezuela amounted to about 493.6 percent in 2017. Since 2017, runaway inflation has hampered efforts to estimate the true rate of price increases in the country.

The economic catastrophe began with a combination of plummeting oil prices and government price controls, causing state-run oil companies to go broke. The government responded by printing new money, causing (non-oil) prices to rise rapidly, accompanied by an increase in unemployment rates, and a breakdown in Gross Domestic Product. Under today's scenario, many Venezuelans are emigrating to find employment and vital supplies, and the population of the South American country is at the lowest level in a decade. The trend of inflation has been exhibited more clearly in Figure 1.

Fig. 1: Venezuela: Inflation rate 2004- 2024 (compared to previous year)



Source: International Monetary Fund, Statistica, 2019

[1] IAS 29 states that an economy is hyperinflationary if (inter alia) "the cumulative inflation rate over three years is approaching, or exceeds, 100%" (IASB 2011, p. A938).

A hyperinflationary setting provides a unique environment with respect to pension plan projections. In an examination of the value relevance of inflation-adjusted (IA) and historical cost (HC) amounts in a hyperinflationary economy, Chamisa et al. (2018) use a unique dataset drawn from annual reports of firms listed on the Zimbabwe Stock Exchange from 2000 to 2005. They find that both sets of amounts are value relevant, but HC amounts are superior to IA amounts. In highly inflationary environments, companies must adjust the rates of salary increases to avoid a drastic fall in the purchasing power of income from defined benefit plans. Consequently, the cost of interest associated with the actuarial liability of the Benefit plans increases substantially in the next fiscal period to the actuarial valuation, sometimes compromising its sustainability over time. In order to minimize this problem, two scenarios for calculating the interest rate are proposed to smooth out this volatile effect; both are based on a geometric average with the expectation of working life or with the duration of the obligations. In Venezuela, pension plans and social benefits are suffering from this impact and we demonstrate the effectiveness of applying actuarial principles to two scenarios that are presented below.

Obviously, we need to use a reasonable interest rate that is not so high that it will compromise the cash flow, resulting in skewed annual results of the companies. Our research seeks to find the possibility of using an average geometric rate of future interest rates expressed as an expected value to discount obligations. We formulate and actuarially evaluate two different scenarios, based on job expectations and Macaulay's duration, of the obligations that allow the sustainability of the plan in an environment of extremely high inflation.

1.1 Determining the Proper Level of Interest Rates

In hyperinflationary environments such as found in Venezuela, actuarial liabilities derived from defined benefit plans such as social benefits, require substantially higher nominal salary increase rates. Although real rates are used in the order of (4% - 8%) of salary adjustment, according to Fisher, inflation generates nominal discount rates even higher than that of salary adjustments (Levi and Makin, 1979). This results in a high annual expense for the company's contribution for next year.

An equivalent interest rate understood as a function of the future and present value of the obligations, depending on the demographics of the plan, would still remain high unless the vast majority of the employees covered by the plan were young, and the turnover rates of staff were relatively low.

This raises the need to use a reasonable interest rate that is not so high so as not too compromise the cash flow and skew annual results of the companies. In this sense, this paper seeks to find the possibility of using an average geometric rate of future interest rates expressed as an expected value to discount obligations. According to the Actuarial Standards Board (2013), "The economic assumptions selected should reflect the actuary's knowledge as of the measurement date. However, the actuary may learn of an event occurring after the measurement date that would have changed the actuary's selection of an economic assumption. If appropriate, the actuary may reflect this change as of the measurement date."

This expected value is generally based on the future forecast of nominal interest rates that have an exponentially approximate decline in future years; (all of them adjusted or derived from the real discount rate used on wages). Another option would be to use Macaulay's duration of obligations, to minimize the impact mentioned above.

The objective of this research is to formulate and actuarially evaluate two scenarios, based on job expectations and Macaulay's duration, of the obligations that allow the sustainability of the plan in an environment of extremely high inflation. The General Accountability Office (2014) examined numerous countries that apply a variety of approaches to discounting. Canada requires determination of multiple measures of plan obligations, based on both assumed returns and high-quality bond rates and annuity prices. The Netherlands requires that plan obligations be measured based on market interest rates but allows the use of assumed returns for determining plan contributions or developing recovery plans. In the United Kingdom, discount rates are determined on a plan-specific basis and can include some allowance for assumed returns in excess of high-quality bond rates, depending on plan characteristics and the strength of the sponsor. The next section describes the mathematical formulation of the model, followed by a description and characteristics of the sample corporation used in the study. An actuarial assessment of the hypotheses follows, and sections on paper conclusions and recommendations round out the research.

1.2 Mathematical Formulation of the Model Under International Standard IAS-19 $(PBO)_{t+1}$

Under IAS19,[2] the method used to determine the actuarial liability commitment is that of the projected unit credit benefit (Project Benefit Unit Credit). The above raises the following between (t, t + 1).

$$PBO_{t+1} = PBO_t + CS_t + CI_t + B_{(t,t+1)} \pm G/P_{(t,t+1)}$$

Where:

PBO_t : Actuarial liabilities in t

CS_t : Cost of service in t

CI_t : Cost of interest in t

$B_{(t,t+1)}$: Benefits paid between (t, t + 1)

G/P: Actuarial gains / losses for the period (t, t + 1)

Experience indicates that the problem generated in hyper-inflationary environments is not at the level of the liability as such $(PBO)_{t+1}$ but of the expense that will be generated in the company's contribution. At the end of the period the actuarial liability (PBO) is conditioned to the ratio of the rates under a function of the type:

$$f(s,i) = \left[\frac{(1+s)}{(1+i)}\right]^t = \left(\frac{1}{(1+r)}\right)^t \text{ siendo } i = (1+s)(1+r) - 1$$

[2] IAS 19 or International Accounting Standard Nineteen rule concerning employee benefits under the IFRS rules set by the International Accounting Standards Board. In this case, "employee benefits" includes wages and salaries as well as pensions, life insurance, and other perquisites. The rules in IAS 19 explains the accounting for longer term employee benefits and post-employment plans such as defined benefit retirement plans.

The function compensates for high salary rates with those of nominal interest and in terms of liabilities the orders of magnitude are reasonable.

However, in nominal terms the interest and service cost component increase substantially for the period (t + 1) when adjusting the $(PBO)_t$ by the nominal rate of the year of the valuation.
Generally, future rates of increase in wages and interest exhibit a geometry in Table 1 under a scenario of gradual improvement of the economy. Then it is adjusted for the real discount rate.

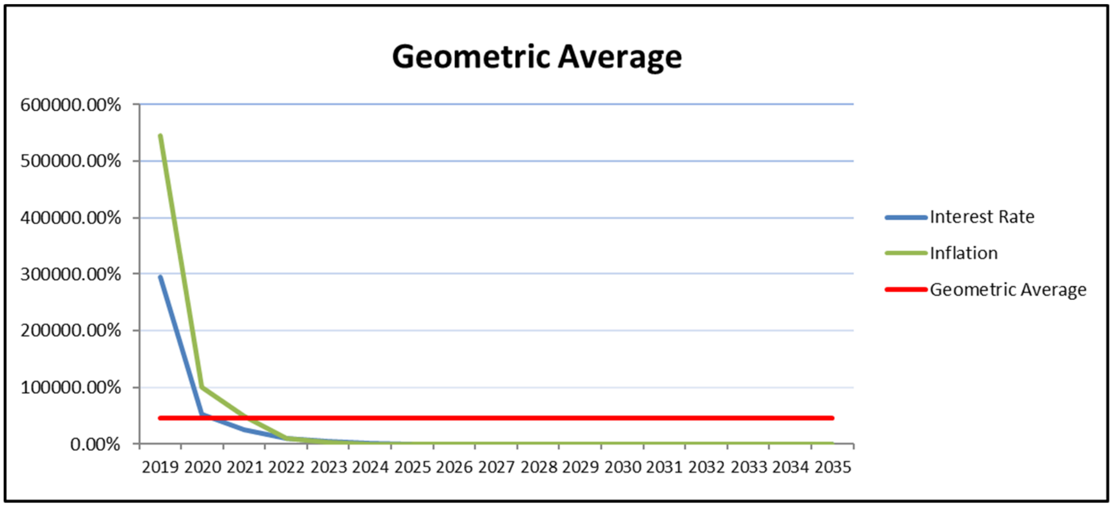
Table 1a: Future rates of increase in wages and interest

Year	Salary Rate	Interest Rate	Time	Geometric Average		Inflation
2019	283705.08%	295057.28%	1	2,951.572832	2,951.57	545579%
2020	50000.00%	52004.00%	2	521.040000	1,537,887.51	100000%
2021	25000.00%	26004.00%	3	261.040000	401,450,155.19	50000%
2022	10000.00%	10404.00%	4	105.040000	42,168,324,301.04	10000%
2023	5000.00%	5204.00%	5	53.040000	2,236,607,920,927.23	3000%
2024	1000.00%	1044.00%	6	11.440000	25,586,794,615,407.60	500%
2025	250.00%	264.00%	7	3.640000	93,135,932,400,083.60	100%
2026	50.00%	56.00%	8	1.560000	145,292,054,544,130.00	20%
2027	40.00%	45.60%	9	1.456000	211,545,231,416,254.00	20%
2028	25.00%	30.00%	10	1.300000	275,008,800,841,130.00	20%
2029	15.00%	19.60%	11	1.196000	328,910,525,805,991.00	20%
2030	15.00%	19.60%	12	1.196000	393,376,988,863,966.00	20%
2031	15.00%	19.60%	13	1.196000	470,478,878,681,303.00	20%
2032	15.00%	19.60%	14	1.196000	562,692,738,902,838.00	20%
2033	15.00%	19.60%	15	1.196000	672,980,515,727,795.00	20%
2034	15.00%	19.60%	16	1.196000	804,884,696,810,442.00	20%
2035	15.00%	19.60%	17	1.196000	962,642,097,385,289.00	20%
Geometric Average					Final Geometric Rate	45215%

Year	Interest Rate	Inflation	Geometric Average	Year	Interest Rate	Inflation	Geometric Average
2019	295057.28%	545579%	45215%	2028	30.00%	20%	45215%
2020	52004.00%	100000%	45215%	2029	19.60%	20%	45215%
2021	26004.00%	50000%	45215%	2030	19.60%	20%	45215%
2022	10404.00%	10000%	45215%	2031	19.60%	20%	45215%
2023	5204.00%	3000%	45215%	2032	19.60%	20%	45215%
2024	1044.00%	500%	45215%	2033	19.60%	20%	45215%

2025	264.00%	100%	45215%
2026	56.00%	20%	45215%
2027	45.60%	20%	45215%
2034	19.60%	20%	45215%
2035	19.60%	20%	45215%

Fig. 2: Interest rate, inflation and geometric average



It is clear in the graph that different scenarios of nominal interest rate declines will generate different geometric averages. (VE_1, VE_2, VE_3).

a) The alternative life expectancy could be useful in determining the terms of the decline in future nominal interest rates. Experience indicates that given the economic dynamics of the country, the projected salary increases granted by companies often end up being substantially smaller than those hypothesized. The latter is what generates an additional problem in that in most cases the contribution actually made by the company does not fit the one derived from the hypothesis; and consequently, adjustments must be made in the Cost of Service (CS) and Cost of Interest (CI) of the period.

If $_tPx$ represents the probability of surviving in employment since (x, x + t) and the maximum age allowed 70 years in some cases then the life expectancy would be

$$e_x = \sum_{t=1}^{n-1} {}_tPx$$

with n being the maximum age and e_x the working life expectancy of an employee of age x in t. Additionally, if the company has N employees, then the average expectation for the entire company will be given by:

$$\left(\sum_{t=1}^{N} e_{xi}\right) \left(N^{-1}\right) = \bar{e}_x$$

The expected geometric average of the estimated nominal interest rates for future years is determined as follows:

$$E_g(i) = \left[(1 + i_1)(1 + i_2) \ldots (1 + i_{\bar{e}_x}\right]^{(\bar{e}_x)^{-1}} - 1$$

Thus, instead of calculating the cost of interest using *i* we would instead be using (k%) E_g (i) as a proxy to what the company would actually grant as salary increase. Where k% is an adjustment factor to eventually recognize a fraction of the total geometric expected value k [0,1]; that is, it would represent that value that eventually moderates the actuarial gain or loss of the period. The desired goal is to minimize the actuarial gain or loss of the year. b) Macaulay duration. The other way to adjust this is to determine the Macaulay duration of the obligations and take an equivalent number of terms for the geometric expected value of the nominal interest rates.

The duration is calculated as follows:

PBO_t = f (t, i) Base Liability

PBO_t = f (t, i + 1%) Liabilities with i + 1%

PBO_t = f (t, i-1%) Liabilities with i-1%

D: Duration in years

$$D = \frac{PBO_{(t,i-1)} - PBO_{(t,t+1)}}{(\Delta i)PBO_t}$$

Sensitivity of the obligation to a change of +/- 1% so that the E_g (i) in this case would be calculated with:

$$E_g(i) = (\prod_{t=1}^{D}(1 + i_t))^{D^{-1}}$$

Depending on the demographics of the company, that is, the distributions associated with age, sex, years of service and integral salary, the value of the

$$D \lesseqgtr \bar{e}_x.$$

In general, in most cases the duration of the obligations is shorter in time than the average labor expectation, but it will depend, as stated earlier, on the demographic makeup of the company.

3. Methodology

3.1 Characteristics of Sample

To illustrate the impact of the basic annual expenditure (Cost of Service + Cost of Interest) of the period, the results of an actuarial valuation of an actual Venezuelan company were utilized. The variables used are:

a) The number of employees (N)

b) The average comprehensive salary (SI)

c) The average cumulative service (S)

d) Total social benefits payable (PS)

e) Actuarial liabilities (PBO)

f) Total annual expenditure (GAT)

- Cost of service (CS)

- Cost of interest (CI)

Characteristics of this company are as follows:

- This case involves a Venezuelan company in the financial sector with a total of 364 employees 119 (Female) and 245 (Male)[1]
- The current weighted average service in years of service is 7.50 years.
- The average integral salary for the entire population 1,101,579.43 Bs. (1,10 MMBs)[2]
- The average age is 41.58 years.

[1] All demographic data was supplied by the company on 9/30/2019

[2] That a geometric average of nominal interest was used in the order of 1539.81%

3.2 Results of the Actuarial Assessment as of 9/30/2019 actual assumptions and hypothesis of the year 2018 for the estimate of 2019

(2019 Hypothesis)

(a) Salary increase rate: 272,789.50%

(b) Real wage increase rate: 32,877%

(c) Actual rate used: 4%

(d) Hypothesis nominal discount rate. 283,705.0%

(e) Declining curve of the nominal interest rate for 2019 forecast in 2018.

(f) Average Rotation Rates by ages vary from 22.12% at 18 years of age to 0% at 61 and older.

(g) Mortality rates were modeled with a Group Annuity Mortality Table (GAM-83)

- PBO (Actuarial Liabilities) (MMBs): 2074.12
- P (Nominal Social) (MMBs): 3,434.56
- (Service Cost) (MMBs): 426.04
- (Cost of Interest) (MMBs): 2779.32

When comparing the starting PBO liability as of 9/30/2018 with that updated as of 9/30/2019, the following is observed:

→ (Represents the starting PBO 15.4 times given the assumptions.

	MMBs
Initial PBO	6.9
Interest cost	106.35
service cost	11.76
Paid Benefits	-32.18
Actuarial Gain/loss	1981.28

If the hypothesized nominal rate and validated by the company of 272,788.50% had been used, for the salary increase, the corresponding nominal discount rate would be 283,705.0% which would be equivalent to multiplying the initial liability PBO_t 2838.05%, that is to say:

	Hypothesis (Case I) Nominal Interest Rate (Full)	Geometric Average (Case II) Adjusted Geometric Average
PBO_t	6.90	6.90
$CI_{t,t+1}$	19.582,54	2000.00
PBO_{t+1}	2074,12	2074.12

In the first case the actuarial gains that would result from recognizing the nominal interest rate would be enormous and without much practical economic sense in a highly inflationary environment. On the contrary, the use of a geometric expected value would be closer to the reality of real increases in salaries granted by the company. The difference between 19,582.54 MMBs and 2074.12 MMBs would be a gross estimate of the actuarial gain derived from the use of the hypothesis. The actuarial gain would be greater than or equal to 17508.42 MMBs, which obviously is a huge amount compared to the actuarial liability at the end of the year PBO $_{(t+1)}$ which obviously would not make much economic sense to the company. Conversely, if the path of the geometric average is used, the actuarial gain, if it exists, would be in the order of 74.12, which is more consistent with the levels of PBO $_{(t+1)}$.

Obviously, there will always be an actuarial gain or loss since the average final salary increase that was actually granted is an ex-post variable that is only known at the end of the fiscal year with any estimate and/or forecast made at the beginning of the period. Generally, the beginning of the respective fiscal year will be the time frame for an estimate, which should be unbiased and of greater likelihood. However, in this unique environmental setting, inflation necessarily runs on the one hand and salary increases on the other.

In Venezuela and as a result of the experience of more than 200 companies from different industrial sectors, the levels of real wage increase are well below inflation, although they are still relatively high, especially in the last two years 2018-2019.

5. Conclusions

Based on the results of the valuation, the cost per interest and the associated part of the service cost that are the components of the annual expenditure are high. One could even categorize them as prohibitively high, which can seriously affect the ongoing operations of the company in terms of cash flow and/or results of operating earnings.

Despite some companies adjusting their book reserves increasingly through a geometric progression, in line with the generation of the companies' incomes and not uniformly at a monthly rate, the amounts associated with the costs of interest would be huge in any such adjustment pattern; therefore, we suggest adoption of one of the alternatives described above.

PG: Geometric Progression of contributions

CT: Total Annual Cost Contribution

Co: Initial contribution

Δ: Growth rate

$$\sum PG = CT\ annual$$

$$CT = C_o + C_o(1+\Delta) + C_o(1+\Delta)^2 + C_o(1+\Delta)^{12}$$

Fig. 3: UNIFORM AMORTIZATION

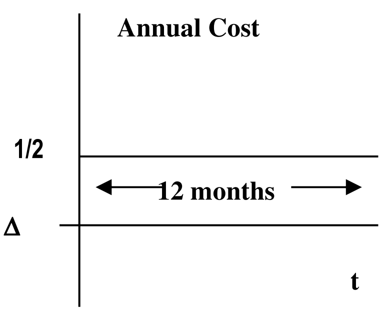
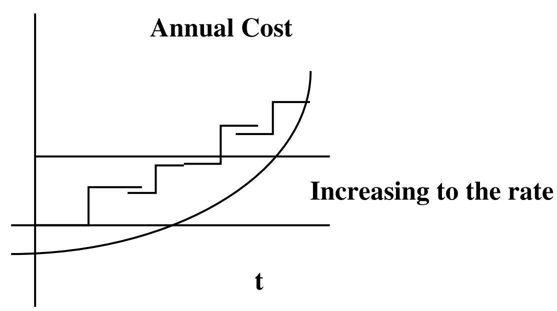


Fig. 4: INCREASING AMORTIZATION



6. Recommendations

Based on the foregoing calculations, we recommend that instead of using the nominal interest rate (i%), the geometric average of the nominal rates that are in the future evolution curve be used in a case either for the time of permanence and/or expectation of working life or for the duration of Macaulay's obligations.

Practice indicates that although companies initially assume relatively high rates in their primary estimates of salary increases given inflation forecasts end up adjusting downwards and grant a much lower wage increase than previously set. Adopting any of the two options of the geometric average would moderate the problem enormously and avoid a surplus in actuarial gain and a lower contribution by annual expenditure of the companies, thus optimizing the financial aspects of the plan avoiding "remeasurement" at any time to adjust the expense and their respective actuarial gains.

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